UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
501 West Ocean Blvd., Suite 4200
LONG BEACH, CALIFORNIA 90802

Refer to NMFS No.:
WCRO-2023-00324

December 26, 2024

Ms. Francis Coffey
Senior Executive Service
U.S. Army Corps of Engineers
Northwestern Division

Mr. Roland K. Springer
Deputy Regional Director
Bureau of Reclamation
1150 North Curtis Road
Boise, Idaho 83706

Michelle Cathcart
Vice President, Generation Asset Management
Bonneville Power Administration
905 Northeast 11th Avenue
Portland, Oregon 97232

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Continued Operation and Maintenance of the Willamette Valley System.

Dear Ms. Coffey, Mr. Springer, and Ms. Cathcart:

Thank you for your March 17, 2023, letter requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the continued operation and maintenance of the Willamette Valley System (WVS). NMFS recognizes the Corps has been designated as the lead action agency in this consultation and recognizes the Bonneville Power Administration and the Bureau of Reclamation are also action agencies based on their respective roles and interests in this consultation.

Thank you also for your request for essential fish habitat (EFH) consultation. NMFS reviewed the proposed action for potential effects on EFH pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. We have concluded that the action would adversely affect EFH designated under the Pacific Salmon Fishery Management Plan. EFH conservation recommendations are provided as part of this consultation.

NMFS examined the proposed action provided by the Corps in March 2023 and the revised proposed action submitted to NMFS in August 2024. Based on our analysis, NMFS determined the proposed action would jeopardize the continued existence of Upper Willamette River (UWR) Chinook salmon (*Oncorhynchus tshawytscha*) and UWR steelhead (*O. mykiss*) and would result in adverse modification of their designated critical habitat. NMFS also determined the proposed action is likely to adversely affect Lower Columbia River Chinook salmon, Upper Columbia spring-run Chinook salmon, Snake River spring/summer-run Chinook salmon, Snake River fall-run Chinook salmon, Columbia River chum salmon (*O. keta*), Lower Columbia River coho salmon (*O. kisutch*), Snake River sockeye salmon (*O. nerka*), Lower Columbia River steelhead, Middle Columbia River steelhead, Upper Columbia River steelhead, Snake River Basin steelhead, and Southern Resident killer whales (*Orcinus orca*) and their designated critical habitat. However, the proposed action is not likely to jeopardize the continued existence of these species or result in the destruction or adverse modification of their critical habitat. NMFS concurs that the proposed action is not likely to adversely affect the southern distinct population segment (DPS) of eulachon (*Thaleichthys pacificus*), the southern DPS of green sturgeon (*Acipenser medirostris*), or Central America and Mexico humpback whales (*Megaptera novaeangliae*), or their designated critical habitat.

Our Biological Opinion includes a Reasonable and Prudent Alternative (RPA) to the proposed action that NMFS believes, if implemented, will not jeopardize UWR Chinook salmon or UWR steelhead, or adversely modify those species' designated critical habitats.

Please contact Kate Wells, Assistant Regional Administrator of the Oregon Washington Coastal Office, at (503) 367-8047, or Kathleen.Wells@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Jennifer Quan
Regional Administrator
West Coast Region

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Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the

Continued Operation and Maintenance of the Willamette Valley System

NMFS Consultation Number: WCRO-2023-00324

Action Agencies: U.S. Army Corps of Engineers, Portland District
Bonneville Power Administration
U.S. Bureau of Reclamation

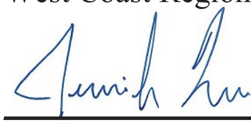
Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	If likely to adversely affect, Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	If likely to adversely affect, is Action Likely to Destroy or Adversely Modify Critical Habitat?
UWR Chinook salmon	Threatened	Yes	Yes	Yes	Yes
UWR Steelhead	Threatened	Yes	Yes	Yes	Yes
LCR Chinook salmon	Threatened	Yes	No	Yes	No
UCR Spring Chinook salmon	Endangered	Yes	No	Yes	No
SR Spring/Summer Chinook salmon	Threatened	Yes	No	Yes	No
SR Fall Chinook salmon	Threatened	Yes	No	Yes	No
CR Chum salmon	Threatened	Yes	No	Yes	No
LCR Coho salmon	Threatened	Yes	No	Yes	No
SR Sockeye salmon	Endangered	Yes	No	Yes	No
LCR Steelhead	Threatened	Yes	No	Yes	No
MCR Steelhead	Threatened	Yes	No	Yes	No
UCR Steelhead	Threatened	Yes	No	Yes	No
SR Steelhead	Threatened	Yes	No	Yes	No
Pacific Eulachon	Threatened	No	No	No	No
Green Sturgeon	Threatened	No	No	No	No
Southern Resident Killer Whales	Endangered	Yes	No	Yes	No
Central America DPS Humpback Whales	Endangered	No	No	No	No
Mexico DPS Humpback Whales	Threatened	No	No	No	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:



Jennifer Quan
Regional Administrator
West Coast Region

Date: December 26, 2024

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7dADM............... 7-day average daily maximum
AFF..................... Adult Fish Facilities
AI........................ Agricultural Irrigation
AM...................... Adaptive Management
BA....................... Biological Assessment
BCL.................... Detroit Big-Cliff
BCLO................. Below Detroit Big-Cliff
BiOp................... Biological Opinion
BPA.................... Bonneville Power Administration
CFR.................... Code of Federal Regulations
cfs....................... Cubic Feet Per Second
CGR................... Cougar Reservoir
CGRO................ Below Cougar Dam
COT.................... Cottage Grove Reservoir
CWA................... Clean Water Act
DDR................... Design Document Report
DET.................... Detroit Dam
DEX.................... Dexter Dam
DEXO................. Below Lookout Point-Dexter Dam
DIP..................... Demographically Independent Population
DO...................... Dissolved Oxygen
DPEIS................ Draft Programmatic EIS
DPS.................... Distinct Population Segment
DT....................... Diversion Tunnel
EDR.................... Engineering Design Report
E-flow................. Environmental Flow
EIS...................... Environmental Impact Statement
EPA.................... (U.S.) Environmental Protection Agency
ESA.................... Endangered Species Act
ESU.................... Evolutionarily Significant Unit
FAL..................... Fall River Creek Dam
FCA.................... Flood Control Act
FIRO……………Forecast Informed Reservoir Operations
FMWQT............. Flow Management and Water Quality Team
FOS.................... Foster Dam
ft/hr..................... feet per hour
FRM................... Flood Risk Management
FSC.................... Floating Surface Collector
FSS.................... Floating Screen Structure

FWWS................ Forebay Warm Water Supply Pipe
GPRO................ Below Green Peter
HCR.................. Hills Creek Reservoir
HCRO................ Below Hills Creek Reservoir
HD..................... House Document
HGMP................ Hatchery Genetic Management Plan
HTT................... Habitat Technical Team
LCRE.................. Lower Columbia River and Estuary
LOP................... Lookout Point Reservoir
MFR.................. Memoranda for the Record
MFW.................. Middle Fork Willamette
MOC.................. Memorandum of Coordination
MPG.................. Major Population Group
MW.................... Megawatt
NAA................... No Action Alternative
NEDC.................Northwest Environmental Defense Center
NEPA................. National Environmental Policy Act
NGVD................. National Geodetic Vertical Datum
NGO.................. Non-governmental Organization
NMFS................ National Marine Fisheries Service
NOAA................ National Oceanic and Atmospheric Administration
NRCS................ Natural Resources Conservation Service
NWFSC .... Northwest Fisheries Science Center
NWPCC..............Northwest Pacific Conservation Council
NWRFC............. Northwest River Forecast Center
NWS.................. National Weather Service
O&M.................. Operations and Maintenance
ODA.................. Oregon Department of Agriculture
ODEQ................ Oregon Department of Environmental Quality
ODFW................ Oregon Department of Fish and Wildlife
OMRR&R........... Operation, Maintenance, Repair, Replacement, and Rehabilitation
OWRD............... Oregon Water Resources Department
PBF................... Primary Biological Factors
PCE................... Primary Constituent Elements
PDO.................. Pacific Decadal Oscillation
DPEIS.................. Draft Programmatic Environmental Impact Statement
pHOS................ Precent Hatchery Origin Spawners
Reclamation....... Bureau of Reclamation
ResSim.............. Reservoir System Simulation
RM&E................ Research, Monitoring, and Evaluation

RMJOC.............. River Management Joint Operating Committee
RO...................... Regulating Outlet
ROD.................. Record of Decision
RPA.................... Reasonable and Prudent Alternative
SRKW................ Southern Resident Killer Whale
SRP.................... Sustainable Rivers Program
SSFO................. Below Foster Dam
SWS................... Selective Withdrawal Structure
TDG.................... Total Dissolved Gas
TMDL................. Total Maximum Daily Load
UCR................... Upper Columbia River
USACE............... United States Army Corps of Engineers
USFS.................. United States Forest Service
USFWS.............. United States Fish and Wildlife Service
USGS................. United States Geological Survey
UWR................... Upper Willamette River
WATER.............. Willamette Action Team for Ecosystem Restoration
WBR................... Willamette Basin Review
WDFW................ Washington Department of Fish and Wildlife
WFOP................ Willamette Fish Operations Plan
WFPOM .... Willamette Fish Passage Operations & Maintenance
WFMWQT...........Willamette Flow Management Water Quality Team
WRB................... Willamette River Basin
WRBBPP........... Willamette River Basin Bank Protection Program
WRDA................ Water Resources Development Act
WTC................... Water Temperature Control
WUA................... Wetted Usable Area
WVS................... Willamette Valley System

1 Introduction

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 402. We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR part 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the West Coast Region Office.

The Portland District, U.S. Army Corps of Engineers (USACE) has requested formal consultation under section 7(a)(2) of the ESA to address ESA-listed species and designated critical habitat under NMFS jurisdiction that are likely to be adversely affected by the proposed operation and maintenance of the Willamette Valley System (WVS). The WVS includes 13 multipurpose dams and reservoirs (impoundments), riverbank-protection projects, fish-passage facilities, adult-fish-collection facilities, and hatchery programs in the Willamette River Basin.

The USACE is the lead federal agency in this consultation because it operates and maintains the WVS for its congressionally authorized purposes; however, the Bonneville Power Administration and the Bureau of Reclamation are also action agencies based on their respective roles and interests in the ongoing operation of the WVS.

Summary of Authorized Purposes and Corps' Authorities

The Corps operates the WVS under several authorities, for multiple purposes. The Flood Control Act of June 28, 1938 (Pub. L. No. 75-761, 52 Stat 1215), authorized the initial construction of Lookout Point, Cottage Grove, Dorena, Fern Ridge, and Detroit dams for flood control and navigation. Detroit was also authorized for irrigation in H.R. Doc. No. 75-544 ("HD 544"). The Flood Control Act of 1948 (Pub. L. No. 80-858, 62 Stat. 1175) authorized hydropower at Detroit Dam and hydropower and reregulation at Big Cliff Dam. Shortly after the end of the second World War, the second largest city in Oregon, Vanport, was completely razed on May 31, 1948, by catastrophic flooding. This catalyzed the passing of the Flood Control Act of May 17, 1950 (Pub. L. No. 81-516, 64 Stat. 163). This act authorized the development of multipurpose and flood control projects across the entire Columbia basin. Specific to the Willamette River Basin, it authorized the addition of Hills Creek, Fall Creek, Cougar, Blue River, Dexter, and Green Peter dams to be constructed and operated "substantially in accordance with the plans recommended…in House Document Numbered 531 [H.R. Doc. 81-532 ("HD 531")]" which included:

- The flood control purpose at Blue River, Cougar, Fall Creek, Green Peter, and Hills
- Creek
- The fish and wildlife purpose at Blue River, Cougar, Detroit, Dorena, Fall Creek, Fern
- Ridge, Foster, Green Peter, Hills Creek, Lookout Point, and Cottage Grove
- The hydropower purpose at Cougar, Green Peter, Hills Creek, and Lookout Point, and
- the hydropower and reregulation purposes at Dexter
- The irrigation purpose at Blue River, Cougar, Dorena, Fall Creek Fern Ridge, Green
- Peter, Hills Creek, Lookout Point, and Cottage Grove
- The navigation purpose at Blue River, Cougar, Fall Creek, Green Peter, and Hills Creek
- The water quality purpose at Blue River, Cougar, Detroit, Dorena, Fall Creek, Fern
- Ridge, Foster, Green Peter, Hills Creek, Lookout Point, and Cottage Grove

Concurrently, Congress appropriated funds to resume construction of the remaining five structures authorized in 1938. The Flood Control Act of 1954 (Pub. L. No. 83-780, 68 Stat. 1264-65) modified the Flood Control Act of 1950 to include power development at Cougar and Green Peter reservoirs "substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 531." The final dam authorized by Congress, under the Flood Control Act of 1960 (Pub. L. No. 86-645, 74 Stat. 480), was Foster Dam, a reregulating dam for Green Peter with space for Flood Control. In 1969, construction of Blue River Dam in the McKenzie River basin was completed marking the end of the dam construction phase for the WVS.

The subsequent Flood Control Act of 1962 (Pub. L. No. 87-874, 76 Stat. 1173) added flood control as an authorized purpose at Fern Ridge. The Water Resources Development Act of 1986 (Pub. L. No. 99-662, 100 Stat. 4144) authorized the development of hydropower by a non-Federal interest at Blue River if the non-Federal interest obtained a license from the Federal Energy Regulatory Commission within three years. This never occurred.

In addition to the project specific authorizations described above, some authorizations apply generally, to all USACE reservoirs including the Flood Control Act of 1944 (Pub. L. No. 78-534, 58 (Pub. L. No. 78-534, 58 Stat. 887) which provides authority for recreation and the Water Supply Act of 1958 (Pub. L. No. 85-500, 72 Stat. 319) authorizing storage for municipal and industrial water supply.

1.1 Consultation History

Preceding the completion of this Opinion on the ongoing operation and maintenance of the WVS, several consultations were conducted that influence the baseline conditions described in this Opinion, and, to some extent, are related to the proposed action for this consultation. Those consultations are summarized below and are followed by the litigation history that prompted initiation of this consultation, and the history of development of this Opinion.

1.1.1 Related ESA Section 7 Consultations

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion, reasonable and prudent alternative, and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

2008 Willamette Valley System ESA-Consultation

In 2008, NMFS consulted with USACE on the operation and maintenance of the WVS, which resulted in NMFS' issuance of a Biological Opinion (NMFS 2008a). NMFS determined that the proposed action to continue operation and maintenance of the WVS, as described in the 2007 biological assessment (Usace 2007), would jeopardize the continued existence of UWR Chinook salmon and UWR steelhead and cause continued destruction and adverse modification of their habitats. Outside the Willamette Basin, NMFS concluded the proposed action would not jeopardize the remaining 11 interior and lower Columbia basin salmon and steelhead Evolutionarily Significant Units (ESUs), nor adversely modify or destroy their habitats . The basis for this conclusion was NMFS' finding that the proposed action would only cause limited to very small changes in flow in the mainstem lower Columbia, thereby resulting in slight to negligible effects on listed salmonids and their habitat. Finally, NMFS concurred with the action agencies' determination that the proposed action was not likely to adversely affect Southern Resident killer whales (SRKW) or the southern distinct population segment (DPS) of green sturgeon. After making a finding of jeopardy for UWR Chinook salmon and UWR steelhead, NMFS provided the action agencies with a suite of necessary modifications to the proposed action to avoid jeopardizing the two listed species in its Reasonable and Prudent Alternative (RPA). See the USACE biological assessment (BA) (USACE 2023a) and NMFS 2008 Opinion (NMFS 2008a) for details of the RPA, which are hereby incorporated by reference and summarized below. In summary, to avoid jeopardy the RPA recommended USACE implement safe and effective downstream fish passage, improvements at fish-handling facilities, temperature control, water-quality improvements, habitat restoration, and research/monitoring and evaluation activities.

Hatchery Genetic Management Plan ESA-consultation

ESA consultation on the WVS hatcheries was initiated in March 2000 when USACE and Bonneville Power Administration (BPA) requested consultation on the impacts of the artificial propagation programs for UWR Chinook salmon and UWR steelhead. On July 14, 2000, NMFS issued a Biological Opinion on the impacts from collection, rearing, and release of salmonids associated with artificial propagation programs on the Upper Willamette Chinook salmon ESU and Upper Willamette Steelhead DPS, which provided incidental take statements (ITS) to the action agencies for operation of the hatchery mitigation programs until September 30, 2003.

Subsequent to the 2000 consultation, the Services and action agencies merged consultations between the Willamette River Basin Project and the Hatcheries Project because of the overlapping actions. The revised proposed action integrated hatchery operations and recommendations for hatchery reform described by the Hatchery Genetic Management Plans (HGMPs) and incorporated measures consistent with NMFS' Hatchery Listing Policy. One 2008 RPA measure was to develop criteria and protocols for the spring Chinook salmon programs that incorporate natural-origin salmon into the hatchery broodstocks.

Allowing natural-origin Chinook salmon to be taken for broodstock requires a separate authorization under the ESA that was not included in the ITS of the 2008 opinion (NMFS 2008a). Authorization for the co-managers to take natural-origin salmon for broodstock can only be done under the ESA's 4(d) Rule's limit 5 for direct take of natural-origin salmon. This required the development of new HGMPs and Section 7 consultation (NMFS 2019a; ODFW and USACE 2016-2019).

The recently completed HGMPs, prepared jointly by Oregon Department of Fish and Wildlife (ODFW) and USACE, provide the most up-to-date description of hatchery fish production numbers for the USACE Willamette Hatchery Mitigation Program (NMFS 2019a). Hatchery performance goals are driven by standards and performance targets identified in the HGMPs for the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette River Basin (WRB).

Concurrent with the completion of the 2019 HGMP biological opinion, NMFS completed a section 4(d) determination for the ongoing WVS hatchery operations and found the actions under the HGMPs were consistent with the section 4(d) rule, contingent on the implementation of several requirements. NMFS also received a letter of concurrence (dated March 19, 2019) from United States Fish and Wildlife Service (USFWS) on its determination that the UWR Chinook salmon hatchery program may affect but is unlikely to adversely affect bull trout (*Salvelinus confluentus*).

NMFS' 2019 Biological Opinion on the HGMPs concluded that the proposed action is not likely to jeopardize the continued existence of Upper Willamette River spring Chinook salmon and UWR steelhead; Lower Columbia River Chinook salmon, coho salmon, and steelhead; Columbia River chum salmon; and Snake River spring/summer Chinook salmon in the Action Area or destroy or adversely modify any designated critical habitat for these species. NMFS specified Terms and Conditions for the proposed action that are necessary to minimize incidental take and continue to monitor and evaluate the programs in the future.

Willamette Basin Review

NMFS completed a section 7 consultation with USACE on the effects of the Willamette Basin Review (WBR) Feasibility Study (FS) on June 28, 2019. Bureau of Reclamation (BOR, Reclamation) was not an action agency for this consultation; therefore, the resultant RPA issued through the WBR consultation applies to USACE only, and the RPA in the 2008 WVS Opinion continues to apply to BOR's water marketing program. The BOR water marketing program requires additional ESA section 7 consultation in order for an expanded program to be covered for incidental take under section 7.

In the 2019 WBR consultation proposed action, USACE proposed to reallocate storage space in the Willamette Basin reservoirs to establish specific storage volumes to meet the projected future water supply needs of fish and wildlife (F&W), agricultural irrigation (AI), and municipal and industrial (M&I) users, while fulfilling other project purposes. USACE also proposed to initiate a water-marketing program upon completion of the reallocation to issue water storage contracts to M&I users and guidelines for managing stored-water releases according to a system of "proportionate reduction" when the conservation pool does not fill. NMFS determined the proposed action would jeopardize the continued existence of UWR Chinook salmon and UWR steelhead and adversely modify their designated critical habitat (NMFS 2019b). Based on this determination, NMFS provided an RPA to USACE that outlined the process by which storage volume decisions and the water marketing program could be implemented.

1.1.2 Litigation

In March 2018, Plaintiffs Northwest Environmental Defense Center (NEDC), WildEarth Guardians, and Native Fish Society filed a complaint in the U.S. District Court for the District of Oregon against USACE and NMFS alleging ongoing violations of sections 7 and 9 of the ESA due to USACE's failure to comply with the 2008 RPA (Northwest Environmental Defense Center, et al. v. United States Army Corps of Engineers, et al., No. 3:18-cv-00437-HZ, (D. Or. September 2021)). The Plaintiffs alleged that by failing to complete certain measures in the RPA, USACE's continued operation and maintenance of the WVS is jeopardizing ESA-listed UWR spring Chinook salmon and UWR steelhead, adversely modifying the species' designated critical habitat, and causing unlawful "take" of these species in excess of the limits set forth in the ITS in violation of the ESA. They further alleged that USACE must reinitiate and complete a new consultation with NMFS to ensure that it is satisfying its duties under the ESA to avoid jeopardy, adverse modification of critical habitat, and unlawful take of these listed species.

The action agencies requested reinitiation of formal consultation with NMFS under section 7 of the ESA in April 2018; however, a complete biological assessment did not accompany the letter, and therefore, NMFS was not able to initiate consultation at that time. In August 2020, the Court ruled in favor of Plaintiffs on all their claims concluding that USACE failed to timely reinitiate consultation with NMFS over the effects of the WVS on ESA-listed salmonids and failed to complete implementation of the RPA within the time periods specified in violation of sections 7 and 9 of the ESA. The Court then ordered remedy proceedings. On September 1, 2021, the Court issued an interim injunction in Northwest Environmental Defense Center et al. V. United States Army Corps of Engineers et al. 2021 (hereafter the Injunction), that requires USACE and NMFS to implement measures intended to improve fish passage and water quality in the WVS to avoid irreparable harm to ESA-listed salmonids during the interim period until the completion of the section 7 consultation.

The Injunction Order included sixteen operations that require changes to how one or more of the WVS dams are currently operated or were continuation of some operations USACE was already implementing and three structural modifications to existing projects. The Court assigned an "Expert Panel" to propose implementation plans for some of the injunction measures. The Panel included two NMFS experts, two USACE experts, two Plaintiffs' experts, and two other experts from other agencies as needed. After the Panel submitted its proposed implementation plans for the injunction measures to the Court, the Court subsequently amended the interim injunction to order implementation of those measures as recommended in the Expert Panel's implementation plans. The USACE proposed action states that they will continue implementing the injunction measures until the environmental impact statement (EIS) process concludes and a new biological opinion is issued. However, for any differences between injunction and new biological opinion actions, USACE will operate consistently with the new biological opinion until the EIS process concludes. Additionally, the anticipated filing related to implementation of this Opinion would direct the Corps to operate consistent with the Biological Opinion/ Reasonable and Prudent Alternative (BiOp/RPA) until the record of decision (ROD) issues.

In addition to these Court-ordered operations, the Court ordered USACE to design, construct, and operate three structural improvement projects, in an expedited manner. These three structural projects have, or are currently undergoing, separate NEPA and Section 7 ESA consultation processes to address the direct, indirect, and cumulative effects of site-specific construction on the human environment and ESA-listed species.

1.1.3 2024 Willamette Valley System ESA Section 7 Consultation

Soon after the court's order was filed, USACE established a rigorous series of interagency meetings to engage all levels of staff and leadership throughout the consultation process. The agencies in attendance included USACE, BOR, BPA, and the U.S. Fish and Wildlife Service (FWS). Deputy-level meetings were, and continue to be, held approximately every other week, and executive level meetings were, and continue to be, held once per month. Additionally, special ad-hoc meetings with these agencies were held when necessary to address specific topics as needed. Staff-level meetings were regularly held as well; at least once per month, the action agencies met with the resource agencies during development of the biological assessment (BA), and those meetings continued, however less frequently, during biological opinion development. Section 7 consultation was initiated on May 31, 2023, and the final biological opinion is due to USACE by December 31, 2024, per the court's order. The sequence of events leading up to the conclusion of this consultation are listed in order below.

- The USACE submitted a draft BA to NMFS on November 18, 2022.
- January 4, 2023, NMFS provided comments on the draft BA.
- March 17, 2023, USACE submitted their final BA to NMFS and FWS.
- April 19, 2023, NMFS responded to USACE's final BA submission with a non-concurrence and insufficiency letter. NMFS did not concur with USACE's determination that the proposed action would not adversely affect Southern Resident killer whales. Additionally, the letter included several information requests related to model results and existing data.
- May 13, 2023, NMFS responded to the USACE transmission of some of the requested supplemental information indicating that NMFS would move forward with the consultation with the information provided by USACE.
- July 28, 2023, the BOR submitted a letter to NMFS clarifying their proposed action included in the USACE BA.

- November 17, 2023, NMFS responded to BOR's proposed action clarification with the agency's understanding of what would be covered under this section 7 consultation, i.e., the existing irrigation contract water marketing program, which includes BOR's issuance of new contracts and maintaining existing ones such that the total water marketing program would not exceed 95,000 acre-feet.
- During June and July 2024, NMFS met with USACE multiple times.
- USACE provided numerous data sets and model results to help supplement the biological opinion analysis.
- USACE provided an updated version of the action agency's proposed action to NMFS on July 26, 2024. This version contained various corrections and clarifications but was substantially unchanged from the original.
- NMFS transmitted the draft Reasonable and Prudent Alternative (RPA) to the action agencies and FWS on September 3, 2024.
- USACE provided initial comments on the draft RPA on September 16, 2024 and more detailed comments on the draft RPA on October 1, 2024.
- NMFS met with USACE in-person and virtually for half-day workshops to discuss various elements of the draft RPA Tuesday September 17, 18, and 19, 2024.
- BPA transmitted comments on the habitat restoration RPAs on October 11, 2024.
- October 11, 2024, NMFS transmitted the draft incidental take statement (ITS) to the action agencies and FWS.
- NMFS presented the draft ITS to the action agencies and FWS during an October 17, 2024, interagency workshop hosted by USACE.
- USACE provided written comments on the ITS on October 24, 2024.
- NMFS transmitted a draft jeopardy biological opinion to the action agencies on November 15, 2024.
- USACE and BPA provided comments on the draft biological opinion on December 6, 2024. BOR provided comments on December 8, 2024.

1.1.4 Consultation with Tribes

On July 30, 2024, NMFS notified the following tribes and tribal associations that may have an interest in the proposed action of its ESA consultation regarding the WVS:

- Confederated Tribes of the Warm Springs Reservation (CTWS)
- Confederated Tribes and Bands of the Yakama Nation (Yakama)
- Confederated Tribes of the Grand Ronde Community of Oregon (CTGR)
- Confederated Tribes of Siletz Indians of Oregon (CTSI)
- Confederated Tribes of the Umatilla Indian Reservation (CTUIR)
- Nez Perce Indian Tribe

Copies of these letters were also sent to designated contact personnel in their respective tribe's natural resources or fisheries programs. The letters summarized the purpose of this consultation and solicited information, traditional knowledge, or comments the tribes and associations might provide to help in the consultation.

Throughout the consultation process, NMFS technical staff met regularly with CTGR staff to discuss matters important to the Tribe and NMFS regarding management of the WVS. Additionally, CTGR requested a government-to-government meeting with NMFS, which was held Friday, May 10, 2024. During this meeting, the CTGR conveyed their support for operational fish passage measures and urged NMFS to compel USACE to implement safe and effective fish passage as soon as possible.

1.2 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for the species addressed in this opinion use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion, we use the terms "effects" and "consequences" interchangeably. We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the environmental baseline of the species and critical habitat
- Evaluate the range wide status of the species and critical habitat expected to be adversely affected by the proposed action
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach
- Evaluate cumulative effects
- In the integration and synthesis, 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, analyze whether the proposed action is likely to: 1) directly or indirectly reduce

appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species; or 2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (see 50 CFR 402.02). The Corps submitted a slightly revised proposed action to NMFS in August 2024. The revisions were clarifications and did not change the substance of the activities proposed by the Action Agencies. The proposed action as submitted by the Corps appears below.

2.1 Willamette Valley Project Description

Congress authorized USACE to construct, operate, and maintain the WVS for flood control (commonly referred to as flood risk management (FRM)) purposes beginning in 1938. The projects and purposes of the WVS were authorized by Congress in different Flood Control Acts (FCA) from 1938 and 1962, the Water Supply Act of 1958, and the Water Resources Development Act of 1986. Under these acts, USACE constructed 13 dams and numerous bank protection revetments along the Willamette River and its tributaries for flood control, irrigation, navigation, hydropower, water quality, fish and wildlife, water supply, and recreation. The FCA of 1950 often referred to as House Document (HD) 531 (House Document 81-531 (1950)), contained the overall guiding legislation for the operations of the WVS.

Figure 2.1-1 shows the geographic extent and location of the WVS project including the 13 Dams, 5 fish hatcheries, 4 adult fish collection facilities.

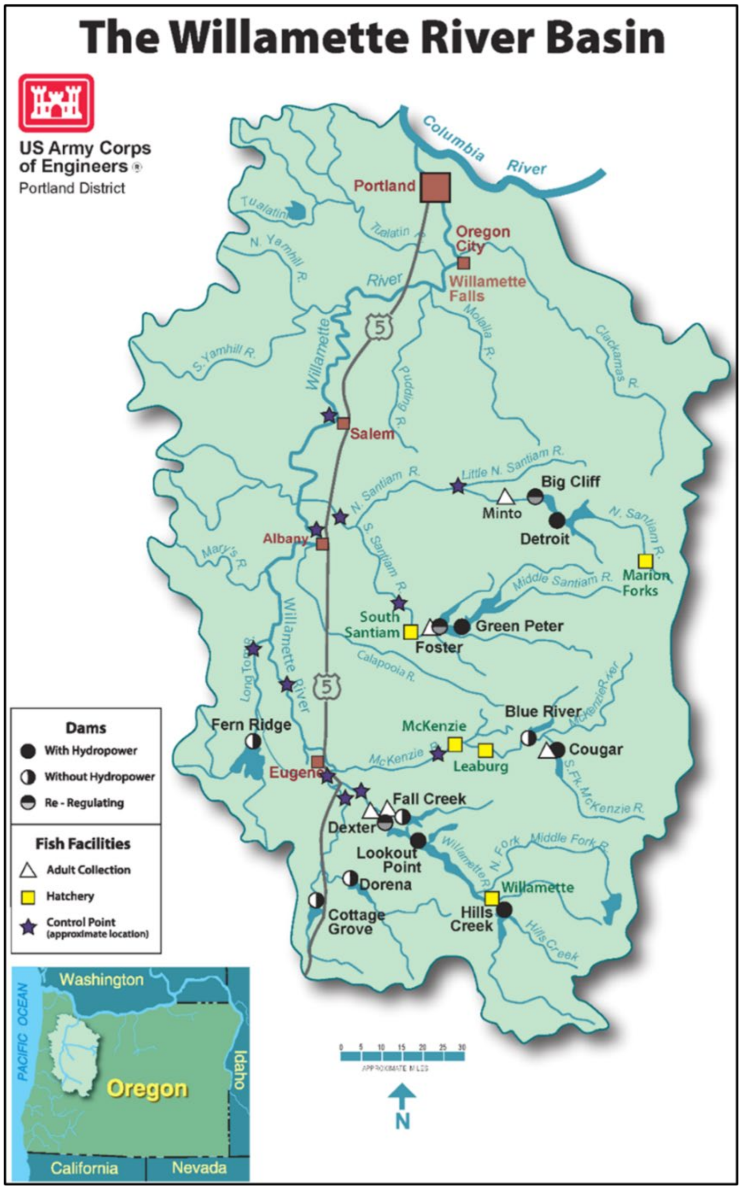

Figure 2.1-1. USACE-Managed Facilities in the Willamette River Basin

2.1.1 Synopsys of Project Authorizations

The Flood Control Act of June 28, 1938 (Pub. L. No. 75-761, 52 Stat 1215), authorized the initial construction of Lookout Point, Cottage Grove, Dorena, Fern Ridge, and Detroit dams for flood control and navigation. Detroit was also authorized for irrigation in H.R. Doc. No. 75-544 ("HD 544"). The Flood Control Act of 1948 (Pub. L. No. 80-858, 62 Stat. 1175) authorized hydropower at Detroit Dam and hydropower and reregulation at Big Cliff Dam.

Shortly after the end of the second World War, the second largest city in Oregon, Vanport, was completely razed on May 31, 1948, by catastrophic flooding. This catalyzed the passing of the Flood Control Act of May 17, 1950 (Pub. L. No. 81-516, 64 Stat. 163). This act authorized the development of multipurpose and flood control projects across the entire Columbia basin. Specific to the Willamette River Basin, it authorized the addition of Hills Creek, Fall Creek, Cougar, Blue River, Dexter, and Green Peter dams to be constructed and operated "substantially in accordance with the plans recommended…in House Document Numbered 531 [H.R. Doc. 81-532 ("HD 531")]" which included:

- The flood control purpose at Blue River, Cougar, Fall Creek, Green Peter, and Hills Creek
- The fish and wildlife purpose at Blue River, Cougar, Detroit, Dorena, Fall Creek, Fern Ridge, Foster, Green Peter, Hills Creek, Lookout Point, and Cottage Grove
- The hydropower purpose at Cougar, Green Peter, Hills Creek, and Lookout Point, and the hydropower and reregulation purposes at Dexter
- The irrigation purpose at Blue River, Cougar, Dorena, Fall Creek Fern Ridge, Green Peter, Hills Creek, Lookout Point, and Cottage Grove
- The navigation purpose at Blue River, Cougar, Fall Creek, Green Peter, and Hills Creek
- The water quality purpose at Blue River, Cougar, Detroit, Dorena, Fall Creek, Fern Ridge, Foster, Green Peter, Hills Creek, Lookout Point, and Cottage Grove

Concurrently, Congress appropriated funds to resume construction of the remaining five structures authorized in 1938. The Flood Control Act of 1954 (Pub. L. No. 83-780, 68 Stat. 1264-65) modified the Flood Control Act of 1950 to include power development at Cougar and Green Peter reservoirs "substantially in accordance with the recommendations of the Chief of Engineers in House Document Numbered 531." The final dam authorized by Congress, under the Flood Control Act of 1960 (Pub. L. No. 86-645, 74 Stat. 480), was Foster Dam, a re-regulating dam for Green Peter with space for Flood Control. In 1969, construction of Blue River Dam in the McKenzie River basin was completed marking the end of the dam construction phase for the Willamette Valley System.

The subsequent Flood Control Act of 1962 (Pub. L. No. 87-874, 76 Stat. 1173) added flood control as an authorized purpose at Fern Ridge. The Water Resources Development Act of 1986 (Pub. L. No. 99-662, 100 Stat. 4144) authorized the development of hydropower by a non-Federal interest at Blue River if the non-Federal interest obtained a license from the Federal Energy Regulatory Commission within three years. This never occurred.

In addition to the project specific authorizations described above, some authorizations apply generally to all USACE reservoirs including the Flood Control Act of 1944 (Pub. L. No. 78-534, 58 (Pub. L. No. 78-534, 58 Stat. 887) which provides authority for recreation and the Water Supply Act of 1958 (Pub. L. No. 85-500, 72 Stat. 319) authorizing storage for municipal and industrial water supply.

2.1.2 Project Purposes

The following Sections provide a brief description of the congressionally authorized project purposes. Table 2.1-1 details the specific purposes of each WVS project dam.

Flood Risk Management

The Corps operates and maintains this system of dams to meet all authorized purposes at each dam Table 2.1-2, with a primary operational focus of reducing flood risk levels, also known as flood risk management (FRM), for communities throughout the Willamette River Basin downstream to the City of Portland, Oregon. The dams are operated as a system providing FRM on six major tributaries affecting approximately 27 percent of the watershed area upstream of Portland, Oregon. Previous estimates of the average annual value of damages prevented by FRM operation in the WVS was $900 million (USACE 2019a). More recent estimates of damages prevented are over a billion dollars annually.

To efficiently execute its FRM mission, USACE coordinates with multiple agencies:

- National Oceanic and Atmospheric Administration's (NOAA's) Northwest River Forecast Center (NWRFC) is responsible for flood forecasting and is co-located with the National Weather Service (NWS), which is responsible for both meteorological forecasting and the issuance of flood warnings. These two offices coordinate closely with USACE's Portland District for dissemination of river information and forecasts.
- The Natural Resources Conservation Service (NRCS) is responsible for obtaining hydrologic data. The NRCS Snow Survey monitors snow water content and cumulative precipitation at many stations in the WRB. Both the NRCS and NWS develop volume runoff forecasts in the spring of each year based on data provided by these field stations. These data are essential for planning for the best use of available water to meet the multiple purposes of the WVS.
- The U.S. Geological Survey (USGS) in Portland, with field assistance from their Eugene office, has the responsibility of collecting, calibrating, and publishing streamflow and water quality data in the WRB.

The variable nature of weather and hydrology make long-term forecasting unreliable in the Willamette Valley System. USACE and NOAA are working together to investigate technologies to improve reliable forecasting abilities beyond just a few days. While these tools could help improve management decisions, increasing variability in regional weather patterns due to climate change will continue to make FRM a challenging, albeit lifesaving, task.

Irrigation

Agricultural irrigation (AI) was anticipated to be a significant use of water stored in the project reservoirs when the WVS was first authorized by Congress. Reclamation administers water service contracts for irrigators on behalf of the federal government, within 15 water service contract reaches. Irrigation use from the WVS reservoirs in the basin has not increased as initially projected and is not expected to increase in the near future at levels near the scope and scale originally envisioned.

On behalf of the federal government, Reclamation obtained two water rights certificates (No. 72755 in 1954 and 72756 in 1968) from the state of Oregon for the entire volume of joint-use, conservation storage in eleven reservoirs in the WVS. These two storage certificates permit storage of unappropriated waters of the State of Oregon, subject to existing rights, in accordance with state law. The amount of water to be stored is exclusive of dead storage and storage solely for purposes other than irrigation, for a maximum of 1,640,100 acre-feet for the eleven reservoirs. The certificates also note the amount of water stored for irrigation will be variable as determined by the Corps of Engineers operations plans in accordance with federal statutes.

USACE and the Oregon Water Resources Department (OWRD) completed the Willamette Basin Review (WBR) Feasibility Study to examine current and projected water needs and demands in the basin for fish and wildlife, municipal & industrial (M&I) water supply, and irrigation. The WBR Feasibility Study Chief's Report was signed in December 2019 and recommended reallocating the joint-use conservation pools to three purposes: fish and wildlife, irrigation, and M&I water supply.

In Section 401(6) of the Water Resources and Development Act of 2020, Congress authorized the reallocation of the conservation storage space in the WVS reservoirs as recommended in the Chief's Report. The system-wide conservation pool storage was divided as shown in Table 2.1-2, with 327,650 acre-feet allocated for irrigation and the remaining allocated for fish and wildlife, and M&I water supply.

Table 2.1-1. Authorized Purposes of the WVS Dams and Reservoirs

Authorized Purpose	Detroit	Big Cliff	Green Peter	Foster	Cougar	Blue River	Hills Creek	Lookout Point	Dexter	Fall Creek	Dorena	Cottage Grove	Fern Ridge
Flood Control	✔		✔	✔	✔	✔	✔	✔	–	✔	✔	✔	✔
Irrigation	✔	–	✔	✔	✔	✔	✔	✔	–	✔	✔	✔	✔
Navigation	✔	–	✔	✔	✔	✔	✔	✔	–	✔	✔	✔	✔
Hydropower	✔	✔	✔	✔	✔	✔	✔	✔	✔				
Fish and Wildlife	✔	–	✔	✔	✔	✔	✔	✔	–	✔	✔	✔	✔
Water Quality	✔	–	✔	✔	✔	✔	✔	✔	–	✔	✔	✔	✔
Recreation	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Water Supply	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Note: Although hydropower is an authorized purpose of Blue River Dam and Reservoir, hydropower facilities have not been developed there.

Table 2.1-1. Volume of Storage by Purpose for All WVS Dams.

Purpose	Combined Storage Space
Fish and Wildlife	1,102,600
Agricultural Irrigation	327,650
M&I Water Supply	159,750

Note: Storage space in acre feet (ac-ft)

While 327,650 acre-feet of storage describes the maximum scale of Reclamation's water marketing program under the current allocations, historical demand for irrigation has been lower than the total allocation. Reclamation has issued water service contracts for 84,349 acre-feet of water from the WVS (June 2024); though the exact value varies from year to year as contracts are executed or expire.

Municipal and Industrial Water Supply

The need for M&I water supply storage was found to be relatively low at the time that the storage capacity of the reservoirs was planned. To date, the M&I systems that have been developed rely on natural flow and groundwater in the WRB. However, population growth is leading to a demand for water that exceeds supplies for many existing M&I systems throughout the basin. This need was one of the factors that led to the WBR Feasibility Study project, which resulted in the reallocation of 159,750 acre-feet from conservation storage to M&I water supply. The first request for a M&I water supply agreement was submitted by EWEB in August 2022, for 437 acre-feet from the Coast Fork projects. Reclamation underwent the transfer proceedings in 2022 to change the character of use of 437AF from irrigation to M&I, and now holds water right certificate No. 96441 to support this M&I agreement. This request is still pending approval.

Navigation

Navigation is an authorized purpose at most projects in the WVS. The original authorized plan for the WVS as described in HD 544 called for open-river navigation improvement above Willamette Falls, in part, by increasing the low-water flow by releases from upstream storage reservoirs. HD531 recognized low channel depths due to increased withdrawal of streamflow as an impediment to navigation upstream of Willamette Falls but identified that storing excess spring runoff and then releasing this stored water during the low flow season would provide adequate channel depth from Corvallis through the Willamette Falls. The authorizing legislation stipulates a minimum flow of 5,000 cubic feet per second (cfs) between Albany and the Santiam River, and 6,500 cfs downstream to Salem to provide navigation depths of 6 feet and 5 feet, respectively.

The upper river above Willamette Falls Locks is no longer utilized by commercial navigation. However, HD531 noted that the flows released for navigation on the mainstem Willamette River, would also reduce the pollution concentrations in the river, providing for improved water quality and fish life. Flows that support downstream navigation and fulfill the navigation purpose also support the water quality purpose.

Hydropower

Federal hydroelectric power facilities are installed at eight of the thirteen USACE projects in the WRB. The electrical energy generated at these projects is marketed by the BPA throughout the Pacific Northwest and Pacific Southwest. There are two main types of federal hydropower projects in the WVS: storage projects that receive unregulated inflow and reregulation projects that receive and moderate dynamic flows from upstream dams. Generation from the storage projects is often based upon daily, weekly, and seasonal fluctuations in power demand ("load") and flows downstream are, therefore, subject to fluctuations that require reregulation.

The reregulation reservoirs are used to absorb the fluctuations in flows from their upstream storage projects and ensure that downstream river flows are more uniform for protection of aquatic habitat and human life, and bank stability. Power generation at the combination reregulation projects is uniformly consistent throughout the day. Lookout Point, Detroit, and Green Peter are storage projects whose outflows are reregulated by dams located downstream: Dexter, Big Cliff, and Foster, respectively. The Hills Creek and Cougar storage projects do not have reregulation dams located downstream but do generate hydropower. Dorena Dam has a private hydropower facility regulated by FERC, and the power generated is not part of the BPA system.

Power generation at the Willamette projects depends on releases for other project purposes such as flood control. However, some flexibility exists within the operating criteria in the selection of the outlet that the water volume flows through. USACE coordinates closely with BPA on when to generate electricity and at what level throughout the day. Projects with hydropower facilities include storage space for power generation but the quantity of storage is relatively small. In general, power storage is kept full to increase the hydraulic head for power generation; however, drawdowns into the power storage may occur for power purposes and have occurred on an ad hoc basis when inflow is too low to meet minimum flows beneficial to ESA-listed species.

Most recently, drawdowns into and below power storage pools have occurred for fish passage and water quality operations as required by the injunction issued by the District Court for the District of Oregon in *Northwest Environmental Defense Center, et al. v. United States Army Corps of Engineers, et al.*

Fish and Wildlife

The WVS operates and maintains structures in a manner that supports fish and wildlife as one of the authorized project purposes throughout the 13 projects within the WVS. The Fish and Wildlife purpose authorizes USACE to operate, study, and mitigate for impacts from inundation of fish and wildlife habitat, blocked fish passage, and some water quality impacts on fish species. It also includes authority for hatchery and propagation. Projects provide opportunities for sport fishing and wildlife hunting, improving habitat, and preserving wildlife. USACE manages for this purpose by implementing actions to restore ecological function, promoting species biodiversity, and monitoring sensitive species among others. This includes changes to the physical configuration of the project and to operations to conserve and enhance fish and wildlife resources. The WVS operations aim to support habitat within the reservoirs and to augment stream flows downstream of dams during dry months to improve conditions and provide habitat. Reallocation of the projects' conservation storage was recently completed during the WBR Feasibility Study project. Under the WBR Feasibility Study project, 1,102,600 acre-feet of conservation storage was allocated for fish and wildlife purposes for the benefit of instream flows downstream of the projects.

Recreation

Recreation facilities are provided at all USACE Reservoirs and along most of the downstream reaches. USACE coordinates with the United States Forest Service (USFS), Oregon State Parks, ODFW, and Linn and Lane counties to build and manage a system of water-related recreation facilities. Activities available at each reservoir vary, but may include camping, picnicking, boating, water skiing, fishing, swimming, hunting, hiking, biking, equestrian use, and wildlife viewing. Tourism resulting from recreation use at USACE lakes and downstream reaches plays an important role in maintaining the economic viability of many Willamette Valley communities. Tourist dollars spent on gas, food, lodging, equipment, and support services all contribute to the diversification of the region's economy.

The seasonality of recreational use at the projects is also an important operational consideration. Annual visitation typically builds slowly beginning in April and into May. Much of the project visitation during springtime can be directly attributed to the opening of fishing seasons. Typically, the lakes receive a large surge in use during Memorial Day weekend. Visitor use will build rapidly through June and July and remain high through Labor Day. During the summer, many reservoirs are held as high as possible for multiple conservation purposes and to support recreation use. In September, visitation begins to decline regardless of reservoir operations. About 60 percent of average annual visitation occurs during the three peak summer months.

USACE managed facilities in the Willamette Valley saw an average of 1.5 million visitors per year from 2019 to 2022. The projects with the most use tend to be project reservoirs near metropolitan areas that have relatively stable pool levels during the summer. Most notable of these are Cottage Grove, Dorena, Fern Ridge, Foster, Dexter, and Detroit lakes. Cougar, Blue River, and Hills Creek have the lowest levels of recreation, likely due to their geographic isolation and relative lack of facilities for recreation.

Recreation seasons have recently been impacted by fish passage and water quality operations as required by the injunction issued by the District Court for the District of Oregon in *Northwest Environmental Defense Center, et al. v. United States Army Corps of Engineers, et al.*

2.1.3 Project Dams

The Willamette Valley System includes 13 project dams that are operated as a system. These dams are described individually below, grouped by sub-basin, from upstream to downstream. Table 2.1-3 lists the pertinent project data for each dam and reservoir in the WVS.

Table 2.1-2. Willamette Valley Basin Projects with Reservoir and Outlets Works Statistics

Statistic	HCR	LOP	DEX	FAL	COT	DOR	FRN	CGR	BLU	GPR	FOS	DET	BCL
Normal Evacuation Rate (cfs)[1,3]	6,000	12,000	12,000	3,800	2,500	4,000	3,000	5,000	3,000	10,000	15,000	10,000	10,000
Maximum Evacuation Rate (cfs)[1,3]	8,000	15,000	15,000	4,500	3,000	5,000	4,000	6,500	3,700	13,000	18,000	17,000	17,000
Max. Conservation Pool Elevation[2]	1541.0	926.0	695.0	830.0	790.0	832.0	373.5	1690.0	1350.0	1010.0	637.0	1563.5	1206.0
Spillway Crest Elevation[2]	1495.5	887.5	660.0	791.6	791.0	835.0	358.5	1656.75	1321.0	968.7	596.8	1541.0	1161.5
Min. Conservation Pool Elevation[2]	1448.0	825.0		728.0	750.0	770.5	353.0	1532.0	1180.0	922.0	613.0	1450.0	
Min. Power Pool Elevation[2]	1414.0	819	690.0					1480.0		887.0	609.00	1425.0	1182.0
Total Conservation Pool Range (ft)	93.0	101.0	n/a	102.0	40.0	61.5	20.5	158.0	170.0	88.0	24.0	113.5	n/a
Total Power Pool Range (ft)	34.0	6.0						52.0		35.0	4.0	25.0	
Storage Levels (ac-ft) [4]													
Total Conservation Storage (kaf) [4]	194.6	324.6		106.5	28.7	65.0	94.5	136.8	78.8	249.9	24.8	280.5	
Total Power Pool Storage (kaf) [4]	48.7	11.4						8.7		62.6	3.6	36.4	
Spillway Number of Spillbays	3	5	7	2	1	1	6	2	2	2	4	6	3
Spillway Capacity of 1 bay at Full Pool	42,500	41,862	35,400		40,800	-	Note 5 [5]			-	41,100	24,290	59,670
Spillway Total Capacity at Minimum Conservation Pool	-			-	-	-	-	-	-	-	40,000	-	-
Spillway Total Capacity at Minimum Conservation Pool	130,000	194,000	-	70,000	-	-	45,000		37,500	92,500	170,000	98,580	-
Spillway Crest Elevation[2]	1495.5	887.5	660.0	791.6	791.0	835.0	358.5	1656.75	1321.0	968.7	596.8	1541.0	1161.5
Spillway Date SW Crest reached on RC	26-Feb	12-Mar		3-Mar			8-Feb	7-Apr	3-Apr	27-Feb		4-Apr	
Number of Regulating Outlets [6]	2	4	0	2	3	5	4	2	2	2	0	4	0
Size of Ros [6]	6'6"x 12'6"	6'9"x12'		5'6"x10'	3'9"x6'6"	5'x6'	6'9"x9'8"	6'6"x12'6"	4'9"x8'	5'6"x10'		5'8"x10'	
1 RO @ 10% Open @ Min Cons Pool (cfs)[1,3]	300	525		250	83	105	130	340	150	426		520	
1 RO @ 10% Open @ Max Cons Pool (cfs)[1,3]	570	745		400	126	176	190	720	327	525		660	
1 RO @ 80% Open @ Min Cons Pool (cfs)[1,3]	2,415	3,240		1,930	611	754	955	2,640	1,243	3,600		3,165	
1 RO @ 80% Open @ Max Cons Pool (cfs)[1,3]	4,400	4,660		3,120	970	1,336	1,715	5,335	2,773	4,460		5,600	
1 RO @ Full Open @ Min Cons Pool (cfs)[1,3]	2,880	4,075		2,440	810	1,077	1,140	2,900	1,855	5,280		4,110	
1 RO @ Full Open @ Max Cons Pool (cfs)[1,3]	5,380	6,030		3,860	1,277	1,828	2,065	5,900	4,135	6,540		7,300	
Top of Regulating Outlets	1,421	736		680	725.5	745	350	1,491	1,140	755		1,345/1,270	
Invert elevation[2]	1,408.75	724		670	719	739	340	1,478.75	1,132	745		1,335/1,260	
Max Useable Elevation[2]		900										1,5411,465	
Number of Hydropower Facility Turbines	2	3	1	0	0	0	0	2	0	2	2	2	1
Hydropower Facilities Nameplate capacity - full pool [7]	18	48	17					15		48	12	64	23
Capacity per Turbine at Minimum Power Pool [3]	800	2600	4000	-	-	-	-	410	-	1950	1550	2100	3200
Capacity per Turbine at Conservation Pool [1,3]	740	2620	4000	-	-	-	-	450	-	2100	1500	2450	3300
Max Unit Discharge [3]	930	3100	4000					640		2400	1550	3100	3300
Max Powerhouse flow capacity [3]	1860	9300	4000					1280		4800	3100	6200	3300
Station Service [3]	100	150	525					100		150	300	150	150

Statistic	HCR	LOP	DEX	FAL	COT	DOR	FRN	CGR	BLU	GPR	FOS	DET	BCL
Intake, top Invert elevation, lake side	1396	790	681	-	-	-	-	1474	-	817	597	1419	
Intake, bottom Invert elevation, lake side	1384	772	637	-	-	-	-	1420	-	803	583	1396	
Penstock diameter, lake side	12	18	n/a	n/a	n/a	n/a	n/a	10.5	n/a	14	13.5	15.0	n/a

Notes: 1. Flow values are approximate. 2. All elevations are in feet (ft) National Geodetic Vertical Datum of 1929 (NGVD 29). 3. For this table, flow and capacity apply to water flow rates and are measured in cubic feet per second (cfs). 4. ac-ft = acre-feet; kaf = thousands of acre-feet. 5. 2@ a time. 6. RO = Regulating Outlets. 7. (MW/unit) = Megawatts per unit.

Cottage Grove (1942)

Cottage Grove Dam and Reservoir (COT) sits on the Coast Fork of the Willamette River about 5 miles south of Cottage Grove, Oregon. The dam is an earth-fill structure with a concrete spillway and controls runoff from 104 square miles of land in the Coast Fork Willamette River watershed. Construction of this project was completed in 1942.

The reservoir provides 31,800 acre-feet of storage. This project is authorized for the purposes of flood control, irrigation, navigation, fish and wildlife, water quality, recreation, and water supply.

Dorena (1949)

Dorena Dam and Reservoir (DOR) is located on the Row River, a tributary of the Coast Fork Willamette River, about six miles east of Cottage Grove, Oregon. The dam is an earth-fill structure with a concrete spillway and controls runoff from 265 square miles of drainage area. The reservoir provides 72,100 acre-feet of storage. This project was completed in 1949 and is authorized for the purposes of flood control, irrigation, navigation, fish and wildlife, water quality, recreation, and water supply.

Dorena Dam also includes a privately-operated hydropower unit that began operation in 2014 and is licensed by Federal Energy Regulation Commission (NMFS 2008b). The unit consists of two turbines: one high flow and one low flow. Only one of the units is in operation at any given time, meaning that roughly half of the generating capacity is utilized depending on flow conditions. The hydropower unit is a run-of-the-river, meaning that the plant does not control flows, but rather uses the flows dictated by USACE. Any hydropower production at Dorena Dam is incidental to how USACE operates the dam and does not affect USACE's mission.

Fern Ridge (1942)

Fern Ridge Dam and Reservoir (FRN) is on the Long Tom River, a tributary of the Willamette River, about 12 miles west of Eugene, Oregon; it is the only dam in the WVS west of Interstate 5. Fern Ridge Dam is an earth-fill structure that includes a gated concrete spillway and outlet works for regulating reservoir levels. The reservoir provides 97,300 acre-feet of storage and controls runoff from a 275-square-mile drainage area. This project is authorized for the purposes of flood control, irrigation, navigation, fish and wildlife, water quality, recreation, and water supply. In 1965 the dam was raised 1.6 feet for additional storage and in 1987 the spillway and outlet works were modified. A Supervisory Control and Data Acquisition system was installed to control the spillway gates in 1992 (USACE 2015). In 2005-2006, USACE repaired the failed internal drainage system in the earth-fill embankment, which had caused depressions and seepage on the downstream dam slope. Repair work included excavation of the downstream face of the dam, replacement of the drainage system, and reconstruction of the embankment.

In 1950, a project was completed that altered the lower Long Tom River from the dam to its confluence with the Willamette River. Alterations to the Long Tom River were made to control the subsequent flooding created by the Fern Ridge dam construction, enabling USACE to maintain the FRM mission downstream of the dam. The Long Tom River below Fern Ridge Dam meanders before joining the mainstem Willamette River north of Monroe, Oregon. The river was shortened from 36.5 miles to 23.6 miles and was channelized with embankments. A series of seven drop structures were built with the intent to reduce channel velocity and decrease erosion, while still moving water downstream efficiently. Three of the seven drop structures, one at Monroe (RM 6.7), one at the Stroda property (RM 10.2), and one just upstream of Ferguson Road (RM 12.7), are constructed of concrete and range in height from 7.5 feet-11.5 feet. The remaining four are smaller rock riffle weirs and are located in the uppermost 4 miles of the constructed channel. Operation and maintenance of all seven structures is minimal.

At the time of writing, USACE, in coordination with the City of Monroe and the Confederate Tribes of Siletz Indians, is working on a Section 1135 Ecosystem Restoration feasibility study on the Long Tom River. The Section 1135 project is evaluating the Monroe drop structure to address issues with fish passage, enhance riparian, wetland and aquatic habitat, and increasing connectivity through a series of restoration measures. Any modifications to the drop structure that result from the 1135 project are not included as part of this proposed action and would be consulted on separately.

Fern Ridge encompasses over 11,000 acres of marsh, wetland, and prairie habitat, with 5,000 acres dedicated to the Fern Ridge Wildlife Area managed by the Oregon Department of Fish and Wildlife (ODFW). USACE also works with ODFW to support resident game and non-game fisheries within the Long Tom River basin.

Hills Creek (1962)

Hills Creek Dam and Reservoir (HCR) is located on the Middle Fork Willamette River 4 miles southwest of Oakridge, Oregon. The dam is an earth-fill structure that was completed in 1962 with a gated concrete spillway and outlet works for regulating reservoir levels (USACE 2015). The reservoir provides 350,000 acre-feet of storage and controls runoff for a 390-square-mile drainage area. The dam has two hydropower generating units capable of producing a total of 36 megawatts (MW). This project is authorized for the purposes of flood control, irrigation, navigation, hydropower, fish and wildlife, water quality, recreation, and water supply (USACE, 2020a).

Lookout Point (1953)

Lookout Point Dam and Reservoir (LOP) is located on the Middle Fork Willamette River about 22 miles southeast of Eugene, Oregon. The dam is an earth and gravel-filled structure with concrete gated spillways. The majority of the construction of Lookout Point Dam, including the powerhouse, was completed in 1953. Lookout Point Reservoir provides 438,200 acre-feet of storage. All three hydropower generating units at this project were completed by 1955 (USACE 2015) and have a combined capacity of 146 MW (USACE 2020a). This project is authorized for the purposes of flood control, irrigation, navigation, hydropower, fish and wildlife, water quality, recreation, and water supply.

Dexter (1954)

Dexter Dam and Reservoir (DEX) is located on the Middle Fork of the Willamette River about 22 miles southeast of Eugene, Oregon and 3 miles downstream of Lookout Point Dam. The dam is an earth and gravel-fill embankment structure with concrete gated spillways (seven total) that regulate power-generating water releases from Lookout Point Dam. The total generation capacity of the hydropower units is 17 MW. Dexter Dam was completed in 1954 and was authorized for the purposes of hydropower, recreation, and water supply (USACE 2020a). Dexter Reservoir provides 27,300 acre-feet of storage used to even out peak discharges of water utilized for power production at Lookout Point Dam, thereby controlling downstream river level fluctuations.

The Dexter Pond Facility is located at the base of Dexter Dam and used to capture adult fish, provide juvenile rearing capacity, and serve as an acclimation facility for juvenile releases. Renovations of the Dexter Pond Facility to improve upstream passage are planned to be complete by May of 2026.

Fall Creek (1966)

Fall Creek Dam and Reservoir (FAL) is located on Fall Creek, a tributary of the Willamette River, about 20 miles southeast of Eugene, Oregon. The dam is a rockfill structure with a gated concrete spillway and outlet works for regulating reservoir levels. Fall Creek Reservoir provides 116,000 acre-feet of storage. Construction of this project was completed in 1965. This project controls runoff from 184 square miles of drainage area and is authorized for the purposes of flood control, irrigation, navigation, fish and wildlife, water quality, recreation, and water supply.

USACE operates an adult fish collection facility at the base of the dam, which completed modernization to NMFS standards in 2019. Returning adult salmon are collected at the facility and USACE personnel transport the fish upstream to spawning areas.

Blue River (1969)

Blue River Dam and Reservoir (BLU) is located on a tributary of the McKenzie River about 38 miles east of Eugene, Oregon. The dam is a rockfill structure with a gated concrete spillway. The reservoir provides 82,800 acre-feet of storage and controls runoff from an 88-square-mile drainage area. This project was completed in 1969 and is authorized for the purposes of flood control, irrigation, navigation, hydropower, fish and wildlife, water quality, recreation, and water supply. While hydropower is one of this project's authorized purposes, no generators have been constructed or installed at this project.

Cougar (1963)

Cougar Dam and Reservoir (CGR) is located on the South Fork McKenzie River, a Willamette tributary, about 42 miles east of Eugene, Oregon. Cougar Reservoir has a storage capacity of 189,000 acre-feet and controls runoff from an area of 208 square miles. The dam, completed in 1964, is a rockfill structure with a concrete spillway with two spillway gates, regulating outlet, and penstocks connecting to a powerhouse. The Project encompasses nearly 5,000 acres, managed primarily by Willamette National Forest.

This project is authorized for the purposes of flood control, irrigation, navigation, hydropower, fish and wildlife, water quality, recreation, and water supply. The total capacity of the two hydropower generating units at this project is 30 MW. In 2004, USACE completed construction of a water temperature control (WTC) tower at Cougar Dam, which improved downstream conditions for ESA-listed fish species.

Construction of an adult fish collection facility was completed in 2010. Adult salmon are collected at the facility and transported upstream of Cougar Reservoir to allow for spawning in natal streams.

Green Peter (1968)

Green Peter Dam and Reservoir (GPR) is located on the Middle Santiam River (within the South Santiam River sub-basin), 11 miles northeast of Sweet Home, Oregon. The dam is a concrete structure with a concrete spillway with two spillway gates, two regulating outlets, and a powerhouse. The Green Peter Reservoir provides 409,800 acre-feet of storage. The total output of this project's two hydropower generating units is 98 MW. Construction of this project was completed in 1967 and it is authorized for the purposes of flood control, irrigation, navigation, hydropower, fish and wildlife, water quality, recreation, and water supply.

The original construction of Green Peter included both up and downstream fish passage facilities. Upstream facilities included a short ladder section to the trapping area, trapping and transport equipment for adult fish ascending the ladder including the holding pool, fish-sweep, fish-hopper, and craneway-hoists. The Green Peter fingerling collection facility was located near the spillway, penstocks, and regulating outlets in the reservoir to take advantage of all attraction as an aid to collect emigrating fish for passage downstream. The major components of the system were: the separator unit, attraction water pumps, well, the transport-pipe system, and the collection horn. The facility was mothballed in 1988 and components have been removed for safety reasons.

Foster (1968)

Foster Dam and Reservoir (FOS) is located on the South Santiam River at the confluence of the South Santiam and Middle Santiam Rivers, approximately 4 miles northeast of Sweet Home, Oregon. Foster Dam is a rockfill earthen embankment dam with a concrete spillway with four spillway gates, a concrete non-overflow section, and a powerhouse. Foster Reservoir is used to regulate power-generating water releases from Green Peter Dam and flows from the South Santiam River. Construction of this project was completed in 1968. Foster Reservoir provides 55,900 acre-feet of storage. This project is authorized for the purposes of flood control, irrigation, navigation, hydropower, fish and wildlife, water quality, recreation, and water supply. The total output of this project's two hydropower generators is 24 MW.

The adult fish facility at Foster was recently improved in 2013, and now includes sorting, transportation, holding and spawning facilities. Optimization of adult collection continues through operational changes and investigation of structural improvements.

Detroit (1953)

Detroit Dam and Reservoir (DET) is located on the North Santiam River approximately 50 miles southeast of Salem, Oregon. At full pool elevation (1,569 feet), Detroit Reservoir covers an area of 3,580 acres with 428,800 acre-feet of usable storage at the confluence of the North Santiam and Breitenbush Rivers (USACE 2019b; 2000). The concrete gravity dam was constructed primarily for FRM, though its authorized purposes also include irrigation, navigation, hydropower, fish and wildlife, water quality, recreation, and water supply.

Construction was completed in 1953 and included six spillway gates, four regulating outlets and a powerhouse (USACE, 2015). The total output of this project's two hydropower generators is 127.8 MW. The USACE project lands surrounding Detroit reservoir encompass over 6,500 acres, which is primarily managed through an agreement with the United States Forest Service, Willamette National Forest.

Upstream passage and hatchery brood collection are performed in the North Santiam at the Minto Fish Collection Facility (Minto). Minto is located on the North Santiam River, downstream of Big Cliff and Detroit Dams. The facility was re-built to meet RPA 4.6.1 of the NMFS 2008 Biological opinion and placed back into operation in 2013.

Big Cliff (1953)

Big Cliff Dam and Reservoir (BCL) is located about 3 miles downstream of the Detroit Dam on the North Santiam River, about 45 miles southeast of Salem, Oregon. Big Cliff Dam is a re-regulating, concrete structure with a concrete spillway and three spillway gates, a non-overflow section, and a powerhouse. Big Cliff Reservoir is a small reservoir that provides 6,430 acre-feet of storage that is used to even out peak discharges of water utilized for power generation at Detroit Dam, thereby controlling downstream river level fluctuations (USACE 2019b). The total output of this project's single generator is 23 MW. This project was completed in 1954 and is authorized for the purposes of hydropower, recreation, and water supply.

2.1.4 Willamette River Basin Bank Protection Program

USACE is responsible for the Willamette River Basin Bank Protection Program (WRBBPP), originally authorized by the Flood Control Act of 1936. Authorization of the WRBBPP allowed USACE to construct and maintain 450,000 linear feet of bank protection works. In 1971, the Senate and House Committees on Public Works expanded the program's scope to 510,000 linear feet. The program uses bank protection structures (e.g., riprap revetments, steel pile bulkheads, timber bulkheads, drift barriers, and earthen embankments) to prevent bank erosion (USACE 2000).

The Flood Control Act of 1950 required local sponsorship for any new bank protection projects and transferred responsibility for maintenance of revetments constructed after 1950 from USACE to the local sponsor. USACE was responsible for the construction of 223 flood control structures in the WRB. Of these structures 193 structures are still active; 88 of these are maintained by USACE; 105 structures are owned and maintained by their local sponsor (USACE 2000).

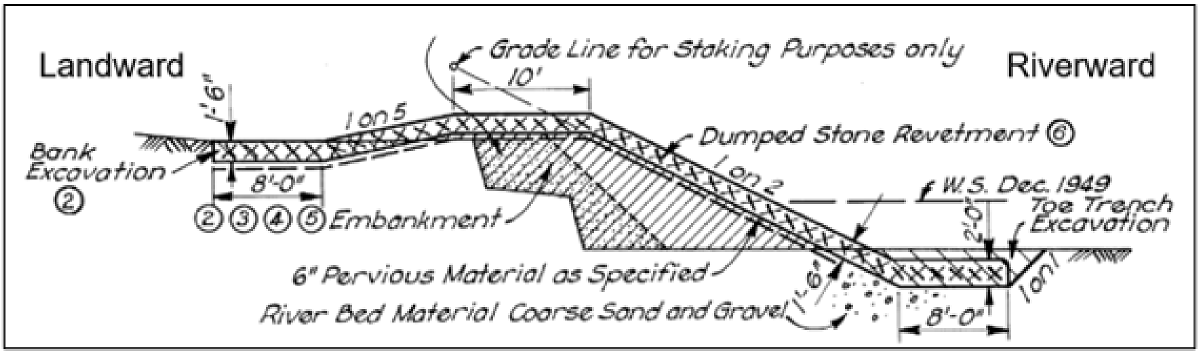

Figure 2.1-2. Sectional Drawing of a Typical WVS Revetment.

A hydraulic, hydrologic, and geomorphic investigation of consequence was conducted in 2013 for 60 USACE-maintained revetment projects in the WRB. The remaining 28 USACE-maintained revetments were excluded from the study because they were either destroyed or located substantially off the main channel and are no longer serving their intended purpose. Though requested, a lack of funding over the past decades has prevented significant maintenance, repair, or replacement of the structures under USACE's control.

2.1.5 Willamette Hatchery Mitigation Program and Infrastructure

Construction of the dams adversely impacted many aquatic species including (but not limited to), UWR spring Chinook salmon, UWR winter steelhead, Pacific lamprey, and resident trout, including the ESA-listed bull trout, by physically blocking their migrations to and from habitat upstream of the dams. Project dams also impacted habitat by inundating some reaches through the creation of reservoirs. In addition, construction of the dams and reservoirs submerged existing hatchery facilities on the Middle Fork Willamette, North Santiam, and South Santiam Rivers and required the relocation of existing hatchery brood egg-collection stations on the Middle Fork Willamette, McKenzie, North Santiam, and South Santiam Rivers.

During and after construction of the WVS, USACE and BPA have funded hatchery production of UWR Chinook, summer steelhead and rainbow trout. Historically this hatchery mitigation focused on providing fish for harvest in sport and commercial fisheries. Further adjustments were made to the program to reduce the negative effects of the hatchery production on listed species, including using the UWR Chinook hatcheries to facilitate reintroduction above WVS dams. The important benefits of hatcheries and the concerns about their long term use are reflected in the Willamette consultation history (see Section 1.8.3), and in the terms and conditions of the most recent NMFS consultation on the program (NMFS 2019b).

McKenzie Hatchery

The McKenzie Hatchery was originally an Oregon state hatchery but was expanded by USACE to mitigate the effects of USACE dams on UWR Chinook salmon within the McKenzie River Sub-basin.

Through formal consultation with the Services, McKenzie releases approximately 120,000 lbs of spring Chinook smolts annually (NMFS 2019a). Because of the conservation role of this hatchery program, USACE integrated conservation-oriented genetic protocols so that the

McKenzie Hatchery would produce USACE's entire mitigation requirement for spring Chinook in the McKenzie sub-basin.

In 2018, the water supply at Mckenzie Hatchery was compromised due to structural integrity issues in Leaburg Canal that supplies the hatchery. To continue fish production, fish are being collected from two locations on the McKenzie River. The primary source of collection is a fish trap at Leaburg Hatchery. Fish are also being collected from a fish sorter located at the top of the left bank ladder, though in lower numbers. In the past, fish were collected at the McKenzie Hatchery; however due to current water conditions, collection the last several seasons has been in the single digits and is ineffective. Broodstock are being held at Leaburg Hatchery and at Foster Fish Facility.

The raceways at Leaburg are designed for juvenile fish and are not deep enough for adults. Covers are placed over the raceways to avoid sunburn. Foster has superior adult holding facilities and thus some of the fish are held there. Incubation of this year's juveniles occurred entirely at McKenzie Hatchery. Leaburg does not physically have the capacity to incubate the number of fish that are required. Early stages of rearing are taking place at McKenzie Hatchery. Once water conditions degrade, fish are moved to Leaburg where they are reared until release. This hybrid operation using both McKenzie and Leaburg Hatchery is ongoing and will continue until a permanent solution is implemented.

Leaburg Hatchery

Leaburg Hatchery is located on the McKenzie River and was constructed in 1953 by USACE and is managed by ODFW. The hatchery is used to rear rainbow trout, summer steelhead, and spring Chinook, as well as provide a temporary holding facility for cutthroat and rainbow trout fingerlings for stocking. It is currently being used to support the McKenzie Hatchery as described above in 1.5.5.1.

Willamette Hatchery

Willamette Hatchery is located along Salmon Creek (Middle Fork of the Willamette River tributary in the Willamette Basin) about 2 miles east of Oakridge, Oregon, off Highway 58. The site is at an elevation of 1,217 feet above sea level.

Through formal consultation with the Services, Willamette Hatchery rears ~2.3 million spring Chinook annually. In addition, the hatchery also has released 13,000 – 28,000 pounds of summer steelhead smolts annually. Because of the conservation role of this hatchery program for UWR Chinook, USACE integrated conservation-oriented genetic protocols so that the Willamette Hatchery would produce USACE's entire mitigation requirement for spring Chinook in the Middle Fork Willamette sub-basin.

Adults are collected at Dexter Dam and transported to the adult Chinook salmon holding facility at the Willamette Hatchery until spawning. The holding facility was constructed in a former earthen rearing pond from the original hatchery. It is inadequate for current adult holding needs at the Willamette Hatchery; consequently, the adults are overcrowded in the pond, not easily captured, and overly stressed which contributes to high pre-spawn mortality of collected broodstock.

Marion Forks Hatchery

Marion Forks Hatchery is located along Marion and Horn Creeks (in the North Santiam River Sub-basin) about 17 miles east of Detroit, Oregon, along Highway 22. The site is at an elevation of 2,580 feet above sea level. Marion Forks Hatchery was constructed in 1951 to compensate for the loss of salmon and steelhead habitat caused by construction of both the Detroit and Big Cliff dams. Minto Fish Facility is an adult fish collection facility located downstream of Big Cliff Dam. USACE constructed the Minto Fish Facility to collect adult UWR Chinook salmon as broodstock (mature individuals used for breeding purposes) to supply eggs for Marion Forks Hatchery. A major reconstruction and updating of the Minto facility was completed in 2013.

South Santiam Hatchery

South Santiam Hatchery and the Foster Fish Collection Facility are located on the South Santiam River just downstream from Foster Dam, 5 miles east of downtown Sweet Home. The facility is at an elevation of 500 feet above sea level. The South Santiam Hatchery began operations in 1968 and sits on 12.6 acres of USACE owned lands and is utilized for egg incubation and juvenile rearing. In July 2014 the Foster Dam Adult Collection Facility was completed and eliminated the need to transport adults and housed brood stock. ODFW operates the hatchery and the collection facility for the rearing of spring Chinook and summer steelhead.

2.2 Development of the Proposed Action

The proposed action is based on the Preferred Alternative developed from the Draft Programmatic Environmental Impact Statement (DPEIS) for the WVS, with some key additions and clarifications that focus on implementation. The preferred alternative was formulated based on activities identified in the 2008 biological opinion and the Configuration/Operation Plan (COP) and was informed by the decade of Research Monitoring & Evaluation (RM&E) conducted in the Basin. As part of the NEPA scoping process, USACE also solicited input from the public about how it should improve its operations to comply with the ESA. For the last 3 years, the USACE has been working with Cooperating Agencies to formulate alternatives that would provide meaningful improvement for the species while being implementable. The DPEIS Preferred Alternative was developed using objectives that focused primarily on improving fish passage through the WVS dams using a combination of modified operations and structural improvements. It also includes other measures to improve water quality through increased water management flexibility and structural modifications. A major consideration in the formulation of the proposed action was the limiting factors for the listed species as well as the constraints and opportunities presented by WVS facilities and missions. After being provided to NMFS in the WVS BA (USACE 2023a), the proposed action was collaboratively refined further through interagency coordination. These refinements fall primarily into three categories:

- Clarification or development of new information through the sufficiency process
- Corrections and minor revisions to the 2023 BA description of the proposed action
- Changes to the proposed action by the Action Agencies after submission of the final biological assessment, including updates to the interim operational measures (see Section 2.3.1, below)

Documentation of the coordination of these changes between the Services and Action Agencies can be found in the consultation history section 1.1.1. The proceeding description of the proposed action here, subsumes the prior versions, and is the basis for the NMFS analysis in this opinion.

2.2.1 Action Area

"Action area" means 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).

The USACE provided the following description of the action area in their BA (USACE 2023a). The action area includes all river reaches, riparian zones, and floodplain areas located downstream of the 13 Willamette dams, including the mainstem Willamette River and the tributaries on which these facilities are located (i.e., mainstem reaches of the North Santiam River, South Santiam River, Santiam River, McKenzie River, South Fork McKenzie River, Blue River, Fall Creek, Middle Fork Willamette River, Row River, Coast Fork Willamette River, and the Long Tom River), and the lower Columbia River from the confluence of the Willamette to the mouth of the Columbia River, including estuarine habitat in which listed salmonids and green sturgeon are affected by the WVS (USACE 2000). This Action Area also encompasses the 42 miles of mainstem streambank revetments maintained by the USACE and the adjacent stream reaches affected by those revetments. The action area also includes:

- The Molalla River from RM 20.2, the Calapooia River from approximately RM 33.5, and the Clackamas River from RM 20.1 to the confluence with the Willamette. These stream reaches include some of the 42 miles of streambank revetments maintained by USACE.
- Stream reaches and land areas permanently or seasonally inundated by Willamette Project reservoirs in dry, average, and wet years.
- All reaches of tributaries located upstream of WVS dams that are presently or were historically accessible to listed fish before construction of the 13 dams in the Willamette Project.
- For the following Southern Resident Killer Whale Critical Habitat Areas: Coastal Washington/Northern Oregon Nearshore, Coastal Washington/Northern Oregon Offshore. See 86 FR 41668 for detailed descriptions of these areas (NMFS 2021a and NMFS 2021b).

2.3 Description of the Proposed Action

The proposed action consists of the continued operation and maintenance of the WVS for the congressionally designated authorized purposes of flood control, hydropower, irrigation, navigation, recreation, fish and wildlife, water supply, water quality, and meaningful action for the species to ensure operation of the WVS complies with the ESA requirements. This includes the continued operation of existing structures and facilities, modifications to operations and construction, and operation and maintenance of new structures. The new elements of the proposed action were developed to improve fish passage through the WVS dams using a combination of modified operations and new structures. It also includes measures to improve downstream water quality, balance water management flexibility, and reduce project effects for ESA-listed fish. These are described in detail in sections 2.3.1 through 2.3.7 below. To inform management decisions both for in-season operations and as part of the long-term implementation plan for the WVS, the proposed action also includes a framework for interagency coordination and adaptive management during implementation based on continued RM&E (see Sections 2.5.10 through 2.5.13).

The proposed action also includes the continuation of the Power Marketing Program and habitat enhancement program by BPA (Section 2.3.8) and the Water Marketing Program for the contracting of irrigation water by Reclamation (Section 2.3.9). A key component of the proposed action is an Adaptive Management and Implementation Plan (see Appendix A to this document), which is a roadmap that lays out the strategy and schedule for implementation, ongoing assessment of the proposed action, and proposed improvements to the Willamette Action Team for Ecosystem Restoration (WATER) governance and coordination process.

Under the proposed action, downstream fish passage structures would be constructed at Detroit Dam, Lookout Point Dam, and on a smaller scale at Foster Dam. A structure to improve downstream water temperature management would be constructed at Detroit, and changes to operations to facilitate downstream fish passage would occur at Cougar and Green Peter dams. The other operational change is a new integrated temperature and habitat flow regime.

Table 2.3-1 provides a high-level overview on what type of long-term solutions (operational or structural action) are proposed at each project location. Detailed descriptions of the actions are provided in the proceeding sections below. USACE also recognizes that not all of the proposed actions can be implemented immediately and is proposing a set of interim operations to improve conditions for ESA-listed fish species until large-scale structural changes are in place. These are described in Section 2.3.1.

Separate site-specific design and environmental compliance are required for components of the proposed action which require construction and are identified in the sub-basin specific sections below. Certain actions would occur basin-wide and those are described in Section 2.3.2, Basin-Wide Actions.

Table 2.3-1. Water Quality and Fish Passage in the Proposed Action.

Dam	Temperature Control	Downstream Fish Passage	Upstream Fish Passage
Dexter	–	–	Rebuilt
Lookout Point	–	New Structure	–
Hills Creek	–	–	–
Fall Creek	–	Continued Operation	Existing
Cougar	Existing	New Operation	Existing
Blue River	–	–	–
Foster	Structural (new)	New Structure	Existing
Green Peter	Operational (new)	New Operation	Structural (new)
Big Cliff	–	–	Existing
Detroit	Structural (new)	New Structure	–

The description of the proposed action is divided into multiple components, the Interim Operations (Section 2.3.1), Basin-Wide Actions (Section 2.3.2), the Long-Term Actions described by sub-basin in Sections 2.3.3 through 2.3.7, the BPA Power Marketing Program (Section 2.3.8), the Reclamation Water Marketing Program (Section 2.3.9), the Implementation Plan detailing the estimated timelines and the prioritization of construction activities (Section 2.5), and the Adaptive Management Plan (Appendix A).

For actions that will be implemented immediately, which are largely operational, the timing of decisions for implementing management measures and/or adjustments is influenced by the operational planning for the conservation release season, which begins with the January water supply forecast and continues through October. The conservation season is approximately from March through October, including the filling season (spring) and the release season (summer). A document titled "Willamette Basin Project Conservation Release Season Operating Plan" (Conservation Plan) is prepared annually to provide flow requirements based on the basin water supply for that year. The Conservation Plan identifies flow and storage needs for each tributary and USACE reservoir in the WVS and mainstem Willamette control points based on the anticipated total system storage in mid-May, from the April forecast.

2.3.1 Interim Operations

The proposed action includes a suite of operations to be implemented immediately after the ROD is signed to improve conditions for the species while structural measures undergo engineering, design, and construction. These operations at a particular dam would continue until the long-term measure is in place. Since some of these operational measures will need to be in place for more than a decade the term of reference used in the BA ("near term operational measure" or NTOM), has been updated to "interim operational measure" in this document. This change in terminology will also be consistent with the terminology of the final EIS and ROD.

The interim measures are modeled after injunction operations ordered by the District Court in *NEDC, et al. v. USACE, et al*. injunctive order, while others have been refined based on adaptive management (AM) during implementation of the injunction operations. One example is the refined operations and timing of reservoir drawdown and lower regulating outlet use at Detroit Dam for fish passage. Some of the changes from the original injunctive order are seeking improved biological performance, while others are necessary to avoid impacts to other resources. Adaptive management of the interim operations will continue during implementation according to the framework for adaptive management and governance in the AM Plan (Appendix A).

Short descriptions of the interim operations, including location, timing, outlet priorities for use to release flow through the dam, and target elevations of the reservoirs are in Table 2.3-2 below. Details for each of these operations are also provided in the sub-basin sections below. These descriptions reflect the most up to date iteration of the operation and are the action agency proposal, however further refinements are ongoing through the injunction. The interim operations are expected to provide immediate benefit to the listed species through anticipated improvements to fish passage and improved water quality.

Due to the timing of injunction operation development and the implementation and monitoring of those actions happening concurrently with the development and publication of the final BA, the analysis and description of potential effects for both the injunction operations and interim measures were qualitative in the BA (in the 2023 BA see section 4.6.2 for the injunction operations, and sections 5.5, 5.6.1, 5.7.1, 5.9.1, 5.10.1, 5.12.1 and 5.13.1 for interim measures). Because of uncertainty surrounding performance and effects of the injunction measures and interim measures at that time, the quantitative analysis in the BA used the pre-injunction operations for the hydrologic (Reservoir System Simulation [ResSim]), temperature (CE-QUAL-W2) and fish modeling (FBW and life cycle modeling), with the general qualitative assumption that the injunction and interim operations would be an improvement over those conditions. After publication of the final BA (March 2023), additional analysis and information has become available through both modeling and monitoring. See Effects section of the USACE BA (2023a) for more detailed information on how this updated information was applied to the effect's analysis.

Table 2.3-2. Summary of Interim Operations.

Location	Description of Interim Operations by Location	Duration of Operation	Priority Outlet	Target Elevation
Detroit	Spring downstream fish passage and operational downstream temperature management spring through early winter	Mid-Mar to Fall	Spillway/ Turbines/ Upper ROs/Lower ROs	n/a
Detroit	Nighttime (dusk to dawn) RO prioritization for improved downstream fish passage	Winter	Upper ROs	Less than 1,500 feet and once downstream temperature management operations have concluded for the year
Big Cliff	Spread spill across as many spillbays as safety protocols allow to reduce downstream total dissolved gas (TDG) exceedances	Year-round	Spillway	Discharges greater than powerhouse capacity
Green Peter	Outplanting plan for reintroduction of adult Chinook salmon above Green Peter Dam	Summer	n/a	n/a
Foster	Delay refill and utilize spillway in the spring for improved downstream fish passage; use the fish weir in the summer for improved downstream temperature management and upstream fish migration/passage	Feb 1 to Jun 15; Jun 16 to approximately late-Jul (similar to No Action Alternative [NAA])	Spillway (spring) Fish Weir (summer)	613 feet (Feb - May) 637 feet (May - Jul)
Foster	Early drawdown and utilization of the spillway for improved downstream fish passage in the fall	Oct 1 to Dec 15	Spillway	613 feet
Cougar	Deep drawdown and RO prioritization for improved downstream fish passage	Early Nov to Dec 15	RO	1,505 feet
Cougar	Delayed reservoir refill and RO prioritization for improved downstream fish passage	Feb to May/Jun	RO	1,520-1,532 feet
Hills Creek	Nighttime (6PM to 10PM) RO prioritization for improved downstream fish passage when elevation less than 1,460 feet.	Approximately Nov to Mar	RO	Less than 1,460 feet
Lookout Point	Utilize spillway for improved downstream fish passage in the spring; RO use in the late summer/fall for downstream temperature management	Mid-Mar to May/Jun (spring); Jul to Oct 15 (RO)	Spillway/RO	890 to 893 feet spring spill Less than 887.5 feet late summer/ fall RO
Lookout Point	Deep drawdown and RO prioritization for improved downstream fish passage	Nov 15 to Dec 15	RO	750 feet

Note: *Long-term operational fish passage at Fall Creek and Green Peter Dams will be implemented immediately after the ROD so they are not included in the interim operations table.

2.3.2 Basin-Wide Actions

The following measures would be applied at multiple locations around the Willamette Basin or affect the entire basin. All measures would be part of early implementation unless otherwise noted in their description. Monitoring and adaptive management for basin-wide actions is included in the Adaptive Management Plan, (Appendix A to this document).

Operation, Maintenance, Repair, Replacement and Rehabilitation of Facilities

After a water resources project is constructed, the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) phase begins. During this phase, ongoing activities are conducted to support the function of a project.

The OMRR&R phase includes a spectrum of activities that range from regular maintenance activities, such as the repainting a rusty guardrail or replacement of lightbulbs; to major maintenance and rehabilitation activities such as the repair, replacement, or rehabilitation of entire facility components (e.g., the replacement of the slide gate seals or repair of hydraulics in a dam). OMRR&R activities occur at all facilities in the WVS including within and around the dams and powerhouses, the adult fish facilities, and the hatcheries.

These ongoing actions, will continue under the proposed action with the signing of the Record of Decision. This section describes the distinction between regular and major OMRR&R of WVS facilities.

Scheduled/Routine Maintenance

Routine maintenance is defined as the maintenance, repair, or replacement of existing fixtures or parts in which no changes are made to original design or purpose, to ensure that WVS facilities run safely. Routine maintenance includes those activities that are predictable and repetitive, but not those that would constitute major repairs or rehabilitation of a capital asset. This type of preventative and corrective maintenance is coordinated and planned to occur at regular intervals and is also referred to as scheduled maintenance.

Routine maintenance is performed on all WVS hatcheries, fish facilities, spillway components, generating units, and supporting systems to ensure project reliability and to comply with federal regulatory requirements. Routine maintenance is coordinated through a regional forum, such as the Willamette Fish Passage Operations & Maintenance (WFPOM) and WATER, see Section 2.5.13 for more info on these groups and processes, to avoid or minimize effects to ESA-listed fish species by designating in-water-work-windows and other construction constraints.

The routine maintenance program allows staff at USACE and BPA to proactively plan and schedule capital improvement programs, many of which constitute major maintenance as described below, based on equipment condition and degradation to ensure system operations remain safe, reliable, and in compliance with applicable laws and regulations.

These activities are described in the Operations and Maintenance Manuals for each facility. The library of Operations and Maintenance Manuals is incorporated here by reference; WVS DPEIS Appendix A provides an annotated bibliography of these manuals.

Unscheduled and Non-routine Maintenance

Unscheduled maintenance is reactive maintenance that addresses issues as they arise. It can occur any time there is a problem, unforeseen maintenance issue, or emergency that requires a project feature, such as a generating unit, be taken offline to resolve the problem. Emergency operations will be managed in accordance with the Willamette Fish Operations Plan (WFOP), and other appropriate Action Agency emergency procedures. The Action Agencies will take all reasonable steps to limit the duration of any emergency changes in system operations that may adversely affect ESA-listed species. Where emergency changes to system operations cause significant adverse effects on ESA-listed species, the Action Agencies will work thru established Regional Forums (e.g., WFPOM, WATER Flow Management, etc.) to communicate the issue and seek feedback on adverse effects and potential operational changes, when feasible. In some instances, for example during extreme high flows, and coincident involuntary spill, operational changes may not be possible. The timing, duration, and extent of these events are unforeseeable. Unscheduled maintenance events are coordinated through the appropriate teams under a regional forum, such as the WFPOM and WATER, to minimize negative effects on fish.

Non-routine maintenance is proactively planned but not performed at regular intervals (e.g., unit overhauls, major structural modifications, or rehabilitations). Non-routine maintenance includes tasks that may be more imperative in nature than routine maintenance and these tasks may or may not constitute major maintenance and rehabilitation.

Major maintenance and major rehabilitation are defined in Engineering Circular 11-2-222. Major maintenance is defined as a non-repetitive item of work or aggregate items of related work for which the total estimated cost exceeds the limit set forth by Engineering Circular 11-2-222, and that does not qualify as major rehabilitation.

Major rehabilitation is defined as structural modifications to restore or ensure continuation of an existing facility's functions or outputs. This does not include normal maintenance of existing capabilities or prevention of deterioration. Examples of non-routine maintenance include power plant modernization and major upgrades of project features.

Non-routine maintenance and major maintenance and rehabilitation may be considered major federal actions. Each action would be assessed for environmental compliance, including ESA compliance, prior to implementation.

Continued Operations for Authorized Purposes

USACE utilizes water control diagrams to manage for the different purposes and seasonal needs. Individual water control diagrams depict the allocated pools and seasonal elevations, also known as water-year-based rule curves, over the course of a year for each project. These water control diagrams are contained in the water control manuals for each individual project, along with detailed operations and procedures. The draft Master Water Control Manual integrates the operation of the individual dams and reservoirs to meet the system-wide goals of the WVS. Figure 2.2 1 is a typical water control diagram that indicates the general trends throughout the year.

Projects with hydropower facilities include storage space designated for power generation during the critical power period from October to March. This storage is relatively small and is between minimum conservation pool and minimum power pool elevations. The power pool is generally kept full to increase the hydraulic head, defined as the potential energy of water due to its height above the bottom of the dam, for power generation.

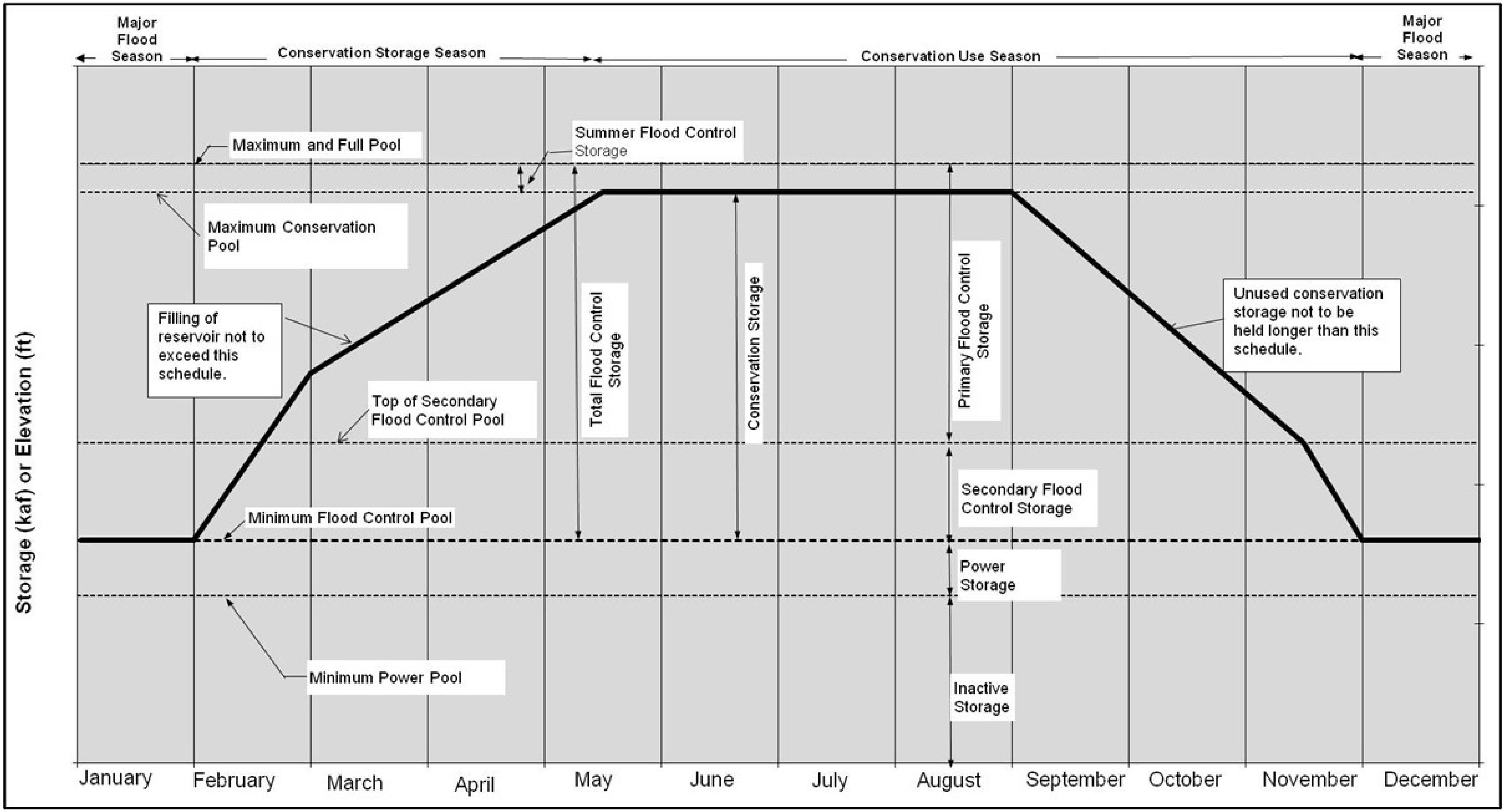

Figure 2.3-1. Generic Willamette Valley System Water Control Diagram.

Departures from the rule curves (storage targets) during reservoir refill may be necessary due to the need for regulation of floods, excessive snowpack above the reservoirs, inadequate water supply, or critical power needs. Refill can be delayed when high runoff is expected, as this provides additional storage for flood damage reduction operations. Generally, each reservoir may fill at a rate no faster than shown in the rule curve unless the reservoir is being managed for downstream floods.

Excess flood water stored above the rule curve during the conservation storage season is released targeting discharges at or below downstream channel capacity. During dry conditions, the reservoir may be higher than the rule curve to reduce the risk of not filling the reservoir. When the water supply is inadequate to maintain both minimum flows and the scheduled rate of filling, maintaining minimum in-stream flows downstream of a dam generally takes precedence, per the 2008 NMFS biological opinion.

USACE is proposing to follow existing water control manuals except when proposed interim operations or long-term operations would require a change to an existing manual as per the USACE regulations. The operations and structures that may require change to the water control manuals are discussed in Section 2.1. Upon completion of the ROD, USACE will make updates to the water control manuals accordingly. Structures may require refinements to their operations as well, depending on site specific design elements. Those potential refinements will be discussed in sub-basin specific sections below.

These ongoing actions will continue under the proposed action with the signing of the Record of Decision. The actual operations take place in what is described as "real time," that is, decisions must be made in a few minutes, days, or at most, a few weeks. Operators regulate the system to satisfy all the various purposes contained in the annual operating plan which are designed in compliance with the water control manuals for the project. In-stream conditions for fish, generation outages, the weather and even the timing of recreational events can influence operational decisions. Operational changes are coordinated through a regional forum, such as the Willamette Flow Management and Water Quality Team (WFMWQT and WATER, see Section 2.5.13 for more info on these groups and processes), to minimize effects to ESA-listed fish species when biologic flow targets may not be met. There are also periodic maintenance activities that affect reservoir levels described in description of maintenance in the preceding sections above.

Refined Integrated Temperature and Habitat Flow Regime

This section describes operational measures to manage streamflow on tributaries and on the mainstem Willamette River via water releases from USACE reservoirs. Physical habitat and water quality are important attributes to consider for meeting the habitat needs of aquatic biota in both flowing and impounded sections of a river system. The Action Agencies are proposing a new suite of operational guidelines related to managing the regulation of flow from those used during implementation of the 2008 NMFS RPA.

These new adaptive "fish flows" included in the proposed action are based on two components: 1) alternative minimum flows that incorporate magnitude, seasonal variation, and annual hydrologic conditions within each major sub-basin and 2) opportunistic/adaptable water releases for real-time water temperature management on the mainstem Willamette River. The proposed flow regime is designed to provide flows protective of UWR Chinook and steelhead habitat needs while adjusting according to real-time hydrologic conditions in each sub-basin. In all but dry years the flows will not vary much from those in the NMFS 2008 biological opinion. However, in dry years it better defines the priorities for the species when an adequate water supply to meet the 2008 flow targets throughout the conservation season is simply unavailable. This action would allow operations to store water in the spring to ensure it is available to augment flows in the drier and hotter spring and summer months for UWR Chinook and steelhead. These adaptable water releases in spring are included in the proposed action to help reduce the exceedance of pre-defined temperature thresholds in dry years when water is scarce, thereby improving the availability and quality of aquatic habitat when temperature conditions in specific locations and river reaches are forecast to exceed biological thresholds for native aquatic species in the Willamette Basin.

Because it is very difficult to optimize flow management for all life stages of UWR Chinook and steelhead simultaneously, USACE is proposing the prioritization described below. Due to their value to population viability relative to younger life stages, adults were chosen as a priority when designing the minimum flow thresholds. Adult Chinook were further identified as a priority relative to adult steelhead because their presence in the freshwater system fully encompasses the steelhead spawning season. These species have very similar flow needs for spawning and pre-spawn mortality significantly constrains productivity of UWR Chinook.

The primary means of collaboration on real-time water management associated with the proposed flow measures would be through the WATER Flow Management and Water Quality Technical Team (FMWQT), consistent with existing standard practice. The frequency of those engagements is driven by conditions in any given conservation season. It is expected that results of annual operations would be reported on at the annual Science Meeting described in the adaptive management process, and documented with coordination memorandums and memorandums for the record through WFPOM (see Section 2.4).

Mainstem Willamette Minimum Flow Thresholds

The minimum flow thresholds at Salem, Oregon are divided into two to three levels as listed in table 2.3-3 for each time period. Each year the Northwest River Forecast Center develops an April-September water supply forecast. This annual forecast will be compared to the 30-year mean. The minimum flow to determine which level threshold applies and will be reviewed every two weeks. Flows are subject to change throughout the season based on the current hydrology and storage conditions. In extenuating circumstances different operations may be implemented through annual water management decisions, in coordination with WATER. Both 7-day moving average and instantaneous values are included to account for daily variability while recognizing an absolute minimum threshold to manage at or above. Minimum threshold flow values for Albany are included in addition to Salem to avoid meeting flows at Salem largely through releases from WVS dams in the North and South Santiam Sub-basins resulting in minimum thresholds not being achieved upstream of Albany and the confluence with the Santiam River.

Table 2.3-3. Mainstem Minimum Flow Thresholds.

Time Period	Water Supply Forecast Percent of 30 Year Average	Salem Minimum Flow, (7 Day Moving Average)	Salem Minimum Flow (Instantaneous)	Albany Minimum Flow
April	<80%	12,000	12,000	
April	80-100%	15,000	13,000	
April	>100%	17,800	14,300	
May	<80%	10,000	8,000	
May	80-100%	13,000	12,000	
May	>100%	15,000	12,000	
June 1 - 15	<80%	8,000	8,000	4,500
June 1 - 15	80-100%	10,000	10,000	4,500
June 1 - 15	>100%	13,000	10,500	4,500
June 16 - 30	<80%	5,500	5,500	4,500
June 16 - 30	>=80%	7,000	7,000	4,500
July	<80%	5,000	5,000	4,500
July	>=80%	6,000	5,500	4,500
August	<80%	5,000	5,000	4,500
August	>=80%	6,500	6,000	4,500
September	<80%	5,000	5,000	4,500
September	>=80%	7,000	6,500	4,500
October	<80%	7,500	6,000	4,500
October	>=80%	10,000	8,000	4,500

Notes: All flows are shown in cubic feet per second (cfs).

In addition to application of minimum flow thresholds, water releases from the WVS dams will be used adaptively during the months of April, May and June in each year to try and reduce water temperatures below pre-defined levels during important migration timeframes for Chinook and steelhead. The goal is to reduce the effects of heat waves and hot air temperatures on water temperatures. To accomplish this water will be released from WVS reservoirs above minimum thresholds to try to achieve the specified temperature target. The specific flow thresholds within this operational measure are based on the observed relationship between flow, air temperature, and water temperature during 2001-2018 (Stratton-Garvin et al. 2022). The accuracy of these regression equations relies on a weekly average (7dADM) metric. While the predicted 7dADM water temperature can be used to focus on specific days that exceed a threshold, adaptive management will be necessary to refine these tools to time flow augmentation with downstream effects on water temperature. Current tools are accurate on a weekly average accuracy. The following guidelines, as measured at Keizer (USGS 14192015; water temperature), Salem (USGS 14191000; streamflow), and Salem Airport (air temperature) are proposed during April-June. In real-time application, if flows identified in Table 2.3-4 are less than those identified from Table 2.3-3, then flows from Table 2.3-3 will be applied.

April - May

A 64ºF (17.8ºC) max threshold 7-day average of daily max (7dADM) water temperature targeting migrating juvenile steelhead corresponding to a minimum 10,000 cfs. This threshold corresponds to a maximum 78ºF 7dADM air temperature. Flow would be augmented up to

18,000 cfs, which would be used in advance of forecasted warmer air temperature up to about 90ºF 7dADM.

June 1-15

A 68ºF (20ºC) max threshold 7-day average of daily max (7dADM) water temperature targeting adult Chinook corresponding to a minimum 8,000 cfs. This threshold corresponds to a maximum 80ºF 7dADM air temperature. Flow would be augmented up to 14,000 cfs, which would be used in advance of forecasted warmer air temperature up to about 89ºF 7dADM.

June 16-30

A 69ºF (20.6ºC) max threshold 7-day average of daily max (7dADM) water temperature in May targeting adult Chinook corresponding to a minimum 8,000 cfs. This threshold corresponds to a maximum 82ºF 7dADM air temperature. Flow would be augmented up to 14,000 cfs, which would be used in advance of forecasted warmer air temperature up to about 92ºF 7dADM.

To apply this flow regime to ResSim, a long-term dataset of the 7dADM air temperature at Salem airport was used (calculated in a "look-ahead" fashion on the upcoming 7 days) to decide whether the forecasted air temperature would be exceeding the triggers defined for each period described above. If air temperature was forecasted to be above the threshold, augmentation from the WVS would occur according to Table 2.3-4 up to the limits defined for each period. Res-Sim does not specify which projects would provide the flow augmentation.

These proposed fish flow targets for temperature management are intended to reduce thermal stress on ESA-listed fish and reduce mortality during extreme heat.

Deviations from the above approach will be considered as part of the WATER process, in coordination with the WFMWQT (see Appendix A to this document). Forecasted 7-day average of daily maximum air temperature at Salem, Oregon will be monitored twice weekly during April-June and coordinated with the WFMWQT for integrating the adaptive flow measure framework into Willamette regulation schedules. Deviations could be expected where operational changes are necessary for project maintenance activities or emergency outages, and due to hydrologic variability requiring changes in flow management designed to avoid and minimize impacts to ESA-listed species. Deviations should be developed based on the best available scientific information and with assumptions about risks, benefits, and uncertainties clearly stated and documented.

Table 2.3-4. Threshold Flows for Cooler Temperatures in Each Timeframe in kcfs.

Air Temperature Threshold [1].	Apr – May - Flow (kcfs) Needed to Keep Below 64ºF Water Temperature	Jun 1-15 - Flow (kcfs) Needed to Keep Below 68ºF Water Temperature	Jun 15-30 - Flow (kcfs) Needed to Keep Below 69ºF Water Temperature
74	8.7	6.4	5.9
75	9	6.6	6
76	9.3	6.9	6.2
77	9.6	7.2	6.5
78	9.9	7.5	6.7
79	10.3	7.8	6.9
80	10.7	8.1	7.2
81	11.2	8.5	7.5
82	11.7	8.9	7.9
83	12.2	9.4	8.2
84	12.7	9.9	8.6
85	13.4	10.4	9
86	14	11	9.5
87	14.7	11.8	10.1
88	15.4	12.7	10.6
89	16.4	13.7	11.3
90	17.4	14.9	12
91	18.6	16.1	12.9
92	19.8	17.7	14
93	-	19.6	14.8

Note: * Threshold Flows at which flow augmentation could provide cooler temperatures in each timeframe and an associated water temperature threshold of which not to exceed. Flows provided in kcfs; temperature estimate in degrees F. Source Stratton, et. al. (in press)

Tributary Minimum Flow Thresholds

The 2008 biological opinion and RPA recognized the 2008 RPA minimum flow targets are not achievable in dry years, as it is not possible to maintain these flow levels in all water years using reservoir storage to augment seasonal stream flows due to naturally occurring hydrologic conditions. This often requires USACE, in coordination with WFMWQT, to make difficult decisions to balance the various flow needs for fish when there is insufficient storage. Recognizing this issue, the 2008 RPA required the Action Agencies to study (RPA 2.4.2) and refine (RPA 2.4.3) the tributary flow targets. Based on a decade of study under RPA 2.4.2, the Action Agencies propose a refinement to these targets as part of the proposed action, consistent with the requirements of RPA 2.4.3.

Two separate minimum flow thresholds for the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette, were developed for the conservation season based on individual pool elevations (Table 2.3-5). One threshold applies when reservoir pool elevations are below 90% of the rule curve elevation, and the other threshold for when the reservoir pool elevation is at or above 90% of the rule curve (see Section 2.2.2.2 for more on the rule curve). In application each year, the minimum flow threshold applied in real-time is chosen according to the pool elevation (< or > 90% of the rule curve) every 2 weeks between February 1 and June 1. The minimum flow thresholds corresponding to the reservoir storage achieved in each tributary on June 1 is then adopted for the remainder of the conservation season. For example, at Detroit Dam, if the reservoir elevation on April 1 is 90% or closer to where it should be on that date, the minimum release would be 1200 cfs; if the reservoir is less than 90% full relative to that date's expected elevation, then the minimum release for fish purposes would be 1050 cfs.

For the higher flow threshold, the early minimum flows provide >=90% Wetted Usable Area (WUA) for Chinook and steelhead spawners below the WVS dams for each tributary (R2 2013, 2; River Design Group and HDR 2015). The lower flow provides 80% WUA for spawning and incubation below WVS dams (R2 2013, 2; River Design Group and HDR 2015). An 80% WUA [NMFS edits in italics] *was borrowed from an older NMFS and USFWS (2013) Biological Opinion for a completely different basin, with different ESA-listed species, and critical habitat elements.*

The minimum flow thresholds for both wetter and drier conditions increase then from the early minimum values according to optimal hydrograph shapes determined by Peterson, Pease, et al. (2022). The results of these studies indicate that water temperature is likely driving the shape of the optimal flow regimes they identified, and drive what is the best candidate for a minimum flow.

Table 2.3-5. Tributary Minimum Flow Thresholds for WVS Reservoirs. *

Start Date	Detroit / Big Cliff >90%	Detroit / Big Cliff <90%	Green Peter / Foster >90%	Green Peter / Foster <90%	Blue River all levels	Cougar** >90%	Cougar** <90%	Fern Ridge all levels	Hills Creek all levels	Lookout Point/ Dexter >90%	Lookout Point / Dexter <90%	Fall Creek all levels	Cottage Grove all levels	Dorena all levels
1-Feb	1050	1050	1140	700	50	300	250	50	400	1200	1000	50	75	190
15-Feb	1050	1050	1140	700	50	300	250	50	400	1200	1000	50	75	190
1-Mar	1050	1050	1140	700	50	300	250	50	400	1200	1000	50	75	190
15-Mar	1050	1050	1140	700	50	300	250	50	400	1200	1000	50	75	190
1-Apr	1200	1050	1200	700	50	360	250	50	400	1440	1000	80	75	190
16-Apr	1500	1050	1500	700	50	450	250	50	400	1800	1000	80	75	190
1-May	1550	1050	1550	770	50	465	275	50	400	1860	1100	80	75	190
16-May	1600	1050	1600	840	50	480	300	50	400	1920	1200	80	75	190
1-Jun	1550	1050	1550	910	50	465	325	50	400	1860	1300	80	75	190
16-Jun	1500	1120	1500	980	50	450	350	50	400	1800	1400	80	75	190
1-Jul	1400	1200	1400	1140	50	420	375	30	400	1680	1500	80	50	100
16-Jul	1250	1280	1250	1140	50	375	400	30	400	1500	1600	80	50	100
1-Aug	1250	1050	1140	1140	50	375	325	30	400	1500	1300	80	50	100
16-Aug	1250	1050	1140	1140	50	375	300	30	400	1500	1200	80	50	100
1-Sep	1250	1050	1140	1140	50	375	300	30	400	1500	1200	200	50	100
16-Sep	1200	1050	1140	1140	50	360	300	30	400	1440	1200	200	50	100
1-Oct	1200	1050	1140	1140	50	360	300	30	400	1440	1200	200	50	100
15-Oct	1200	1050	1140	1140	50	360	300	30	400	1440	1200	50	50	100
1-Nov	1200	1050	1140	1140	50	360	300	30	400	1440	1200	50	50	100
15-Nov	1200	1050	1140	1140	50	360	300	30	400	1440	1200	50	50	100

Notes: * Tributary minimum flow thresholds corresponding to reservoir elevation of ≥90% of the water control diagram (rule curve) or < 90% of the water control diagrams for WVS reservoirs.

** For preferred alternative, Cougar minimum flow 1 = flow 4 due to deep drawdown.

Where minimum flows required for dam operations are greater than flows listed in the table, those project-specific minimums will be applied in place of those minimums listed. These include an operating outflow minimum limit of 1050 cfs from Detroit/Big Cliff dams, and 1350 cfs for Lookout Point/Dexter dams.

From September 1 to October 15, maximum outflows from DET/BCL, GPR/FOS, CGR, and LOP/DEX will be applied to protect against redd dewatering after the spawning season (Table 2.3-6). Because high flows encourage spawning in areas of the river which could become dewatered after reservoirs have been drafted for flood risk management, reducing egg and fry survival, maximum flows were developed based on spawning WUA estimates developed by R2 (2013) River Design Group and HDR (2015). The 75% WUA spawning flow at the upper portion of the WUA flow relationship was chosen. This flow level is higher than the 100% WUA flow estimates by R2 (2013) and RDG (2015). The 75% WUA spawning flow level was chosen to help balance the need to encourage spawning in areas that will remain wetted after reservoir drafting and the need to increase flows to draft reservoirs for flood management.

Table 2.3-6. Maximum Annual Sep. 1 to Oct. 15 Outflows During Chinook Spawning.

Chinook spawning	North Santiam (Big Cliff) [a]	South Santiam (Foster) [a]	South Fork McKenzie (Cougar) [b]	Middle Fork Willamette (Dexter) [c]
Recommended Max Spawning Q (75% WUA Q; cfs)	2175	2825	880	3500
For reference:				
100% WUA Q (cfs)	1300	1500	500	1900
For reference: 2008 biological opinion max spawning season flows (cfs)	3000	3000	580	3500

Notes: Maximum outflows to be achieved during the Chinook spawning season, September 1 to October 15, annually. Flows based on average Wetted Usable Area (WUA) values across study reaches for flows achieving 75% of the spawning habitat below these dams as reported by R2 (2013) and RDG (2016), as averaged across study reaches.

[a] Average of reaches 1 and 2 from R2 2013.

[b] Average of mainstem S. Fork transects 1,2,3,7 from RDG 2016.

[c] Average of Mainstem transects 1,2,3,10 from RDG 2016.

Tributary Target Temperatures

Target temperatures for water releases have been developed to guide operations at WVS dams. These targets are based on analysis of observed unregulated water temperatures upstream of the dams occurring since 2000, when high-resolution water temperature data has been available for the Willamette Basin (Figure 2.3-2). See sub-basin-specific subsections below and WVS DPEIS Appendix D, 1.4 for more details.

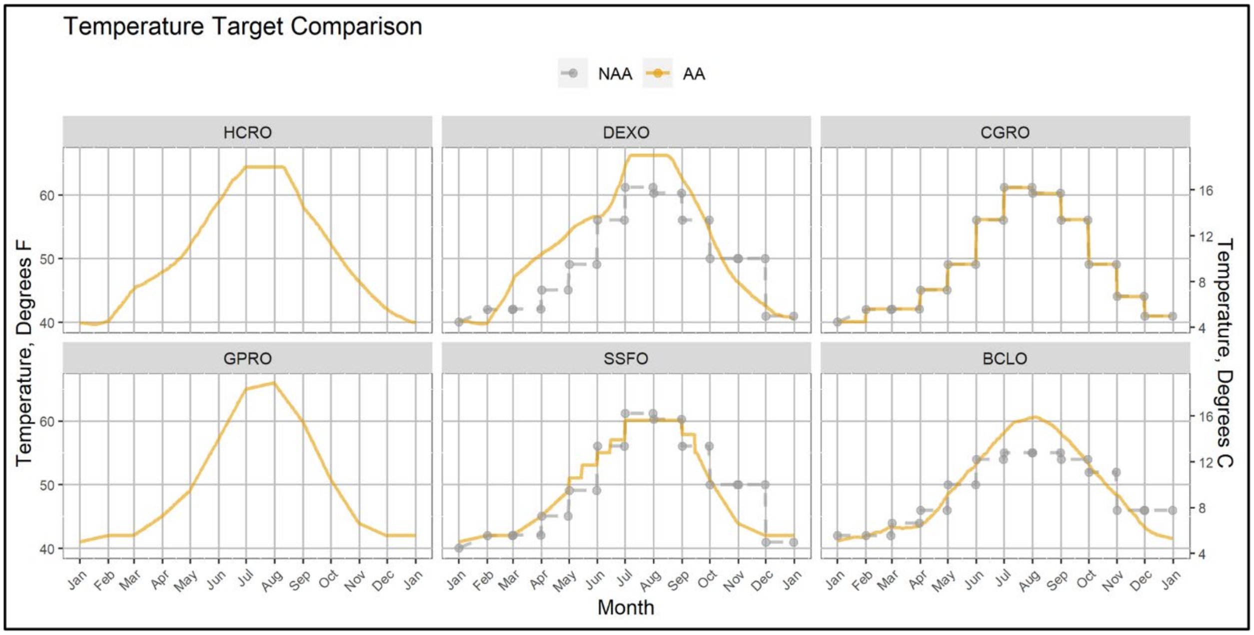

Figure 2.3-2. Temperature Targets Used at Each CE-QUAL-W2 Reservoir Temperature targets used at each CE-QUAL-W2 reservoir temperature model within the WVS DPEIS for all alternatives except No Action (labeled "AA") compared to maximum temperature targets used operationally by USACE from 2017 to 2022 (labeled "NAA"). Sites are defined as below the following dams: Detroit-Big Cliff: BCLO, Green Peter: GPRO, Foster: SSFO, Cougar: CGRO, Hills Creek: HCRO, Lookout Point-Dexter: DEXO. Note: HCRO and GPRO sites did not have NAA operational temperature targets defined.

Table 2.3-7. Comparison NAA and AA Maximum Temperature Targets by Reservoir *

Month	HCRO AA	DEXO AA	DEXO NAA	CGRO AA	CGRO NAA	GPRO AA	SSFO AA	SSFO NAA	BCLO AA	BCLO NAA
Jan	40.0	40.4	40.1	40.1	40.1	41.0	41.0	40.1	41.2	42.0
Feb	40.2	39.9	42.0	42.1	42.0	42.0	42.0	42.0	42.0	42.0
Mar	45.2	46.6	42.1	42.1	42.1	42.1	42.1	42.1	43.4	44.0
Apr	48.0	50.7	45.1	45.1	45.1	45.1	45.1	45.1	43.7	46.0
May	52.3	54.2	49.1	49.1	49.1	49.3	51.1	49.1	48.5	50.0
Jun	59.0	56.6	56.1	56.1	56.1	57.3	55.0	56.1	53.4	54.0
Jul	64.4	64.6	61.2	61.2	61.2	65.0	60.1	61.2	58.2	55.0
Aug	64.4	66.2	60.3	60.3	60.3	65.8	60.1	60.3	60.5	55.0
Sep	58.1	62.5	56.1	56.1	56.1	59.7	57.9	56.1	58.0	54.0
Oct	52.3	54.2	50.0	49.1	49.1	50.8	50.8	50.0	53.2	52.0
Nov	46.4	46.3	50.0	44.1	44.1	43.9	43.9	50.0	48.4	46.0
Dec	42.1	42.6	41.0	41.0	41.0	42.0	42.0	41.0	43.3	46.0

Notes: * Comparison of maximum temperature targets used operationally (labeled "NAA"), and temperature targets used in the WVS DPEIS temperature simulations for all alternatives except No Action (labeled "AA"). Monthly values for AA targets are provided based on the target for the 1st day of each month even though targets vary daily. Sites are defined as below the following dams: Detroit-Big Cliff: BCLO, Green Peter: GPRO, Foster: SSFO, Cougar: CGRO, Hills Creek: HCRO, Lookout Point-Dexter: DEXO. Note: HCRO and GPRO sites did not have NAA operational temperature targets defined.

Augment Instream Flows Utilizing Power Pool

To increase flexibility in meeting flow requirements for the species, USACE will use water stored within the power pools at Detroit, Green Peter, Lookout Point, and Hills Creek to supplement downstream flows to assist in meeting minimum tributary flows during the summer and late fall. Under project authorities, the power pool has historically been reserved exclusively for power generation, with the ability to modestly draft into the power pool on a case-by-case basis. Decisions to use water from the power pool must be coordinated with BPA to ensure that power requirements have also been considered.

Using water from the power pool would occur when natural stream flows are not adequate to meet minimum flow targets included in Table 2.3-5. The measure would only be implemented to meet ESA obligations and not to provide water to meet consumptive needs. Due to the annual variability in hydrologic conditions throughout the basin, a set priority for use of the power pools is not possible and would be determined on an as-needed basis based on flow conditions in the tributaries. An annual coordination process would be defined. The draft limits would be based on project location.

Table 2.3-8. Power Pool Elevations, Storage Volume and Percent Total Storage.

Project	Lowest Proposed Draft Elevation Limit [1, 2]	Minimum Conservation Pool Elevation [2.]	Power Pool Storage Volume [3.]	Power Pool Storage [4.]
Detroit	1,425	1,450	36,375	21.2%
Green Peter	887	922	62,600	36.5%
Lookout Point	819	825	11,377	6.6%
Hills Creek	1,414	1,448	48,800	28.5%

Notes: [1.] (Minimum Power Pool Elevation)
[2.] Elevations are in feet NGVD29.
[3.] Reservoir storage volumes are in Acre-Feet (ac-ft).
[4.] Power Pool Storage is shown as a percentage of total storage.

The re-regulating reservoirs Dexter and Big Cliff do not have power pool storage. Foster has the smallest amount of power pool storage in the WVS (3.6 acre-feet); the available amount is basically negligible in comparison to the other reservoirs with power pool storage in the WVS. Therefore, Dexter, Big Cliff, and Foster would not be included.

Augment Instream Flows Utilizing Inactive Pool

Instream flows would be augmented using the inactive pool for Blue River and Fall Creek dams. The inactive pool is designed to trap sediment and is the lowest storage area in a reservoir. The inactive storage by volume for these four reservoirs are listed in Table 2.3-9. Because the inactive pool is the last available storage in a reservoir, inactive pool water is traditionally reserved for extreme droughts, emergencies, and used only after the conservation pool has been emptied. Drafting into inactive storage increases the risk of not refilling the reservoirs depending on the water year. In 2015, Willamette Valley reservoirs drafted into the inactive storage pool to meet minimum flows with minimum effects (USACE 2015).

Table 2.3-9. Inactive Storage Volume by Project.

Project	Inactive Storage Volume [1.]	Inactive Storage [2.]
Blue River	3,430	1.0%
Fall Creek	9,505	2.6%

Notes: [1.] Volumes are in acre-feet.
[2.] Inactive Storage is shown as a percentage of total storage

Using the inactive pools would assist in meeting downstream minimum flows during the late summer and fall. The reservoirs are generally not drafted below their minimum conservation pools, unless hydrologic conditions result in reservoir inflows less than what is needed to provide downstream minimum flows. Water stored in the designated inactive pools would be used to support meeting minimum flow targets when natural streamflows are inadequate. This measure would allow the water stored in the inactive pool to be used when needed without additional analysis on a case-by-case or year-by-year basis. The lowest outlet in the reservoir would be used to draft the reservoir to the desired elevation without a need for structural modifications. If the minimum conservation pool elevation is reached before September 1, the elevation would be dropped to the low flow target. If the minimum conservation pool elevation is reached after September 1, the existing flow target would be kept.

Gravel Augmentation

A sediment nourishment program would be developed and implemented below Big Cliff, Foster, Cougar, and Blue River dams as part of the proposed action. USACE would seek authorization of these ecosystem restoration projects and then would begin the studies and designs necessary to implement individual projects. USACE would determine an appropriate sediment gradation and annual nourishment quantity at appropriate injection sites to achieve the desired habitat improvements for spawning adult and rearing juvenile spring Chinook and winter steelhead. USACE would also determine if modifications to reservoir outflows would be necessary for sediment nourishment program success. This component would be part of the AM Plan (Appendix A), which would ensure that expected habitat gains are realized and negative effects are minimized and provide the necessary flexibility to adjust the program to real-world site conditions observed.

Adapt Hatchery Program

Congress authorized USACE to mitigate for the construction of the WVS, recognizing that the dams would block habitat access to habitat for migratory fish and inundate habitat that would otherwise have existed along free-flowing rivers and several hatchery facilities. USACE has done so by funding the production and release of hatchery salmon, steelhead trout, and rainbow trout. In the authorizing statute Congress did not define detailed goals for mitigation or the level of fish production to be achieved. It has been within USACE discretion to determine how to implement the fish mitigation program, either through hatchery programs, passage improvements, or a combination of the two. Current levels of mitigation production are defined in HGMPs prepared by ODFW and USACE as discussed in Sections 1.5.5 and 1.8.3 [sections in

BA, USACE 2023a]. The effects associated with the USACE funded hatchery mitigation program have been previously consulted on in the NMFS (2019a) *Evaluation of Hatchery Programs for Spring Chinook Salmon, Summer Steelhead, and Rainbow Trout in the Upper Willamette River Basin*, Biological Opinion (henceforth referred to as the 2019 Hatchery Biological Opinion, see sections 1.5.5, 1.8.3 and 4.6.1 in [in BA, USACE 2023a]for a program description, consultation history, and environmental baseline effects, respectively).

The overall goal of this new measure is to adjust production of WVS hatcheries for mitigation obligations and conservation needs after demonstrated improvements to fish access to habitat above dams. This is consistent with the terms and conditions of the 2019 NMFS Biological Opinion for the hatchery program (term and condition 1a), as well as the stated objectives of the spring Chinook HGMPs (i.e., Objective 4 in the Middle Fork Willamette Spring Chinook HGMP). Each sub-basin hatchery program will be considered separately according to the metrics and protocols described. A summary of this action is included below; the full description, including metrics and protocols for when and how adjustments to production will be considered and applied, is included in WVS DEIS Appendix A. When the metrics trigger a change to Chinook production USACE will coordinate with the NMFS on whether or not the proposed change triggers reinitiation of the 2019 Hatchery Biological Opinion.

Hatchery Chinook salmon - Before fish passage improvements at WVS dams in each sub-basin, hatchery juvenile spring Chinook releases and outplanting of adult spring Chinook hatchery fish above dams will occur according to the HGMPs and NMFS associated 2019 biological opinion. Following the implementation of fish passage improvements, hatchery spring Chinook production will remain at production levels as defined in the HGMPs, and hatchery-origin returns (HORs) would continue to supplement natural-origin returns (NORs) in order to meet, but not exceed, the abundance thresholds as defined in the HGMPs, and until decision criteria are achieved for the following metrics: annual dam passage survival , measured in two separate years within the first five years, and cohort replacement rate (CRR) for three separate cohorts. If the CRR for Chinook is >1 based on a geometric mean, then the full credit for fish passage improvements will be applied. In this case Chinook production will be reduced over a period of five years to a Reduced Level of Production (see WVS DPEIS Appendix A). If CRR < 1 after implementation of passage improvements for seven years, then mitigation credit reductions will not occur at this time and instead be re-assessed again after year 14. If CRR remains < 1 after year 14, further assessment of the major factors affecting population performance (those relating to the WVS and those not) will occur to help inform management decisions.

Hatchery rainbow trout - trout hatchery mitigation needs after fish passage improvements at WVS dams will be developed with the State of Oregon. The initial authorization for game fish mitigation related to construction and operation of the WVS was based on concerns about the productivity of resident fish given impoundment and inundation by authorized projects. Trout mitigation changes as it relates to passage improvements at WVS may be important to consider given these assumptions about productivity of resident trout in reservoirs, addressing effects of ongoing hatchery trout stocking on ESA-listed fish reintroduction and natural production (including local fisheries for hatchery stocked trout), and/or to account for other mitigation credits that have or are continuing to occur (e.g., BPA is directly addressing the mitigation for inundation through the Wildlife Enhancement Memorandum of Agreement; BPA & ODFW 2010). Impacts to ESA-listed fish from rainbow trout is recognized and the current HGMPs describe approaches to limit overlap of rainbow trout and ESA-listed fish. USACE anticipates that further changes may need to be made once passage is implemented to limit impacts on reintroduced populations.

Hatchery Summer Steelhead - In association with improved fish passage conditions at WVS dams, any changes to the mitigation hatchery production of summer steelhead as funded by USACE will also be developed with the State of Oregon. Non-native hatchery summer steelhead are produced to mitigate for the effects of the WVS on native ESA-listed winter steelhead. Plans for any reintroduction of winter steelhead above WVS dams (including within the UWR Steelhead Distinct Population Segment) have not been developed. Summer steelhead provide no conservation value to support winter steelhead reintroduction above WVS dams and are known to have negative impacts on winter steelhead in the Willamette Basin (e.g., fitness effects associated with introgression). It also may not be feasible to assess winter steelhead CRR. Progeny of rainbow trout and steelhead can become either resident (rainbow trout) or anadromous (steelhead). Recent work indicates that non-anadromy may be an adaptive strategy in response to reservoir inundation with lack of adequate passage and that these strategies are plastic, i.e., anadromous females can breed with non-anadromous males with documented success of anadromous progeny as summarized in McAllister et al. (2022). Estimates of CRR for steelhead are uncertain given some offspring will remain in freshwater and mature as rainbow trout, and some adult steelhead returns will be progeny of rainbow trout.

Maintain Revetments Using Nature-based Engineering/Alter for Ecosystem Restoration

As described in section 1.5.4 above, the WRBBPP consists of 193 active bank protection structures, 83 of which are maintained by USACE and 105 of which are maintained by a local non-federal sponsor. Under the proposed action, USACE would continue to carry out basin wide maintenance of individual revetments when necessary and funded for WRBBPP bank protection structures currently operated and maintained by USACE. In doing so, it would incorporate more natural materials and nature-based engineering principals to the extent that it does not change the purpose of the project. Funding for maintenance of the existing revetments is requested as part of each budget cycle but has not been received in many years.

Changes to these structures beyond these existing limits on authority would require a modification or change to project purpose. USACE would seek opportunities to work with non-federal sponsors to assess feasibility of an environmental restoration project that would substantially alter an USACE maintained revetment project. The Continuing Authority Program Section 1135 Project Modifications for Improvement of the Environment (WRDA 1986) is the only authority that allows USACE to alter a federal project for ecosystem restoration purposes. This program requires a non-federal cost-share sponsor to proceed. Site-specific design and environmental compliance would be required at the time of implementation.

Existing information would be used to identify projects with the greatest potential; however, additional technical analysis would likely be necessary to further evaluate potential effects of the modifications to downstream property owners and projects. Post-construction monitoring would also be conducted to ensure that the project performs as intended, both biologically and for bank protection. This information would also be used to investigate the implementation of future substantial alterations to revetments.

Revetments constructed by USACE that are now owned and maintained by non-federal sponsors, where the non-federal sponsor is interested in modifying revetments are subject to review and permitting requirements the Clean Water Act and the Rivers and Harbors Act. While USACE is responsible for the administration of portions of these regulatory programs, as delegated to them by Congress, those programs are outside the scope of this action and Consultation, as they are statutorily defined and nondiscretionary.

Maintenance of Existing and New Fish Release Sites Above Dams

Basin wide actions would be taken to ensure safe and effective release of adult fish above the dams. Outplanting refers to the release of hatchery adult Chinook above a dam for reintroduction or supplementation, transporting refers to the trapping and upstream passage of natural origin adult spring Chinook and winter steelhead to stream reaches above WVS dams. Specific actions would vary within the Willamette River Basin by upstream reach, but in general, adult hatchery fish would be outplanted to support salmonid reintroduction with a goal of eventually only transporting returning adult wild fish to locations upstream of barriers to migration (dams and reservoirs). This reintroduction effort will be planned and implemented under a pending Reintroduction Plan produced by ODFW and NMFS. The sites in Table 2.3-10 are proposed based on their access to high quality habitat. Some proposed sites may require minor improvements. In these cases, site-specific designs and environmental compliance would be completed prior to construction, if needed.

Table 2.3-10. Current and Proposed Adult Release Sites.

Project	Description	Existing or Proposed Status
Detroit	Private Site	Proposed
Detroit	Breitenbush USGS Gauge Site (#14179000)	Proposed
Detroit	Parrish Lake Road (Upper)	Existing
Detroit	Cooper's Ridge (Lower)	Existing
Minto	North Santiam River upstream of Minto	Existing
Foster	Gordon Road (Upper)	Existing
Foster	River Bend A (Lower)	Existing
Foster	Reservoir release	Proposed
Cougar	Hardrock campground (lower)	Existing
Cougar	Homestead campground (upper)	Proposed
Lookout Point	Site 1 (lower)	Existing
Lookout Point	Site 3 (upper)	Proposed
Fall Creek	Gold Creek Confluence (upper)	Existing
Fall Creek	Site C (lower)	Existing
Hills Creek	Construction site (spur road)	Existing
Hills Creek	Paddy's Valley	Existing
Blue River	Lower release site 2-5 miles above head of reservoir	Proposed
Green Peter	Lower release site 2-5 miles above head of reservoir in Quartzville Creek	Proposed
Green Peter	Lower release site 2-5 miles above head of reservoir in Middle Santiam	Proposed

Existing Operations Continued

These ongoing actions, will continue under the proposed action with the signing of the Record of Decision.

Sustainable Rivers Project – Environmental Flows

Implementation of environmental flows, or e-flows, will continue. These flows were developed by USACE in coordination with The Nature Conservancy at multiple projects within the WRB. The implementation of e-flows is event-driven, meaning they are based on regulator/operator judgment and constrained by FRM operations. Maximizing e-flows is valuable to efficiently manage aquatic habitats as it creates both opportunities for, and the means to manage, fish spawning, incubation, and other habitat needs. Fish populations and other aquatic organisms are adapted to these variable flow conditions.

Each seasonal flow contributes to some aspect of ecosystem health. Fall flows occur from October to November, winter high flows occur from November to February, and smaller spring flows occur from March to June. Environmental flow (E-flow) recommendations have been developed for the Middle Fork Willamette River, McKenzie River, and the North, South, and mainstem Santiam Rivers. Flow recommendations are defined by event duration, number of events per year, range of flow magnitude, and frequency.

E-flow operations are governed by the Water Control Manual operational requirements for each project and the 2008 NMFS biological opinion. The general intent is to maximize opportunities for achieving e-flows while considering operational constraints and forecast uncertainty. E-flow operations require the use of stored water to achieve environmental goals. This can be particularly difficult to achieve during hydrologically and meteorologically dry water years.

Continued Operation of Existing Adult Fish Facilities

USACE would continue to operate and maintain the existing adult fish collection facilities located at Dexter, Foster, Fall Creek, Minto (downstream of Big Cliff), and Cougar dams in accordance with the Willamette Fish Operations Plan (WFOP). The WFOP guides USACE actions related to fish protection and passage at the 13 Willamette projects and is updated annually by USACE in coordination with the BPA as well as regional federal, state, and Tribal fish agencies and other partners through the Willamette Fish Passage Operations and Maintenance work group (WFPOM). Generally, adult fish collection facilities are operated annually between March and October. However, the WFOP describes year-round operations and maintenance (O&M) activities of the adult fish collection facilities, as coordinated through WFPOM, to protect and enhance anadromous and resident fish species listed as endangered or threatened under the ESA, as well as non-listed species of concern including lamprey.

In addition to an overview of each subbasin, the facilities, and the dam operations, sections of the WFOP related to fish are: Section 5. Fish Facility Operations, Section 5.2.1. Fish Collection and Handling, Section 5.2.2. Transport and Outplanting, and Section 6. Fish Facility Maintenance. For adult fish, the WFOP states:

> "*Disposition of adult fish will be determined annually vetted through WFPOM, and published or attached in the WFOP upon finalization.*"

Specifically, this includes targets for hauling frequencies, outplanting release sites, and a target number of adult spring Chinook to be outplanted by location. The goals are updated annually by the WFPOM team.

Additional instructions for fish handling were added to Section 5.2.1 and continue to be followed, such as the description of a fin clip sampling procedure in the North Santiam Subbasin Fish Operating Plan:

> *"5.2.1.17 During processing/sorting, fin clip samples will be collected for genetic analysis from all natural-origin (intact adipose fin) adult Upper Willamette River (UWR) spring Chinook salmon and winter steelhead collected. These samples will be preserved, associated with any relevant individual ID information (e.g., floy tag number) and data collected at sorting, and stored at the facility with appropriate records..."*

The WFOP lists the specific maintenance periods for each fish facility, such as when ladders or sorting pools could be shut down or dewatered. Additionally, the WFOP dates for the inspections, and the readiness of the facilities for operation, are listed for reporting to the WFPOM Team. It also describes specific maintenance activities that would require dewatering, with the steps prior to and during the dewatering including fish salvage. The annual WFOP would follow the existing example provided in Appendix F to the 2023 Biological Assessment, and additional information on adaptive management governance and interagency coordination is provided in section 2.3.4 and 2.3.5 below.

2.3.3 Coast Fork and Long Tom Sub-basins

USACE is not proposing significant changes to the current operations and maintenance for these sub basins under the proposed action, remaining unchanged from those described in the 2007 BA and 2008 NMFS Biological Opinion (Usace 2007; NMFS 2008a). One minor potential change would be small changes to releases due to the proposed flow management measure (see Section 2.2.2.3). These changes would occur predominantly in the summer when there is a very low likelihood of UWR Chinook and UWR steelhead presence. As part of a separate effort, thus not a part of this proposed action, USACE is partnering with a non-federal sponsor to investigate the removal of the Monroe drop structure on the Long Tom river, if implemented this could improve fish passage in that reach.

2.3.4 Middle Fork of the Willamette Sub-Basin

Under both the interim and long-term measures adult fish facility operations, including upstream passage, will continue to be implemented. In the Middle Fork Willamette this occurs at both the Fall Creek and Dexter adult fish facilities. During early implementation the Dexter adult facility will be reconstructed pursuant to the court ordered Injunction.

Annual operations and maintenance, including fish disposition and release locations will be coordinated through the interagency coordination process described in the adaptive management and Willamette Fish Operations plans. This is discussed in greater detail in Section 2.2.2.

Middle Fork Willamette Interim Operations

Hills Creek

In support of fall and winter downstream fish passage for juvenile UWR Chinook, USACE would prioritize RO flows at night (from 1800 to 2200) when the Hills Creek Reservoir is <EL 1460 ft. Modifications to the timing and duration of this prioritized RO operation will be evaluated as part of adaptive management. Table 2.3-11 summarizes the trigger, timing, and implementation of the interim flow measures at Hills Creek.

Table 2.3-11. Interim operations at Hills Creek in the Fall

	Value
Duration (Hours/Days)	Daily From 1800 - 2200
Target Date	Fall, once the reservoir elevation is 50 feet or less above the regulating outlets
End Date	March
Max pool elevation (ft, datum NGVD29)	1,459 ft or below
Outlet (RO/spillway/etc.)	RO (minimum gate opening 1.25 feet)

Lookout Point

Interim measures at Lookout Point would consist of a drawdown in the fall and utilization of the spillway in the spring in support of fish passage for juvenile UWR Chinook as well as downstream temperature management. For the fall fish passage operation, drawdown of the reservoir would begin on 1 July at a rate necessary to achieve a target pool of EL 750 by 15 November. Between 1 September and 15 October, the total discharge of the dam would be maintained at, or below, maximum flows for spawning (3500 cfs). After spawning has concluded, the draft rate will be revised to ensure the target elevation is reached as early as 15 November. The target elevation would be maintained if feasible for a minimum of 3 weeks, but no later than 15 December. Drawdown will be prioritized through the ROs anytime the reservoir is below minimum conservation pool elevation. The reservoir would then refill to the minimum conservation pool as feasible.

The refill of Lookout Point Reservoir to just above spillway crest (EL 890) would start on 01 February to support the spring downstream fish passage operation. If necessary to refill Lookout Point Reservoir, storage from Hills Creek Reservoir may be used in early March. Once Lookout Point Reservoir elevation is 2.5 feet over spillway crest (EL 890), continuous, ungated spill would occur using as many gates (five are available) as needed to approximate the rate of inflow to maintain the reservoir level between EL 890 and EL 893. Additionally, nighttime (dusk to dawn) spillway releases at Dexter would also be implemented. This operation would occur for as long as water conditions allow, for at least 30 days. Additionally, USACE would operate the Lookout Point powerhouse only as needed to remain within the desired reservoir elevation limits, or to control downstream total dissolved gas (TDG).

After the initial 30-day period, gated spill at night at both projects (Lookout Point and Dexter), with generation during the day, would continue until 1 July when the gradual start of reservoir drawdown (for the fall downstream fish passage) would commence. Throughout the late summer and fall, the ROs would be used as needed to reduce downstream water temperatures when water temperatures downstream of Dexter Dam are near 60 degrees. This operation would be carried out as long as possible and prior to reservoir turnover.

Table 2.3-12 summarizes the trigger, timing, and implementation of the interim operations measures at Lookout Point.

Table 2.3-12. Lookout Point Interim Operations in Spring, Summer, and Fall/Winter

Timing Metric	Fall Downstream Passage	Early Spring Fish Passage	Summer Fish Passage	Summer/Fall Temperature
Duration (hours/days)		24 /7	Nighttime spill	
Target Date*	15 November	15 March	16 March	15 July
End Date	15 December	For at least 30 days (or until reservoir is below 890')	Until reservoir is below spillway crest	~15 October
Min pool elevation (ft, datum NGVD29)	-	890 ft	890 ft	-
Max pool elevation (ft, datum NGVD29)	761 ft	893 ft	No upper limit	887.5 ft
Outlet (RO/spillway/etc)	RO Min opening 1 foot	Spillway (ungated)	Spillway (gated)	RO (with turbine use) Min RO opening 1 foot

Note: *Drawdown would start in the summer, with a target of reaching targeted elevation by 15-November.

Middle Fork Willamette Long Term Measures

Water Quality

No water quality measures are proposed at Hills Creek, Lookout Point, or Dexter dams.

Fish Passage

A structural fish passage solution is being proposed to provide downstream fish passage at Lookout Point Dam. USACE believes a Floating Surface Collector (FSC) (pumped flow only) is the most likely solution, but the final selection of a design will occur as part of the engineering and design phase. An FSC would collect fish near the dam and allow for them to be transported downstream via 'trap and haul' methods. The FSC would be attached to a mooring structure located near the upstream face of the dam. Site specific design, including construction approach, and environmental compliance documentation would need to be completed before the FSC could be constructed.

The Fall Creek operation is a drawdown to the bottom of the regulating outlet at elevation 780 ft. The operation targets the drawdown to this elevation in late fall, but the annual dates are dependent on the actual hydrologic conditions in the sub-basin. Typical drawdown begins in October but can be as late as early December depending on hydrology. Once the target elevation is achieved, the reservoir is held at this elevation for two weeks before refilling the reservoir to minimum conservation pool. This operation was modeled off the Fall Creek operations from 2011 to 2021.

[USACE interpretation]: Analysis of the proposed action estimates Chinook population performance is expected to result in natural sustainable populations of Chinook above dams in the four sub-basins affected by the WVS in this ESU. The WVS DEIS analysis also indicated that the performance of the Middle Fork Chinook population may be lower if passage is included at HCR, in comparison to only at Lookout Point Dam. The need for long-term fish passage at Hills Creek Dam will be determined as part of the Adaptive Management Plan and process. USACE commits to establishing a check-in point with the Services, as described in the Adaptive Management Plan (Appendix A) to determine an appropriate downstream passage solution at Hills Creek Dam if UWR Chinook downstream passage is not successful in at least 3 out of 4 of the proposed locations where passage is proposed.

2.3.5 McKenzie Sub-basin

Adult fish facility operations, including upstream passage, will continue to be implemented at the Cougar Dam adult trap. Annual operations and maintenance, including fish disposition and release locations will be coordinated through the interagency coordination process described in the Adaptive Management and Willamette Fish Operations plans. This is discussed in greater detail in section 2.2.2. The following subsections describe the actions USACE plans to undertake in the near- and long-term.

McKenzie Interim Operations

Interim actions at Cougar would include a fall drawdown and spring delayed refill operation to improve fish passage. The fall drawdown would target an elevation range of EL 1505 +/- 5 ft, or approximately 27 ft below normal winter reservoir elevation (minimum conservation pool elevation), by early November. Drafting of the reservoir would start by early September to ensure the target elevation is reached by early November. Total dam discharges would be managed during September to October 15 below a maximum of 880 cfs to avoid dewatering of Chinook redds later in the fall and winter when discharge is dependent on inflows. The ROs would be prioritized throughout the implementation of this operation; however, some station service (a 150 cfs release, which is the minimum flow through one turbine unit) may be required early on to ensure no loss of remote flood risk management capability. Refill to minimum conservation pool, elevation 1532 ft, would begin 15 December and operations transitioned to nighttime (dusk to dawn) RO releases and daytime generation.

As part of the Injunction USACE will conduct structural modifications to the ROs and stilling basin to improve water quality and reduce fish passage mortality. These structural changes are part of the Baseline. However, minor changes to these interim operations will occur as the operation is optimized to capitalize on these structural improvements.

During storms and associated flood risk reduction events, the reservoir may fill rather than using the turbines to increase outflows out of Cougar Dam to reduce potential effects of fish passage through the turbine. This would be done in coordination with NMFS and USFWS based on real-time conditions downstream of the dam. Once the event passes, RO discharges will be increased to draw the reservoir back to the target EL 1505 ft as quickly as possible.

Spring operations would commence on 1 February, when the drafting of the reservoir would commence, to reach the spring downstream fish passage target elevation of 1520 ft by mid-March. Cougar Reservoir refill will be delayed until May or June depending on water year conditions (i.e., wet, average, dry). In dry years, Cougar Reservoir may be refilled as early as 1 May, while in wet years, refill may not begin until 1 June. Refill would occur early enough that the reservoir can reach at least EL 1571 ft by Summer so that the Cougar Water Temperature Control Tower (WTCT) weirs can be used for downstream water temperature management.

The ROs at Cougar Dam are known to produce elevated downstream TDG when releases are in excess of 800 cfs. Modest increases in downstream TDG are expected to be less detrimental to the dominant life history stage (eggs incubating in gravel redds) in the reach downstream of Cougar at the time of year the operation for downstream fish passage via the RO is scheduled (early November to December 15) compared to passing juvenile fish through the turbine units.

Table 2.3-13 summarizes the trigger, timing, and implementation of the interim flow measures at Cougar.

Table 2.3-13. Interim operational measures at Cougar in the Spring and Fall/Winter

Metric	Fall Downstream Passage	Spring Downstream Passage
Duration (hours/days)	Continuous RO	-
Target Date	1 November	Delay refill 1 February with drawdown to target elevation (El. 1520 ft.) by 1 April
End Date	15 December	Mid-April – Mid June;
Min pool elevation (ft, datum NGVD29)	1505 ft +/- 5 ft	1520 ft
Outlet (RO/spillway/etc.)	Prioritize RO during drawdown; RO (night) and Turbine (day) during refill	Prioritize RO during drawdown; RO (night) and Turbine (day) during refill
Min flow (cfs)	N/A	N/A
Max flow (cfs)	880 cfs through the ROs to manage for downstream TDG when possible	N/A
Additional Information	Add turbines if necessary to manage for downstream TDG exceedances	refill as high as possible with min flow of 300 cfs

McKenzie Long Term Measures

Water Quality

No water quality measures are proposed at Blue River Dam. The USACE would continue operating the existing water temperature control tower at Cougar Dam, when the reservoir refills above the WTCT operating limits. The downstream fish passage operation utilizing the diversion tunnel will likely make the use of the WTCT in more years impossible.

Fish Passage

USACE is proposing to provide spring and fall volitional downstream fish passage at Cougar Dam through operations that use the diversion tunnel (DT), which is near the pre project riverbed elevation. Implementation of this operation would operate the reservoir at elevations below the conservation pool, power pool, and the inactive or dead storage pool at Cougar reservoir. The WCM manual directs USACE to follow a rule curve that attempts to refill Cougar Reservoir to a maximum elevation of 1640 feet and hold that elevation until September before releasing water for the FRM season. The top of the DT sits at an elevation of 1290 feet, 350 feet below the maximum conservation pool and 200 feet below the existing hydropower turbine intakes. Using the DT for volitional downstream passage will have a substantial impact on the Congressionally authorized purposes of the Cougar Project. Therefore, USACE is proposing to initiate a Disposition Study and dam safety study to seek the statutory authority to operate the dam in such a substantially different manner, and to utilize the DT outlet for routine operations.

The Disposition study would look at deauthorizing hydropower at Cougar while also evaluating how best to operate the reservoir for remaining purposes at Cougar Dam. The study would also look at what operations are technically feasible and the continued federal interest in the project.

Routine use of the DT for downstream volitional passage would also require structural modifications to the dam and diversion tunnel to allow for safe operations, and address dam safety concerns associated with fluctuating pool levels at these lower elevations. These modifications may include, but are not limited to, the design and construction of redundant gate structures to allow for routine inspections of the DT, and a tower at the DT with a bridge connecting it to the reservoir shoreline. A dam safety review, and construction details about the tower and gate modifications will be developed during the engineering design process. Implementation of these modifications (both operational and structural), will have site specific environmental compliance including ESA consultation on the potential effects (See Figure 2.5-1 for proposed completion dates).

If Congress decides to not authorize an operation that utilizes the DT or if the DT is found to be unsafe for routine use USACE will coordinate with both USFWS and NMFS on the potential need for reinitiation of consultation under Section 7 of the ESA.

To understand the effects of utilizing the DT for Downstream volitional passage USACE tested an operation as part of the EIS analysis that attempted to retain the existing purposes at Cougar Dam. The operation analyzed by USACE drew the reservoir down to 25 feet over the top of the DT, targeting an elevation of 1330 feet, in the spring and fall, resulting in increased passage rates and survival for fish moving downstream, but then attempted to refill to meet the other purposes. The operation's details are outlined in Table 2.3-14.

Table 2.3-14. Analyzed long-term operational measures at Cougar in the Spring and Fall/Winter.

Timing Metric	Fall Downstream Passage	Spring Downstream Passage
Duration (hours/days)	Continuous Diversion Tunnel Operation	Continuous Diversion Tunnel Operation
Target Date	1 November	Delay refill 1 February with drawdown to target elevation (El. 1330 ft.) by 1 April
End Date	15 December	Mid-April – Mid June;
Max pool elevation (ft, datum NGVD29)	1330 ft +/- 5 ft	1330 ft
Outlet (RO/spillway/etc.)	Min gate opening 1.25 feet	Min gate opening 1.25 feet
Min flow (cfs)	N/A	N/A
Max flow (cfs)	880 cfs total discharge 1 September to 15 October to manage Chinook redd placement	N/A
Additional Information	N/A	Refill as high as possible with min flow of 300 cfs

Ultimately, the final operations and structural modifications designed and implemented for utilizing the DT as a routine outlet for downstream fish passage will be informed by the proposed studies detailed above, Congressional direction, as well as input from NMFS and other stakeholders during these processes.

2.3.6 South Santiam

Actions in the South Santiam will focus on improvements to both upstream and downstream passage at Foster and Green Peter Dams. This will require an integrated approach of both structural and operational improvements. Under both the interim and long-term measures adult fish facility operations, including upstream passage through transportation, will continue to be implemented. In the South Santiam this currently occurs at the Foster Dam. As part of the proposed action upstream passage at Green Peter Dam will be established through the construction of a new/refurbished adult fish facility. In both cases annual operations and maintenance, including fish disposition and release locations, will be coordinated through the interagency coordination process described in the adaptive management and Willamette Fish Operations plans. This is discussed in greater detail above in section 2.2.2.

South Santiam Interim Operations

Interim operations would include outplanting of up to 800 hatchery adult Chinook captured at the Foster adult fish facility (AFF) upstream of the Green Peter Dam between May through September to support Chinook salmon reintroduction and RM&E, and the ongoing transporting of all unmarked Chinook and winter steelhead collected at the Foster AFF to the South Santiam River above Foster Reservoir.

There are no downstream fish passage operations at Green Peter Dam defined as interim measures, as the long-term method for downstream fish passage at Green Peter Dam involves spring spill and fall drawdown operations which will be implemented immediately post Record of Decision. Details of the long-term actions are described below in Section 2.2.6.2 South Santiam Long Term Measures.

Interim operational measures at Foster Dam include delayed refill in the Spring, where USACE would hold a minimum conservation pool between EL 613 ft and EL 615 ft from February 1st to May 15th, each year. The spillway would be operated from dusk to dawn; one turbine unit would be operated for station service power, and to help reduce TDG levels. After May 15th, Foster reservoir would be rapidly refilled using storage from Green Peter and inflow from the South Santiam. Operators will also use operations at Green Peter tied to fish passage and temperature control as a means of improving temperatures and upstream passage at Foster Dam. Night-time spillway operations, with one-unit operations as described above, would continue. Additionally, the warmer surface waters provided by the fish weir would also be used to aid in attracting adult salmon to the Foster AFF for collection from 16 June to mid- to late-July. The fish weir would be operated at 300 cfs with the duration of operation depending on storage in both Green Peter and Foster Reservoirs and biological need (i.e., numbers of adult Chinook in the Foster tailrace). Close coordination with the Willamette Flow Management and Water Quality Team (WFMWQT) and the Foster Fish Facility manager would be necessary for the intra-season management of this operation.

During the fall, Foster reservoir would be drawn down following Labor Day weekend, to reach a target of EL 620 ft to EL 625 ft by October 1st. Beginning on October 1st through December 15th of each year, USACE would utilize the spillway to pass fish at night, while power generation occurs during the day.

Table 2.3-15 below summarizes the triggers, timing, and implementation of the interim measures at Foster Dam.

Table 2.3-15. Interim operational measures at Foster in the Spring and Fall/Winter.

Timing Metric	Spring Downstream Passage	Fall Downstream Passage
Duration (hours/days)	4pm – 8am (dusk to dawn)	Drawdown: continuous Spillway Operation: at night Turbines: day
Target Date	Delayed Refill start: 1 February Operate Fish Weir: 16 June	1 October
End Date	Delayed Refill end: 16 May Operate Fish Weir: Mid/late July - the duration of operation depending on storage in both Green Peter and Foster Reservoirs and biological need	15 December
Max pool elevation (ft, datum NGVD29)	Minimum conservation pool (El. 613-615 ft.) until refill starts on 16-May	620-625 ft by October 1
Outlet (RO/spillway/etc.)	Spillway at night, one turbine unit will be operated for station service (~300 cfs), and to reduce/balance TDG levels created by the spill operation.	Spillway at night
Min flow (cfs)	Fish weir flow: 300	NA
Max flow (cfs)	NA	NA

South Santiam Long Term Measures

Water Quality

Green Peter Water Temperature Management

Green Peter reservoir experiences strong temperature stratification during the spring, summer, and fall before reservoir turnover. Generally, water becomes colder with depth, but when the water in the top layer becomes denser than the bottom layer, due to a significant change in outside temperature, the reservoir 'turns over': the layers mix as the cold, dense water rises to the surface and the warmer, less dense water sinks (Boehrer and Schultze 2008). Due to the strong stratification that the reservoir experiences, there is an opportunity to manage downstream water temperatures by using a combination of outlets at Green Peter Dam.

The spillway would be used when reservoir levels are appropriate in the spring and summer to release warmer surface water from spring through autumn. By extending the use of the spillway, a larger volume of warm surface water from the reservoir can be released and cold deep water can be reserved for later in the fall/early winter when necessary for fish incubation. Up to 60% of total release would be through the spillway as soon as available in May to provide attraction temperatures for upstream migrant adult Chinook.

In the fall, relatively cooler water would be released (up to 60% of total flow) from the regulating outlets (below the power intakes). This cooler water (compared to releases through the turbines) can provide a benefit for chinook egg incubation downstream. Actual mix between outlets would depend on target temperatures.

The ROs consist of separate tunnels and gates through the dams and are designed to provide alternative means of releasing lake water aside from the turbines and spillway, especially during high flows and/or floods. The ROs are a low-level outlet, most often used as the primary outlet for releasing lower flows. Green Peter has one set of ROs. The ROs, also critical for FRM, manage low to higher flows until the reservoir reaches above the spillway crest.

The ROs were designed for use during high flows, not for regular usage at relatively low flow or frequent gate changes, such as is often desired for temperature management. They are aging and would need to be reinforced and modernized to be used routinely with high head pressure (during times when the lake is full). The implementation frequency, timing, and duration of the action is dependent on the seasonal reservoir hydrology and temperature conditions and observed conditions downstream of the project.

Table 2.3-16. Green Peter Long-Term Temperature Management Operations.

Timing Metric	Spring and Summer Spill	Fall Regulating Outlet
Description of work		Use ROs during fall to meet temperature target.
Duration (hours/days)		45 days
Target Date	15 April or when spillway is accessible	1 October
End Date	31 August or until spillway is not accessible	15 November
Max pool elevation (ft, datum NGVD29)		745 ft (2) close proximity to the turbines (795 ft elevation)
Outlet (RO/spillway/etc.)	Spillway	Regulating Outlets
Min flow (cfs)	60% of total outflow during specified period except where applied and combined with measure 714. In this case, the downstream temperature target will determine the discharge ratio of discharge between the spillway and turbines	60% of total outflow to ROs during this timeframe except when combined with measure 40, where fish passage is prioritized.
Max flow (cfs)		4420 cfs
Additional Information		Current head restrictions on ROs are assumed for this measure.

Foster Fish Ladder Temperature Improvement

Collection of adult Chinook at Foster Dam, which migrate upstream in the South Santiam River to Foster Dam in spring and summer, is affected by water temperatures immediately below Foster Dam and in the fishway of the Foster Adult Fish Facility (AFF). The existing water supply for the fish ladder is located at the powerhouse intakes, below the thermocline, and as a result the temperature of the flow from the pre-sort pool at the top of the fish ladder and from the ladder entrances is much cooler compared to the historic or ambient river temperatures. During the later spring and summer months, the Foster forebay is stratified in terms of temperature.

Construction and operation of a new Forebay Warm Water Supply (FWWS) pipe, which would draw warm water from above the thermocline in the Foster forebay, would reduce the differences in temperature between the fish ladder entrance and the tailrace. This warm-water supply pipe would be retrofitted to the face of Foster Dam (at elevation 630 feet) and piped to the existing adult fish ladder at the Foster AFF. The existing water supply pipe would remain in use and a network of pipes and valves would allow the two water sources to be mixed to achieve desired temperatures at the side fish ladder entrance, AWS sump, pre-sort pool and truck fill location. The temperature targets were developed as a function of the upstream South Santiam River (USGS 14185000; South Santiam River below Cascadia, OR), with maximum target temperatures constrained by needs for fish health (USACE 2019c). A juvenile fish exclusion screen would be provided upstream of the FWWS intake to keep juvenile fish from entering the FWWS pipe. Figure 2.3-3 provides a piping schematic and identifies four temperature target locations.

Assumptions for operation of the FWWS include 144 cfs in May and 72 cfs during June through the pipe (bypassing the turbines), but further temperature modeling during final design of the FWWS would calculate an optimal flow that would meet a temperature target for the fish ladder. Currently, the Foster fish ladder is fed by deeper water in Foster Reservoir via the turbine intakes. The proposed measure would add flexibility to provide more normative temperatures in the fish ladder and attract upstream migrant fish in a timelier manner during the spring. This should decrease the time it takes for fish to pass the project, as well as reduce the straying of hatchery fish and the percentage of hatchery origin spawners in the wild. Currently, precent hatchery origin spawners (pHOS) below Foster Dam is extremely high as documented by carcass surveys. Many adult Chinook congregate in the tailrace of Foster Dam and go un-collected in the Foster AFF. Once the FWWS is completed, adult collection rates from the tailrace will increase, reducing straying of hatchery Chinook downstream and pHOS in the South Santiam below Foster Dam.

The Green Peter spring spill operation may result in a reduced amount of flow needed from the FWWS (based on design in USACE 2019c), to meet the ladder target temperatures. Site specific design and environmental compliance documentation would be done for the construction of this measure.

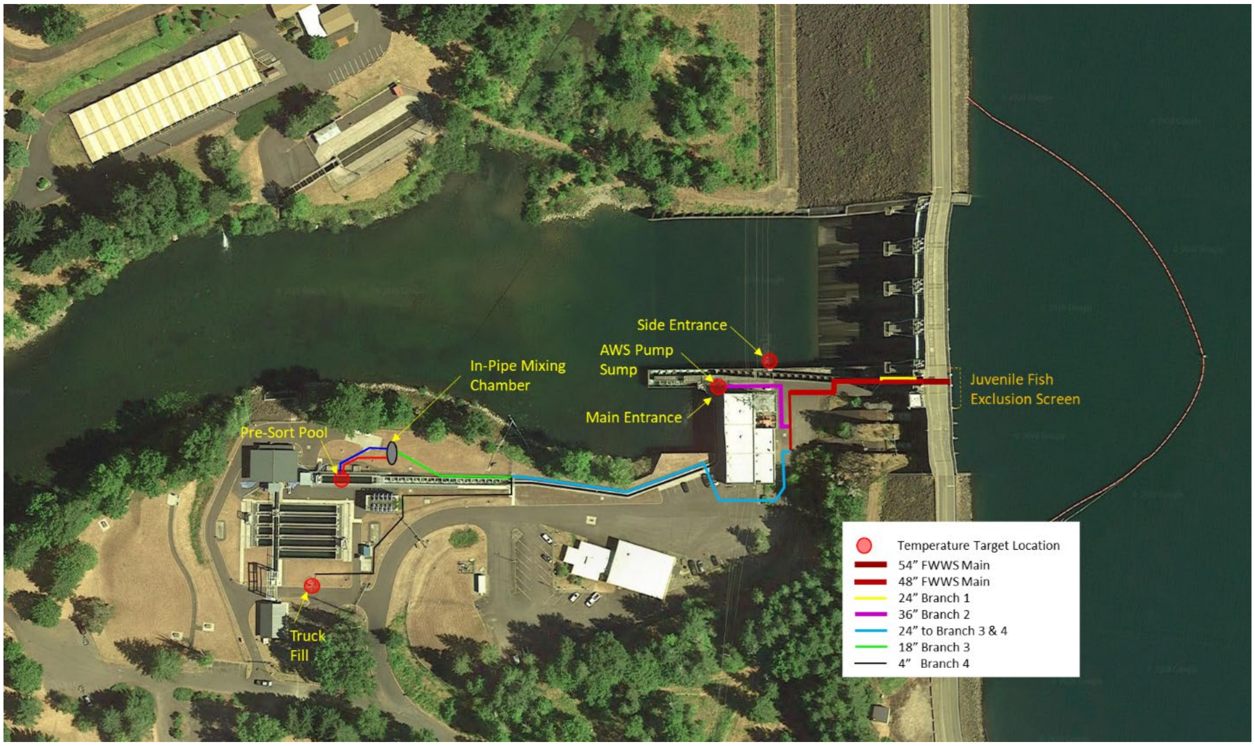

Figure 2.3-3. FWWS piping schematic with temperature target locations.

Fish Passage

Green Peter Dam

Upstream Passage

An Adult Fish Facility (AFF) will be constructed at the base of Green Peter Dam as part of the proposed action, to support upstream passage of fish to reaches in Quartzville Creek and the Middle Santiam River above the dam. The design of the facility would be determined during the construction design phase.

The design of the Green Peter AFF will consider and incorporate flow and water temperature requirements to ensure adequate fish attraction into the facility for collection and avoidance of stress and disease in fish being collected. Lessons learned from the failure of the original Green Peter adult ladder will be adopted (Wagner and Ingram 1973).

Specifications for the AFF will be determined during the engineering, design, and construction phases of implementation. The design for the AFF is assumed to be similar in scope and design to those constructed at Cougar Dam and Fall Creek Dam, including features to improve Pacific lamprey passage through the fishway. Site specific design and environmental compliance documentation would be done as part of the implementation of the proposed action.

Once the new Green Peter AFF is completed, all unmarked adult Chinook and steelhead collected at Foster will be released at the head of Foster Reservoir to allow adults to volitionally continue their migration upstream into either the South Santiam River or the Middle Santiam to Green Peter AFF where they will be collected and transported upstream of Green Peter Dam.

Once unmarked adult Chinook are transported above Green Peter Dam, outplanting of hatchery Chinook will only be done to supplement natural origin returns when needed to achieve 800 total, unless a lower target is determined by the reintroduction plan for the South Santiam which will be completed by NMFS and ODFW as a term and condition of the 2019 Willamette hatchery biological opinion (NMFS 2019a).

Downstream Fish Passage

Downstream fish passage at Green Peter Dam would be accomplished by use of the spillway in the spring, and a deep drawdown of the reservoir to the regulating outlet in the fall. Spill for fish passage would commence once the reservoir reaches spillway crest, or El. 971 ft. and would continue as hydrology supports, for at least 30 days. Reservoir elevations during this operation are expected to range from 971 ft. to 1005 ft. and spill is expected to range from a minimum of 460 cubic feet per second (cfs) to 3,000 cfs, based on the Green Peter spillway rating table, with a minimum gate opening of 1.5 feet. Flow will be passed over the spillway from dusk to dawn when the reservoir is between elevations 971 ft. and 985 ft. Once the reservoir is at 986 ft or higher, then the spillway will be used to pass all flow.

The reservoir would be drafted starting July 1 to achieve the target elevation of 780 ft (25 ft over the top of the RO) by November 15. This elevation would be held for three weeks and as hydrology allows, or until December 15 to increase the number and the survival of juvenile salmon and steelhead passing downstream of WVS dams. Turbine use would be limited to between the hours of 10:00AM and 6:00PM during the drawdown operations (July 1 – December 15) whenever the reservoir elevation is within 50 ft of the penstock. After December 15, the reservoir would be allowed to refill to minimum conservation pool.

Table 2.3-17. Green Peter Long-Term Fish Passage Operations.

Timing Metric	Spring and Summer Spill	Fall Drawdown
Description of work	Use spillway to pass fish in spring	Use ROs to pass fish in fall. Limit turbine operations to reduce fish passing via penstocks.
Duration (hours/days)	Dusk to dawn for at least 30 days	24 hours a day for 3 weeks
Target Date	May 1 (or as soon as pool elevation allows)	1) Drafting of each reservoir will begin July 1. 2) During the spawning season (Sept 1 to Oct 15), the total discharge from the dam will be maintained at or below the maximum flows for spawning. 3) After the spawning season ends Oct 15, the draft rate will then be revised as needed to achieve the Nov 15 target elevation of 780 ft. 4) target elevation will be achieved at the earliest Nov 15, and the latest Dec 15.
End Date	July 1 (or as hydrology supports)	Maintain target elevation as feasible for 3 weeks, but no later than Dec 15. Then refill to minimum conservation pool as feasible.
Max pool elevation (ft, datum NGVD29)	<25 ft above spillway crest	780
Outlet	Spillway	Regulating Outlet

Timing Metric	Spring and Summer Spill	Fall Drawdown
Outlet restriction	No turbine operations at Foster Dam during 0600 to 1000, and 1800 to 2200 from April 15 to July 1. Operations of turbines should be secondary to spillway operations.	Limit turbine use when reservoir elevation is within 50 ft or less of turbine intake

Foster Dam

Recent returns of both Natural Origin Return (NOR) UWR Chinook and UWR steelhead have been low (see Section 4.11.1). Improvements are necessary to improve the likelihood these populations above Foster Dam can persist without reliance on hatchery supplementation. USACE proposes using a structural solution to facilitate improved downstream passage. The conceptual design is a structure which would provide a surface route. This would utilize a flow rate of 500-800 cfs through the new structure or over the spillway. The approach, feasibility, design, cost, and biological benefit of the structure will be determined during the construction design phase.

Table 2.3-18. Assumptions for Downstream Passage at Foster Dam.

Passage Element	Description
Description of work	Implement structural passage at Foster Dam
Duration (hours/days)	Fish structure operates 24/7, year-round at 600 cfs. No spillway operation for fish passage purposes or temperatures (i.e., this replaces the NAA fish operations).
Pool elevation (feet, datum NGVD29)	615 (min elevation) to 635 (max elevation): Foster Spillway
Restricted Outlet (RO/spillway/etc.)	Turbines restricted between 7:00PM – 7:00AM during fish passage seasons
Estimated Day/Month Start	When within operating range
Duration of Outlet Restriction (days)	When within operating range
Maximum Flow (cfs)	800 cfs

2.3.7 North Santiam Sub-basin

Under both the interim and long-term measures adult fish facility operations will continue at the Minto facility below Big Cliff dam. Annual operations and maintenance, including fish disposition and release locations will be coordinated through the interagency coordination process described in the adaptive management and Willamette Fish Operations plans (USACE 2024a Appendix F to the Biological Assessment). This is also discussed in greater detail above in section 2.2.2.

North Santiam Interim Operations

Detroit Dam and Reservoir

Downstream fish passage in the spring and water temperature management throughout late Spring and Summer at Detroit would be accomplished through strategic use of the spillway, turbines, and regulating outlets (ROs). Spillway operations would initiate when Detroit Reservoir reaches the spillway crest elevation (EL 1541 ft) and continue until the reservoir is drafted below the spillway crest. From there, a combination of turbine and RO discharges will be implemented until water temperature management is no longer possible due to reservoir turnover. Once water temperature management is complete for the season, operational priorities would shift towards the implementation of downstream fish passage operations.

Downstream fish passage in the Fall would be accomplished by prioritizing flow releases through the upper ROs (UROs) during the Fall and Winter once the Detroit Reservoir elevation is less than 100 feet above the turbine intakes (EL 1419 ft). During the specified date ranges, turbines would be operated during the day and the UROs at night (from dusk until dawn). However, turbine operation may occur for Station Service[1] if needed for emergencies or for downstream TDG management.

Table 2.3-19. Interim operational measures at Detroit in the Spring and Fall/Winter.

Timing Metric	Downstream Fish Passage	Downstream Temperature Management
Duration (hours/days)	6pm to 7am (dusk to dawn)	N/A
Est. Start Date	Spillway: spring RO: fall (once temperature management operations have concluded; early to mid-Nov)	Spring (when reservoir elevation reaches spillway crest)
Est. End Date	Spillway: fall (when elevation is below spillway) RO: when rule curve reaches 1500'	Winter (when reservoir becomes isothermal)
Outlet (RO/spillway/etc.)	Spillway and ROs (when reservoir 1500 ft – 1450 ft, and temperature management has concluded for the season)	Spillway, turbines, and upper and lower ROs
Additional Information	Do not use ROs until head over the RO is less than 200 feet.	N/A

Big Cliff

Elevated TDG is generated when water is passed through the non-turbine outlets at Detroit and Big Cliff dams. TDG abatement at Big Cliff Reservoir would be accomplished through spreading spill across multiple spill bays when possible. The Big Cliff turbine is less harmful on fish and downstream water temperature and would be utilized to the extent possible to reduce downstream TDG levels. TDG produced by Detroit, particularly when a non-turbine unit is used to discharge water, would not be prevented, or abated from spread spill operations at Big Cliff. The total volume of water that can pass through the turbine intakes varies by reservoir elevation and ranges from 2810 cfs to 3200 cfs. Flows that exceed this range must be split between the

[1] Station Service outflow varies by elevation, but averages ~300 cfs when the reservoir is at or near minimum conservation pool elevations.

powerhouse and spillway and are generally observed during high flow, or involuntary spill events.

The minimum gate opening for spill operations of each spill bay at Big Cliff dam is 0.75 feet. This equates to discharges ranging from 770 cfs to 1130 cfs for a minimum and maximum conservation pool range of EL 1182 ft and EL 1206 ft, respectively. Under the lowest of reservoir elevations, spreading flow between two bays is only possible once the total outflow is greater than 4740 cfs, which is the sum of the discharge from two spill bays at minimum gate opening plus powerhouse capacity. Under the highest reservoir elevations, flows cannot be spread between two bays until the total outflow is greater than 5070 cfs, which is the sum of the discharge from two spill bays at minimum gate opening plus powerhouse capacity. Without large flow conditions, spreading spill is limited at Big Cliff Dam due to the minimum gate opening constraints. Table 2.3-20 summarizes the trigger, timing, and implementation of the interim TDG operation at Big Cliff.

As part of the Injunction USACE is also building TDG abatement structures below Big Cliff Dam. Since the construction was ordered as part of the Injunction these structures and their construction were included in the environmental baseline, and are covered under the existing SLOPES IV Restoration programmatic biological opinion. However, the ongoing operation and maintenance of the structures post ROD, is part of the proposed action.

These structures would mimic naturally occurring rapids and riffles to increase the air-water interface. Increased turbulence and mixing would expose more of the supersaturated flows to the surface which would help increase de-gassing, thereby reducing the levels of TDG downstream. Current plans are to construct one structure and evaluate its effectiveness and if necessary, construct a second structure to achieve the desired level of TDG abatement.

Table 2.3-20. Interim TDG operation at Big Cliff Dam.*

	Specification
Duration (hours/days)	24/7
Est. Start Date	Year Round
Est. End Date	Year Round
Max pool elevation (ft, datum NGVD29)	1182 ft (min. conservation pool); 1206 ft (max. conservation pool)
Outlet (RO/spillway/etc.)	Spillway
Min flow (cfs)	4740/5070
Max flow (cfs)	N/A

*Operation is to spread spill when spillway flows are above 4,740 cfs.

North Santiam Long Term Measures

Water Quality

As part of the proposed downstream fish passage system, USACE is proposing to address downstream temperatures below Detroit Dam with a structural modification. The alternative selected in the July 2017 final engineering documentation report was selective withdrawal structure (TDG) which would provide more normative water temperatures downstream of the project. Figure 2.3-4 shows how a SWS blends warmer surface water with cooler deep water by using multiple outlets at varying elevations within the reservoir to meet downstream water temperature targets. The SWS would allow USACE to send this blended water through the powerhouses and continue to generate power while still meeting downstream objectives. Water temperature simulations assume outlet details and temperature targets align with those used in previous studies (Buccola et al. 2012; Buccola, Turner, and Rounds 2016; Buccola 2017; USACE 2019b; 2019e).

The SWS has already undergone significant design efforts and is at the 30% Plans and Specifications level of design (see Section 2.3.2 for more on the design process and timeline). Final design and environmental compliance documentation would be done prior to construction of the SWS.

Fish Passage

USACE is also proposing a structural solution for downstream passage at Detroit Dam. The design currently proposed is the 2017 engineering design report (EDR) selected alternative for a Floating Screen Structure (FSS) (gravity fed flow which may include pumps for supplementing flow) to pass downstream migrating juveniles. The FSS would be attached to the SWS at the face of the dam. Juvenile fish would be collected near the dam and transported downstream via 'trap and haul' methods. Initial design and environmental compliance efforts for the FSS at Detroit as documented in the Detailed Design Report and Detroit Downstream Passage DPEIS, respectively, would be used for this measure at Detroit Dam. The next stage of design would be the Plans and Specifications, which is the level of design needed to advertise and award the construction contract. The Plans and Specifications level of design and environmental compliance documentation for the construction of the FSS would be completed during implementation of the proposed action.

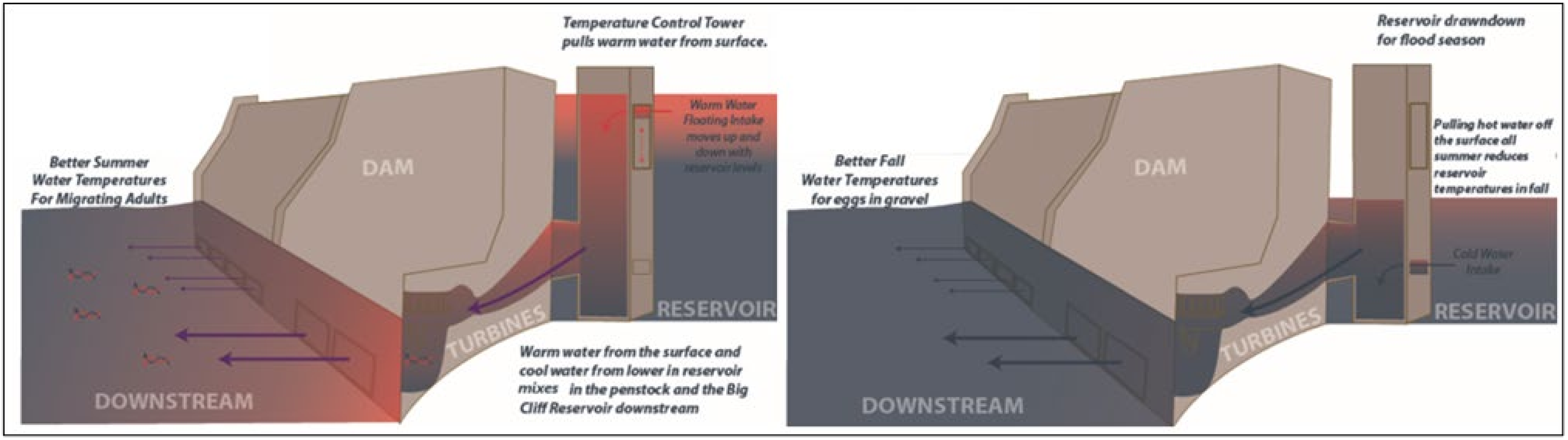

Figure 2.3-4. Graphical Representation of a Water Temperature Control Operation.

2.3.8 Bonneville Power Administration (BPA) Power Marketing

The BPA proposed action remains largely unchanged from that described in the 2007 supplemental BA and in section 1.7.2 of the Biological Assessment.

BPA markets and transmits hydroelectric power generated by eight USACE-owned and operated WVS power-producing facilities. BPA pays for a portion of the capital, operations, and maintenance costs of those eight dams (USACE 2000). BPA also builds and operates transmission lines that deliver the electricity from the WVS dams. The Interim operations will impact power generation timing and amounts by limiting turbine use during fish passage operations, as described in the previous sub-basin sections. This will ultimately reduce the overall power generated and thus marketed by BPA. Additionally, the long-term operations at Green Peter and Cougar dams will also impact generation and power marketing.

As part of the proposed action, the Action Agencies will continue to implement habitat actions consistent with the NMFS 2008 biological opinion's RPA 7.1. These habitat actions will be within the framework developed for the Willamette Action Team for Ecosystem Restoration Habitat Technical Team (WATER HTT). The individual projects to be implemented by the WATER HTT would be analyzed during site-specific project analyses, and environmental compliance (including ESA) would be done at the time of implementation.

BPA will continue to market and sell hydropower produced by the WVS project, as well as continue to fund and implement habitat restoration actions under its authority from the Northwest Power Act, as described in the 2008 NMFS RPA and section 1.8.2 of the Biological Assessment.

2.3.9 Bureau of Reclamation Water Marketing Program

Reclamation proposes to continue the administration of the Willamette Irrigation Water Marketing Program (Program), including the administration of existing contracts and writing new contracts for irrigation subject to the limitations of USACE's operation and maintenance of the WVS and related ESA obligations and in accordance with the limitations in RPA 3.0 – 3.4 in the 2008 Biological Opinion. Until it is modified, the water marketing program will continue to comply with the 2008 RPA, thus the total water marketing program would not exceed 95,000 acre-feet.

Accordingly, Reclamation will administer existing irrigation contracts and write new contracts for irrigation use of stored water up to 95,000 acre-feet provided: the contract is consistent with the irrigation storage allocation; it is possible to fulfill the contract under USACE's operating plan; and it complies with all other applicable laws and treaties. Reclamation will subject water service contracts to conditions that meet ESA constraints, per the 2008 RPA and water being made available by USACE. A sample contract currently in use by Reclamation is provided in Appendix B to the 2023 Biological Assessment. Reclamation proposes to continue to use this contract for future irrigation contracts.

Reclamation would continue to require water service contractors comply with the diversion rate and volume limits imposed by the State's secondary water use permit. Contractors will continue to be responsible for monitoring and reporting their water use with a measuring device which remains at all times available for reading by the United States or appropriate State-appointed watermaster.

In 2019, Congress reallocated the conservation space of the WVS, providing 327,650 acre-feet of storage space to irrigation. During the course of this consultation, Reclamation, NMFS and USACE agreed to complete a second consultation following this BiOp to evaluate the use of the full irrigation allocation and to support the transfer of the purpose of use on the WVS storage certificates consistent with Congressionally authorized allocations in the basin review. A letter exchange between Reclamation and NMFS clarified the agencies' positions on Basin Review implementation[2].

As of June 2024, Reclamation has issued water service contracts for 84,349 acre-feet of water from the WVS. The exact value varies from year to year as contracts are executed or expire. The majority of contracts are located on the mainstem Willamette River, as listed in Table 2.2-21 [missing]. The Willamette Basin Review projects future demand will increase (USACE 2019a, Appendix B).

Reclamation intends to administer existing and future contracts at the current pricing rate shown on the sample contract. Reclamation will determine if an irrigation contract rate review is needed in the future. Reclamation contracts would include terms and conditions relative to water availability:

i. The United States does not guarantee the availability of water at the point of the contractor's diversion facilities as they may now be constructed or constructed hereafter because of possible fluctuations in reservoir surface elevations and downstream flows associated with the WVS.
ii. The obligation of the United States to furnish water under this contract is subject to an operating plan for the WVS determined in accordance with the law governing the project and other applicable State and Federal laws, including but not limited to, the ESA.
iii. The obligation of the United States to furnish water under this contract shall be subject and subordinate to a determination of water availability to be made annually by the United States, taking into account the operating plan for the project, water forecasts, and other factors, including but not limited to those that may affect the ability of the United States under the ESA to provide flows for candidate, listed, or proposed species or to protect or preserve designated or proposed critical habitat.
iv. Reclamation retains the right to review and modify the terms and conditions of this contract at any time to avoid or minimize impacts to endangered species or other valuable natural resources. Reclamation's Contracting Officer (CO) shall review this contract from time to time, but not less often than once every 5 years in the interests of conservation and protection of environmental resources. The terms and conditions of this contract, including the amount of stored water provided hereunder, may be modified, as determined by the CO, to avoid or minimize impacts to species and/or critical habitat that are proposed, listed, or designated under the ESA, or to other valuable natural resources. The CO shall notify the Contractor of any contract modifications.

[2] Letter from Reclamation Columbia Pacific Northwest Regional Office to NMFS Oregon Washington Coastal Office, July 28, 2023 and NMFS letter in reply to Reclamation Nov. 17, 2023.

v. The contractor shall install, operate, and maintain fish screening devices at the point of diversion to prevent game fish and ESA and State-listed fish from getting entrained in the proposed diversions, as well as installing a fishway at any obstruction that will provide adequate upstream and downstream passage for fish. The point of diversion must comply with State and Federal fish screening and passage standards as a condition precedent for receipt of water service. Applicants for permits may submit evidence that the ODFW has determined screens and/or fishways are not necessary. The required screens and fishways must be functional and approved by ODFW before diversion of any water.

vi. Prior to delivery of water under this contract, the Contractor shall submit to the CO written verification that, where required, fish passage structure(s) and fish screens compliant with State and Federal standards, as set by the State and Federal officers responsible for establishment of said standards, are operational at the point(s) of diversion described above, or that the Contractor and the ODFW, USFWS, and/or NMFS have reached a mutually satisfactory agreement concerning compliance with State and Federal fish screening/passage standards at said point(s) of diversion. Such fish screen(s) and/or fish passage structure(s) shall be furnished, installed, operated, and maintained by and at the expense of the Contractor, but shall remain at all times available for inspection by the CO, the State of Oregon, USFWS, and/or NMFS, whose representatives may, at all times, have access to them over any lands of the Contractor.

2.4 Duration and Timing of the Proposed Federal Action

The 2023 BA identified a 30-year term for the proposed action, aligned with the 2023 draft EIS coverage. The start of this term is tied to the date that USACE anticipates the WVS Record of Decision (ROD) will be signed, in 2025. Hence, the proposed actions covered by the Opinion are those anticipated to be implemented from 2025-2054. Given past efforts to complete steps for major actions, including design and construction of structural components, and the need for Congressional funding, there is uncertainty associated with the USACE's ability to implement elements of the proposed action. Figure 2-5 shows the implementation timeline for proposed actions at the reservoirs and dams.

While each measure within the proposed action is considered a priority, it's infeasible to carry out all actions simultaneously. Therefore, careful consideration was given to the following topics in consideration of implementation timing:

- Projects in sub-basins with multi-species benefit
- Projects that are closest to construction phase (e.g., have an existing design)
- On-going projects
- To the greatest extent possible, accelerate timelines for Study Design and funding documentation where possible
- Complete alternatives development and design aspects of projects prior to EIS ROD
- Identify data gaps and operational research needs
- Impacts to other Congressionally authorized purposes (e.g., water supply)

2.5 Implementation of Proposed Federal Action

Once the above set of considerations were assessed, the measures of the proposed action were organized into three categories including: (1) actions that could begin conceptual design efforts prior to the ROD for the WVS DPEIS; (2) actions that could be implemented immediately after the ROD is signed; and (3) long-term measures (or actions) that would take longer to complete either due to the need to complete detailed engineering designs of complex fish passage structures, the need for further study, or congressional approval. The proceeding content of this section focuses on the implementation timing of the third category of actions. The order of prioritization was then discussed with federal and state agencies working on the DPEIS, including NMFS and USFWS. The Implementation Timeline shown in Figure 2.5-1 is the core of the implementation plan.

The Implementation Plan, which is part of the Adaptive Management Plan (AM Plan), identifies the prioritization of measures for implementation, a timeline for their implementation, and implementation performance criteria that must be met. It describes the sequencing of the measures in the proposed action, and links immediate operations to improve fish passage and water quality (e.g., interim operations measure) to the longer-term structural measures, such as the downstream fish passage construction projects. The plan identifies check-ins, or points along the implementation timeline where course correction (i.e., "on-ramps/off-ramps") may be necessary based on RM&E. The Implementation Plan is considered a roadmap that lays out a strategy and plan for implementation of the proposed action. Considerations such as basin-wide priorities including costs, risk and uncertainty, and RM&E of data gaps, have been used to shape the Implementation Plan and to develop a schedule that is both reasonable and implementable given the information available to USACE at present.

Timing of decisions for implementing management measures and/or adjustments is influenced by the operational planning for the conservation release season, which begins with the January water supply forecast and continues through October. The conservation season is approximately from March through October, including the filling season (spring) and the release season (summer). A document titled "Willamette Basin Project Conservation Release Season Operating Plan" (Conservation Plan) is prepared annually to provide flow requirements based on the basin water supply for that year. The Conservation Plan identifies flow and storage needs for each tributary and USACE reservoir in the WVS and mainstem Willamette control points based on the anticipated total system storage in mid-May, from the April forecast.

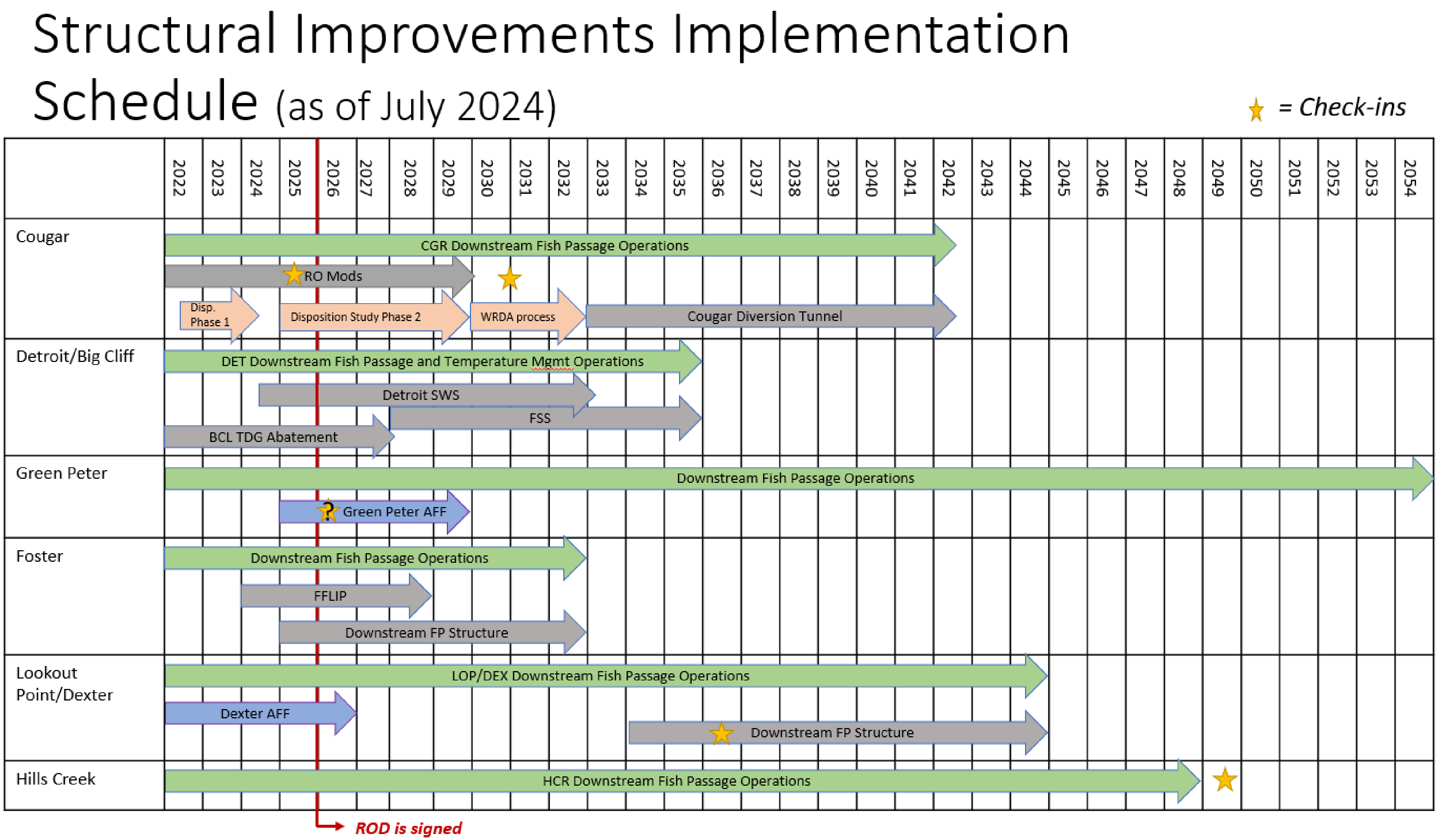

Figure 2.5-1. Implementation Timeline for Actions within the proposed action.

2.5.1 Lookout Point Implementation

Interim operational measures will be implemented following the signing of the WVS EIS ROD (see Section 2.2.4.1) until the long-term measures come online. During this period USACE anticipates starting the Engineering Design Report (EDR) and alternatives analysis for long-term structural downstream fish passage at Lookout Point in 2034 (Figure 2.5-1). During the EDR phase, further review of existing fish passage data and the identification of further RM&E needs will be completed. A major check-in will occur at the conclusion of the EDR, and USACE will decide whether to move forward with the Design Document Report (DDR) phase of Lookout Point downstream fish passage design or wait for additional RM&E and/or the post-construction evaluation of the Detroit Dam downstream passage structure to be completed so that lessons learned from Detroit can be applied to Lookout Point prior to construction.

The current assumption is that the Lookout Point DDR will start in 2035. Construction of a downstream fish passage structure at Lookout Point Dam is set for completion in 2044. Under this schedule there is some limited ability to apply lessons learned from Detroit and other regional high-head downstream passage efforts. This would allow for a final design to build on successes/failure of other design efforts. We would anticipate a decision process at the end of EDR to make a final decision on best path forward incorporating new information from other regional collectors and should include one year of passage data from Detroit's downstream passage structure.

In the interim, immediate improvements to downstream fish passage and survival are expected from the implementation of the deep winter drawdown of Lookout Point Reservoir. While this operation is not yet fully developed, it is assumed that the reservoir will be drawn down to EL 750 ft, or approximately 25 feet above the ROs during the winter; the ROs will be prioritized and used as a surface outlet for downstream passage. This measure started in 2023 and will continue until a structural solution is fully constructed and operational.

2.5.2 Hills Creek Implementation

Operations for improved downstream fish passage and survival will continue to be implemented at Hills Creek Dam through the term of the EIS. The operation includes prioritization of the ROs while the reservoir is < EL1460 ft. Upstream and downstream structural fish passage is included for evaluation under the Adaptive Management Plan.

The WVS DPEIS analysis of the Preferred Alternative estimates Chinook population performance is expected to result in natural sustainable populations of Chinook above dams in all four sub-basins affected by the WVS in this ESU; however, there is uncertainty in performance estimates (see Section 5.2). Long-term monitoring completed by ODFW shows a growing bull trout population in the Middle Fork Willamette above Hills Creek Dam, however individuals passing below Hills Creek cannot return to the spawning population above the dam. It is also uncertain what the effects of downstream passage changes will mean for population performance of bull trout in the Middle Fork Willamette.

The Adaptive Management Plan (AM Plan) describes monitoring and decision criteria for Hills Creek fish passage measures (see Appendix A to this document, Sections 2.4.9, 5.5.6, and 5.5.7), accounting for needs of both bull trout and spring Chinook salmon. A review will be completed to assess the feasibility and likelihood that a safe and effective upstream fish trap for bull trout can be operated in the tailrace of Hills Creek Dam to support the trap and transport of bull trout above the dam, and to review effective designs and features. The review is expected to take one year and will begin in 2026. If found feasible the timing for completion of this trap would be 6.5 years, with 1.5 years each for EDR, DDR, P&S, and 1 year for construction. Trap completion is therefore scheduled for 2033.

For Chinook, the AM Plan includes review of monitoring results for passage measures at other dams where changes are included in the proposed action to help determine the potential for achieving adequate performance for UWR Chinook salmon populations affected. Results will be reviewed following protocols included in the AM Plan and Implementation Plan (Appendix A to this document) to determine if additional measures are necessary. The timing of this evaluation would be late in the overall implementation schedule to allow for long term fish passage measures to come online, in calendar year 2049. If results from implementation of the proposed action measures are found inadequate, additional measures could take the form of adding downstream passage at Hills Creek Dam, other new measures to address WVS effects, or adjustments or modifications to the measures already taken in any of the four Chinook populations affected by the WVS. It will be important to consider where additional measures or modifications are best targeted to address the needs of the UWR Chinook Salmon ESU effectively. This uncertainty resulted in passage projects at other locations receiving priority.

2.5.3 Fall Creek Implementation

Where an operational solution, which is immediately implementable, is proposed as the long-term solution, the operational solution will be implemented after the signing of the ROD. The operational solution at Fall Creek is being proposed for the long term and is within the USACE existing authorities. The operation details are described in Section 2.2.4.2 and vary from the Injunction operation. This operation will still be optimized under the AM Plan.

Monitoring actions are included in the AM Plan (Appendix A to this document). Monitoring results will be reported and reviewed annually. For fish passage, a 5-year check-in will be conducted to review if targets were achieved. A 5-year check-in timing was chosen due to the seasonal and annual variability that occurs and the resulting need for multiple years of data to evaluate if targets were achieved. Check-ins can also occur more often if information warrants, however caution should be taken before implementing operational changes to fish passage operations before multiple years of data are collected.

2.5.4 Cougar Implementation

After the Cougar RO modifications ordered under the Injunction are complete and evaluated, a second check-in will take place late in the year 2030 or in 2031. During this check-in, information from the Disposition Study, in conjunction with any post-construction evaluation data from the Cougar RO modifications, would be used to inform the next steps for downstream fish passage at Cougar Dam assuming Congress authorizes the proposed substantial changes to the project's purposes. USACE will lean forward in execution by planning for the Disposition Study prior to signing the ROD; however, such a major change in operations requires a significant amount of study to ensure, among other things, the diversion tunnel can safely be operated. Additionally, Congress will have to act on the recommendation submitted by USACE relating to any deauthorization of authorities or change in authorities at Cougar Dam. Congress usually approves USACE Water Resources Projects in the biennial Water Resources Development Act. By 2033, a determination would be made as to whether USACE would have sufficient authority to move forward with the Cougar long term downstream passage measure design. This time frame reflects the serious nature of the studies and the time frame needed for Congress to act. At present, the timing, scope, and scale of the Disposition Study (for hydropower deauthorization at Cougar Dam) is unknown, so refinements to the Implementation Timeline, specifically for Cougar, should be anticipated.

If it is determined to move forward with the Cougar Dam long term downstream passage measure, congressional approval and funding will be required prior to the start of the EDR phase of the project. Some parts of a traditional EDR would have been conducted during a deauthorization study, limiting the timeframe necessary for an EDR. The construction impacts including any impacts from sediment mobilization for the initial draw down will be covered by site specific environmental compliance, including Section 7 consultation. This would tentatively put completion of the diversion tunnel project in calendar year 2042.

2.5.5 Green Peter Implementation

Where an operational solution, which is immediately implementable, is proposed as the long-term solution, the operation will be implemented after the signing of the ROD. An operational solution at Green Peter is being proposed for the long term and is within the USACE existing authorities. The operational details described in Section 2.3.6 (Table 2.5-1) and vary slightly from the Injunction operation. This operation will still be optimized under the AM Plan.
An Adult Fish Facility (AFF) will be constructed at the base of Green Peter Dam to support upstream migration and the release of fish in Quartzville Creek and the Middle Santiam River above the dam. The Green Peter AFF project will start in FY25, with anticipated completion of a facility by 2030. Until then, fish collected at the Foster AFF will be used for trapping, transportation, and outplanting purposes.

2.5.6 Foster Implementation

Interim measures for fall and spring downstream fish passage and summer water temperature management operations through use of the Foster fish weir will continue. The design work for the Foster fish ladder warm water supply pipe (FFLIP project, or FWWS) will continue prior to signing of the ROD. After the ROD is signed, USACE will advertise the construction contract in the fall of 2026 and is projected to complete construction of the FFLIP by end of 2028.

USACE proposes to begin the EDR phase of a structural downstream fish passage solution at Foster Dam in 2025. The design and timeline assume the solution will be a modification on the weir internal to the Spillway. The EDR and DDR phases for the downstream fish passage structure should take a total of three years to complete, with P&S and construction taking an additional 3.5 years. Completion of a downstream fish passage structure is expected by late 2032. It should be noted that the downstream fish passage structure at Foster Dam is anticipated to be a simpler structure as compared to the structures at Detroit or Lookout Point Dam, therefore the timeframe for completion is shorter.

2.5.7 Detroit Implementation

Once the ROD is signed there will be interim operations implemented until the long-term actions of structural fish passage and temperature control are completed. These early actions include the continued implementation of interim operations for improved fall, winter and spring downstream fish passage and downstream water temperature management.

Once the ROD is signed, USACE will complete the DDR phase of the Detroit Selective Withdrawal Structure (SWS). The Floating Screen Structure (FSS) design effort will follow with a plans and specifications phase and ultimately project construction. Implementation timing is included in the AM Plan (Appendix A to this document, Section 2.4.2). Due to the limited physical space on the dam and adjacent staging areas, the structures will be constructed in two phases with the SWS constructed first, then the FSS. Anticipated completion of all construction is approximately December 2035, although this is dependent on many factors including appropriation of funds. The Implementation Timelines do not include post-construction evaluation timelines. Performance metrics and criteria are defined in the AM Plan (Appendix A, Section 5.2).

2.5.8 Fiscal Processes and Measure Timing

Several outside policies and processes impose important constraints on scheduling and execution. The most significant constraint is the USACE annual budget process for Civil Works, a two-year development process that can be generally summarized as a develop-defend-execute cycle (see Figure 2.5-2). USACE budgets and executes its mission on a Fiscal Year (FY) basis. The FY begins October 1 and ends September 30 the following year. Funding availability affects the ability to execute the Program.

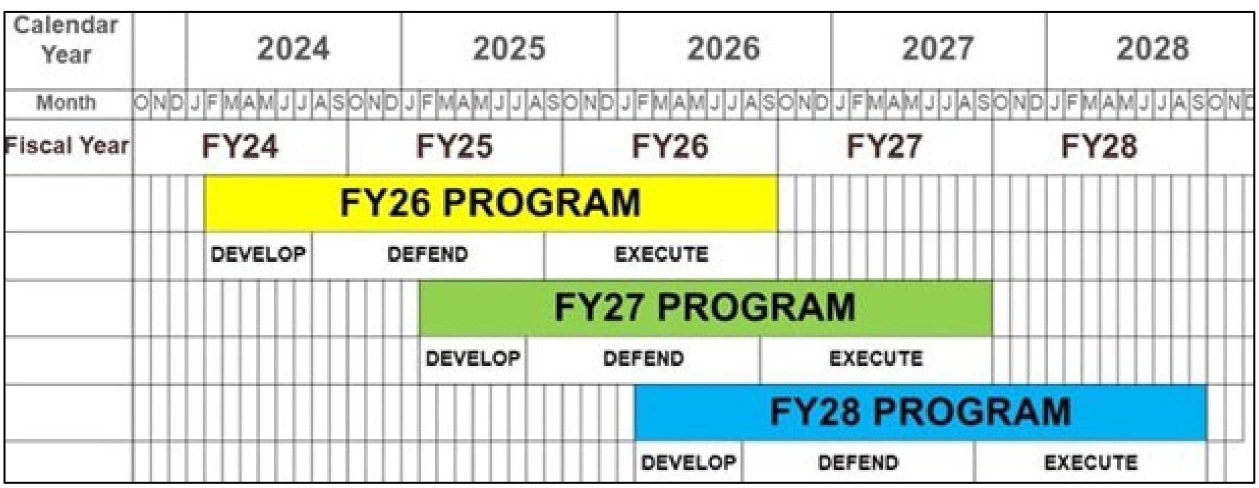

Figure 2.5-2. Example of Civil Works Budget Development Cycle.

The year-round budget process engaged in by USACE occurs on a timetable that affects other considerations for timing and implementation of the proposed action. To receive funding, a project requires both authorization from Congress, providing the permission for work to occur, and appropriations which may provide funding. Congress generally authorizes numerous new USACE projects and provides policy direction to the agency in biennial Water Resources Development Acts (WRDAs). The WRDAs do not provide funds to conduct activities, nor are they reauthorization bills. Federal funding for USACE Civil Works activities is provided in annual Energy and Water Development appropriations acts or supplemental appropriations acts.

In the absence of congressional passage of an agency-specific appropriation, Civil Works annual funding is generally included in an all-encompassing "omnibus" bill. If a bill has not passed at the start of the FY, Congress typically passes a Continuing Resolution Authority (CRA), which allows USACE to continue operations until such time as an appropriations bill is passed or the CRA expires. Under a CRA, funding is typically provided on a month-to-month basis (or other similar timeframe) based on the previous year's funding level or the President's Budget (whichever is less) and no new projects may be started.

Activities within the current FY or the next FY (FY+1) may be subject to minor adjustment only, given the budgets are already fixed, actions planned, and mechanisms to shift those actions limited. Emphasis should therefore be placed on establishing needs to set the future direction and budget. Defining needs for the FY+2 Program and budget would be the focus of USACE working with WATER on an ongoing, annual basis.

Once USACE budgets are submitted, they get ranked across each business line. This occurs first at the District, then Division, then Headquarters level. Budgets are transmitted from Headquarters to the Assistant Secretary of the Army for Civil Works (ASA-CW) for review prior to submission to the Office of Management and Budget (OMB). All budget packages across the nation are reviewed by OMB and around February of each year OMB releases the President's Budget (PBud), which provides the administration's national budget recommendation for the following fiscal year, which begins the following October. The budget is deliberated by Congress and the PBud can either be added to or subtracted from prior to Congress passing final appropriation bills.

For many USACE projects, appropriations are received on an annual basis and are expected to be executed (spent) each year. USACE construction projects are by regulation required to follow a standard design and construction process (ER 1110-2-1150). This process initiates with an EDR, followed by a DDR, Plans and Specifications, and finally construction. The duration of each phase of the design-construction process is dependent on the complexity of the project and generally takes at minimum one year per phase leading to construction, with potentially more time needed for complex projects. Complex projects may require modeling, more technical deliberation, or additional reviews; all of which add both time and cost.

2.5.9 Adaptive Management Plan

To continue the implementation of the interagency coordination specified in the 2008 biological opinions, the Action Agencies are proposing an update to this coordination summarized in this section. The Adaptive Management Plan (AM Plan) outlines the governance structure, the annual adaptive management process for inter-agency collaboration, engaging with stakeholders, and incorporating new information into management priorities. The AM Plan also outlines the decision criteria relevant to monitoring and evaluating the success of management measures at achieving stated objectives. The AM Plan is presented as Appendix A to this document.

USACE's adaptive management technical guide (USACE 2019d) defines adaptive management (AM) as a formal, science-based, risk management strategy that permits implementation of actions despite uncertainties. Knowledge gained from monitoring and evaluating results is used to adjust and direct future decisions. Simply stated, AM is learning while doing in the face of uncertain outcomes. These AM concepts are consistent with those presented in the U.S. Department of Interior's AM technical guide (B. K. Williams, Szaro, and Shapiro 2009). Figure 2.5-3 illustrates the steps in an AM cycle compatible with USACE projects.

The full WVS AM Plan is included as Appendix A to this document. The remainder of this section provides an outline of the AM Plan. In addition, during the sufficiency review of the 2023 BA and interagency coordination between the action agencies and Services, the USACE received feedback on the proposed adaptive management plan and process. This resulted in an update to the plan to clarify and refine the description of the AM process.

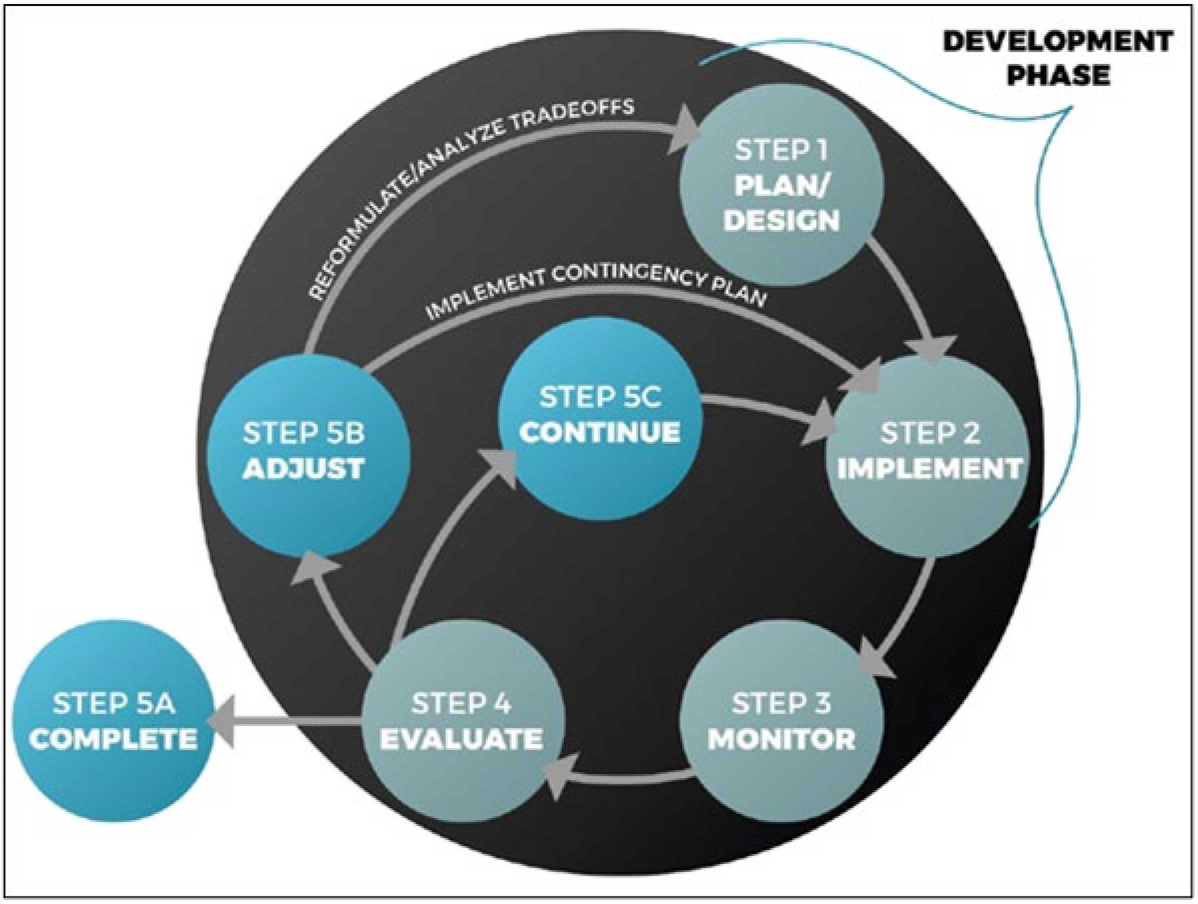

Figure 2.5-3. USACE Adaptive Management Cycle.

2.5.10 Adaptive Management of the Proposed Action

Although the limiting factors and effects of the WVS project on ESA listed fish are relatively well understood due to extensive research completed, especially since 2008, critical uncertainties remain in the expected performance of some measures in the proposed action to address project effects (e.g., downstream fish passage). Therefore, much of the focus in the AM Plan will be on the post implementation performance of the interim and long-term measures identified in the WVS EIS preferred alternative.

Evaluating the performance of measures included in the proposed action at meeting stated objectives would be based on the application of decision criteria. The term “decision criteria” refers to the set of pre-determined conditions that trigger or guide a decision or the implementation of a contingency plan. Decision criteria would be used to determine success of measures as well as identify when decisions on adjustment of actions are needed. Decision criteria direct research, monitoring, and evaluation efforts and are the basis of information reviewed during the annual science update process.

The use of decision criteria plays a key role in the evaluation of management measures and in the adaptive decision-making process. As described in the Adaptive Management Plan (Appendix A to this document), decision criteria include performance metrics, targets, and decision triggers and are defined as follows:

- **Performance metric** – A specific metric or quantitative indicator that is monitored and can be used to estimate and report consequences of management alternatives with respect to a particular objective.
- **Target** – A specific value or range of performance metric that defines success. Targets can be quantitative values or overall trends (directional or trajectory).
- **Decision Trigger** - A pre-defined commitment (population or habitat metric for a specific objective) that triggers a change in a management action. Decision triggers are addressed in the Evaluate step (Step 4 of the AM process shown in Figure 2.5-3) and specify the metrics and actions that will be taken if monitoring indicates performance metrics are or are not reaching target values. In some cases, a decision trigger may be learning a new piece of information that triggers the Continue/Adjust/Complete step (Step 5 of the AM process shown in Figure 2.5-3).

The remainder of the AM Plan is organized by basin-wide measures and by sub-basin. The proposed action includes both long-term measures, as well as interim operations measures. Within each section the following components are described for each measure included in the proposed action:

- Measure Definition and Function
- Constraints
- Performance Metrics and Targets
- Research, Monitoring, and Evaluation
- Risks and Uncertainties
- Decision Triggers and Adaptive Actions
- Decision-Making and Collaboration

The AM Plan framework also provides an important avenue for new information to be incorporated and inform and adapt implementation moving forward.

2.5.11 Adaptive Management Governance

Governance of an AM program includes the approach for improved management through integrating information into decision making, identifying:

- What decisions need to be made
- Who is involved in the decision process

- How decisions are made
- When decisions are required

The role of adaptive governance is to establish and promote frameworks by which decision makers can discuss, identify, and approve decisions to adjust management policies, plans, and actions.

Decisions for implementation of the proposed action would be made at three general levels of authority (defined as Oversight, Program Management, and Adaptive Management Implementation Team, see Figure 2.5-4).

1. The Oversight level includes agency senior leaders, who are responsible for decisions related to Federal policies and protocols and other issues that may significantly affect stakeholder interests or authorized purposes, and therefore involve collaboration with stakeholders and/or the public. These decisions are primarily made during the Plan/Design step (Step 1) of the AM cycle as the proposed action is developed, but because they are periodically revisited, could occur during the Adjust/Continue step (Step 5).
2. The Program Management level, which includes agency program and project managers, develops updates to the implementation plan and makes decisions regarding resource allocation, minor long-term operations modifications, reporting and communication, and collaboration. Management-level decisions are primarily made at the Plan/Design and Implementation steps (Steps 1 and 3) of the AM cycle but can include decisions at each step of the process.
3. The Adaptive Management Implementation Team-level decisions include the wide ranging and numerous judgments needed for the day-to-day operation and implementation of the proposed action. These include how monitoring is implemented, how assessments are conducted and reported, how projects are implemented, etc. Note, however, that the real-time flow management decisions are made by the USACE Portland District Reservoir Regulation and Water Quality.

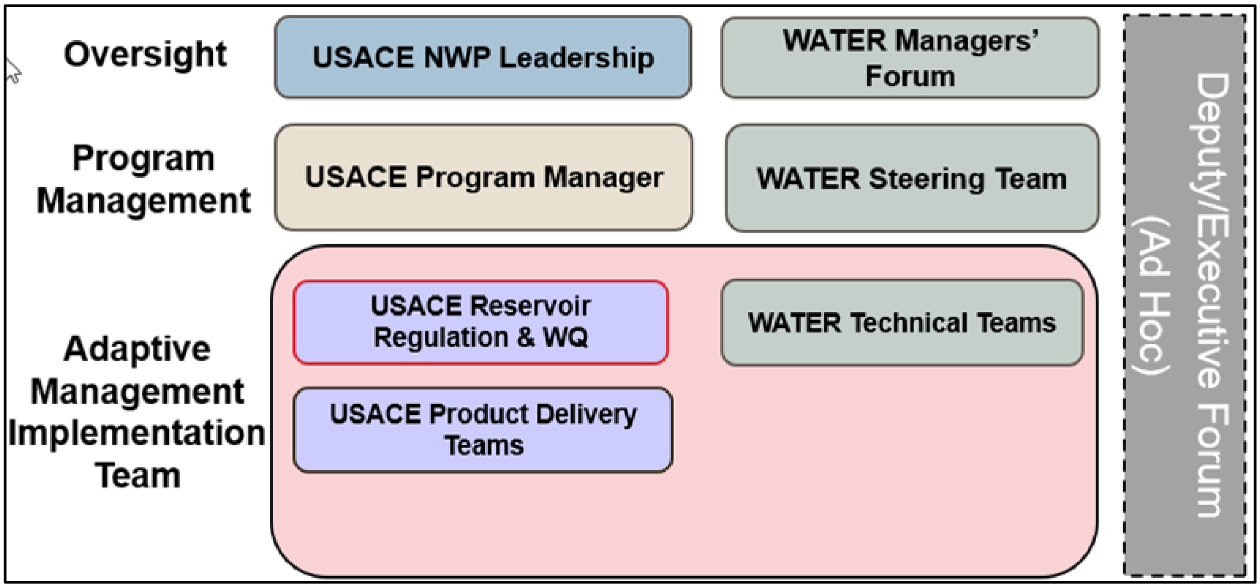

Figure 2.5-4. Adaptive Management Governance Structure.

2.5.12 RM&E and the Near-term Implementation Plan

USACE is proposing an annual AM process that would revolve around monitoring informed updates and the generation and sharing of information about proposed action performance, then using that information for adjustments to the Near-term measures and plan. Tables 2.5-1 and 2.5-2 summarize this annual process. The following description outlines the basic process. It should be noted that the science update and Near-Term Implementation Plan update processes described are in addition to, not a replacement of, the regular within year WATER collaboration that USACE engages in as part of real-time flow management and fish passage O&M.

Table 2.5-1. Summary of Annual Adaptive Management Science Update Process.

Meeting/Product	Description	Timeframe
Science Meeting	A science meeting would be held for agency technical staff, WATER representatives, and the public to be briefed on research and monitoring findings.	February
Annual AM Workshop	Annual meeting where primary exchange of information between scientists and decision makers occurs. Includes close collaboration with WATER Technical Teams. Focus is on updates to the Implementation Plan given implications of new knowledge and implementation progress.	March
AM Workshop Summary	Documents topics, issues, and outcomes discussed during the AM Workshop. Provides documentation to support any further discussions within WATER teams and drafting of the Implementation Plan update.	April/May

Table 2.5-2. Summary of Near-Term A.M. Plan Update Process

Meeting/Product	Description	Timeframe
WATER Recommendations	WATER may develop recommendations on the Implementation Plan. Recommendations should focus on FY+2 needs and direction for the program (FY+3 and FY+4) but can include suggested adjustments to other years.	June/July
Draft Updates to Near-Term Implementation Plan	The draft Implementation Plan will be updated to incorporate science updates and associated WATER recommendations and sent out to the Management Team for review.	Nov/Dec
Final Near-Term Implementation Plan Update	The Implementation Plan will reflect annual implementation progress and any additional adjustments to outyears.	January

The Implementation Plan provides the long-term strategy for implementation of management measures included in the Preferred Alternative. Following signing of a ROD, USACE would begin implementing measures based on the IP. Program Management would also need to account for necessary RM&E of management measures and research aimed at reducing uncertainty into near-term budget requests. However, implementation is highly dependent on the appropriation of funds and variability in budgets from year to year. In addition, new learning or emerging issues identified through the science update process could lead USACE in collaboration with WATER to adjust the prioritization reflected in the IP. To account for these necessary adjustments, USACE would maintain a rolling 3 to 5-year implementation plan that incorporates any updates necessitated by implementation progress and/or science updates. The "typical" events in the near-term implementation plan update process would be as follows:

vii. **WATER Recommendations** – USACE would collaborate with WATER to assess if the group has interest in submitting recommendations to USACE regarding any adjustments to prioritization or inclusion of actions in the IP.

viii. **Draft Updates to Near-Term Implementation Plan** – Based on the outcomes of the AM Workshop and any WATER Recommendations, the Near-Term IP would be updated to reflect any necessary changes in program implementation and prioritization. A draft Near-Term IP will be provided to WATER for review.

ix. **Final Near-Term Implementation Plan Update** – By January, USACE would finalize updates to the Near-Term IP and incorporate this information in its budget planning.

Supplemental information was provided by USACE to NMFS following submission of the BA to NMFS on the approach for assessing and determining changes to Interim Measures (see email and attachments from R. Piaskowski to A. Mullan, November 2023). The Decision Triggers for considering changes were revised as:

1. Monitoring results indicate the expected directional change not achieved
2. New data shows potential for improvement in one or more near-term metrics
3. Negative consequences occur including those for environmental objectives, or other mission areas

The assessment of proposed near-term changes was clarified to account for feasibility, benefits, impacts, schedule, and cost, and the following:

- Must meet requirements of an RPA under the ESA for authorization, economic feasibility and technical feasibility

- – Does not increase flood risks or reduce dam safety
- – Does not result in un-acceptable tradeoffs for other ESA objectives (e.g. performance criteria cannot be met)
- – Accounts for impacts to other missions (and verify NEPA compliance)
- – Accounts for the timing and duration of benefits when considering schedule for long-term measure(s)
- – Where new funds are required, implementation timing will be subject to funding approval as part of the federal 3-year budget cycle
- – Assessment will be based on available information, including estimated changes in:
  - Reservoir and river hydrology (RES-SIM)
  - Temperature and TDG (CE-Qual-W2 and TDG models)
  - Downstream fish passage survival (FBW)
  - Downstream fish habitat conditions (USGS habitat/flow model)

Metrics to assess Interim measures were also revised to the following, replacing those listed in the original plan submitted with the BA, and also replacing the previously referred to "experimental framework" sub section listed in the original plan:

*

Activity	Near-term metrics*	Near-term Targets
Downstream passage	Dam passage survival Dam passage injury Dam passage efficiency Dam passage timing Passage age/size composition	Expected directional change in metric achieved compared to previous operation
Temperatures	7-day Average of the Daily Max (7dADM) at Salem	
Total dissolved gas	Total dissolved gas (TDG) levels below dam	

Metric(s) monitored for Downstream Passage depends on operation and information needs.

The following diagram, shared as part of the revisions provided to NMFS in November 2023, shows how near-term measures will be reviewed and updated annually in collaboration with WATER:

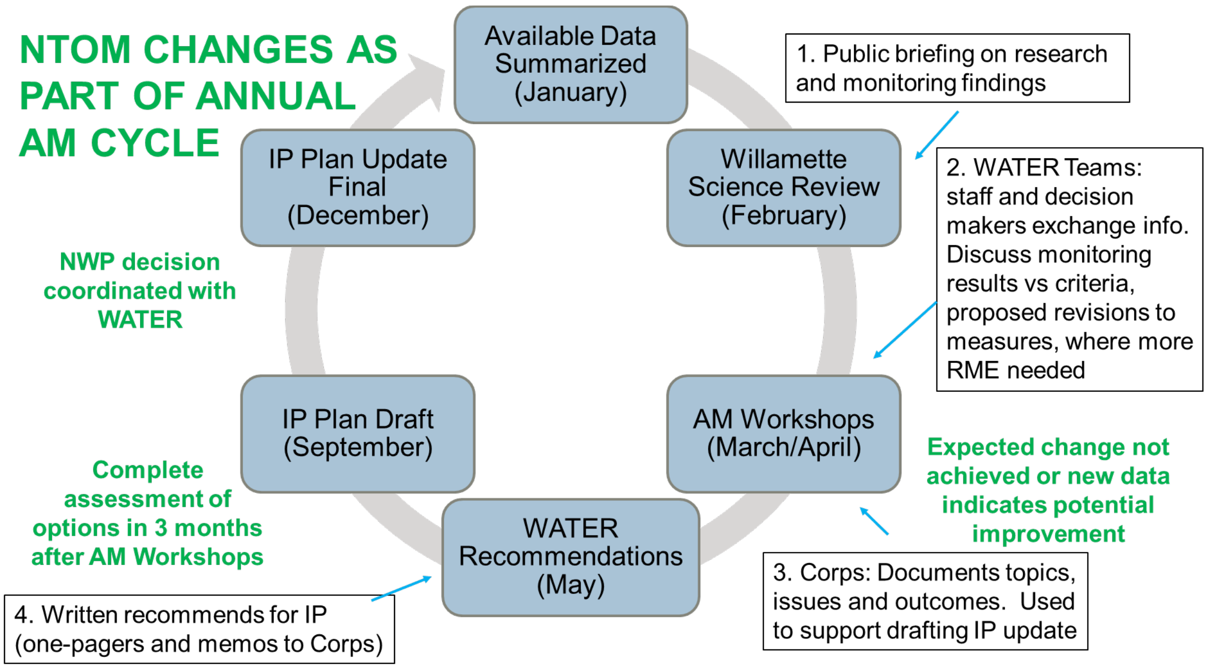

Figure 2.5-5. AM Plan measures will be reviewed and updated annually in collaboration with WATER.

2.5.13 Willamette Team for Ecosystem Restoration (WATER)

Integral to the Adaptive Management Governance Structure is continued collaboration between the Action Agencies and the Willamette Action Team for Ecosystem Restoration (WATER). The purpose of WATER is to provide a forum for coordination and recommendations among the sovereign governments as well as the other Federal and Oregon State agencies working to implement strategies for ESA compliance associated with the Willamette Project. Establishment of WATER was a core feature of the adaptive management strategy in the 2008 Reasonable and Prudent Alternative (RPA 9.1) developed during the 2008 consultation on the WVS. Participation in WATER does not alter the duty of these agencies in other interactions. WATER is not intended to make decisions for the participating agencies, rather it is intended to aid in decision making. All decisions under the authority of the federal government will continue to be made by the appropriate federal agency with the statutory authority to make such decisions.

USACE is proposing a revised structure for WATER, primarily with changes occurring at the technical team level (see Figure 2.5-6). The roles and responsibilities of each element of WATER in supporting implementation and adaptive management of the proposed action are described in the Implementation and Adaptive Management Plan (see Appendix A to this document), and summarized in Figure 2.5-6.

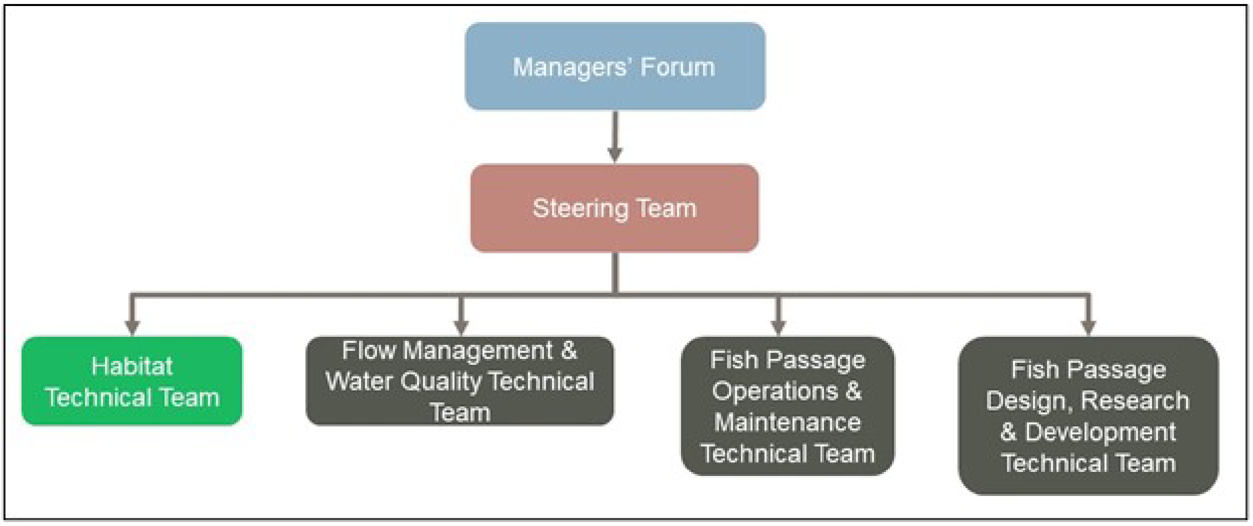

Figure 2.5-6. Proposed WATER Structure.

Managers' Forum

The Manager's Forum would provide senior management level oversight to the implementation of the WVS Biological Opinions. The Manager's Forum serves as the regional policy and management level body representing the key participating federal agencies with responsibility for operating and maintaining the federal dams in the Willamette Basin (USACE, USBR, BPA).

It is anticipated that the Manager's Forum will continue to consist of senior level management from federal and state agencies and Tribes with fisheries and water resource management responsibilities in the WRB. The USACE representative serves as the chair of the forum.

Manager's Forum Roles and Responsibilities

The Manager's Forum will provide review, input, and policy guidance related to the development and implementation of actions as they relate to the WVS Biological Opinion. While most discussions and recommendations will be delegated to lower-level teams, the Manager's Forum serves as the highest body for any disputes or discussions deferred to the management level. Responsibilities include:

- Make final recommendations about priorities
- Make final recommendations about targets and objectives
- Make final recommendations about program structure and changes
- Resolve disputes

WATER managers shall demonstrate leadership and commitment with respect to the outcomes of WATER and Adaptive Management by:

- Taking accountability for the effectiveness of the Steering Team and Technical Teams.
- Promoting the use of the Adaptive Management approach.

Steering Team

The Steering Team is the second tier of WATER comprised of senior managers who have the authority from their respective agencies to provide input on management decisions related to Biological Opinion implementation. The Steering Team is responsible for synthesizing recommendations from the Technical Teams into prioritizations based on budgetary, legal, policy constraints, and other considerations. These prioritizations will get incorporated into the Implementation Plan, which the Steering Team will review. The Steering Team is also the level at which the participating entities will seek to resolve disagreements. The Steering Team is integral to providing recommendations on overall strategy and direction for Biological Opinion implementation, keeping the Managers Forum informed of high-priority issues, and providing direction for the technical teams.

Team Roles and Responsibilities:

- Make recommendations on action and research prioritization. Recommendations should focus on FY+2 needs and direction for the program (FY+3 and FY+4) but can include suggested adjustments to other years.
- Recommend changes to program components and governance.
- Review the Implementation Plan annually and provide comments.
- Consider any recommendations for independent review from the Technical Teams.

Technical Teams

The third tier of WATER is comprised of groups of focused technical teams, each of which represents different elements of the implementation of the Willamette Biological Opinions. Technical teams are charged with implementing the actions listed in the Biological Opinions and in providing the Steering Team technical information and considerations that may aid management discussions. WATER technical teams do not supplant existing federal, state or tribal decision-making authorities. Technical teams are critical opportunities for other governmental agencies to jointly explore potential solutions and seek agreement on recommendations to the Action Agencies.

Technical teams will be comprised of key function area technical experts from each of the involved federal and state agencies and Tribes, including the Action Agencies. Experts from academia and consulting firms may also attend meetings as needed to provide relevant information.

1. General responsibilities for the Technical Team are outlined below. Each team will have additional roles and responsibilities based on their respective areas of responsibilities.
2. Participate in the Willamette Fisheries Science Review to understand the latest science and its implications on future technical team direction
3. Participate in the Adaptive Management Workshop to discuss the latest technical results and its implication for AM plan implementation.
4. Establish workgroups as needed on an ad-hoc or permanent basis.
5. Review changing field conditions to identify long-term trends that may necessitate adjustments to implementation.
6. Identify relevant studies or analyses that may be necessitated by emerging issues or considerations and provide recommendations to the Steering Team on research priorities.

Fish Passage Operations and Management Technical Team

The Willamette Fish Passage Operations and Maintenance (WFPOM) forum develops recommendations for ongoing operations and maintenance activities that may affect listed fish species. This forum also includes technical discussions relating to hatchery programs. This forum is responsible for providing input on annual changes to the Willamette Fish Operations Plan, which dictates how facilities must operate to minimize impacts to ESA-listed species. The WFPOM at times may develop in-season recommendations for real-time operational management for consideration by the FMWQT, consistent with pre-defined operational measure objectives for ESA-listed fish. Recommendations from the WFPOM and other WATER teams seeking continuing changes (multi-year or permanent) to modify operations will be determined through the annual AM process. This team is also used to coordinate emergency deviations from the WFOP through the Memorandum of Change/ Memorandum for the Record process (MOC/MFR). This process is summarized below and described in detail in the WFOP.

Team Roles and Responsibilities

1. Coordinate ongoing maintenance and construction activities, both scheduled and unscheduled, as well as any emergency operations that occur.
2. Coordinate and review operations required for any future research or construction activities.
3. Discuss hatchery program implementation and provide updates on hatchery-related activities
4. Provide input to annual revisions of the WFOP
5. Provide input for development and review of the annual Conservation Plan for achieving operational measures for at-dam fish passage.

Annual Fish Operations Plan

The *Willamette Fish Operations Plan* (WFOP) is developed annually by the U.S. Army Corps of Engineers in coordination with the Bonneville Power Administration and regional Federal, State and Tribal fish agencies and other partners through the WFPOM coordination team. For an example WFOP please refer to Appendix F of the 2023 BA. The WFOP describes year-round operations and maintenance activities at Corps projects in the Willamette Basin as coordinated through WFPOM to protect and enhance anadromous and resident fish species listed as endangered or threatened under the ESA, as well as non-listed species of concern. The WFOP guides USACE actions related to fish protection and passage at the 13 Willamette projects. Other Corps documents and agreements related to fish passage at these projects are consistent with the WFOP.

Currently, the WFOP is developed in accordance with the NMFS Section 7 Biological Onion on the Operation and Maintenance of the WVS (NMFS 2008a), RPA Action 4.3 for the operation and maintenance of Willamette Valley dams and fish passage facilities to minimize impacts to fish. The Action Agencies propose to continue this annual process as part of the action and ongoing interagency coordination for the WVS O&M. As part of the annual process, the WFOP is revised as necessary to incorporate changes to project O&M as a result of new facilities or changes in operational procedures. Revisions to the WFOP will include those developed and incorporated into the Near Team Implementation Plan. Revisions will also incorporate changes adopted through coordination with NOAA Fisheries and USFWS as part of the ESA Section 7 consultation, Recovery Plan, or Incidental Take permit processes, and through consideration of other regional input and plans. If any revisions to the WFOP are necessary, they will be made in accordance with the coordination process for revisions. Comments on the WFOP are welcome and may be sent to WFPOM and/or the Corps' Portland District Operations Division Fisheries Section, in Portland, Oregon. Draft and final WFOPs from 2015 through present, including all Change Forms, are available online at the *Willamette Fish Operations Plan Website*: http://pweb.crohms.org/tmt/documents/FPOM/2010/Willamette_Coordination/WFOP/

The WFOP also serves as the documentation for fish disposition plans at the fish facilities, where the release site for the various species and stocks as well as adult Chinook outplant (hatchery supplementation) levels are specified. This helps guide the daily decisions by the facility operators to meet these goals. Criteria for adult fish facilities are contained in the project-specific WFOP Chapters 2–5. Additional criteria may be developed as part of the ESA Section 10 permit process and/or in coordination with the WFPOM.

The phrase "*when practicable*" is used in the WFOP to describe Project actions for fish that may vary on a case-by-case basis and thus require the exercise of professional judgment by Project staff. These situations may be due to real-time biological and/or other environmental conditions, availability of Project staff and/or equipment, or integrity of fish facility or other dam structures. In these cases, the Project biologist and other Project personnel will consider all relevant factors to determine the best way to proceed and implement appropriate action. These actions will be coordinated with fish agencies and tribes via the MOC/MFR process when they deviate from the WFOP.

River operational emergencies may occur that require projects to temporarily deviate from the WFOP. To the extent practicable, these operations will be coordinated with fish agencies and tribes via the Memorandum of Change process and conducted in a manner to avoid or minimize fish impacts. Normally, coordination occurs prior to an action; however, if an emergency situation requires immediate attention, coordination will be completed as soon as practicable afterwards.

Flow Management and Water Quality Technical Team

The primary responsibility of the Flow Management and Water Quality Team (FMWQT) is to provide a coordinating body for recommendations on project operations related to instream flows, water quality, and water storage. This team is also responsible for coordinating and commenting on the Annual Conservation Plan and Annual Water Quality Monitoring Report. FMWQT will be chaired by a representative of the USACE. The FMWQT provides recommendations to USACE on operations in real time regarding how to best achieve pre-defined ESA-fish related operational objectives for instream flow, water quality and fish passage. USACE uses that information in determining how to balance among those and other operation mission objectives where conflicts or constraints exist. Input on fish passage prioritization may also be provided to the FMWQT from the WFPOM in real time where in-season constraints exist. In-season changes are intended to be implemented only within that given season. Recommendations from FMWQT and other WATER teams seeking continuing changes (multi-year or permanent) to modify operations will be determined through the annual AM process and will have to undergo any necessary environmental compliance before implementation.

The FMWQT is chaired by a representative of the USACE (Portland District Reservoir Regulation and Water Quality Section). Other members include key Federal and state agencies with water management authorities and responsibilities in the Willamette Basin, including the Services, BPA, Reclamation, USEPA, OWRD, Oregon Department of Environmental Quality (ODEQ), and ODFW. The FMWQT will be utilized by USACE to communicate the established minimum flow thresholds and provide forecasted model information to the participants. USACE has ultimate authority for operating reservoir elevations and downstream flows to meet authorized project purposes. These meetings allow for the agencies to have adequate opportunity for providing input on flow management operations.

The FMWQT meets frequently throughout the year, with monthly meetings during the development and implementation of the annual conservation storage and release plan. More frequent meetings occur during real-time operations if there are questions to resolve.

On September 21, 2006, the ODEQ finalized the Willamette Basin total maximum daily loads (TMDLs) for temperature, mercury, and bacteria. In 2021, ODEQ and EPA revised the mercury TMDL criteria for the Willamette Basin. Revisions are also underway for the Willamette Basin temperature TMDL, which is expected to be finalized in 2024. FMWQT serves as the primary communication and coordination tool for TMDL implementation planning through an interagency work group. Annual reporting on water quality measures is also included as part of the annual water quality monitoring report.

Team Roles and Responsibilities:

x. Contribute technical input necessary to support implementation of flow management, operations for at-dam fish passage, and water quality measures.
xi. Provide information about storage capacity within the system and annual forecast of general hydrologic conditions; communicate USACE adaptive strategies.
xii. Provide advice and consultation during real-time operations, particularly for, but not limited to, the conservation storage and release season.
xiii. Conduct annual reviews of WVS operations and document issues, concerns and opportunities associated with improving operations to better meet ESA and Clean Water Act (CWA) compliance requirements where possible.
xiv. Provide debriefing materials to other WATER forums regarding flow management, water quality operations, and operational fish passage.
xv. TMDL implementation planning.
xvi. Assist in development of uniform water quality criteria and standards for CWA and ESA compliance.
xvii. Review and evaluate the latest water quality science.

Annual Conservation Plan

The USACE prepares an annual plan for the conservation release season (April/May-October). This plan is drafted in the spring, in coordination with the FMWQT, and finalized in May. This plan is communicated out in multiple forums including WFPOM and the FMWQT meetings. The Conservation Plan describes how the authorized project purposes will be accomplished during the conservation season based on the water supply forecast. The Conservation Plan will reflect relevant measures included in the most recent version of the Near-Term Implementation Plan.

Annual Water Quality Report

The *Willamette Basin Annual Water Quality Report* is written annually to address Reasonable and Prudent Alternative (RPA) 5.1.4 of the National Marine Fisheries Service's (NMFS) 2008 WVS Biological Opinion. This RPA titled, *Monitoring and reporting of interim water quality improvement measures*, states that for each year from 2009 through the term of the Biological Opinion, the United States Army Corps of Engineers (Corps) will monitor and evaluate the effectiveness of interim and permanent water quality improvement measures in the Willamette Basin and produce an annual report for the region by 1 March of the following year. The water quality improvement measures may include modifying operations at the Corps projects to improve downstream water temperatures and reduce total dissolved gas (TDG) for anadromous fish species listed under the ESA. The Action Agencies propose to continue this annual reporting through the Annual Water Quality Report as part of the proposed action. The annual report will reflect monitoring and analysis of relevant measures included the Near-Term Implementation Plan.

The ODEQ TMDL target temperatures for downstream of the Corps reservoirs in the Willamette Basin are also included in this annual reporting for comparison purposes. In addition, the *Willamette Basin Annual Interim TMDL Water Quality Plan* (*WQP)* will be included within this report as a combined effort to address TMDL implementation and Biological Opinion provisions below Willamette Basin Corps projects.

Fish Passage Design, Research and Development Technical Team

The Fish Facility Design, Research, and Development Team is a technical team comprised of engineers, biologists and other fish facility technical experts. The purpose of this workgroup is to provide technical input and review for engineering fish passage improvements (e.g., fish collection facilities, fish passage systems, etc.). USACE PDT representatives will participate in this forum as needed to provide updates and to seek input on PDT efforts relating to design or research of Biological Opinion-related projects.

The Fish Facility Design, Research, and Development Team will also consider what research and monitoring may be needed to inform future fish passage facility design or fish passage operations in support of Biological Opinion implementation and the AM Plan. Research may also be needed to determine the effectiveness of new fish structures or operations, or to evaluate the impact of changing conditions on the continued effectiveness of facilities or operations. Results from this research will be discussed and recommendations made to PDTs or other WATER technical forums to support the AM process, or to the Steering Team to inform management decisions and funding prioritization.

Team Roles and Responsibilities:

xviii. Review and provide input on fish passage design and construction planning efforts tied to Biological Opinion implementation.

xix. Provide recommendations on potential research and monitoring needed to inform fish passage structures or operations included in the Biological Opinionas well as the AM Plan.

xx. Provide data and recommendations to the Steering Team and other WATER teams as appropriate to support management discussions on overall strategy and funding prioritization.

3 Range-wide Status of Species and Designated Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status of each species is determined by the level of extinction risk that the listed species faces, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. This opinion also examines the condition of designated critical habitat, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated critical habitat, and discusses the function of the PBFs that are essential for the species' conservation.

The UWR Chinook salmon and steelhead are expected to be exposed to a wider range of effects as a result of the proposed action, as well as effects of greater magnitude and duration, than any other species considered in this opinion. Consequently, the status of these species is discussed in greater detail. Additional information is provided for specific UWR Chinook salmon and steelhead populations in tributaries that may be affected by the proposed action, i.e., tributaries with Willamette Valley Project dams and reservoirs.

Table 3-1, below provides a summary of listing and recovery plan information, status summaries, and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. These documents are available on the NMFS West Coast Region website (http://www.westcoast.fisheries.noaa.gov/).

Table 3-2.5-1. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species determined to be adversely affected or jeopardized in this opinion. Listing status: 'T' means listed as threatened; 'E' means listed as endangered; 'P' means proposed for listing or designation.

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
Lower Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River spring-run	E 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	ESA section 9 applies
Snake River spring/summer-run	T 6/28/05; 70 FR 37160	10/25/99; 64 FR 57399	6/28/05; 70 FR 37160
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
Chum salmon *(O. keta)*			
Columbia River	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Coho salmon *(O. kisutch)*			
Lower Columbia River	T 6/28/05; 70 FR 37160	2/24/16; 81 FR 9252	6/28/05; 70 FR 37160
Sockeye salmon *(O. nerka)*			
Snake River	E 8/15/11; 70 FR 37160	12/28/93; 58 FR 68543	ESA section 9 applies
Steelhead (*O. mykiss*)			
Lower Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Willamette River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Middle Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Upper Columbia River	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	2/1/06; 71 FR 5178
Snake River Basin	T 1/5/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160
Southern Resident Killer Whale	E 11/18/05; 70 FR 69903	11/29/06; 70 FR 69054	

3.1 Upper Willamette River (UWR) Chinook Salmon and Critical Habitat Status

On March 24, 1999, NMFS listed the UWR Chinook salmon evolutionarily significant unit (ESU) as threatened (64 FR 14308). That status was affirmed on June 28, 2005, (70 FR 37160) and updated on April 14, 2014 (79 FR 20802). The most recent status review, in 2024, concluded that this ESU should retain its threatened status (NMFS a). Critical habitat was designated on September 2, 2005 (70 FR 52630). More information can be found in the recovery plan (ODFW and NMFS 2011) and the most recent status review and viability assessment (NMFS 2024a; Ford ed. 2022).

3.1.1 Status of UWR Chinook Salmon

The UWR Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon originating from the Clackamas River and in the Willamette River and its tributaries above Willamette Falls, Oregon, as well as UWR Chinook salmon from six artificial propagation programs (NMFS 2024a). The six artificial propagation programs considered part of the ESU are the McKenzie River Hatchery Program, North Santiam River Program (Oregon Department of Fish and Wildlife (ODFW) stock # 21), South Santiam River Program and the Molalla River Program (ODFW stock #24), Willamette Hatchery Program, and the Clackamas

Hatchery Program spring-run Chinook hatchery programs (NMFS 2024a; 85 FR 81822, December 17, 2020).

The Willamette/Lower Columbia Technical Recovery Team (WLCTRT) identified seven independent populations within this ESU, as shown in Table 3.1-1 and Figure 3.1-1 below (Myers et al. 2006); all populations are part of the same stratum (Cascades Tributaries Stratum) or major population group (WLCTRT 2003).

Table 3.1-1. Historical populations in the UWR Chinook salmon ESU (Myers et al. 2006).

Stratum	Population*
Upper Willamette	Clackamas (C)
	Molalla
	North Santiam River (C)
	South Santiam River
	Calapooia
	McKenzie (C)(G)
	Middle Fork Willamette (C)

*The designations "C" and "G" identify Core and Genetic Legacy populations, respectively. Core populations historically represented the centers of abundance and productivity for a major population group. Genetic legacy populations have had minimal influence from nonendemic fish due to artificial propagation activities or exhibit important life history characteristics no longer found throughout the ESU (WLCTRT 2003).

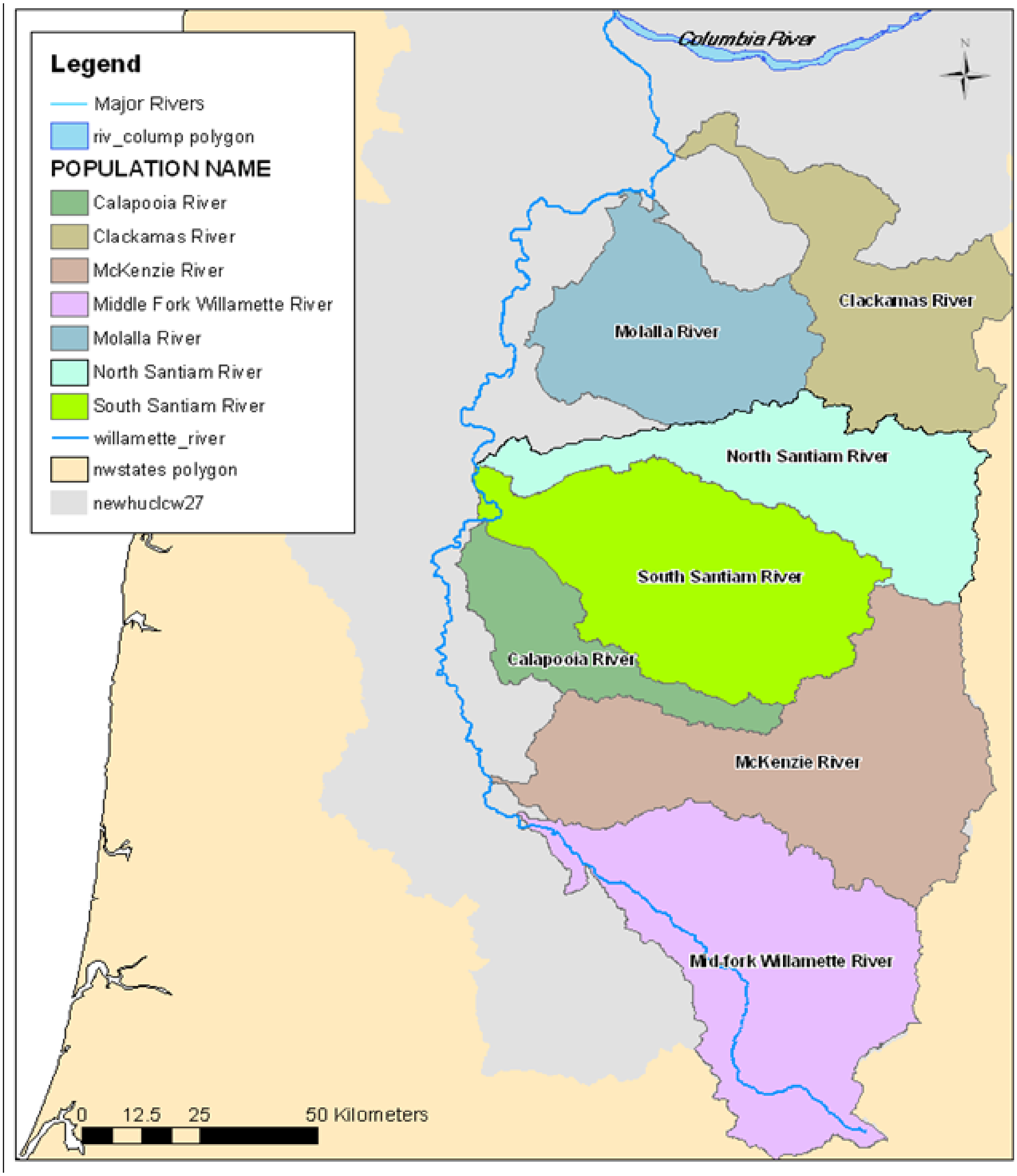

Figure 3.1-1. Map of historical populations in the UWR Chinook ESU (Myers et al. 2006).

UWR Chinook salmon differ from other Columbia River basin Chinook salmon according to both genetic and life-history data and are one of the most genetically distinct groups of Chinook salmon in the Columbia River Basin (Schreck et al. 1986, Utter et al. 1989, Waples et al. 1993, Myers et al. 1998). Historically (before the laddering of Willamette Falls), passage by returning adult salmonids over Willamette Falls (RKm 37) was possible only during the winter and spring high-flow periods. The early run timing of Willamette River spring-run Chinook salmon relative to other lower Columbia River spring-run populations is viewed as an adaptation to flow conditions at the falls. Since the Willamette Valley was not glaciated during the last epoch, the reproductive isolation provided by the falls was probably uninterrupted for a considerable time and provided the potential for significant local adaptation relative to other Columbia River populations (Myers et al. 2006). UWR Chinook salmon still contain a unique set of genetic resources compared to other Chinook salmon stocks in the Willamette-Lower Columbia (W/LC) Domain (Figure 3.1-2); also see Myers et al. 1998 and Myers et al. 2006).

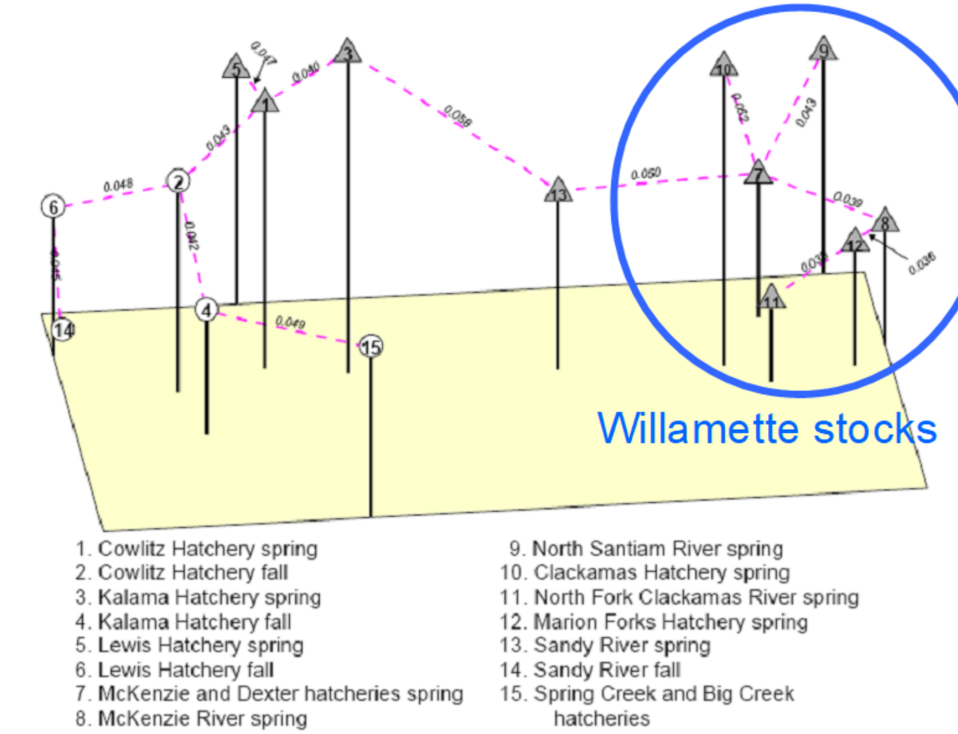

Figure 3.1-2. Three-dimensional representation of genetic difference, showing similarity of UWR Chinook stocks (indicated by proximity in the diagram) and their distinctness from Lower Columbia Chinook stocks (indicated by distance in the diagram). Figure adapted from Myers et al. 2006.

Life History and Factors for Decline

While adult UWR Chinook salmon can begin appearing in the lower Willamette River in January, the majority of the run were previously seen at Willamette Falls ladder in April through May (Myers et al. 2006), but since 2000, there have been a number of years when only 50 percent of the run or less has passed by the end of May (2008, 2011, 2022, 2023, and near 50 percent in 2017 and 2020) (ODFW Willamette Falls Fish Counts https://myodfw.com/willamette-falls-fish-counts). In the past, Mattson (1963) found later-arriving adult migrants were larger and older and speculated that this portion of the run intermingled with the earlier-run fish on the spawning grounds but did not represent a distinct run (Myers et al. 2006). Similarly, 5-year-old fish dominated the run historically, whereas it is now dominated by 4-year-old adults (Mattson 1963). Generally speaking, spawning occurs from

August through October and typically peaks in September, though timing can vary among populations; fry then emerge from spawning reaches between early December and March (ODFW and NMFS 2011; Schroeder et al. 2016).

A recent review of peak Willamette River mainstem emigration timing (year 2005-2014) for juvenile salmon emerging below USACE dams found distinct groups moved in June–July (subyearling), March–May (yearling smolts), and November–December (called “autumn smolts”) (Schroeder et al. 2016) (Figure 3.1-3). Many juveniles reach the Willamette River mainstem migration corridor as yearlings, but subyearlings are also found in the Willamette River (Friesen et al. 2004). These subyearling migrants enter the Willamette River mainstem (as fry) as early as May and head to the lower Columbia River as early as June (Schroeder et al. 2005). Other subyearling migrants remain in the Willamette River tributaries through their first spring and summer; some spend their first winter in the mainstem Willamette River, while others move past Willamette Falls (in the lower Willamette River) before winter to rear in the Columbia River estuary and may enter the ocean as early as March (Shroeder et al. 2005; Shroeder et al. 2016). While the most prevalent life-history strategy is to migrate as yearlings, the asynchronous contributions of these various strategies maintains life history diversity within the ESU and within populations which strengthens their resilience to changes in environmental conditions including climate change. Maintaining and restoring critical habitats to support this diverse set of life histories can provide stability and resilience to the UWR Chinook salmon populations (Schroeder et al. 2016).

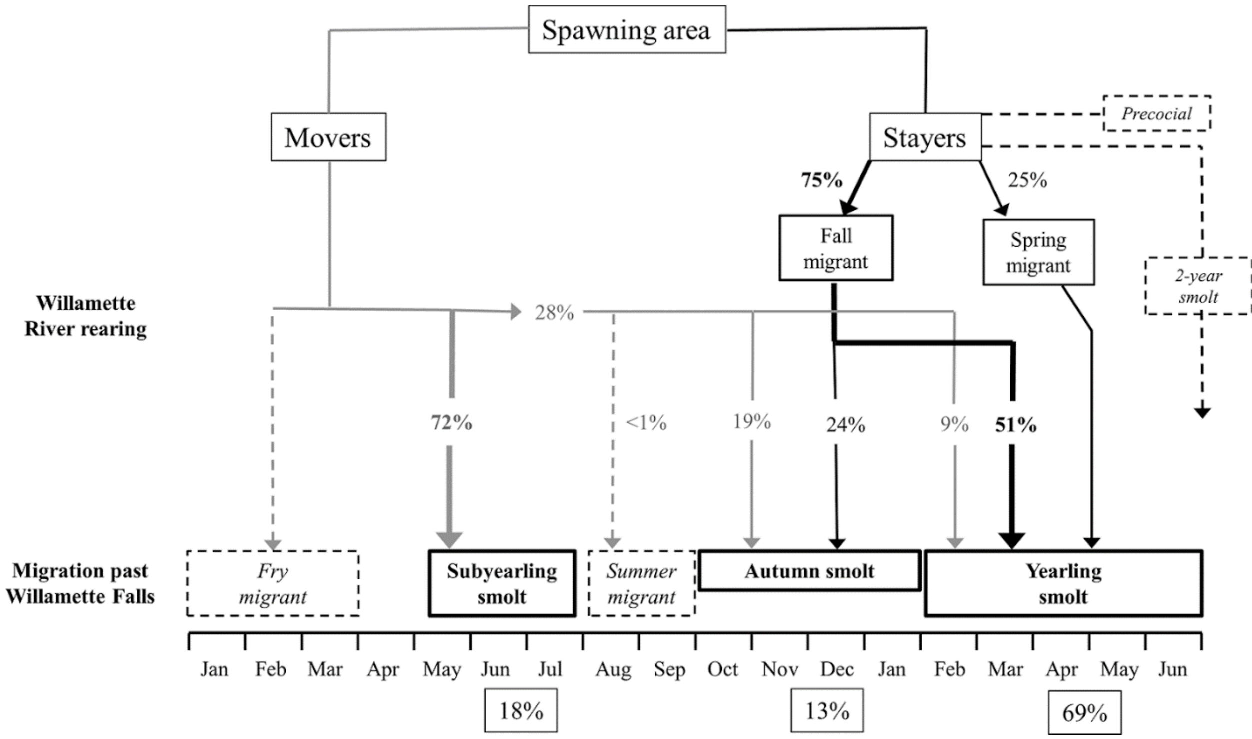

Figure 3.1-3. (From Shroeder et al. 2016). Migratory pathways of juvenile Chinook salmon from spawning areas to Willamette Falls for two phenotypes: fish that migrate from natal areas as emergent fry (movers = gray lines) and those that rear in spawning areas (stayers = black lines). Primary migratory pathways are represented by thick lines and arrows, and smolt types are in boxes with thick borders and bold font; secondary pathways are narrow lines and arrows or dashed lines, and secondary migrant types are in boxes with dashed borders and italic font. Percentages for the pathways are additive, and percentages in boxes below the x axis are the mean contribution of three smolt types to the estimated smolt production, 2004–2013 brood years.

Historically, up to 300,000 total Chinook salmon adults returned to the upper Willamette River each year. However, around the time of listing, the abundance estimate for the natural-origin UWR Chinook salmon was not much greater than 10,000 fish (Myers et al. 2006). The current 10-year (2015–2024) average for natural-origin adult returns (Clackamas plus Willamette Falls counts) remains close to 10,000; approximately 65 to 85 percent of the total adult return (to the Willamette Falls Dam) are of hatchery origin (Figure 3.1-4). However, in the last 10 years, the natural-origin Clackamas UWR Chinook salmon population has been trending upward while the UWR Chinook salmon populations that are much more significantly affected by the proposed action (North Santiam, South Santiam, McKenzie and Middle Fork Willamette) have been trending downward (Figure 3.1-5). In 2007 and 2011, two separate extinction-risk assessments were completed for the UWR Chinook salmon ESU and its component populations (McElhany et al. 2007; ODFW & NMFS 2011). Both assessments gave the ESU a high to very high risk of extinction in the next 100 years. Since ESA listing and recent extinction risk assessments were completed, adult returns for six of the seven populations have continued to decline. The Clackamas population (which does not pass over or through Willamette Falls Dam because of its location upstream of the confluence) is the only population that has seen recent increases in adult returns. Since about 2010, no marked Chinook salmon have been passed above the Clackamas North Fork Dam. Only a small percentage of those passed are hatchery-origin and the few that are (< 5%) are mis-marked hatchery fish. The recent increases in Clackamas population returns and its success can be attributed to state-of-the-art volitional fish passage improvements (for juveniles and adults) that have been implemented at the River Mill and North Fork dams between 2012 and 2015 (see Clackamas River sub-basin section in the Environmental Baseline for further details on Clackamas fish passage improvements and adult returns).

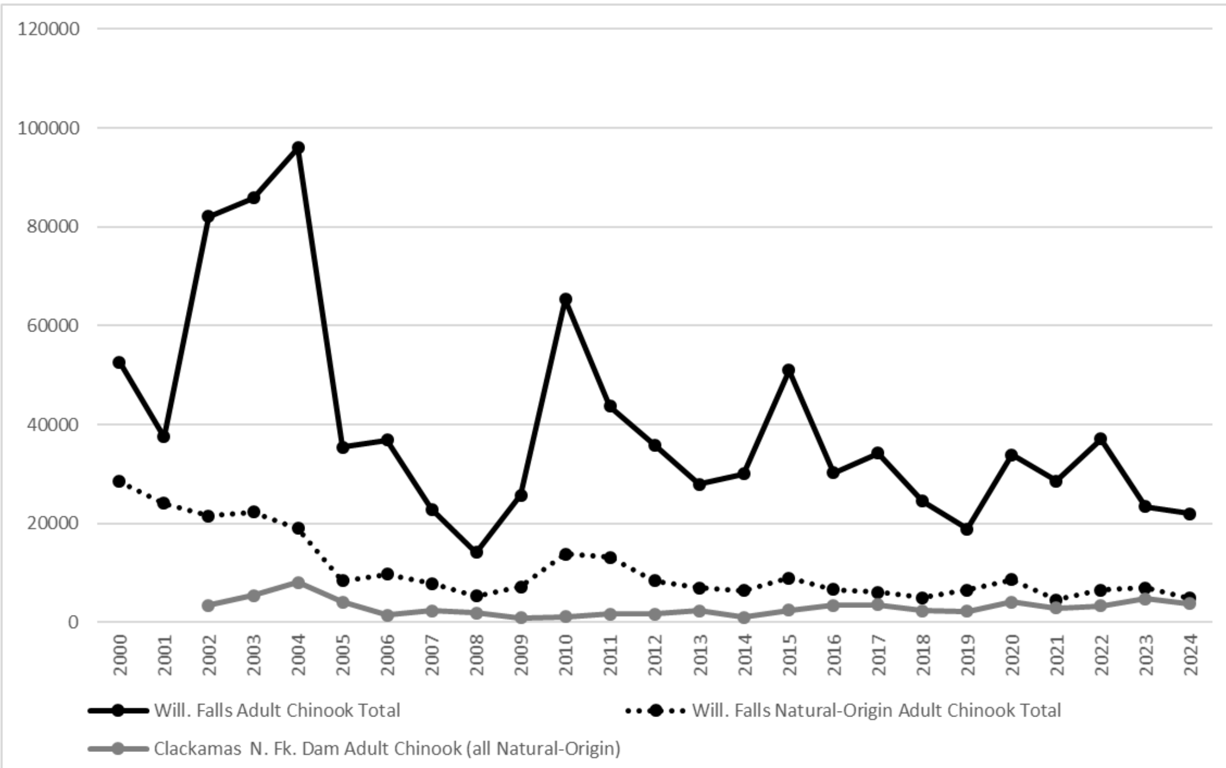

Figure 3.1-4. Annual total counts of adult UWR Chinook salmon returns to the Willamette Falls Dam and the Clackamas River North Fork Dam. Six of the seven ESA-listed UWR Chinook salmon populations must pass Willamette Falls Dam prior to reaching their natal sub-basin, not including the Clackamas population.

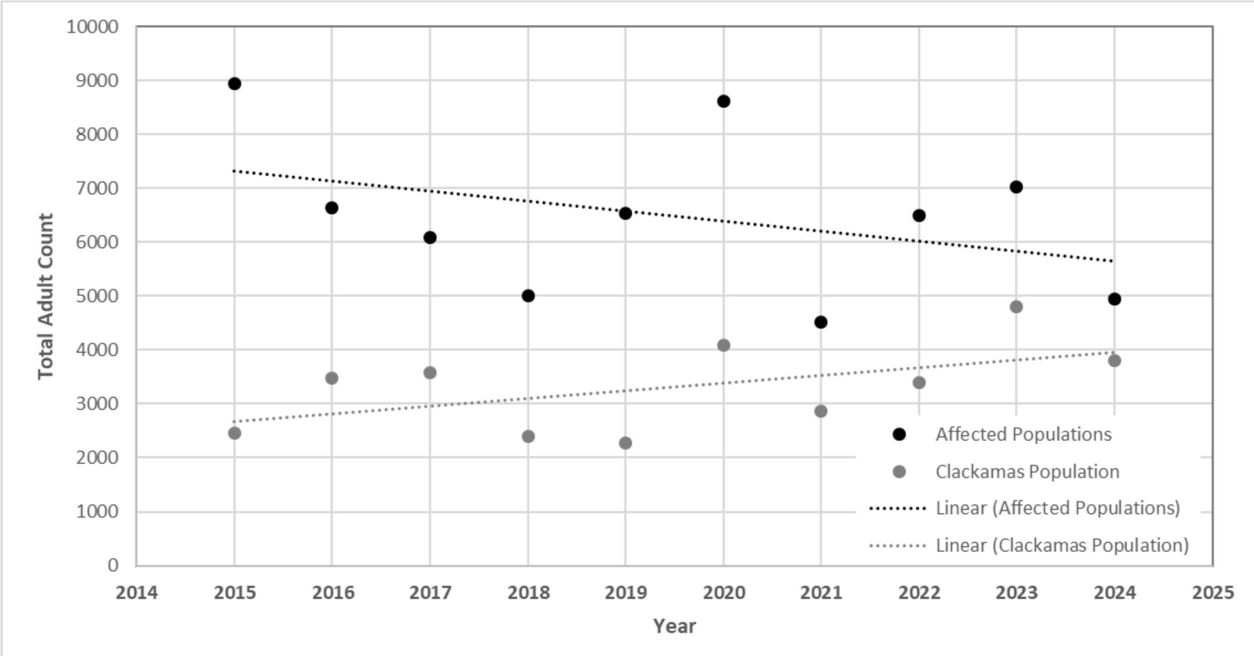

Figure 3.1-5. Annual total counts of natural-origin adult UWR Chinook salmon returns to the Clackamas North Fork Dam (Clackamas population) vs. Willamette Falls Dam (all other UWR Chinook salmon populations) from year 2015-2024, with associated trendlines. The Clackamas UWR Chinook salmon population is not significantly affected by the Proposed Action, but are affected by non-federal dams that now include upstream and downstream volitional fish passage facilities. The major four UWR populations that are included in the Willamette Falls Dam count (North Santiam, South Santiam, McKenzie and the Middle Fork Willamette) are significantly affected by the Proposed Action and have been significantly impacted by the construction of the WVS USACE dams which do not presently provide either upstream or downstream volitional passage.

A key factor in the decline of the UWR Chinook salmon ESU was the construction in the 1950s and 1960s of nine (of thirteen) WVS flood-control dams that block access to 70–95 percent of the historic spawning areas for three populations (North Santiam, South Santiam, Middle Fork Willamette) and 25 percent of spawning habitat in the McKenzie River subbasin where some headwater spawning areas remain accessible. Other factors contributing to the decline of the ESU included early fishery exploitation (beginning in the late 19th century) and dramatic declines in water quality (ODFW and NMFS 2011). Other concerns cited by NMFS at the time of listing included: 1) habitat degradation caused by agricultural development and urbanization; 2) prolonged and extensive spring Chinook salmon hatchery production in the basin, and high proportions of returning hatchery-origin adults; 3) the introduction of fall-run Chinook salmon into the basin, and 4) the impacts of high harvest rates (ODFW and NMFS 2011; 63 FR 11482).

Recovery Plan

The ESA recovery plan for UWR Chinook salmon (ODFW and NMFS 2011) includes delisting criteria for the ESU, identifies factors currently limiting its recovery, and outlines management actions necessary for recovery. The biological delisting criteria are based on recommendations by the W/LC TRT. They are hierarchical in nature, with ESU-level criteria based on the status of natural-origin UWR Chinook salmon assessed at the population level. Population-level assessments are based on evaluation of population abundance, productivity, spatial structure, and diversity (these parameters are referred to as the viable salmonid population—or VSP—parameters; McElhany et al. 2007) and an overall extinction risk characterization. Achieving recovery (i.e., delisting) of the ESU will require sufficient improvement in these areas. The Conservation and Recovery Plan for Upper Willamette Chinook salmon and steelhead (ODFW and NMFS 2011) describes the viability criteria in detail and the parameter values needed for persistence of individual populations and recovery of the ESU.

Abundance, Productivity, Spatial Structure and Diversity

The extinction risk for each population over a 100-year time frame was estimated qualitatively based on criteria identified by the WLC-TRT (McElhany et al. 2007). The rating system categorized extinction risk as very low, low, moderate, high, and very high based on abundance, productivity, spatial structure, and diversity characteristics. Based on the results for each population, McElhany et al. (2007) determined that the risk of extinction for the entire ESU was "high." A similar viability assessment was conducted for the 2011 UWR Recovery Plan for Chinook salmon and steelhead, which resulted in similar extinction risk categories for individual populations within the UWR Chinook salmon ESU (ODFW and NMFS 2011). The Recovery Plan assessment also assigned a "desired status" to each population at which recovery could be achieved (Figure 3.1-6 below).

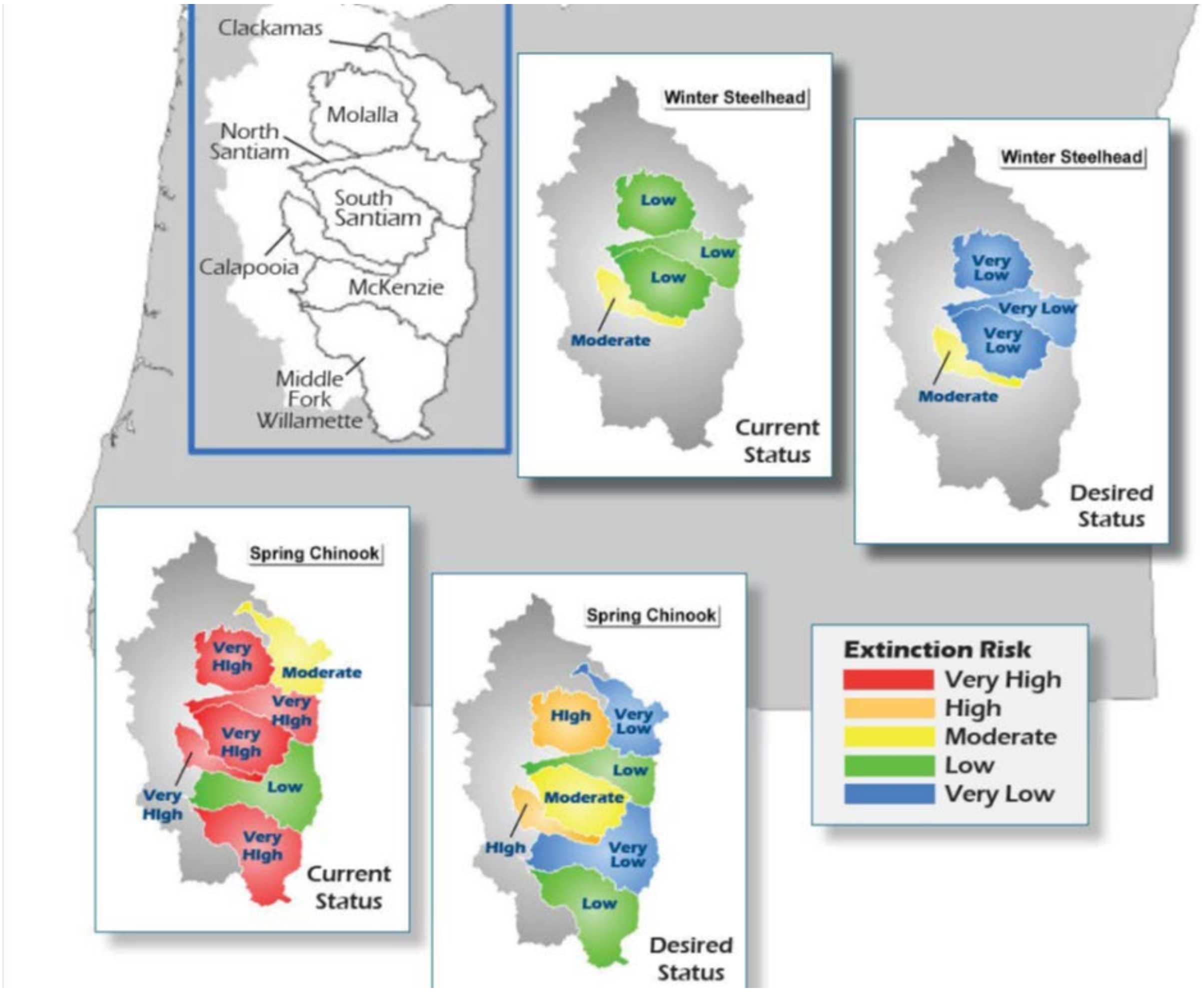

Figure 3.1-6. Map of Upper Willamette River Chinook salmon and steelhead populations including the 2011 "current" status and the desired extinction risk status for achieving recovery (ODFW and NMFS 2011).

Since the McElhany et al. (2007) and recovery plan assessments (ODFW and NMFS 2011), abundance levels for all but one (Clackamas) of the seven distinct populations of UWR Chinook salmon remain well below their recovery goals (NMFS 2024a). The other six natural-origin populations in this ESU have very low current abundance (less than a few hundred fish), and high proportions of hatchery-origin spawners (pHOS), ranging from 43 to 93 percent in 2015–2019 (Ford ed. 2022). Only the Clackamas population, where volitional upstream and downstream passage conditions have recently been improved, exceeds its abundance recovery goals, and pHOS goal of only 3 percent for 2015–2019 (Ford ed. 2022). To meet the biological recovery criteria for viability, the UWR Chinook salmon ESU must have four viable populations (ODFW and NMFS 2011).

The 2010 NMFS 5-year status review concluded that all populations were at a very high risk of extinction, except for the Clackamas and the McKenzie populations, which were at moderate and low risks, respectively. In the subsequent status review (NMFS 2016a), NMFS found that while a few populations had experienced slight improvements in status, there was still a decline in overall natural-origin spawner abundance for the entire ESU. The Clackamas and McKenzie River populations, previously viewed as strongholds within the ESU, had experienced declines, and this was of particular concern for the McKenzie River population (NWFSC 2015, NMFS 2016a). The more recent Five-Year Status Review (NMFS 2024a, status review hereinafter) also noted that the Calapooia River population was functionally extinct and that the Molalla River population remained at critically low abundance (though there was and is considerable uncertainty in the level of natural production in the Molalla River). The South Santiam River population had also continued to decline in abundance (since the 2010 status review). The North Santiam River population abundance improved slightly at the time of the 2016 review, and has leveled-off since, averaging close to approximately 1,000 natural-origin adult returns per year (NMFS 2024a). Improvement in the status of the Middle Fork Willamette River population was solely related to the return of natural-origin adults to Fall Creek; however, the capacity of the Fall Creek basin alone cannot meet Middle Fork Willamette River population recovery goals, and Fall Creek returns have declined in the last few years (NWFSC 2015). In the latest viability assessment and status review (Ford ed. 2022 and NMFS 2024a), the declining trend in the viability of the UWR Chinook salmon ESU continued.

In terms of spatial structure, the most recent status review (NMFS 2024a) noted that volitional access to historical spawning and rearing areas remained restricted by large dams in the four populations (North Santiam, South Santiam, McKenzie, and Middle Fork Willamette) that were historically the most productive. Though trap-and-haul efforts move some adults above the dams to higher quality spawning habitats, a significant number of Chinook salmon in these populations are restricted to spawning and rearing in the lowland reaches where land development, water temperatures, and water quality may be limiting and where pre-spawning mortality rates can be high (Sharpe et al. 2017b). Areas immediately downstream of high-head dams may also be subject to high levels of TDG. Hatchery production had remained relatively stable since earlier status reviews, although a number of operational changes had been made at hatcheries that could eventually reduce hatchery impacts (NWFSC 2015, NMFS 2016a).

Given the prospect of long-term climate change, recent status reviews noted that the inability of many populations to volitionally access historical headwater spawning and rearing areas may put this ESU at greater risk (NWFSC 2015, NMFS 2016a, NMFS 2024a). Climate-change modeling predicts that in the absence of volitional passage to and from colder headwater areas, some populations would be at a high risk of extinction by 2040 (Myers et al. 2018).

Limiting Factors

The factors that have caused the decline of this ESU to its threatened status and continue to limit the ESU's ability to recover include multipurpose dams, hatcheries, harvest, habitat degradation (tributary, mainstem, and estuarine), predation, and ocean and climate conditions. These factors are summarized briefly below. Of these factors, harvest is believed to have been reduced to a point where it is no longer limiting recovery based on assessments by ODFW as part of its recovery planning process (ODFW and NMFS 2011). Additional information on limiting factors is described for individual populations in the environmental baseline section of this Opinion.

Understanding the limiting factors and threats that affect the UWR Chinook salmon ESU provides important information and perspective regarding the status of the species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. The recovery plan for UWR Chinook salmon (ODFW and NMFS 2011) identifies key and secondary limiting factors and threats for each population by area and life stage. These include:

- Degraded freshwater habitat, including floodplain connectivity and function, channel structure and complexity, incubation gravels, riparian areas, and gravel and large-wood recruitment
- Degraded water quality including elevated water temperature and toxins
- Increased disease incidence
- Altered stream flows
- Reduced access to spawning and rearing habitats due to migration barriers, impaired fish passage, and increased pre-spawn mortality associated with conditions below dams
- Altered food web due to reduced inputs of microdetritus
- Predation by native and non-native species, including hatchery fish
- Competition related to introduced races of salmon and steelhead
- Altered population traits due to fisheries, bycatch, and natural-origin fish interbreeding with hatchery-origin fish

Abundance data for UWR Chinook salmon are available from counts at the Willamette Falls fishway. In 2015, there was a relatively large run of UWR Chinook salmon, with 51,046 total adults (9,954 natural-origin adults) counted at Willamette Falls. However, the 5-year geometric mean for returning adults at Willamette Falls (2015 to 2019) indicated a decline in both natural-origin and total numbers of adults from the previous 5-year geometric mean, for 2010 to 2014. The current 5-year geometric mean (2019-2023) indicates an even further decline over time (Table 3.1-2).

Table 3.1-2. 5-year geometric mean estimates of adult abundance for most of UWR Chinook salmon ESU including hatchery fish (not including jacks; source Willamette Falls Fish Counts).

Year	Adult total count (hatchery and natural origin)	Years averaged	5-Year Geometric Mean
		2010-2014	37,463
2014	30,071		
2015	51,046		
2016	30,317		
2017	34,186		
2018	24,543	2014-2018	32,985
2019	18,882		
2020	33,888		

Year	Adult total count (hatchery and natural origin)	Years averaged	5-Year Geometric Mean
2021	28,646		
2022	37,057		
2023	23,422	2019-2023	27,563
2024	21,989		

Observations of anomalous ocean conditions from 2013 to 2015 indicated that outmigrant year classes experienced below-average ocean survival and its lingering effects, which led researchers to predict lower adult Chinook salmon returns through at least 2019 (Cavole 2016). Some of the negative impacts of these ocean conditions on juvenile salmonids had subsided by spring 2018, but other aspects of the ecosystem (e.g., temperatures below the 50-m surface layer) had not returned to normal (Harvey et al. 2019). Expectations for marine survival were relatively mixed for juveniles that reached the ocean in 2019 (Chasco et al. 2021), suggesting that adult returns could increase somewhat in 2021. Ocean conditions did begin turning around in 2020 and were very favorable in 2021 and marginally favorable in 2022 and 2023 based on the NOAA ocean condition indicators chart[3]. This is somewhat reflected in the Chinook salmon adult returns from 2022 to 2024. Some indicators have found to be more strongly correlated with Chinook salmon ocean survival than others (Peterson et al. 2010).

3.1.2 Status of UWR Chinook Salmon Designated Critical Habitat

NMFS designated critical habitat for UWR Chinook salmon on September 2, 2005 (70 FR 52630). For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each listed species they support. The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (e.g., spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NMFS 2005a). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or if it serves another important role (e.g., obligate area for migration to upstream spawning areas). The physical and biological features (PBFs, previously known as PCEs) or essential features of critical habitat for salmon and steelhead are identified in Tables 3.1-3 and 3.1-4.

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[3] NOAA Ocean Indicators Chart accessed on 11/18/2024. https://www.fisheries.noaa.gov/west-coast/science-data/ocean-conditions-indicators-trends

Table 3.1-3. Primary constituent elements (PCEs) of critical habitats designated for ESA-listed salmon and steelhead species considered in this Opinion (except SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, SR sockeye salmon), and corresponding species life history events.

Primary Constituent Elements Site Type	**Primary Constituent Elements Site Attribute**	**Species Life History Event**
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing

CHART Critical Habitat Assessments

The CHART for each recovery domain assessed biological information pertaining to habitat occupied by listed salmon and steelhead to determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3-point score for the PBFs in each HUC_5 watershed for:

Factor 1. Quantity,
Factor 2. Quality – Current Condition,
Factor 3. Quality – Potential Condition,
Factor 4. Support of Rarity Importance,
Factor 5. Support of Abundant Populations, and
Factor 6. Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality – current condition), which considers the existing condition of the quality of PBFs in the

HUC_5 watershed; and Factor 3 (quality – potential condition), which considers the likelihood of achieving PBF potential in the HUC watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

Critical habitat for UWR Chinook salmon is designated in the following states and counties: i) OR—Benton, Clackamas, Clatsop, Columbia, Lane, Linn, Marion, Multnomah, Polk, and Yamhill. (ii) WA—Clark, Cowlitz, Pacific, and Wahkiakum. Most watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a, NMFS 2016a) and have some or high potential for improvement. Similar to the discussion above regarding effects on the species, the status of critical habitat is likely to be affected by climate change, with predicted rising temperatures and alterations in stream flow patterns. Improved access to spawning and rearing habitat and habitat restoration efforts will help reduce those effects associated with climate change on critical habitat.

Figure 3.1-7 shows the current designated critical habitat for UWR Chinook salmon. NMFS (2005b) also designated critical habitat for UWR Chinook salmon to include all estuarine areas and river reaches from the mouth of the Columbia River upstream to the confluence of the Willamette River (50 CFR 226.212(i)), which is not included in Figure 3.1-7 but is considered to be part of the affected area. NMFS will update the critical habitat designations as needed.

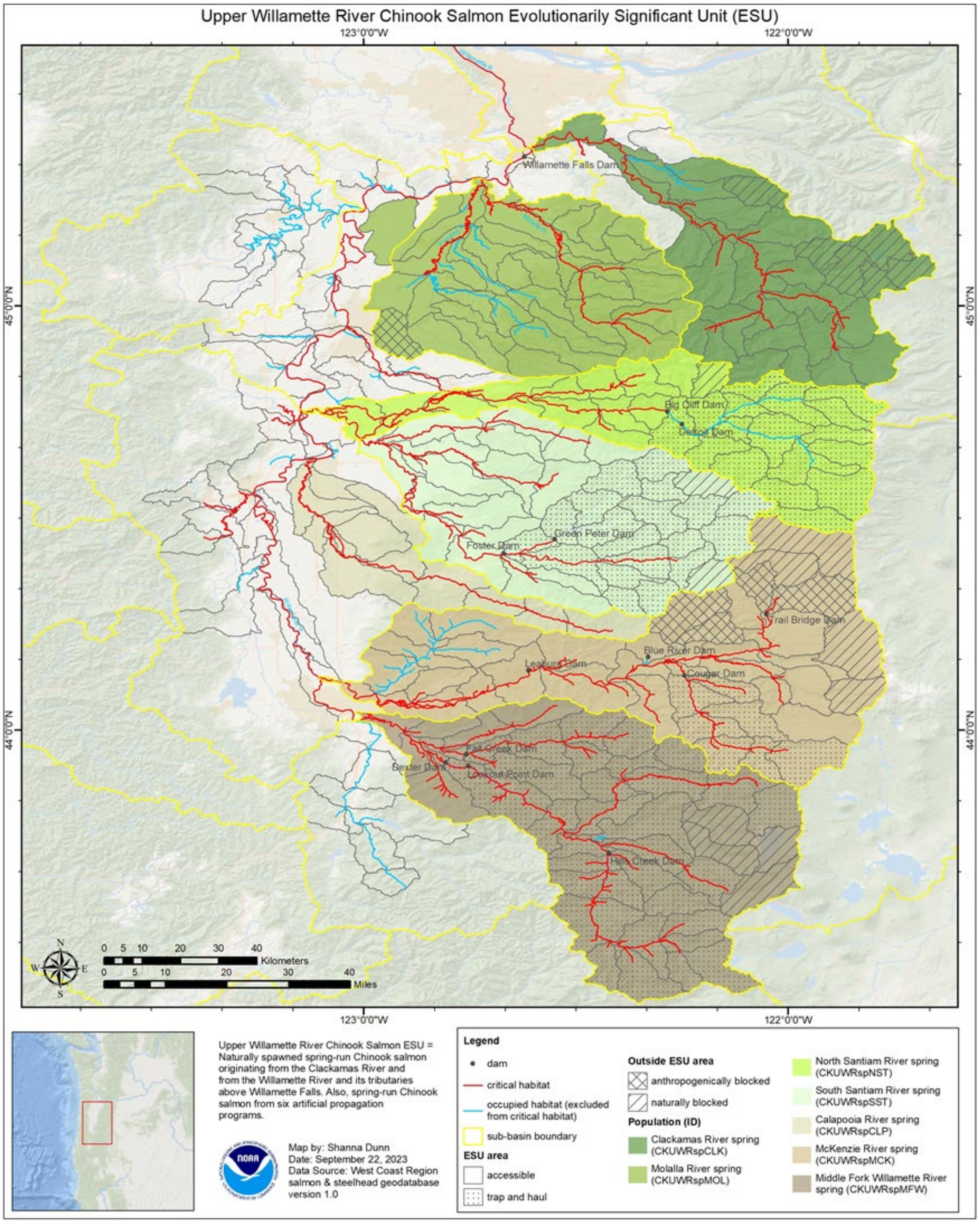


Figure 3.1-7. Map of critical habitat for ESA-listed Upper Willamette River Chinook salmon. Critical habitat has also been designated in the Columbia River and estuary.

Willamette River Basin

Land management activities have degraded stream habitat conditions in the Willamette River mainstem above Willamette Falls and in associated subbasins. In the Willamette River mainstem and lower sub-basin mainstem reaches, high-density urban development and widespread agricultural effects have reduced the quality and complexity of aquatic and riparian habitats and altered sediment and water quality and quantity as well as watershed processes. The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75 percent. In addition, the construction of 37 dams in the basin has blocked access to more than 435 miles of spawning habitat. The dams also alter the temperature regime of the Willamette River and its tributaries, thereby affecting the timing and development of naturally spawned eggs and fry. Logging in the Cascade and Coast Ranges, and agriculture, urbanization, and gravel mining on valley floors have contributed to increased erosion and sediment loads throughout the basin.

The Willamette River mainstem has been channelized and stripped of large wood. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). The total area of river channels and islands in the Willamette River decreased from 41,000 to 23,000 acres, and the total length of all channels decreased from 355 miles to 264 miles between 1895 and 1995 (Gregory *et al.* 2002a). They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench, and due to this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach, from Newberg to Albany (RM 50 to 120), incurred losses of 12 percent of primary channel area, 16 percent of side channels, 33 percent of alcoves, and 9 percent of island area. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40 percent of both channel length and channel area were lost, along with 21 percent of the primary channel, 41 percent of side channels, 74 percent of alcoves, and 80 percent of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the Corps. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26 percent of the total length is revetted, 65 percent of the meander bends are revetted (Gregory *et al.* 2002b). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory *et al.* 2002b).

Riparian forests have diminished considerably in the lower reaches of the Willamette River (Gregory *et al.* 2002c). Sedell and Froggatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation, along with snagging of large wood in the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest comprise large functional losses to the river, reducing structural features, inputs of wood and litter, shade, entrained allochthonous materials, and flood-flow-filtering capacity. Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. The once expansive forests of the Willamette River floodplain provided valuable nutrients and organic matter during flood pulses, food sources for macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels.

Hyporheic flow in the Willamette River has been examined through discharge measurements and is significant in some areas, particularly those with gravel deposits (Wentz *et al.* 1998; Fernald *et al.* 2001). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining. Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, which has been limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald *et al.* 2001).

A number of restoration and protection actions have been implemented in freshwater and estuarine habitats throughout the range of UWR Chinook salmon and steelhead. However, at this point there is not yet information demonstrating that improvements in habitat conditions have led to improvements in population viability (NMFS 2016a). A lack of access to historical spawning and rearing areas caused by dams in the east-side tributaries will, in the absence of effective passage programs, continue to confine UWR species to lower tributary and mainstream reaches that generally have higher temperatures and poorer water quality and are more impacted by land development (NWFSC 2015). Degraded habitat conditions throughout the range of UWR Chinook salmon ESU and UWR steelhead continue to be a concern, particularly with regard to land-use activities that affect the quality and accessibility of suitable habitat as well as habitat-forming processes (NMFS 2016a).

Lower Columbia River and Estuary

Critical habitat is also designated for UWR Chinook salmon in the lower Columbia River estuary. For the purposes of this analysis, we broadly define the estuary to include the entire reach where tidal forces and river flows interact, regardless of the extent of saltwater intrusion. This encompasses areas from Bonneville Dam (RM 146) to the mouth of the Columbia River. NMFS considers the estuary to have a high conservation value because it connects every population with the ocean and is used by rearing and migrating juveniles as well as migrating adults

Human activities since the late 1800s have altered the form and function of the Columbia River estuary, reducing the quantity and quality of its PBFs. Historically, the downstream half of the estuary was a dynamic environment with multiple channels, extensive wetlands, sandbars, and shallow areas. Winter and spring floods, low flows in late summer, large woody debris floating downstream, and a shallow bar at the mouth of the Columbia River maintained this environment. Today, navigation channels have been dredged, deepened, and maintained; jetties and pile-dike fields have been constructed to stabilize and concentrate flow in the mainstem navigation channel; and causeways have been constructed that restrict the position of tributary confluences.

In addition, more than 70 percent of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban uses. Many wetlands along the shore in the upper reaches of the estuary were converted to industrial and agricultural lands after levees and dikes were constructed. Furthermore, water storage and release patterns from upstream reservoirs have changed the seasonal pattern and volume of discharge.

The peaks of spring/summer floods have been reduced, and the amount of water discharged during winter has increased; these changes may have had important impacts on salmon diversity and productivity by changing the types of habitat available. Bottom et al. (2005) estimate that, together, hydrosystem operations and reduced river flows caused by climate change have decreased the delivery of sediment to the lower river and estuary by more than 50 percent (as measured at Vancouver, Washington).

Dampening of established flow variations in the Columbia River estuary through flow regulation may have reduced the diversity of salmon migration patterns, with potential effects on arrival times and sizes of fish entering the estuary and ocean. Reduced floodplain inundation has eliminated shallow-water habitats, which were seasonally important rearing areas and refugia for juvenile salmonids, particularly for small subyearling migrants such as some UWR Chinook salmon. Disconnecting the tidal river from its floodplain also prevented delivery of woody debris, organic matter, and prey resources to the estuary, with potential consequences for estuarine food chains.

The effect of these changes as a whole is that critical habitat is not able to fully serve its conservation role in many of the designated watersheds. Factors limiting the functioning of PBFs and thus the conservation value of critical habitat for UWR Chinook salmon within the action area are discussed in more detail in the Environmental Baseline section (Chapter 4).

3.1.3 Climate Change Implications for UWR Chinook Salmon and their Designated Critical Habitat

One factor affecting the rangewide status of UWR Chinook salmon and aquatic habitat in general is climate change. The USGCRP reports average warming in the Pacific Northwest of about 1.3ºF from 1895 to 2011 and projects an increase in average annual temperature of 3.3ºF to 9.7ºF by 2070 to 2099 (compared to the period 1970 to 1999), depending largely on total global emissions of heat-trapping gasses (predictions based on a variety of emission scenarios including B1, RCP4.5, A1B, A2, A1FI, and RCP8.5 scenarios); the increases are projected to be largest in summer (Melillo et al. 2014, USGCRP 2018). The 5 warmest years in the 1880 to 2023 record have all occurred since 2016, while 10 of the 10 warmest years have occurred since 2014 (Lindsey and Dahlman 2020). Climate change has negative implications for designated critical habitats in the Pacific Northwest (Climate Impacts Group 2004, Scheuerell and Williams 2005, Zabel et al. 2006, ISAB 2007), characterized by the ISAB as follows:

- Warmer air temperatures will result in diminished snowpack and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.

- With a smaller snowpack, watershed runoff will decrease earlier in the season, resulting in lower stream flows in June through September. Peak river flows, and river flows in general, are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures are expected to rise, especially during the summer months when lower stream flows co-occur with warmer air temperatures.

Likely changes in temperature, precipitation, and wind patterns (as well as sea-level rise in the lower estuary) have implications for survival and recovery of UWR Chinook salmon in both their freshwater, estuarine, and marine habitats and the PBFs of their critical habitat. While total precipitation changes are uncertain, increasing air temperature will result in more precipitation falling as rain rather than snow in watersheds across the basin (ISAB 2007). In general, these changes in air temperatures, river temperatures, and river flows are expected to cause changes in salmon distribution, behavior, growth, and survival, although the magnitude of these changes remains unclear. In coastal areas, projections indicate an increase of 1 to 4 feet of global sea-level rise by the end of the century. This sea-level rise and storm surge pose a risk to infrastructure, and coastal wetlands and tide flats are likely to erode or be lost as a result of seawater inundation (Mote et al. 2014). Ocean acidification is also expected to negatively impact Pacific salmon and organisms within their marine food webs.

Climate change would affect UWR Chinook salmon and critical habitat in the following ways: 1) warmer stream temperatures could increase pre-spawning mortality and cause changes in growth, development rates, and disease resistance, 2) changes in flow regimes (larger winter floods and lower flows in the summer and fall) could reduce overwintering habitat for juveniles, reduce egg and juvenile survival, reduce spawning habitat access/availability, and alter spawning-run timing, 3) timing of smolt migration may change due to a modified timing of the spring freshet, 4) changing ocean conditions and marine food webs could affect ocean survival and growth, and 5) predicted sea-level rise could cause significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007).

Crozier et al. (2019) assessed UWR Chinook salmon as having a very high vulnerability to the effects of climate change based on an analysis of the ESU's sensitivity (very high) and exposure (high). Further, the species was determined to have a moderate adaptive capacity. A moderate score for adaptive capacity reflected the conclusion that although UWR Chinook salmon exhibit a remarkable ability to survive in such a highly altered system, it is unclear whether the ESU has further adaptive capacity given its elevated extrinsic pressures and depressed natural production. Modified environments available to Chinook salmon in the Willamette River have exerted powerful selection pressures such that the ESU itself may be fundamentally transforming. For example, in Green Peter Reservoir, individuals have been collected that appear to have completed their entire life cycle in fresh water as the offspring of adfluvial parents rather than as hatchery releases (Romer and Monzyk 2014). Use of reservoirs may be under-reported, as are other juvenile life-history patterns (Bourret et al. 2014). However, the extent to which alternate rearing patterns represent either a viable strategy or an ecological trap is unknown (Bourret et al. 2014). Nonetheless, actions to modify reservoir operations to benefit juvenile production are being considered (Johnson and Friesen 2014), despite uncertain outcomes.

Exposure attributes for UWR Chinook salmon were ranked high overall because of very high scores for ocean acidification and stream temperature. Mean August temperature was projected to increase 2.5°F by the 2040s and 4.3°F by the 2080s. Other high-exposure attributes included sea surface temperature and hydrologic regime shift. Although approximately 90 percent of the basin is already rain-dominated, the remaining 10 percent is very likely to change to rain-dominated by the 2040s. Scores for ocean acidification and sea surface temperature were similar to those of most ESUs.

Sensitivity attributes for this ESU were ranked very high because of a host of factors, including vulnerability in the adult freshwater stage and cumulative threats to the species' entire life cycle and life-history diversity.

3.2 Upper Willamette River Steelhead and Designated Critical Habitat Status

On March 25, 1999, NMFS listed UWR steelhead as threatened (64 FR 14517) and reaffirmed that status on January 5, 2006 (71 FR 834). The status was upheld on April 14, 2014 (79 FR 20802). The most recent status review, in 2024, concluded that this ESU should retain its threatened status (NMFS 2024a). Critical habitat for UWR steelhead was designated September 2, 2005 (70 FR 52630). The summary that follows describes the status of UWR steelhead. Additional information can be found in the recovery plan (ODFW and NMFS 2011) and the most recent status review for this species (NMFS 2024a).

3.2.1 Status of UWR Steelhead

The UWR steelhead DPS includes all naturally spawned anadromous, winter-run *O. mykiss* originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to, and including, the Calapooia River. There is only one major population group in this DPS, which is composed of four historical populations (Figure 3.2-1 below from Myers et al. 2006). All four populations remain extant and produce low to moderate numbers of natural-origin steelhead each year. Winter steelhead hatchery releases within the boundary of the UWR steelhead DPS ended in 1999; however, there is still a hatchery program for non-native summer steelhead. The current summer-run steelhead hatchery program within the geographic area of the DPS is not part of the DPS because it was originally derived from a non-native, out-of-DPS Skamania broodstock (NMFS 2024a). The timing and location of spawning summer-run steelhead overlaps with that of the native late-winter run (Keefer and Caudill 2010; Firman et al. 2004), so the potential exists for interbreeding between the two run types as well as for competition for food and habitat among juveniles. Genetic analysis has also recently provided concrete evidence for natural production of Willamette basin hatchery summer steelhead releases (Johnson et al. 2021).

The Willamette/Lower Columbia Technical Recovery Team (WLCTRT) identified four historical demographically independent populations for UWR winter-run steelhead: Molalla, North Santiam, South Santiam, and Calapooia (Figure 3.2-1; Myers et al. 2006); all populations are part of the same stratum (Cascades Tributaries Stratum) or major population group

(WLCTRT 2003). The WLCTRT delineated the populations based on geography, migration rates, genetic attributes, life-history patterns, phenotypic characteristics, population dynamics, and environmental and habitat characteristics (Myers et al. 2006).

Fish passing Willamette Falls prior to February 15 are considered to be early winter-run fish for management purposes, but there is overlap between when the early winter run ends and the late winter run begins, creating the potential for temporal overlap between the run types during spawning. Early winter-run steelhead are not native to the upper Willamette River, as they originate from tributaries to the lower Columbia River (Big Creek hatchery stock), which were released throughout the Willamette River system for decades (Myers et al. 2006). There is also evidence demonstrating that these early-run steelhead comprise the majority of winter steelhead inhabiting west-side Willamette River tributaries, where native steelhead did not historically spawn (Van Doornik et al. 2015; Johnson et al. 2021).

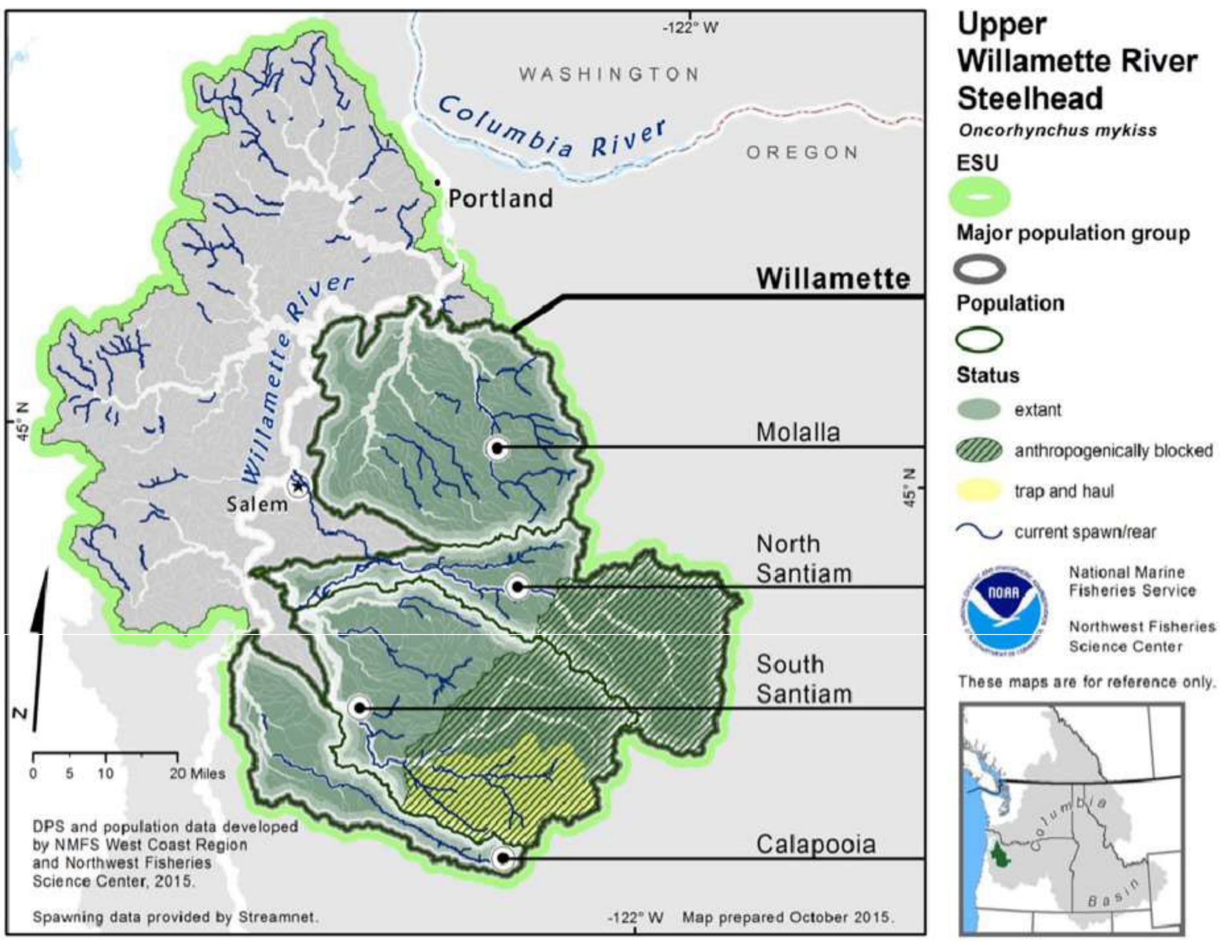


Figure 3.2-1. Map of the UWR winter steelhead DPS's spawning and rearing areas, illustrating the four populations within the one major population group. The westside tributaries of the DPS were not defined as a primary population needed to meet recovery goals for the DPS, although they do have designated critical habitat (ODFW and NMFS 2011).

Life History and Factors for Decline

Before construction of a fish ladder at Willamette Falls in the early 1900s, flow conditions allowed steelhead to ascend Willamette Falls only during the late winter and spring. As a result, UWR steelhead evolved as winter-run fish, returning to freshwater in January through April, passing Willamette Falls from mid-February to mid-May, and spawning in March through June, with peak spawning in late April and early May. They typically migrate farther upstream than Chinook salmon and can spawn in smaller, higher gradient streams and side channels. UWR steelhead may spawn more than once, although these repeat spawners (called kelts) are relatively rare. Juvenile steelhead rear in headwater tributaries and upper portions of the subbasins for 1 to 4 years (most often 2 years), then migrate quickly downstream in April through May, through the mainstem Willamette River and Columbia River estuary into the ocean. UWR steelhead typically forage in the ocean for 1 to 4 years (most often 2 years) and during this time are thought to migrate north to Canada and Alaska and into the North Pacific including the Alaska Gyre (ODFW and NMFS 2011).

At the time of listing of this DPS, NMFS noted concerns with genetic integrity of the DPS due to the construction of fish ladders at Willamette Falls as early as 1885, which facilitated the successful introduction of out-of-basin steelhead into the upper Willamette River basin even before the aforementioned hatchery fish introductions. Also noted were blockage of historical spawning habitat by the Willamette Valley System (WVS) dams and other smaller dams or impassable culverts throughout the region and habitat degradation related to forestry, agriculture, and urbanization in the Willamette Valley. During the 2016–17 return year, pinniped predation at Willamette Falls became a concern. Increases in the pinniped population at the falls, in conjunction with low steelhead return, resulted in an estimated 25 percent predation rate on winter steelhead (Steingass et al. 2019).

Recovery Plan

The ESA recovery plan for UWR steelhead (ODFW and NMFS 2011) includes delisting criteria for the DPS, identification of factors currently limiting its recovery, and management actions necessary for its recovery. The biological delisting criteria are based on recommendations by the W/LC TRT. They are hierarchical in nature, with DPS-level criteria based on the status of natural-origin fish assessed at the population level. Population-level assessments are based on evaluation of population abundance, productivity, spatial structure, and diversity (McElhany et al. 2000) and an overall extinction risk characterization. Achieving recovery (i.e., delisting) of the DPS will require sufficient improvement in its abundance, productivity, spatial structure, and diversity.

Abundance, Productivity, Spatial Structure and Diversity

Considerable uncertainty exists in many of the abundance estimates for this DPS. Willamette Falls Dam fish counts provide the best historical abundance index for this DPS; however, many of the steelhead passing the dam are not part of the historical east-side tributary populations (NMFS 2016a; Ford ed. 2022). Radio-tagging studies suggested that a considerable proportion of winter-run steelhead ascending Willamette Falls do not enter the spawning areas that constitute this DPS; the review noted that these fish might be non-native, early winter-run steelhead that have colonized the western tributaries, misidentified summer-run steelhead, or late winter-run steelhead that have colonized tributaries not historically part of the DPS (NWFSC 2015). After fluctuating for several decades, abundance of natural-origin winter steelhead ascending the Willamette Falls fish ladder had been declining steeply since 1988 (Figure 3.2-2). The run in 1996 (1,801) was the lowest in 30 years (Busby et al. 1996, 63 FR 11798), and the 2017 run total (822) was the lowest since counts at the falls began in the late 1960s. With the initiation of pinniped control measures, predation levels fell to an estimated 8 percent in 2019 (Steingass et al. 2019) and further in subsequent years. Pinniped control efforts combined with improved ocean conditions for steelhead are both possible explanations for the strong winter steelhead return observed in 2024 at Willamette Falls (Figure 3.2-2). However, counts of steelhead returns to eastside tributaries provide more population-specific information on abundance trends for ESA-listed UWR steelhead (Ford ed. 2022); those will be presented and discussed further in the individual sub-basin sections of the Environmental Baseline (Chapter 4).

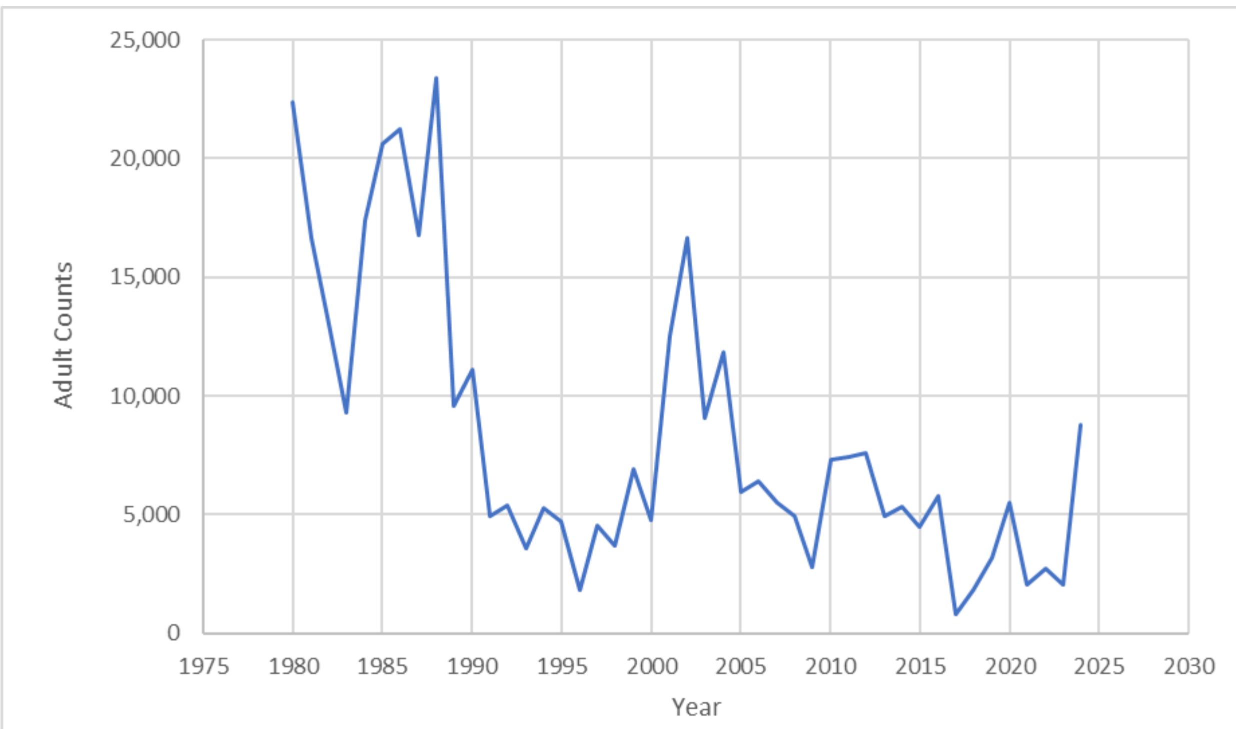


Figure 3.2-2. Total annual counts of all adult winter steelhead passing Willamette Falls Dam since 1980. Hatchery releases of winter steelhead have not occurred in the Willamette basin above Willamette Falls since 1999, making 2005 the last possible year for hatchery-origin adult returns. *Note: Not all adult winter steelhead that pass Willamette Falls Dam are considered to be part of the primary Upper Willamette steelhead DPS.*

In the 2016 five-year status review for UWR steelhead (NMFS 2016a), NMFS noted that, overall, past declines in abundance (Ford et al. 2011) continued through the period 2010 to 2015, and the declining trends have continued. Although the declines noted in the 2016 review were relatively moderate, the review noted that continued declines would be a cause for concern (NWFSC 2015). Populations in this DPS have experienced long-term declines in spawner abundance (Table 3.2-1; Ford ed. 2022). The underlying causes of these declines (aside from observed pinniped predation rates below Willamette Falls) is not well understood. Returning adult winter steelhead have not experienced warmer water temperatures as frequently as the UWR Chinook salmon, and prespawn mortalities have not been found to be significant, although few spawning surveys are done due to less safe conditions during higher flows when UWR steeelhead are spawning.

Table 3.2-1. 5-year geometric mean of raw natural spawner counts for the Upper Willamette River steelhead DPS. Willamette Falls counts represent counts of prespawning winter steelhead, and include an unknown number of non-native early-winter-run steelhead. Population estimates (1990–2009) were calculated using proportional assignment of Willamette Falls counts. In parentheses, 5-year geometric mean of raw total spawner counts is shown. A value only in parentheses means that a total spawner count was available but no or only one estimate of wild spawners available. The geometric mean was computed as the product of counts raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the 2 most recent 5-year periods is shown on the far right.

Population	MPG	1990–94	1995–99	2000–04	2005–09	2010–14	2015–19	% change
Willamette Falls W	Cascade	(5,619)	(3,961)	(10,293)	(5,028)	(6,431)	(2,628)	(–59)
Calapooia River W	Cascade	149 (149)	219 (219)	406 (406)	214 (214)	—	—	—
Molalla River W	Cascade	1,182 (1,462)	726 (798)	1,924 (1,924)	1,357 (1,357)	—	—	—
North Santiam River W	Cascade	2,495 (2,928)	1,953 (2,388)	3,333 (3,423)	2,500 (2,500)	—	—	—
South Santiam River W	Cascade	1,940 (1,940)	1,277 (1,277)	2,440 (2,440)	1,594 (1,594)	—	—	—

Overall, the UWR steelhead DPS has continued to decline in abundance. Although the most recent counts at Willamette Falls show improvements from the record 2017 lows, it should be noted that current high counts are equivalent to past low counts. More definitive genetic monitoring of steelhead ascending Willamette Falls, in tandem with radio tagging work, needs to be undertaken to estimate the total abundance of the DPS.

Improvements to Bennett Dam fish passage and operational temperature control at Detroit Dam may be providing some stability in abundance in the North Santiam River demographically independent population (DIP). It is unclear if sufficient high-quality habitat is available below Detroit Dam to support the population reaching its VSP recovery goal or if some form of access to the upper watershed is necessary to sustain a "recovered" population (NMFS 2024a). Similarly, the South Santiam River basin may not be able to achieve its recovery goal status without access to historical spawning and rearing habitat above Green Peter Dam (Quartzville Creek and the Middle Santiam River) and/or improved juvenile downstream passage at Foster Dam (NMFS 2024a).

Spatial structure and diversity continue to limit the recovery of UWR steelhead. While genetic diversity goals are partially achieved through the closure of winter-run steelhead hatchery programs, there is some concern that the summer-run steelhead releases in the North and South Santiam Rivers may be influencing the viability of native steelhead. Genetic analysis suggests that there is introgression among native late-winter steelhead and summer-run steelhead (Van Doornik et al. 2015, Johnson et al. 2013, Johnson et al. 2021).

While the viability of the ESU appears to be declining, the recent uptick in abundance may provide a short-term demographic buffer. Furthermore, increased monitoring is necessary to provide quantitative verification of sustainability for most of the populations. In the absence of substantial changes in accessibility to high-quality habitat, the DPS will remain at “moderate-to-high” risk. Overall, the UWR steelhead DPS is, therefore, at “moderate-to-high” risk, with a declining viability trend (NMFS 2024a).

Limiting Factors

Understanding the limiting factors and threats that affect the UWR steelhead DPS provides important information and perspective regarding the status of the species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. The recovery plan and subsequent 5-year reviews for UWR steelhead (ODFW and NMFS 2011, NMFS 2024a) identify key and secondary limiting factors and threats for each population by area and life stage. These include:

- Restricted access to historical spawning and rearing habitat in the North and South Santiam subbasins by the WVS flood control/hydropower dams operated by the Corps. Dams block or delay adult fish passage to major portions of the historical holding and spawning habitat for UWR steelhead in the North Santiam and South Santiam subbasins. In addition, most WVS dams have limited facilities or operational provisions for safely passing juvenile steelhead downstream of the facilities. In the absence of effective passage programs, UWR steelhead will continue to be confined to lowland reaches, where land development, water temperatures, and water quality are limiting, and pre-spawning mortality levels are generally high (NMFS 2016a).
- Hydropower-related limiting factors extend to the Columbia River estuary where adverse effects on estuarine habitat quality and quantity are related to the cumulative effects of Columbia River basin dams. Effects include an altered seasonal flow regime and Columbia River plume due to flow management (ODFW and NMFS 2011).
- Land uses including agriculture, timber harvest, mining and grazing activities, diking, damming, development of transportation, and urbanization have reduced access to historically productive habitats and reduced the quality of remaining habitat by weakening important watershed processes and functions (ODFW and NMFS 2011).
- Predation by birds, native and non-native fish, and marine mammals, including increased marine mammal predation at Willamette Falls (NMFS 2016a, Brown et al. 2017). Piscivorous birds, including Caspian terns (*Hydroprogne caspia*) and cormorants (*Phalacrocorax* spp.), and fishes, including northern pikeminnow (*Ptychocheilus oregonensis*), predate significant numbers of juvenile steelhead. Steelhead smolts are especially vulnerable to Caspian tern predation in the Columbia River (Evans et al. 2018). Pikeminnow are significant predators of yearling juvenile migrants in the Willamette and Columbia rivers (Friesen and Ward 1999). The magnitude of pinniped predation for UWR steelhead in the estuary is not known, though the presence of California sea lions (*Zalophus californianus*) and Steller sea lions (*Eumetopias jubatus*) at the Astoria Mooring Basin has been increasing over the past few years. Similarly, the number of sea lions observed at Willamette Falls was increasing. Since implementation of the sea lion removal program at Willamette Falls, predation on the UWR steelhead DPS has fallen from 24.7 percent in 2017 to 0.9 percent in 2023, and predation on UWR

Chinook salmon has fallen from 9.1 percent in 2015 to 1.9 percent in 2023 (Anderson 2024).
- The presence of hatchery-reared and feral hatchery-origin fish that may affect the growth and survival of juvenile late-winter steelhead. In the North and South Santiam rivers, juveniles are largely confined by dams to below much of their historical spawning and rearing habitat. Releases of large numbers of hatchery-origin summer steelhead may temporarily exceed rearing capacities and displace winter juvenile steelhead.
- Historical harvest, although significant reforms were implemented in the early 1990s, and whereas harvest may have been a listing factor for winter steelhead, the reforms that have been implemented have reduced fishery harvest impacts such that it is no longer identified as a limiting factor. The current exploitation rates on natural-origin steelhead from sport fisheries are in the range of 0 to 3 percent, and steelhead are not intercepted in ocean fisheries to a measurable degree. There is some additional incidental mortality in the commercial net fisheries for hatchery Chinook salmon and steelhead in the lower Columbia River (ODFW and NMFS 2011).
- Climate change effects, including increased stream temperatures, changes in precipitation/streamflow, and years of low ocean productivity (NMFS 2016a).

3.2.2 Status of UWR Steelhead Designated Critical Habitat

NMFS (2005b) designated critical habitat for UWR steelhead to include all estuarine areas and river reaches from the mouth of the Columbia River, into the lower Willamette River upstream to Willamette Falls, and in seven subbasins, as well as the mainstem above Willamette Falls to the confluence with the Calapooia River (50 CFR 226.212(r)). Critical habitat for UWR steelhead encompasses seven subbasins. For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each listed species they support. The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NMFS 2005a). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or if it serves another important role (e.g., obligate area for migration to upstream spawning areas). The physical and biological features (PBFs) of critical habitat for salmon and steelhead are identified in Tables 3-4 (found above in UWR Chinook Status of Critical Habitat section 3.1.1.2).

CHART Critical Habitat Assessments

The CHART for each recovery domain assessed biological information pertaining to habitat occupied by listed salmon and steelhead to 1) determine whether those areas contained PBFs essential for the conservation of those species and 2) whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PBFs in each HUC_5 watershed for:

- Factor 1. Quantity,
- Factor 2. Quality – Current Condition,
- Factor 3. Quality – Potential Condition,
- Factor 4. Support of Rarity Importance,
- Factor 5. Support of Abundant Populations, and
- Factor 6. Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality – current condition), which considers the existing condition of the quality of PBFs in the HUC_5 watershed; and Factor 3 (quality – potential condition), which considers the likelihood of achieving PBF potential in the HUC_5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

Critical habitat for UWR steelhead is designated in the following states and counties: i) OR—Benton, Clatsop, Columbia, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill; (ii) WA—Clark, Cowlitz, Pacific, and Wahkiakum. Most watersheds with PCEs for salmon and steelhead are in fair-to-poor or fair-to-good condition (NMFS 2005a, NMFS 2016a) and have some or high potential for improvement. Similar to the discussion above regarding effects on the species, the status of critical habitat is likely to be affected by climate change, with predicted rising temperatures and alterations in stream-flow patterns. Improved access to spawning and rearing habitat and habitat restoration efforts will help reduce those effects on critical habitat.

Figure 3.2-3 shows the current designated critical habitat for UWR steelhead. NMFS (2005a) also designated critical habitat for UWR steelhead to include all estuarine areas and river reaches from the mouth of the Columbia River upstream to the confluence of the Willamette River, which is not shown in Figure 3.2-1 but is part of the affected area (50 CFR 226.212(i)). NMFS will update the critical habitat designations as needed.

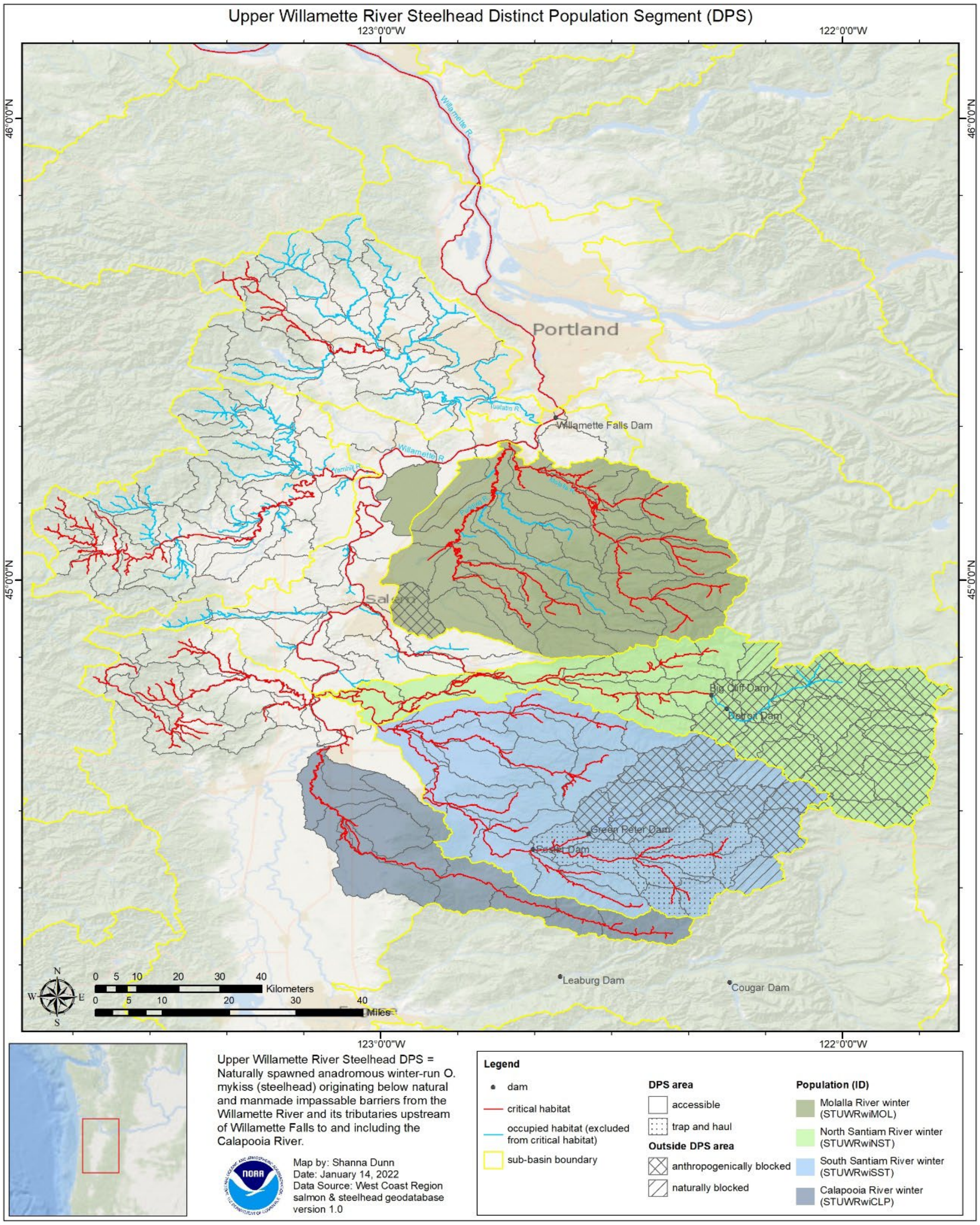


Figure 3.2-3. Map of critical habitat for ESA-listed Upper Willamette River steelhead. Critical habitat has also been designated in the Columbia River and estuary.

Willamette River Basin

Land management activities have degraded stream habitat conditions in the Willamette River mainstem above Willamette Falls and in associated subbasins. In the Willamette River mainstem and lower sub-basin mainstem reaches, high-density urban development and widespread agricultural effects have reduced the quality and complexity of aquatic and riparian habitats, altered sediment and water quality and quantity as well as watershed processes. The Willamette River, once a highly braided river system, has been dramatically simplified through channelization, dredging, and other activities that have reduced rearing habitat by as much as 75 percent. In addition, the construction of 37 dams in the basin blocked access to more than 435 miles of stream and river spawning habitat. These dams alter the temperature regime of the Willamette River and its tributaries, thereby affecting the timing and development of naturally spawned eggs and fry. Logging in the Cascade and Coast Ranges and agriculture, urbanization, and gravel mining on valley floors have contributed to increased erosion and sediment loads throughout the basin.

The Willamette River mainstem has been channelized and stripped of large wood. Development began to encroach on the riparian forest beginning in the 1870s (Sedell and Froggatt 1984). The total area of river channels and islands in the Willamette River decreased from 41,000 to 23,000 acres, and the total length of all channels decreased from 355 miles to 264 miles between 1895 and 1995 (Gregory *et al.* 2002a). They noted that the lower reach, from the mouth of the river to Newberg (RM 50), is confined within a basaltic trench and that, because of this geomorphic constraint, less channel area has been lost than in upstream areas. The middle reach, from Newberg to Albany (RM 50 to 120), incurred losses of 12 percent of primary channel area, 16 percent of side channels, 33 percent of alcoves, and 9 percent of island area. Even greater changes occurred in the upper reach, from Albany to Eugene (RM 187). There, approximately 40 percent of both channel length and channel area were lost, along with 21 percent of the primary channel, 41 percent of side channels, 74 percent of alcoves, and 80 percent of island areas.

The banks of the Willamette River have more than 96 miles of revetments; approximately half were constructed by the Corps. Generally, the revetments were placed in the vicinity of roads or on the outside bank of river bends, so that while only 26 percent of the total length is revetted, 65 percent of the meander bends are revetted (Gregory *et al.* 2002b). The majority of dynamic sections have been armored, reducing adjustments in channel bed and sediment storage by the river, and thereby diminishing both the complexity and productivity of aquatic habitats (Gregory *et al.* 2002b).

Riparian forests have diminished considerably in the lower reaches of the Willamette River (Gregory *et al.* 2002c). Sedell and Froggatt (1984) noted that agriculture and cutting of streamside trees were major agents of change for riparian vegetation along with snagging of large wood in the channel. The reduced shoreline, fewer and smaller snags, and reduced riparian forest comprise large functional losses to the river, reducing structural features, inputs of wood and litter, shade, entrained allochthonous materials, and flood-flow-filtering capacity. Extensive changes began before the major dams were built, with navigational and agricultural demands dominating the early use of the river. The once expansive forests of the Willamette River floodplain provided valuable nutrients and organic matter during flood pulses, food sources for macroinvertebrates, and slow-water refugia for fish during flood events. These forests also cooled river temperatures as the river flowed through its many channels.

Hyporheic flow in the Willamette River has been examined through discharge measurements and is significant in some areas, particularly those with gravel deposits (Wentz *et al.* 1998; Fernald *et al.* 2001). The loss of channel complexity and meandering that fosters creations of gravel deposits decreases the potential for hyporheic flows, as does gravel mining. Hyporheic flow processes water and affects its quality on reemerging into the main channel, stabilizing variations in physical and chemical water characteristics. Hyporheic flow is important for ecological functions, some aspects of water quality (such as temperature and dissolved oxygen), and some benthic invertebrate life stages. Alcove habitat, which has been limited by channelization, combines low hydraulic stress and high food availability with the potential for hyporheic flows across the steep hydraulic gradients in the gravel separating them from the main channel (Fernald *et al.* 2001).

A number of restoration and protection actions have been implemented in freshwater and estuarine habitats throughout the range of UWR Chinook salmon and steelhead. However, at this point there is not yet information demonstrating that improvements in habitat conditions have led to improvements in population viability (NMFS 2016a). A lack of access to historical spawning and rearing areas caused by dams in the east-side tributaries will, in the absence of effective passage programs, continue to confine UWR species to lower tributary and mainstream reaches that generally have higher temperatures and poorer water quality and are more impacted by land development (NWFSC 2015). Degraded habitat conditions throughout the range of the UWR Chinook salmon ESU and UWR steelhead DPS continue to be a concern, particularly with regard to land-use activities that affect the quality and accessibility of suitable habitat as well as habitat-forming processes (NMFS 2016a).

Lower Columbia River and Estuary

For the purposes of this analysis, we broadly define the estuary to include the entire reach where tidal forces and river flows interact, regardless of the extent of saltwater intrusion. This encompasses areas from Bonneville Dam (RM 146) to the mouth of the Columbia River. NMFS considers the estuary to have a high conservation value because it connects every population with the ocean and is used by rearing and migrating juveniles as well as migrating adults.

Human activities since the late 1800s have altered its form and function, reducing the quantity and quality of its PBFs. Historically, the downstream half of the estuary was a dynamic environment with multiple channels, extensive wetlands, sandbars, and shallow areas. Winter and spring floods, low flows in late summer, large woody debris floating downstream, and a shallow bar at the mouth of the Columbia River maintained this environment. Today, navigation channels have been dredged, deepened, and maintained; jetties and pile-dike fields have been constructed to stabilize and concentrate flow in the mainstem navigation channel; and causeways have been constructed that restrict the position of tributary confluences.

In addition, more than 70 percent of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban use. Many wetlands along the shore in the upper reaches of the estuary were converted to industrial and agricultural lands after levees and dikes were constructed. Furthermore, water storage and release patterns from upstream reservoirs have changed the seasonal pattern and volume of discharge.

The peaks of spring/summer floods have been reduced, and the amount of water discharged during winter has increased; these changes may have had important impacts on salmon diversity and productivity by changing the types of habitat available. Bottom et al. (2005) estimate that, together, hydrosystem operations and reduced river flows caused by climate change have decreased the delivery of sediment to the lower river and estuary by more than 50 percent (as measured at Vancouver, Washington).

Dampening of established flow variations in the Columbia River estuary through flow regulation may have reduced the diversity of salmon migration patterns, with potential effects on arrival times and sizes of fish entering the estuary and ocean. Reduced floodplain inundation has eliminated shallow-water habitats, which were seasonally important rearing areas and refugia for juvenile salmonids. Disconnecting the tidal river from its floodplain also prevented delivery of woody debris, organic matter, and prey resources to the estuary, with potential consequences for estuarine food chains.

The effect of these changes as a whole is that critical habitat is not able to fully serve its conservation role in many of the designated watersheds. Factors limiting the functioning of PCEs and thus the conservation value of critical habitat for UWR steelhead within the action area are discussed in more detail in the Environmental Baseline section below.

3.2.3 Climate Change Implications for UWR Steelhead and their Designated Critical Habitat

One factor affecting the rangewide status of UWR steelhead and aquatic habitat is climate change. The USGCRP reports average warming in the Pacific Northwest of about 1.3ºF from 1895 to 2011 and projects an increase in average annual temperature of 3.3ºF to 9.7ºF by 2070 to 2099 (compared to the period 1970 to 1999), depending largely on total global emissions of heat-trapping gases (predictions based on a variety of emission scenarios including B1, RCP4.5, A1B, A2, A1FI, and RCP8.5 scenarios); the increases are projected to be largest in summer (Melillo et al. 2014, USGCRP 2018). The 5 warmest years in the 1880 to 2023 record have all occurred since 2016, while 10 of the 10 warmest years have occurred since 2014 (Lindsey and Dahlman 2020). Climate change has negative implications for designated critical habitats in the Pacific Northwest (Climate Impacts Group 2004, Scheuerell and Williams 2005, Zabel et al. 2006, ISAB 2007), characterized by the ISAB as follows:

- Warmer air temperatures will result in diminished snowpack and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a smaller snowpack, watershed runoff will decrease earlier in the season, resulting in lower stream flows in June through September. Peak river flows, and river flows in general, are likely to increase during the winter due to more precipitation falling as rain rather than snow.

- Water temperatures are expected to rise, especially during the summer months when lower stream flows co-occur with warmer air temperatures.

Likely changes in temperature, precipitation, and wind patterns (as well as sea-level rise in the lower estuary) have implications for survival and recovery of UWR steelhead in both their freshwater, estuarine, and marine habitats and the PBFs of their critical habitat. While total precipitation changes are uncertain, increasing air temperatures will result in more precipitation falling as rain rather than snow in watersheds across the basin (ISAB 2007). In general, these changes in air temperatures, river temperatures, and river flows are expected to cause changes in salmon distribution, behavior, growth, and survival, although the magnitude of these changes remains unclear. In coastal areas, projections indicate an increase of 1 to 4 feet of global sea-level rise by the end of the century; sea-level rise and storm surge pose a risk to infrastructure, and coastal wetlands, and tide flats are likely to erode or be lost as a result of seawater inundation (Mote et al. 2014). Ocean acidification is also expected to negatively impact Pacific salmon and organisms within their marine food webs.

Climate change would affect UWR steelhead in the following ways: 1) warmer stream temperatures could cause changes in growth and development rates and disease resistance, 2) changes in flow regimes (larger winter floods and lower flows in the summer and fall) could reduce egg and juvenile survival and alter outmigration and spawning-run timing, and 3) changing ocean conditions and marine food webs could affect ocean survival and growth.

Crozier et al. (2019) assessed UWR steelhead as having a high vulnerability to the effects of climate change based on an analysis of the DPS's sensitivity (high) and exposure (high). Further, the species was determined to have a moderate adaptive capacity. The moderate score for adaptive capacity reflected in the conclusion is based on the following analysis. Winter steelhead in the UWR have an extended freshwater residency, and the majority of naturally produced smolts migrate during their second spring (Keefer and Caudill 2010). Although it is possible for winter steelhead to complete the life cycle as resident *O. mykiss*, there is little information on the frequency of this life-history trajectory, and it is not thought to be common among naturally produced fish. While juvenile winter steelhead will redistribute themselves during freshwater residency, cooler, higher-elevation rearing habitat is not present in tributary basins (Molalla and Calapooia Rivers), inaccessible due to impassable dams (North Santiam, Brietenbush, and Middle Santiam Rivers), or severely degraded (South Santiam River). There is considerable flexibility in juvenile migration timing (Keefer and Caudill 2010) and adult return timing (Naughton et al. 2015) to adapt to changing temperature extremes. There has been no hatchery supplementation of winter-run steelhead since the late 1990s, and, with the exception of hybridization with non-native summer-run and early-winter run steelhead, the genetic integrity of this DPS is thought to be relatively intact (Van Doornik et al. 2015, NMFS 2019a).

One of the most important factors driving the sensitivity of UWR steelhead to the effects of climate change was hatchery influence, which was ranked high. Though hatchery propagation of this lineage is no longer occurring, there are established populations of nonnative winter-run steelhead, active hatchery summer-run steelhead production, and feral natural production of non-native summer- and winter-run steelhead in the basin (Busby et al. 1996, Van Doornik et al. 2015, NMFS 2019a). There is also a potential legacy of stocking non-native hatchery rainbow trout to support recreational harvest in reservoirs and rivers.

The most important freshwater exposure factor was stream temperature, which is important because juvenile steelhead generally rear for 1 or more years in fresh water before migrating (Busby et al. 1996). Of the four recognized populations of winter steelhead in the UWR basin (Myers et al. 2006), all drain the west slope of the Cascade Range, but only the North Santiam River extends into the high Cascades region where snow melt and groundwater contribute significantly to stream flows (Chang et al. 2018). Access to much of the higher elevation historical spawning habitat in the North Santiam is blocked by impassable dams (NWFSC 2015). In studies of steelhead in other basins, warmer summer temperatures are associated with development of anadromy, whereas a resident life-history was more prevalent in streams with colder summer water temperatures (McMillan et al. 2012). In contrast, the distribution of native steelhead in the UWR basin is not clearly associated with gradients in summer stream temperatures.

In the Willamette River basin, native late-winter migrating steelhead populations occur in watersheds draining the Cascade Mountains on the eastern edge of the basin. Interestingly, native steelhead populations are not believed to occur in the upper extremes of the basin, nor in the tributaries on its western edge that drain the Coastal Range, though it is well known that steelhead migrate much longer distances to reach spawning grounds in other watersheds (Busby et al. 1996). In other systems, longer steelhead migrations are associated with much earlier (months earlier) timing of adult returns relative to the spring spawn timing of UWR steelhead. Thus, the late winter entry of UWR steelhead, which is believed to be an adaptation to allow historical passage over Willamette falls (Busby et al. 1996), may pose a temporal constraint on the migration distance that native steelhead can attain prior to spawning. Such time constraints may be more important than temperature in terms of the distribution of steelhead in the Willamette River basin.

3.3 Status of Lower Columbia River Salmon and Steelhead and their Designated Critical Habitat

Lower Columbia River (LCR) Chinook salmon, LCR coho salmon, and Columbia River (CR) chum salmon spawn and rear in Columbia River tributaries from Hood River and the White Salmon River downstream to the mouth of the Columbia River. LCR steelhead spawn and rear in Columbia River tributaries between the Wind and Cowlitz rivers (inclusive) in Washington and between the Hood and Willamette rivers (inclusive) in Oregon. All four ESA-listed LCR ESUs/DPSs do include one population in the Clackamas River (belonging to a Cascade major population group, or MPG), which is a Willamette River tributary. The fall Chinook salmon in the Clackamas are a Cascade Fall MPG population, the winter steelhead in the Clackamas are a Cascade Winter MPG population, and the coho and chum salmon are both Cascade MPG populations. Therefore, a small proportion of fish from these ESUs and DPSs also use the lower Willamette River mainstem as rearing and/or migratory habitat similar to UWR Chinook salmon and steelhead. These species are likely to be affected by the proposed action but to a much lesser extent than the UWR species.

3.3.1 Status of LCR Species

Lower Columbia River Chinook Salmon

Background

The ESU includes all naturally produced populations of Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River and includes the Willamette River to Willamette Falls, Oregon, with the exception of: 1) spring-run Chinook salmon in the Clackamas River; 2) fall-run Chinook salmon originating from Upper Columbia River bright hatchery stocks, that spawn in the mainstem Columbia River below Bonneville Dam, and in other tributaries upstream from the Sandy River to the Hood and White Salmon Rivers; (3) spring-run Chinook salmon originating from the Round Butte Hatchery (Deschutes River, Oregon) and spawning in the Hood River; (4) spring-run Chinook salmon originating from the Carson National Fish Hatchery and spawning in the Wind River; and (5) naturally spawned Chinook salmon originating from the Rogue River Fall Chinook Program (NMFS 2022a).

The ESU spans three distinct ecological regions: Coastal, Cascade, and Gorge. Distinct life-histories (run and spawn timing) within ecological regions in this ESU were identified as major population groups (MPGs). In total, 32 historical, demographically independent populations (DIPs) were identified in this ESU—9 spring-run, 21 fall-run, and 2 late fall-run, which were organized into 6 MPGs (based on run timing and ecological region). LCR Chinook salmon populations exhibit three different life-history types based on return timing and other features: fall-run (or "tules"), late-fall-run (or "brights"), and spring-run. This ESU includes Chinook salmon from 19 artificial propagation programs (70 FR 37159, June 28, 2005; 85 FR 81822, December 17, 2020).

Recovery plan targets for this species are tailored for each life history type, and within each type, specific population targets are identified (NMFS 2013a). For spring Chinook salmon, all populations are affected by aspects of habitat loss and degradation. Four of the nine populations require significant reductions in every threat category. Protection and improvement of tributary and estuarine habitat are specifically noted.

For fall Chinook salmon, recovery requires restoration of the Coast and Cascade strata to high probability of persistence, which is to be achieved primarily by ensuring habitat protection and restoration. Very large improvements are needed for most fall Chinook salmon populations to improve their probability of persistence. For late fall Chinook salmon, recovery requires maintenance of the North Fork Lewis and Sandy populations, which are comparatively healthy, together with improving the probability of persistence of the Sandy population from its current status of "high" to "very high." Improving the status of the Sandy population depends largely on harvest and hatchery changes. Habitat improvements to the Columbia River estuary and tributary spawning areas are also necessary.

Spatial Structure and Diversity

Recent dam removals (Condit Dam, Marmot Dam, and Powerdale Dam) have not only improved/provided access but allow the restoration of hydrological processes that may improve downstream habitat conditions. Once passage actions are undertaken, it may still take several years for the benefits to become evident. For example, the removal of Marmot Dam in 2007 and the Little Sandy River diversion dam in 2008 have clearly demonstrated improvement in the abundance of spring-run Chinook salmon returning to the Sandy River during this most recent period. Still, several programs continue to improve their operations and may achieve fish collection efficiencies suitable to support sustainable populations in previously inaccessible habitat sometime in the near future (5–10 years). In addition to these large-scale efforts, there have been a number of recovery actions throughout the ESU to remove or improve thousands of sub-standard culverts and other small-scale passage barriers, as well as breaching dikes to provide access to juvenile habitat (Ford ed. 2022).

Although the spatial structure contribution to Lower Columbia River Chinook salmon ESU viability has improved during the current review period (2015–19), effective access to upstream habitat in the Cowlitz and Lewis River basins remains the major limitation (Ford ed. 2022). Fish passage operations for spring-run Chinook salmon (trap-and-haul) were begun on the Lewis River in 2012, reestablishing access to historically occupied habitat above Swift Dam (RKM 77.1). Few adults have been available for passage, and juvenile passage efficiencies were initially poor for Chinook salmon, but recent modifications to the collector at Swift Dam have shown improvements in efficiency (PacifiCorp 2020). The installation of a new collection structure at Cowlitz Falls Dam appears to provide improved collection efficiency and survival: 78.7% fish passage survival for Chinook salmon in 2019 (Rubenson et al. 2019). The collection of juvenile fall-run Chinook salmon from the Tilton River at Mayfield Dam appears to be relatively successful, with increasing numbers of fall-run Chinook salmon returning in the last few years (Ford ed. 2022).

Hatchery contributions remain high for a number of populations, and it is likely that many returning unmarked adults are the progeny of hatchery-origin parents, especially where large hatchery programs operate. These reductions in fall-run Chinook salmon releases in the Coastal and Cascade strata have been offset by increases in fall-run Chinook salmon in the Gorge stratum (Ford ed. 2022). While overall hatchery production has been reduced slightly, hatchery-produced fish still represent a majority of fish returning to the ESU (NMFS 2022a).

Abundance and Productivity

Overall, there has been modest change since the last status review in the biological status of Chinook salmon populations in the Lower Columbia River Chinook salmon ESU (NWFSC 2015), although some populations did exhibit marked improvements. Increases in abundance were noted in about half of the fall-run populations, and in 75% of the spring-run populations for which data were available. Many of the populations in this ESU remain at high risk, with low natural-origin abundance levels (NMFS 2022a). Although many of the populations in this ESU are at “high” risk, it is important to note that poor ocean and freshwater conditions existed during the 2015–19 period and, despite these conditions, the status of a number of populations improved, some remarkably so (Grays River Tule, Lower Cowlitz River Tule, and Kalama River Tule fall runs) (Ford ed. 2022).

Relative to baseline VSP levels identified in the Recovery Plan (NMFS 2013a) there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals (NMFS 2022a). Overall, the viability of the Lower Columbia River Chinook salmon ESU has increased somewhat since the last status review, although the ESU remains at "moderate" risk of extinction (Ford ed. 2022).

Limiting factors

Limiting factors for this species include (NMFS 2013a):

- Reduced access to spawning and rearing habitat
- Hatchery-related effects
- Harvest-related effects on fall Chinook salmon
- An altered flow regime and Columbia River plume
- Reduced access to off-channel rearing habitat
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Contaminants

Lower Columbia River Coho Salmon

On June 28, 2005, NMFS listed the LCR coho salmon ESU as a threatened species (70 FR 37160). The threatened status was reaffirmed on April 14, 2014. The status review in 2016 concluded that this ESU should retain its threatened status (81 FR 33468). Critical habitat was designated on January 24, 2016 (81 FR 9252). The summary that follows describes the status of LCR coho salmon. More information can be found in the recovery plan (NMFS 2013a) and the most recent status review (NMFS 2022a), which reaffirmed the threatened status for this species.

The Lower Columbia River (LCR) coho salmon ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries from the mouth of the Columbia up to and including the White Salmon and Hood rivers and includes the Willamette River to Willamette Falls, Oregon, as well as 24 artificial propagation programs (NMFS 2022a). Most of the populations in this ESU contain a substantial number of hatchery-origin spawners. Myers et al. (2006) identified three MPGs (Coastal, Cascade, and Gorge), containing a total of 24 DIPs in the Lower Columbia River coho salmon ESU (NWFSC 2015; Ford ed. 2022).

This species is included in the Lower Columbia River recovery plan (NMFS 2013a). Specific recovery goals are to improve all four viability parameters to the point that the Coast, Cascade, and Gorge strata achieve high probability of persistence. Protection of existing high-functioning habitat and restoration of tributary habitat are noted needs, along with reduction of hatchery and harvest impacts. Large improvements are needed in the persistence probability of most populations of this ESU.

Spatial Structure and Diversity

There have been a number of large-scale efforts to improve habitat accessibility, one of the primary metrics for spatial structure, in this ESU. On the Hood River, Powerdale Dam was removed in 2010 and, while this dam previously provided fish passage, removal of the dam is thought to eliminate passage delays and injuries. Condit Dam on the White Salmon River was removed in 2011, and this provided access to previously inaccessible habitat. Fish passage operations (trap and haul) began on the Lewis River in 2012, thereby reestablishing access to historically occupied habitat above Swift Dam. However, juvenile passage efficiencies are still relatively poor. Presently, the trap-and-haul program for the Upper Cowlitz, Cispus, and Tilton River populations are the only means by which coho salmon can access spawning habitat for these populations. A trap-and-haul program also currently maintains access to the North Toutle River above the sediment retention structure with coho salmon and steelhead being passed above the dam (NWFSC 2015).

Since 2015, there have been incremental improvements in spatial structure, but poor ocean and freshwater conditions have been such as to mask any benefits from these activities. Similarly, fish passage at culverts has improved, with 132 km (79 mi) of stream habitat being opened up in Washington State alone since 2015 (LCFRB 2020), but a large number of small-scale fish barriers still need to be upgraded or removed. Hatchery releases into the Gorge MPG have remained fairly steady at slightly over 3 million annually. Natural production in this MPG is limited, and the influence of hatchery-origin fish on the spawning grounds remains higher than in other regions (Ford ed. 2022).

Abundance and Productivity

Overall abundance trends for the Lower Columbia River coho salmon ESU in the last status review were generally negative (Ford ed. 2022). Natural spawner and total abundances have decreased in almost all populations. In light of the poor ocean and freshwater conditions that occurred during much of this recent review period, it should be noted that some of the populations exhibited resilience and only experienced relatively small declines in abundance. Some populations were exhibiting positive productivity trends during the last year of review (Ford ed. 2022). For individual populations, the risk of extinction spans the full range, from "low" to "very high." Overall, the Lower Columbia River coho salmon ESU remains at "moderate" risk, and viability is largely unchanged from the prior status review.

Limiting Factors

Limiting factors for this species include (NMFS 2013a):

- Degraded estuarine and nearshore marine habitat
- Fish passage barriers
- Degraded freshwater habitat: Hatchery-related effects
- Harvest-related effects
- An altered flow regime and Columbia River plume
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment- and nutrient-related changes in the estuary

- Juvenile fish wake strandings
- Contaminants

Lower Columbia River Steelhead

The Lower Columbia River steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and Hood Rivers (inclusive). The DPS excludes fish originating from the upper Willamette River basin above Willamette Falls. This DPS includes steelhead from the following artificial propagation programs: the Cowlitz Trout Hatchery Late Winter-run Program (Lower Cowlitz); Kalama River Wild Winter-run and Summer-run Programs; Clackamas Hatchery Late Winter-run Program; Sandy Hatchery Late Winter-run Program; Hood River Winter-run Program; Lewis River Wild Late-run Winter Steelhead Program; Upper Cowlitz Wild Program; and the Tilton River Wild Program (71 FR 834, January 5, 2006; 85 FR 81822, December 17, 2020).

Myers et al. (2006) identified two MPGs (Cascade and Gorge) containing 23 DIPs, including 6 summer-run steelhead populations and 17 winter-run populations. There are 14 steelhead populations in the Winter-run Cascade MPG (Lower Cowlitz, Upper Cowlitz, Cispus, Tilton, SF Toutle, NF Toutle, Coweeman, Kalama, NF Lewis, EF Lewis, Salmon Creek, Clackamas, Sandy, and Washougal), four populations in the summer-run Cascade MPG (Kalama, NF Lewis, EF Lewis, and Washougal), three populations in the Winter-run Gorge MPG (Lower Gorge, Upper Gorge, and Hood), and two populations in the Summer-run Gorge MPG (Wind and Hood).

This species is included in the Lower Columbia River recovery plan (NMFS 2013a). For this species, threats in all categories must be reduced, but the most crucial elements are protecting favorable tributary habitat and restoring habitat in the Upper Cowlitz, Cispus, North Fork Toutle, Kalama, and Sandy subbasins (for winter steelhead) and the East Fork Lewis and Hood, subbasins (for summer steelhead). Protection and improvement is also needed among the South Fork Toutle and Clackamas winter steelhead populations.

Spatial Structure and Diversity

There have been a number of large-scale efforts to improve habitat accessibility (one of the primary metrics for spatial structure) in this ESU. Trap-and-haul operations began on the Lewis River in 2012 for winter-run steelhead, thereby reestablishing access to historically occupied habitat above Swift Dam (Ford ed.2022). In 2014, 1,033 adult winter steelhead (integrated program fish) were transported to the upper Lewis River; however, juvenile collection efficiency is still below target levels. In addition, there have been a number of recovery actions throughout the ESU to remove or improve culverts and other small-scale passage barriers. Many of these actions (including the removal of Condit Dam on the White Salmon River) have occurred too recently to be fully evaluated. The juvenile collection facilities at North Fork Dam in the Clackamas River appear to be successful enough to support increases in abundance (Ford ed. 2022).

Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews (Ford ed. 2022). Total steelhead hatchery releases in the Lower Columbia River Steelhead DPS have decreased since the last status review, declining from a total (summer and winter run) release of approximately 3.5 million to 3 million from 2008 to 2014. Some populations continue to have relatively high fractions of hatchery-origin spawners, whereas others (e.g., Wind River) have relatively few hatchery-origin spawners.

Abundance and Productivity

The Winter-run Western Cascade MPG includes native winter-run steelhead in 14 DIPs from the Cowlitz River to the Washougal River (Ford ed. 2022). Abundances have remained fairly stable and have remained low, averaging in the hundreds of fish. Notable exceptions to this were the Clackamas and Sandy River winter-run steelhead populations, which are exhibiting recent rises in NOR abundance and maintaining low levels of hatchery-origin steelhead on the spawning grounds (Jacobsen et al. 2014). In the Summer-run Cascade MPG, there are four summer-run steelhead populations. Absolute abundances have been in the hundreds of fish. Long- and short-term trends for three DIPs (Kalama, East Fork Lewis and Washougal) are positive, though the 2014 surveys indicate a drop in abundance for all three. The Winter-run Gorge MPG has three DIPs. In both the Lower and Upper Gorge population, surveys for winter steelhead are very limited. Abundance levels have been low, but relatively stable, in the Hood River. In recent years, spawners from the integrated hatchery program have constituted the majority of naturally spawning fish. The Wind River and Hood River are the two DIPs in the Summer-run Gorge MPG. Hood River summer-run steelhead have not been monitored since the last status review. Adult abundance in the Wind River remains stable but at a low level (hundreds of fish).

It is not possible to determine the risk status of this DPS given the uncertainty in abundance estimates for nearly half of the populations. Additionally, nearly all of the populations for which there are abundance data exhibited negative abundance trends in 2018 and 2019 (Ford ed. 2022). The latest 5-year status review was completed for LCR steelhead in 2022 (NMFS 2022a). Though issues such as marine mammal and pinniped predation, habitat loss and climate change, remain limiting factors for recovery for LCR steelhead, their abundance persists at low levels. Ultimately, the status review concluded that no reclassification for the LCR steelhead DPS is warranted; therefore, they remain listed as threatened.

Limiting factors

Limiting factors for this species include (NMFS 2013a):

- Degraded estuarine and nearshore marine habitat
- Degraded freshwater habitat
- Reduced access to spawning and rearing habitat
- Avian and marine mammal predation
- Hatchery-related effects
- An altered flow regime and Columbia River plume
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment- and nutrient-related changes in the estuary

- Juvenile fish wake strandings
- Contaminants

Columbia River Chum Salmon

This ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon, as well as four artificial propagation programs (USOFR 2020) (Grays River Hatchery, Big Creek Hatchery, Lewis River Hatchery, and Washougal Hatchery). With the exception of the Grays River stock of fish raised at Big Creek Hatchery, all of the hatchery programs in this ESU use integrated stocks developed to supplement natural production. Ford et al. (2011) concluded that the vast majority (14 out of 17) chum populations remain extirpated or nearly so. The ESU comprises three MPGs—the Coastal Range MPG, the Cascade Range MPG, and the Gorge MPG.

Columbia River chum salmon are included in the Lower Columbia River recovery plan (NMFS 2013a). Recovery targets for this species focus on improving tributary and estuarine habitat conditions and re-establishing populations where they may have been extirpated to increase all four viability parameters. Specific recovery goals are to restore Coast and Cascade chum salmon strata to a high probability of persistence and to improve the persistence probability of the two Gorge populations by protecting and restoring spawning habitat, side-channel and off-channel habitats, alcoves, wetlands, floodplains, *etc.* Even with improvements observed during the last 5 years, the majority of DIPs in this ESU remain at a high or very high risk category, and considerable progress remains to be made to achieve the recovery goals (NWFSC 2015).

Spatial Structure and Diversity

In this ESU, there have been a number of large-scale efforts to improve habitat accessibility, one of the primary metrics for spatial structure. On the Hood River, Powerdale Dam was removed in 2010, and while this dam previously provided for fish passage, removal of the dam is thought to eliminate passage delays and injuries. Condit Dam on the White Salmon River was removed in 2012, and this provided access to previously inaccessible habitat. Both of these dams were above Bonneville Dam, and at present, there are few fish available (122 adults in 2014) to colonize these recently accessible habitats.

Abundance and Productivity

Populations in the Coast Range MPG, other than the Grays River DIP, exist at very low abundances and are intermittently observed in very low numbers (<10) in most tributaries other than the Grays River. Two chum salmon spawning aggregates in the mainstem Columbia River just upstream of the I-205 bridge are part of the Washougal River aggregate. In November 2013, two adult chum salmon were observed at the North Fork Dam in the Clackamas River. Chum salmon have also been collected at a number of hatcheries and weirs throughout the Cascade Range MPG but only in very limited numbers (<10). While the absolute numbers of fish present in many populations are critically low, they may represent important reserves of genetic diversity. Within the Gorge MPG, the Lower Gorge population includes chum salmon returning to Hamilton, Hardy, and Duncan Creeks, and the Ives Island area of the mainstem Columbia River below Bonneville Dam. Other mainstem Columbia River spawning aggregations include

Multnomah and Horsetail Creeks on the Oregon shoreline and the St. Cloud area along the Washington shoreline. For the CR Chum Salmon ESU, some populations have increased in abundance during this review period. However, improvements in a few populations do not warrant a change in the risk category for the ESU as a whole, especially given the uncertainty regarding climatic effects in the near future (Ford ed. 2022; Myers, personal communication, May 11, 2022). The viability of this ESU is relatively unchanged since the last review and therefore remains at moderate to high risk of extinction (NMFS 2022a).

Limiting Factors

Limiting factors for this species are (NMFS 2013a):

- Degraded estuarine and nearshore marine habitat
- Degraded freshwater habitat
- Degraded stream flow as a result of hydropower and water supply operations
- Reduced water quality
- Current or potential predation
- An altered flow regime and Columbia River plume
- Reduced access to off-channel rearing habitat in the lower Columbia River

3.3.2 Status of LCR Species' Designated Critical Habitat

This section describes the status of designated critical habitat affected by the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-listed species because they support one or more of the species' life stages (*e.g.*, sites with conditions that support spawning, rearing, migration, and foraging).

For most salmon and steelhead, NMFS' critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005a). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential because of factors such as limited availability, a unique contribution of the population it served, or serving another important role.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 3.3-1, below.

Table 3.3-1. Critical habitat, designation date, federal register citation, and status summary for the Lower Columbia River species considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Columbia River chum salmon	9/02/05 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
Lower Columbia River coho salmon	2/24/16 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Lower Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.

3.3.3 Climate Change Implications for LCR Species and Designated Critical Habitat

One factor affecting the rangewide status of LCR / CR salmon and steelhead ESUs and aquatic habitat is climate change. The USGCRP reports average warming in the Pacific Northwest of about 1.3ºF from 1895 to 2011 and projects an increase in average annual temperature of 3.3ºF to 9.7ºF by 2070 to 2099 (compared to the period 1970 to 1999), depending largely on total global emissions of heat-trapping gases (predictions based on a variety of emission scenarios including B1, RCP4.5, A1B, A2, A1FI, and RCP8.5 scenarios); these increases are projected to be largest in summer (Melillo et al. 2014, USGCRP 2018). The 5 warmest years in the 1880 to 2019 record have all occurred since 2015, while 9 of the 10 warmest years have occurred since 2005 (Lindsey and Dahlman 2020). Climate change has negative implications for designated critical habitats in the Pacific Northwest (Climate Impacts Group 2004, Scheuerell and Williams 2005, Zabel et al. 2006, ISAB 2007), characterized by the ISAB as follows:

- Warmer air temperatures will result in diminished snowpack and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a smaller snowpack, watershed runoff will decrease earlier in the season, resulting in lower stream flows in June through September. Peak river flows, and river flows in

general, are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures are expected to rise, especially during the summer months when lower stream flows co-occur with warmer air temperatures.

Likely changes in temperature, precipitation, and wind patterns (as well as sea-level rise in the lower estuary) have implications for survival and recovery of LCR / CR salmon and steelhead in both their freshwater, estuarine, and marine habitats and the PBFs of their critical habitat. While total precipitation changes are uncertain, increasing air temperature will result in more precipitation falling as rain rather than snow in watersheds across the basin (ISAB 2007). In general, these changes in air temperatures, river temperatures, and river flows are expected to cause changes in salmon distribution, behavior, growth, and survival, although the magnitude of these changes remains unclear. In coastal areas, projections indicate an increase of 1 to 4 feet of global sea-level rise by the end of the century. Sea-level rise and storm surge pose a risk to infrastructure, and coastal wetlands and tide flats are likely to erode or be lost as a result of seawater inundation (Mote et al. 2014). Ocean acidification is also expected to negatively impact Pacific salmon and organisms within their marine food webs.

There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict bio-ecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty. As we continue to deal with a changing climate, certain management actions may help alleviate some of the potential adverse effects of climate change (e.g., hatcheries serving as a genetic reserve and source of abundance for natural populations). Pacific anadromous fish are adapted to natural cycles of variation in freshwater and marine environments, and their resilience to future environmental conditions depends on both the characteristics of individual populations and on the level and rate of change. However, the life-history types that will be successful in the future are neither static nor predictable, so maintaining or promoting the diversity currently found in the natural populations of Pacific anadromous fish is the wisest strategy for continued existence of populations, including those in the LCR / CR salmon and steelhead ESUs.

Climate change would affect LCR / CR salmon and steelhead and their critical habitats through physical and chemical changes to their habitats (e.g., increased water temperature, decreased ocean pH, changes in the timing and volume of stream flow). The physical and chemical changes may result in biological impacts such as, but not limited to, reduced ocean survival, changes in growth and development, and changes in run timing and spawning timing (Link et al. 2015). These biological changes can lead to changes in species productivity and abundance, distribution, food-web structure, community structure, invasive species impacts, and biodiversity and resilience (Link et al. 2015).

LCR Chinook Salmon

Crozier et al. (2019) assessed LCR Chinook salmon as having a moderate vulnerability to the effects of climate change based on an analysis of the ESU's sensitivity (moderate) and exposure (high). Further, the species was determined to have a high adaptive capacity because of the high degree of life-history diversity expressed by the different populations (Crozier et al. 2019).

LCR Chinook salmon have a high exposure score for summer stream temperature. If spring-run adults or yearling juveniles are restricted to lower river reaches because of lower flows, summer temperatures might become limiting. This ESU scored moderate for hydrologic regime shift, indicating that reduced snowmelt and higher winter flows may affect these fish in some areas. To access headwater areas, spring-run LCR Chinook salmon rely on high flows from snowmelt during April to June; thus, a reduced spring freshet might require earlier migration. Timing of river entry for the spring run of LCR Chinook salmon is triggered by a rising thermograph (Keefer et al. 2008). If spring temperatures are higher and spring flows lower, adults may move into headwater reaches sooner than normal. It is conceivable that their energy stores might be insufficient to sustain them over the summer and through to the early-fall spawning period, when temperatures decline. Higher resolution study of specific habitats is needed to clarify the extent of this risk.

Fall-run adults from the LCR Chinook ESU return to fresh water at an advanced state of maturation during September to October. For these fish, river entry is triggered by a falling thermograph, so warmer temperatures may delay arrival at spawning grounds or require fish to hold and spawn in waters at lethal or sublethal temperatures, resulting in direct or indirect mortality (Schreck et al. 2013, Keefer et al. 2018a). There is some indication that holding in sublethal temperatures can degrade the quality of both male and female gametes (McCullough et al. 2001, Lahnsteiner and Kletzl 2012). Late-fall adults from this ESU may be less subject to deleterious temperatures given the November timing of their freshwater entry. Timing of maturation and spawning strongly influences the susceptibility of different run types to climate change.

As for all ESUs, warmer winter temperatures will likely accelerate embryonic development and emergence timing. Delayed spawning might reduce temperature effects on emergence timing. However, warmer developmental temperatures can still lead to lowered condition in alevins (Fuhrman et al. 2018), which may have less yolk to tide them over until external food sources are available. At present, we lack sufficient information on how stream productivity changes with warming temperature to determine whether bioenergetic constraints will be detrimental to salmon. Nevertheless, downstream migration is triggered by flow and facilitated by snowmelt in spring. Whether directly or indirectly, LCR Chinook salmon juveniles will be affected by warmer stream temperatures as well as by changing estuary and coastal ocean conditions (Daly and Brodeur 2015).

Climate change could affect productivity in tributary habitat through changes in flow and increasing temperatures, which could affect the spawn timing, incubation timing, and rearing and migration timing of LCR Chinook salmon populations. However, it is somewhat unclear how changes in the timing of specific life-history stages would affect survival, if at all, especially during the duration of the effects of the proposed action. Recent analyses by Crozier et al. (2019) rated the vulnerability of LCR Chinook salmon to the effects of climate change as moderate, and we expect abundances over the next 24 years to decrease and extinction risk to increase.

CR Chum Salmon

Crozier et al. (2019) assessed CR chum salmon as having moderate vulnerability to the effects of climate change based on an analysis of the ESU’s sensitivity (moderate) and exposure (moderate). Further, this ESU was determined to have moderate adaptive capacity (Crozier et al. 2019). Given the late-autumn return and spawn timing of CR chum salmon, temperatures under climate change scenarios may not be limiting for adult prespawn survival or early life history. Furthermore, the preference for some of these chum salmon to spawn in areas with groundwater seeps provides relatively constant incubation conditions and would somewhat moderate the effect of changes in temperature and precipitation. Sea-level changes could impact the habitat of chum salmon that spawn in the lowermost reaches of Columbia River tributaries by pushing water farther onto the floodplain, as well as allowing saltwater to move farther upstream along the bottom of the lower river.

Estuary and ocean temperature conditions may change more rapidly than incubation conditions, especially at groundwater seeps, and such changes could leave juvenile migrants “out-of-sync” with nursery conditions. The small size of juvenile emergent chum salmon migrating to the estuary makes them especially vulnerable to changing conditions in the lower river and estuary as well. For example, the quantity, type, and timing of zooplankton that juvenile chum salmon feed upon while rearing in the Columbia River estuary and nearshore environs may be dramatically altered under climate change, especially due to ocean acidification. It is during this early ocean entry period that chum salmon are most vulnerable to alterations in their environment.

LCR Coho Salmon

Crozier et al. (2019) assessed LCR coho salmon as having a high vulnerability to the effects of climate change based on an analysis of the ESU’s sensitivity (high) and exposure (high). Further, the species was determined to have a moderate adaptive capacity because its flexibility in the juvenile rearing period is likely similar to that of other coho salmon.

Climate change would affect LCR coho salmon in the following ways: 1) changes in ocean survival, 2) changes in growth and development rates, 3) changes in disease resistance, and 4) changes in flow regime (especially flooding and low-flow events) that could affect survival and behavior (run timing, spawning timing, etc.).

Adults are less constrained in freshwater entry timing than California coho salmon, and thus could potentially respond temporally to changing environmental conditions (Crozier et al. 2019).

In September, early returning adults may encounter seasonally warm temperatures or low flows that delay entry into spawning tributaries. However, these adults will typically hold in estuaries or larger rivers and rapidly ascend tributaries to spawn when conditions become suitable (Clark et al. 2014). Seasonal drops in stream temperature and increases in discharge improve conditions for adult migration as well as egg incubation. Thus, incubating eggs of LCR coho salmon are unlikely to be exposed to excessively warm temperatures or desiccation.

Because juveniles typically spend at least 1 year in freshwater, they can be stressed by warm stream conditions or low flows in summer (Ebersole et al. 2009) and by floods that may displace juveniles or reduce survival in winter (Nickelson et al. 1992). Ratings of high sensitivity in the juvenile freshwater stage and for exposure to increased stream temperatures reflected these findings and resulted in the juvenile freshwater stage ranking as a highly vulnerable life stage.

Though the quality of information is mixed, sensitivity in the marine stage is certainly high, and exposure to changing marine conditions—namely, high levels of ocean acidification—will occur. However, data quality used to evaluate climate-related threats was limited, and future evidence may alter these rankings.

LCR Steelhead

Crozier et al. (2019) assessed LCR steelhead as having moderate vulnerability to the effects of climate change based on an analysis of the DPS's sensitivity (moderate) and exposure (high). Further, this DPS was determined to have high adaptive capacity (Crozier et al. 2019). Overall, the moderate ranking for this DPS reflected substantial exposure to changes in the freshwater environment tempered by moderate sensitivity via tolerance for warm conditions and reproductive timing that avoids peak temperatures. Exposure to ocean acidification was very high due to the strong magnitude of expected pH change, the broad spatial extent of ocean acidification, and the certainty in the direction of change. Exposure was also ranked high for sea surface temperature, reflecting the broad spatial extent of this attribute. Exposure to stream temperature was ranked very high, and exposure to summer water deficit was moderate. Exposure to nearshore attributes was low, since these steelhead tend to spend less time in the nearshore environment and migrate offshore more quickly than some other salmon species. These nearshore attributes to which steelhead had low exposure included sea level rise, upwelling, and ocean currents.

Wade et al. (2013) found that relative to other stocks of Pacific Northwest steelhead, LCR steelhead had moderate exposure to expected changes in stream temperature and high exposure to changes in flow. Steelhead of this DPS were expected to have high sensitivity scores based on habitat condition and threatened population status.

LCR steelhead juveniles rapidly migrate through the estuary in late spring and experience a short window of exposure to estuarine factors relative to other species (Fresh et al. 2005). Therefore, exposure to sea-level-rise effects on the estuary was low. Compared to other steelhead, however, fish in this DPS use the estuary more extensively. Therefore, these fish had slightly higher exposure scores for sea-level rise than other Oregon and Washington steelhead stocks.

LCR steelhead can tolerate a broad range of temperatures and have a very flexible life history. However, this DPS may have to shift migration or spawn timing if hydrologic regime changes affect migration and spawning (Wade et al. 2013). Butverall, the adaptive capacity for this DPS us thought to be high (Crozier et al. 2019).

3.4 Interior Columbia River Salmon and Steelhead Status of Species and Designated Critical Habitat

Middle Columbia River steelhead, Snake River (SR) spring/summer Chinook salmon, SR fall Chinook salmon, SR sockeye salmon, SR steelhead, Upper Columbia River (UCR) spring Chinook salmon, and UCR steelhead spawn in tributaries to the Columbia River above the mouth of the Willamette River (NMFS 2005a). Adults and juveniles of these ESUs migrate through the lower Columbia River, and some juvenile rearing occurs there as well as in the lower Willamette River below Willamette Falls. The species status and critical habitat information for these seven upper Columbia River basin species is summarized in Tables 3.4-1 and 3.4-2 below.

Table 3.4-1. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each ESA-listed species from the upper Columbia River considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009a	NMFS 2022b; Ford ed. 2022	This DPS comprises 17 extant populations. Recent (five-year) returns are declining across all populations, the declines are from relatively high returns in the previous five-to-ten-year interval, so the longer-term risk metrics that are meant to buffer against short-period changes in abundance and productivity remain unchanged. The Middle Columbia River steelhead DPS does not currently meet the viability criteria described in the Middle Columbia River steelhead recovery plan.	· Degraded freshwater habitat · Mainstem Columbia River hydropower-related impacts · Degraded estuarine and nearshore marine habitat · Hatchery-related effects · Harvest-related effects · Effects of predation, competition, and disease
Snake Riverspring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2017a	NMFS 2022c; Ford ed. 2022	This ESU comprises 28 extant and four extirpated populations. There have been improvements in abundance/productivity in several populations relative to the time of listing, but the majority of populations experienced sharp declines in abundance in the recent five-year period Overall, at this time we conclude that the Snake River spring/ summer-run Chinook salmon ESU continues to be at moderate-to-high risk.	· Degraded freshwater habitat · Effects related to the hydropower system in the mainstem Columbia River, · Altered flows and degraded water quality · Harvest-related effects · Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River fall-runChinook salmon	Threatened 6/28/05	NMFS 2017b	NMFS 2022d; Ford ed. 2022	This ESU has one extant population. The single extant population in the ESU is currently meeting the criteria for a rating of "viable" developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Complex (NMFS 2017b). The Snake River fall-run Chinook salmon ESU therefore is considered to be at a moderate-to- low risk of extinction.	· Degraded floodplain connectivity and function · Harvest-related effects · Loss of access to historical habitat above Hells Canyon and other Snake River dams · Impacts from mainstem Columbia River and Snake River hydropower systems · Hatchery-related effects · Degraded estuarine and nearshore habitat.
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015a	NMFS 2022e; Ford ed. 2022	This single population ESU is at remains at "extremely high risk," although there has been substantial progress on the first phase of the proposed recovery approach—developing a hatchery-based program to amplify and conserve the stock to facilitate reintroductions. Current climate change modeling supports the "extremely high risk" rating with the potential for extirpation in the near future (Crozier et al. 2020). The viability of the Snake River sockeye salmon ESU therefore has likely declined since the time of the prior review, and the extinction risk category remains "high."	· Effects related to the hydropower system in the mainstem Columbia River · Reduced water quality and elevated temperatures in the Salmon River · Water quantity · Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake Riverbasin steelhead	Threatened 1/5/06	NMFS 2017a	NMFS 2022f; Ford ed. 2022	This DPS comprises 24 populations. Based on the updated viability information available for this review, all five MPGs are not meeting the specific objectives in the draft recovery plan, and the viability of many individual populations remains uncertain. Of particular note, the updated, population-level abundance estimates have made very clear the recent (last five years) sharp declines that are extremely worrisome, were they to continue.	· Adverse effects related to the mainstem Columbia River hydropower system · Impaired tributary fish passage · Degraded freshwater habitat · Increased water temperature · Harvest-related effects, particularly for B-run steelhead · Predation · Genetic diversity effects from out-of-population hatchery releases ·
Upper ColumbiaRiver steelhead	Threatened 1/5/06	Upper Columbia Salmon Recovery Board 2007	NMFS 2022g; Ford ed. 2022	This DPS comprises four independent populations. The most recent estimates (five-year geometric mean) of total and natural-origin spawner abundance have declined since the last report, largely erasing gains observed over the past two decades for all four populations (Figure 12, Table 6). Recent declines are persistent and large enough to result in small, but negative 15-year trends in abundance for all four populations. The overall Upper Columbia River steelhead DPS viability remains largely unchanged from the prior review, and the DPS is at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	· Adverse effects related to the mainstem Columbia River hydropower system · Impaired tributary fish passage · Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality · Hatchery-related effects · Predation and competition · Harvest-related effects

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Columbia River spring-run Chinook salmon	Endangered 6/28/05	Upper Columbia Salmon Recovery Board 2007	NMFS 2022g; Ford ed. 2022	This ESU comprises four independent populations. Current estimates of natural-origin spawner abundance decreased substantially relative to the levels observed in the prior review for all three extant populations. Productivities also continued to be very low, and both abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Salmon Recovery Plan for all three populations. Based on the information available for this review, the Upper Columbia River spring-run Chinook salmon ESU remains at high risk, with viability largely unchanged since 2016. .	· Effects related to hydropower system in the mainstem Columbia River · Degraded freshwater habitat · Degraded estuarine and nearshore marine habitat · Hatchery-related effects · Persistence of non-native (exotic) fish species · Harvest in Columbia River fisheries

Table 3.4-2. Critical habitat, designation date, federal register citation, and status summary for each of the ESA-listed species from the upper Columbia River basin considered in this opinion

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Upper Columbia River spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015a). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Middle Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005a). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Snake River basin steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.

3.4.1 Climate Change Implications for Upper Columbia Basin ESA-Listed Salmon Species and Designated Critical Habitat

Middle Columbia River Steelhead

Crozier et al. (2019) assessed MCR steelhead as having high vulnerability to the effects of climate change based on an analysis of the DPS's biological sensitivity (high), climate exposure (high), and adaptive capacity (moderate). Though marine exposures were ranked high for MCR steelhead, the corresponding sensitivity of this species is poorly understood, and this was reflected in generally low data-quality ranks for both marine and estuarine attributes. Linkages between adult returns and marine conditions have not been extensively evaluated for this DPS, although some inferences can be made from general ocean distribution information and temporal patterns in SAR rates.

Although detailed information on ocean distributions for MCR steelhead is not available, past studies suggest that steelhead from Pacific coastal systems generally occur in the Gulf of Alaska and subarctic waters south of the Aleutian Islands (Light et al. 1989). Abdul-Aziz et al. (2011) developed spatially explicit representations of open-ocean thermal habitat for steelhead. They found that under a multimodel ensemble average of climate model outputs using the A1B emissions scenario summer habitat area declined by 36 percent for the 2080s, with the largest habitat losses in the northeast Pacific Ocean. Wintertime habitat area losses were 2 percent, with reductions at the southern end of the historical range largely offset by habitat area gains in the Bering Sea and Sea of Okhotsk.

Whether a general northward and westward displacement of the most frequently observed thermal open-ocean habitat will have substantial impacts on the life cycle, productivity, or spawning distribution of these steelhead is not known. A recent study of SAR ratios found similarities in annual marine survival patterns, with regional groupings for Puget Sound, British Columbia, and coastal Washington and Oregon (Kendall et al. 2015). These groupings suggest that for steelhead, marine/estuarine factors associated with the point of ocean entry may be a more important determinant of year class survival than general conditions in the adult ocean range.

The life stage of MCR steelhead with the highest sensitivity to climate change was the adult freshwater stage. Because many adults spend months in fresh water prior to spawning and hold during the warmest temperatures and lowest flows of the year, they may be particularly vulnerable to climate-related influences on these factors. Because of the general threat to the summer-run life history, this DPS was scored moderate in cumulative life-cycle effects.

Exposure to other stressors ranked high, and for MCR steelhead, these include migration challenges from dams, especially limiting their movement upstream and downstream while over-summering and for repeating spawning. They are also vulnerable to predators and angling in thermal or flow refugia. Many of these stressors influence adults primarily, but juveniles also face habitat stress. Other stressors likely to be exacerbated in the face of climate change include widespread invasion of nonnative, warm water species (Sanderson et al. 2009) and contaminants

(Yeakley et al. 2014). Hatchery influence, both within and outside of the mid-Columbia, was ranked high in reducing the resilience of steelhead in this DPS.

Snake River Fall Chinook

Crozier et al. (2019) assessed SR fall Chinook salmon as having high vulnerability to the effects of climate change based on high exposure to climate effects, high biological sensitivity, and high adaptive capacity. For SR fall Chinook salmon, the upstream migration and pre-spawn holding period extends from mid-August through October (Connor et al. 2018). Returning adults are exposed to temperatures exceeding 68°F, with cumulative exposures being highest for early-returning adults (Keefer and Caudill 2015). Exposure to stream temperature in the Snake River basin was ranked high for this ESU, and models suggest that future migrants may experience lower migration and spawning success because of rising temperatures (Connor et al. 2018). Nonetheless, the vulnerability of this ESU during the adult freshwater stage was ranked as moderate, because most adults migrate after temperatures have peaked and spawn after temperatures have declined in the fall.

Snake River Spring – Summer Chinook

Crozier et al. (2019) assessed SR spring/summer Chinook salmon as having very high overall vulnerability to the effects of climate change based on an analysis of the ESU's sensitivity (high) and exposure (very high). Further, this ESU was determined to have high adaptive capacity (Crozier et al. 2019). The high overall sensitivity rank of this ESU stemmed largely from characteristics of its migration. Negative effects of high temperatures encountered during the adult and juvenile freshwater stages have been documented (Crozier and Zabel 2006; Crozier et al. 2017a, 2017b). Populations within this ESU that migrate later, such as the Pahsimeroi and South Fork Salmon River populations, encounter stressful temperatures during their adult migration. However, both spring- and summer-run populations are at risk for prespawn mortality while holding in tributary habitats during peak summer temperatures (Bowerman et al. 2016).

This ESU was ranked very high risk for the adult freshwater stage. Because juveniles spend a full year in freshwater, they can experience negative effects on survival from warm summer temperatures and low flows (Crozier and Zabel 2006, Crozier et al. 2008b). Smolt survival during migration to the ocean depends strongly on rapid flows from snowmelt (Zabel et al. 2008, Widener et al. 2018). Thus, sensitivity in the juvenile freshwater stage was ranked high.

The Interior Columbia Recovery Domain is likely to lose a substantial portion of snowpack, so this ESU was ranked very high for hydrologic regime shift. Furthermore, exposure to stream temperature change ranked very high, elevating vulnerability to very high in both the juvenile and adult freshwater stages. A vast majority of populations in this ESU exhibit the yearling life-history strategy. Therefore, loss of this rearing strategy would mean loss of a significant characteristic of this ESU, a threat reflected in the high score for cumulative life-cycle effects. Carryover effects between life stages also increased the cumulative life-cycle-effects risk, as discussed below.

SR spring/summer Chinook salmon sensitivity was ranked moderate at the marine stage, although some scorers considered the marine mortality risk to be high. Marine survival for this

ESU is lower during warm phases of the Pacific Decadal Oscillation (PDO), and rising sea surface temperature is likely to have impacts similar to the warm ocean conditions associated with both warm phases of the PDO and low adult survival (Zabel et al. 2006, Crozier et al. 2008b). On the other hand, while smolt migration is slower in low snowpack years, earlier smolt migration timing might benefit this ESU in relation to ocean upwelling (earlier ocean arrival is almost always better, but is dependent on size). At present, much of the population enters the ocean later than the optimal period for survival (Scheuerell et al. 2009). SR spring/summer Chinook salmon have a relatively short estuarine rearing period (Weitkamp et al. 2012, 2015), which resulted in low scores for estuary stage and sea level rise. Observations suggest that longer freshwater rearing produces larger smolts, which then spend less time in the estuary. Of primary concern in the cumulative life-cycle-effects attribute is loss of unique life-history types, including the spring/summer adult run type and the yearling juvenile life-history strategy.

Accumulated effects from shifts in successive life stages may reduce survival in subsequent life stages. For example, earlier migration timing at the juvenile freshwater stage may mean that fish are smaller at ocean entry and less likely to encounter favorable ocean feeding conditions. Smaller size is a disadvantage at ocean arrival, so if they are leaving the tributaries because they are too hot that could be a disadvantage at ocean entry. Such a timing alteration could in turn reduce early marine survival (Crozier et al. 2008a). Thus, sensitivity of this ESU was considered high for cumulative life-cycle effects.

Overall SR spring/summer Chinook salmon was ranked high in adaptive capacity. This ESU may have sufficient adaptive capacity to increase the production of subyearling smolts, or for yearling smolts to migrate earlier in spring. Adults may have some flexibility in migration timing to avoid high stream temperatures in the migration corridor. However, this would likely have a differential impact on different populations, which could ultimately reduce diversity in the basin. Early migrating adults in this ESU will still need to hold for extended periods until temperatures cool in the fall, and this will increase exposure to high stream temperatures and risk from harvest. Energetic costs during the holding period might limit adaptive capacity in the adult stage.

Snake River Sockeye

Crozier et al. (2019) recently completed a climate vulnerability assessment for Pacific salmon and steelhead, including SR sockeye salmon. They concluded that this species has a very high risk of overall climate vulnerability based on its very high risk for biological sensitivity, high risk for climate exposure, and low capacity to adapt. Life-stage sensitivity attributes for this ESU were scored very high for the adult freshwater stage, which essentially caused the very high score in cumulative life-cycle effects. Rates of adult and juvenile migration survival are strongly correlated with temperature in the Columbia River, and catastrophic effects of temperature on the adult migration have been observed recently. Adult migration survival for SR sockeye salmon to spawning grounds ranged from 1 percent in the extremely warm year of 2015 to 60 percent in the more average year 2010 (Crozier et al. 2015, 2018). The anadromous run essentially disappeared altogether in the early 1990s and has rebounded somewhat in recent years because of large releases of captive broodstock and improved ocean survival (Williams et al. 2014, NWFSC 2015). Ocean survival is well predicted by environmental climate indices, particularly upwelling and the Pacific Northwest Index (Williams et al. 2014). However, the impact of climate change specifically on marine survival is uncertain, which led to a moderate score for the marine stage.

SR sockeye salmon were scored low in estuary stage sensitivity because of their rapid migration from fresh water to the early marine stage. Risk during early life history was also scored low because of the high elevation and relatively stable lake temperatures that influence the egg stage. Scores for the juvenile freshwater stage were spread across many bins (sd = 0.89) because of uncertainty in how juvenile rearing and migration would be affected by climate change. The primary rearing lake is likely to remain suitable for sockeye, but the long-distance migratory stage is sensitive to reduced freshets that will result from reduced snowpack. Because smolt production is now dependent on hatchery releases, there is great uncertainty in how management and fish condition will change in the future. Many juveniles are transported past the eight dams along their migration route, which improves juvenile survival but has negative effects on marine survival and adult migration success (Crozier et al. 2015, 2018). All these anthropogenic influences make predictions about natural-origin sockeye difficult. In exposure attributes, this ESU was scored as very high risk for stream temperature and ocean acidification and high risk for hydrologic regime and sea-surface temperature.

SR sockeye salmon scored low in adaptive capacity. Sockeye salmon are unlikely to respond to climate change by changing their life-history characteristics, other than reverting to a fully freshwater life history, which would constitute the complete loss of a fundamental characteristic of this ESU. The resident population in Redfish Lake has already contributed significantly to the present anadromous broodstock. Furthermore, little potential habitat exists that might improve in suitability. Low population abundance and spatial diversity suggest limited genetic heterogeneity that would support rapid adaptation. Adult migration spans a broad temporal window (April to mid-August), which might contract to avoid high temperatures and low flows in summer, as has been observed in the larger Okanogan and Wenatchee sockeye ESUs (Crozier et al. 2011).

SR Steelhead

Crozier et al. (2019) assessed SR steelhead as having high overall vulnerability to the effects of climate change based on an analysis of the DPS' sensitivity (high) and exposure (high). Further, this DPS was determined to have moderate adaptive capacity (Crozier et al. 2019). The high sensitivity score was assigned in part because of the DPS' high sensitivity at the adult freshwater stage. Most populations are subject to high stream temperatures during the upstream migration and pre-spawn holding phases (Wade et al. 2013). Moreover, for populations in Lower Snake River tributaries, the presence of mainstem dams (particularly Lower Granite Dam) may exacerbate straying. Exposure to increased stream temperature and summer water deficit during the upstream migration and holding periods were also high to very high, indicating a high climate change vulnerability for SR steelhead in the adult freshwater stage.

Although detailed information on ocean distributions for Columbia River steelhead is not available, past studies suggest that steelhead from Pacific coastal systems generally occur in the Gulf of Alaska and the subarctic waters south of the Aleutian Islands (Light et al. 1989). Abdul-Aziz et al. (2011) developed spatially explicit representations of open ocean thermal habitat for steelhead. They found that under a multimodel ensemble average of climate model outputs using the A1B emissions scenario, summer habitat area declined by 36 percent for the 2080s, with the largest habitat losses in the northeast Pacific Ocean. Wintertime habitat area losses were 2 percent, with reductions at the southern end of the historical range largely offset by habitat area gains in the Bering Sea and Sea of Okhotsk.

Whether a general northward and westward displacement of the most frequently observed thermal open ocean habitat will have substantial impacts on the life-cycle, productivity, or spawning distribution of these steelhead is not known. A recent study of smolt-to-adult survival trends found similar patterns in annual marine survival for stocks within regional groupings for Puget Sound, British Columbia and coastal Washington and Oregon (Kendall et al. 2017). Such patterns suggest that marine/estuarine factors associated with the point of ocean entry may be more important determinants of year-class survival for steelhead than general conditions in the adult ocean range.

Despite moderate to high exposure scores for flooding, stream temperature, and summer water deficit, sensitivity scores were ranked low to moderate for the early life-history (egg incubation) and juvenile freshwater stage. Sensitivity of egg incubation was rated low because stream temperature and flows are generally well within tolerance limits. Therefore, vulnerability of SR steelhead is likely somewhat lower at the egg incubation and juvenile rearing stages. Sensitivity scores were low to moderate for the estuary stage. Exposure was ranked high for sea surface temperature, with low exposure to ocean currents, upwelling, and sea level rise. Sensitivity was ranked moderate for the marine stage.

The overall rating for adaptive capacity was moderate for SR steelhead, but there was also a large number of low scores. This DPS could have some potential for shifts in adult return and upstream migration timing to avoid peak late summer temperatures, but that may lead to increased negative effects from lower flows. For populations in high-temperature or low-flow areas, there are limited opportunities to shift juvenile rearing patterns to avoid climate change effects.

UCR Spring Chinook and UCR Steelhead

According to the most recent 5-year status review for Upper Columbia River (UCR) steelhead, and Chinook salmon, climate change poses a major risk. Recent life cycle modeling suggests that increases in smolt survival are needed to overcome the negative impacts of climate change for Chinook salmon populations in this ESU; and that changing ocean conditions put these populations at high risk of extinction (Crozier et al. 2021) (NMFS 2022g). Additionally, Crozier et al. (2019) concluded that both species have a high risk of overall climate vulnerability based on their high risk for biological sensitivity, high risk for climate exposure, and moderate capacity to adapt. Life-stage sensitivity attributes for UCR spring-run Chinook salmon scored high for both juvenile and adult freshwater stages. UCR steelhead scored high in the adult freshwater stage. Ocean survival is well predicted by environmental climate indices, particularly upwelling and the Pacific Northwest Index (Williams et al. 2014). However, the impact of climate change specifically on marine survival is uncertain, leading to a moderate score for the marine stage (NMFS 2022g).

Uncertainty in Climate Predictions

There is considerable uncertainty in the predicted effects of climate change in general, including in the Pacific Northwest. The indirect effects of climate change are also uncertain, including whether human "climate refugees" will move into the range of salmon and steelhead, increasing stresses on their respective habitats (Dalton et al. 2013, Poesch et al. 2016).

Many of the effects of climate change (e.g., increased temperature, altered flow, coastal productivity) will have direct impacts on the food webs that species rely on in freshwater, estuarine, and marine habitats to grow and survive. Such ecological effects are extremely difficult to predict even in fairly simple systems, and minor differences in life-history characteristics among stocks of salmon may lead to large differences in their response (e.g., Crozier et al. 2008b; Martins et al. 2011, 2012). This means it is likely that there will be "winners and losers," meaning some salmon populations may enjoy different degrees or levels of benefit from climate change while others will suffer varying levels of harm.

Climate change is expected to impact anadromous fish during all stages of their complex life cycle. In addition to the direct effects of rising temperatures, indirect effects include alterations in stream-flow patterns in freshwater and changes to food webs in freshwater, estuarine, and marine habitats. There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict bio-ecological changes to fish or food webs in response to these physical/chemical changes is less certain, leading to a range of potential future outcomes.

3.5 Status of the Southern Resident Killer Whale DPS

Southern Resident killer whales (SRKWs) are an ecotype of fish-eating killer whales in the eastern North Pacific. The SRKW DPS, composed of J, K, and L pods, was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). A 5-year review under the ESA completed in 2021 concluded that SRKWs should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2021c). NMFS considers SRKWs to be currently among nine species at high risk of extinction as part of NMFS's Species in the Spotlight initiative because of their endangered status, their declining population trend, and because they are considered high priority for recovery due to conflict with human activities and based on current recovery programs addressing those threats. The population has relatively high mortality and low reproduction, unlike other resident killer whale populations, which have generally been increasing since the 1970s (Carretta et al. 2023). Current management priorities are outlined in the 2021-2025 Species in the Spotlight Action Plan.

The factors limiting SRKW recovery as described in the final recovery plan include reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008c). This section summarizes the status of SRKW throughout their range and information taken largely from the recovery plan (NMFS 2008c), the most recent 5-year review (NMFS 2021c), and the PFMC SRKW Ad Hoc Workgroup's report (PFMC 2020), as well as new data that became available more recently.

Killer whales, including SRKWs, are a long-lived species and sexual maturity can occur at age 10 (NMFS 2008c). Females produce a low number of surviving calves (n < 10, but generally fewer) over the course of their reproductive lifespan (Bain 1990; Olesiuk et al. 1990). Compared to Northern Resident killer whales (NRKWs), which are a resident killer whale population with a sympatric geographic distribution ranging from coastal waters of Washington State and British Columbia north to Southeast Alaska, SRKW females appear to have reduced fecundity (Ward et al. 2013; Vélez-Espino et al. 2014), and all age classes of SRKWs have reduced survival compared to other fish-eating populations of killer whales in the Northeast Pacific (Ward et al. 2013).

Since the early 1970s, annual summer censuses have occurred in the Salish Sea using photo-identification techniques (Bigg et al. 1990; CWR 2023). The population of SRKW was at its lowest known abundance (n = 67) in the early 1970s following live-captures for aquaria display and highest recorded abundance (98 animals) in 1995. Subsequently, the population declined from 1995-2001 (from 98 whales in 1995 to 81 whales in 2001). Although the population experienced growth between 2001 and 2006 and a brief increase from 78 to 81 whales as a result of multiple successful pregnancies (n = 9) in 2013 and 2014, the population has been declining since 2006. At the time of the 2023 summer census, the Center for Whale Research (CWR) reported 75 SRKWs in the population, including two calves that were born in 2023 (CWR 2023). Since the 2023 census, one adult male is presumed dead, along a calf born in late 2023, bringing the population size to 74. The previously published historical estimated abundance of SRKWs was 140 animals (NMFS 2008c), which included the number of whales killed or removed for public display in the 1960s and 1970s (summed across all years) added to the remaining population at the time the captures ended.

Because of this population's small abundance, it is also susceptible to demographic stochasticity, or randomness in the pattern of births and deaths among individuals in a population. Several sources of demographic variance (e.g., differences between or within individuals) can affect small populations and contribute to variance in a population's growth and increased extinction risk. Sources of demographic variance can include environmental stochasticity, or fluctuations in the environment that drive changes in birth and death rates, and demographic heterogeneity, or variation in birth or death rates of individuals because of differences in their individual fitness (including sexual determinations). In combination, these and other sources of random variation combine to amplify the probability of extinction (Gilpin and Michael 1986; Fagan and Holmes 2006; Melbourne and Hastings 2008). The larger the population size, the greater the buffer against stochastic events and genetic risks.

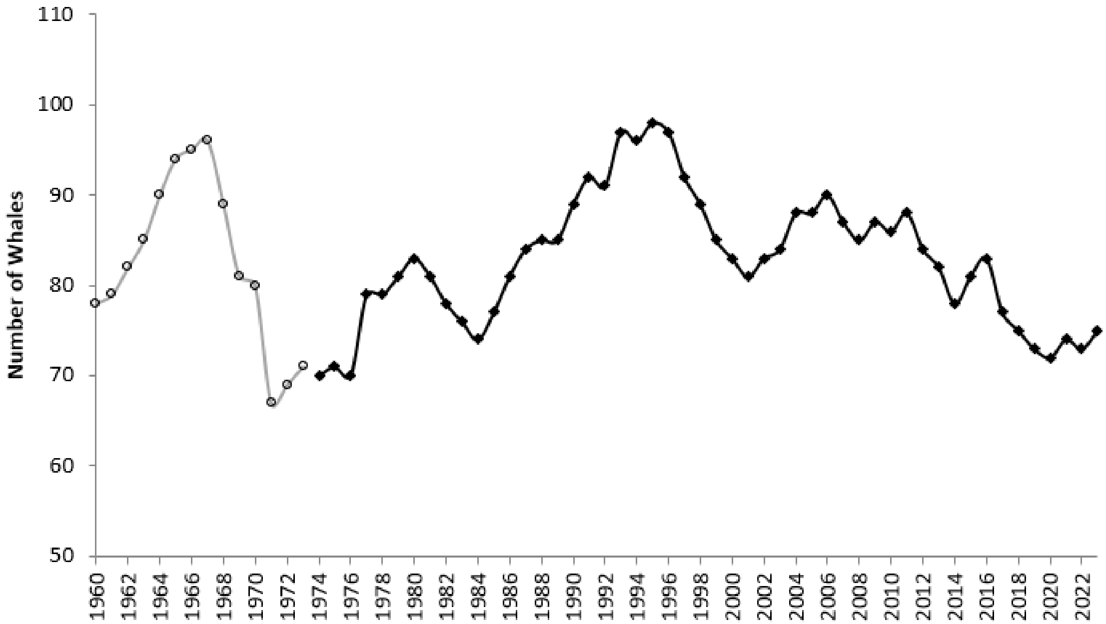


Figure 3.5-1. Population size and trend of SRKWs, 1960-2023. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2023 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) and were provided by the CWR (2023, unpublished data) and NMFS (2008c). Data for these years represent the number of whales present at the end of each calendar year, or after the summer census for 2012 onwards.

Seasonal mortality rates among SRKWs and NRKWs may be highest during the winter and early spring, based on strandings data and the number of animals missing from pods returning to inland waters each spring. Olesiuk et al. (2005) reported that high neonate mortality occurred outside of the summer season. Additionally, multiple new calves have been documented in winter months that did not survive to the following summer season (CWR unpublished data). Stranding rates are higher in winter and spring for all killer whale ecotypes in Washington and Oregon (Norman et al. 2004) and a recent review of killer whale strandings in the northeast Pacific provided insight into health, nutritional status and causes of mortality for all killer whale ecotypes (fish- and mammal-eating) (Raverty et al. 2020).

The NWFSC continues to evaluate changes in fecundity and survival rates, and has updated population viability analyses conducted for the 2004 Status Review of Southern Resident Killer Whales (Krahn et al. 2004b), the science panel review (Hilborn et al. 2012; Ward et al. 2013), and previous 5-year status reviews (NMFS 2011a; 2016b). Subsequently, population estimates, including data from the most recent five years (2017-2021), project a downward trend over the next 25 years (Figure 3.5-1). The declining trend is, in part, due to the changing age and sex structure of the population (the sex ratio at birth was estimated in the model at 55% male and 45% female following current trends), but also related to the relatively low fecundity rate observed from 2017 to 2021. Though these fecundity rates are declining, average SRKW survival rates estimated by the NWFSC have been slowly increasing since the late 1990s. The population projection indicates the strongest decline if future fecundity rates are assumed to be similar to 2017-2021, and higher but still declining if average fecundity and survival rates over all years (1985-2021) are used (Figure 3.5-1). The projection using the highest fecundity and survival rates (1985-1989) shows some stability and even a slight increase over the next decade before severely declining. A 25-year projection was selected because as the model projects out over a longer time frame (e.g., 50 years), there is increased uncertainty around the estimates (also see Hilborn et al. (2012)).

Limiting Factors and Threats

Several factors identified in the final recovery plan for SRKWs may be limiting recovery. The recovery plan identifies three major threats including (1) quantity and quality of prey, (2) toxic chemicals that accumulate in top predators, and (3) impacts from sound and vessels. Oil spills, disease, and the small population size are also risk factors. It is likely that multiple threats are acting together to impact the whales. Modeling exercises have attempted to identify which threats are most significant to survival and recovery (e.g. Lacy et al. (2017); Murray et al. (2021)), and available data suggests that all of the threats are potential limiting factors (NMFS 2008c; Murray et al. 2021; NMFS 2021c).

Recent work by Williams et al. (2024) supports these assertions. In an updated population viability assessment (PVA) model (drawing from work in Lacy et al. (2017)), Williams et al. (2024) showed that several factors are affecting the SRKW population growth rate, such as Chinook salmon abundance, PCB accumulation, noise from vessels, and inbreeding, among others. While this work indicates that Chinook salmon abundance may have the largest influence on population growth rate, it is unclear how inbreeding depression (Kardos et al. 2023) may temper this response found by the authors, as the Williams paper does not appear to have taken into account the Kardos results. As a result, it is hard to predict if the results of the population growth projected by Williams concomitant with a prey increase would change if inbreeding depression was considered more thoroughly. There are many limitations to interpreting the specific results, and unquantified uncertainty in the model (see Effects Section 2.5.3.1 for more detail), but in general, the findings by Williams et al. (2024) support the large body of knowledge (see Abundance, Productivity, and Trends, above) projecting population decline over the long term, and the importance of Chinook salmon prey abundance, as well as the impact of other limiting factors, on the recovery of SRKWs.

Quantity and Quality of Prey

SRKW consume a variety of fish species (22 species) and one species of squid (Ford 1998; Ford et al. 2000; Ford and Ellis 2006; Hanson et al. 2010b; Ford et al. 2016), but salmon are identified as their primary prey. The best available information suggests an overall preference for Chinook salmon (*Oncorhynchus tshawytscha)* during the summer and fall. Chum salmon (*O. keta)*, coho salmon (*O. kisutch)*, and steelhead (*O. mykiss*) may also be important in the SRKW diet at particular times and in specific locations. Rockfish (*Sebastes* spp.), Pacific halibut (*Hippoglossus stenolepis*), and Pacific herring (*Clupea pallasi*) were also observed during predation events (Ford and Ellis 2006), however, these data may underestimate the extent of feeding on bottom fish (Baird 2000). A number of smaller flatfish, lingcod (*Ophiodon elongatus*), greenling (*Hexagrammos* spp.), and squid have been identified in stomach content analysis of resident whales (Ford 1998).

Deoxyribonucleic acid (DNA) quantification methods are also used to estimate the proportion of different prey species in the diet of SRKWs from fecal samples. Ford et al. (2016) confirmed the importance of Chinook salmon to SRKWs in the early- to mid-summer months (May to August) by sequencing DNA from whale feces collected in inland waters of Washington and British Columbia. Salmon and steelhead made up to 98% of the inferred diet, of which almost 80% were Chinook salmon. Coho salmon and steelhead are also found in the diet in inland waters of Washington and British Columbia during spring and fall months when Chinook salmon are less abundant. Specifically, coho salmon contribute to over 40% of the diet in September in inland waters, which is evidence of prey-shifting by SRKWs at the end of summer towards coho salmon (Ford 1998; Ford and Ellis 2006; Hanson et al. 2010b; Ford et al. 2016). Less than 3% each of chum salmon, sockeye salmon, and steelhead were observed in fecal DNA samples collected from May to September in inland waters.

Nutritional Limitation and Body Condition

When prey are scarce or in low density, SRKWs likely spend more time foraging than when prey are plentiful or in high density. Increased energy expenditure and prey limitation can cause poor body condition and nutritional stress, which is the condition of being unable to acquire adequate energy and nutrients from prey resources. As a chronic condition, it can lead to reduced body size of individuals and lower reproductive and survival rates in a population (Trites and Donnelly 2003). During periods of nutritional stress and poor body condition, cetaceans lose adipose tissue behind the cranium, displaying a condition known as "peanut-head" in extreme cases (Pettis et al. 2004; Bradford et al. 2012; Joblon et al. 2014). Between 1994 and 2008, 13 SRKWs (males and females across a range of ages) were observed from boats to have a pronounced "peanut-head," or sunken neck, and all but two subsequently died (Durban et al. 2009, CWR unpublished data). None of the whales that died were subsequently recovered, and therefore the definitive cause of death could not be identified.

Toxic Chemicals

SRKWs are exposed to persistent pollutants primarily through their diet. For example, Chinook salmon contain higher levels of some persistent pollutants than other salmon species, but only limited information is available for pollutant levels in Chinook salmon (Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016). These harmful pollutants, through consumption of prey species that contain these pollutants, are stored in the blubber and can later be released; when the pollutants are released, they are redistributed to other tissues when the whales metabolize the blubber, for example, in response to food shortages or reduced acquisition of food energy. The release of pollutants can also occur during gestation or lactation, exposing calves to contaminants (and temporarily reducing the burden for lactating females). Once the pollutants mobilize into circulation, they have the potential to cause a toxic response. Fecal samples showed that toxicants were highest in concentration when prey availability was low, and the possibility of toxicity was therefore highest with low prey (Lundin et al. 2016). Therefore, nutritional stress from reduced prey, including Chinook salmon populations, that may occur or may be occurring, may act synergistically with high pollutant levels in SRKWs and result in adverse health effects.

Disturbance from Vessels and Sound

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. While in inland waters of Washington and British Columbia, SRKWs are the principal target species for the commercial whale watch industry (Hoyt 2001; O'Connor et al. 2009) and encounter a variety of other vessels in their urban environment (e.g., recreational, fishing, ferries, military, shipping). Several main threats from vessels include direct vessel strikes, the masking of echolocation and communication signals by anthropogenic sound, and behavioral changes (NMFS 2008c). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals (NMFS 2010; 2018c; 2021). Research has shown that SRKWs spend more time traveling and performing surface active behaviors and less time foraging in the presence of all vessel types, including kayaks (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010). Further, noise from and/or presence of motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales and their foraging dives and success (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010; Holt et al. 2021b; Holt et al. 2021a), or the probability of being in a foraging state (Williams et al. 2021). New models of SRKW behavioral states showed that both males and females spent less time in foraging states, with fewer prey-capture dives and less time spent in prey capture dives, when vessels were near (within 400 yds on average) (Holt et al. 2021a). The impact was greater for females, who were more likely than males to switch from deep and intermediate dive foraging behaviors to travel/respiration states when vessels were near (Holt et al. 2021a).

Oil Spills

In the Northwest, SRKWs are the most vulnerable marine mammal population to the risks imposed by an oil spill due to their overall small population size, strong site fidelity to areas with high oil spill risk, large groups of individuals together at once, late reproductive maturity, low reproductive rate, and specialized diet, among other attributes (Jarvela-Rosenberger et al. 2017). Oil spills have occurred in the range of SRKWs in the past, most recently in August 2022 when a commercial fishing vessel sank near San Juan Island, but no SRKW were seen near the oil sheen that was spilled. Oil can be discharged into the marine environment in any number of ways, including shipping accidents, refineries and associated production facilities, and pipelines. Despite many improvements in spill prevention since the late 1980s, much of the region inhabited by SRKWs remains at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers.

If repeated ingestion of petroleum hydrocarbons by killer whales occurs, it would likely cause adverse effects, though long-term consequences are poorly understood. In marine mammals, acute exposure to petroleum products can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion and disease, pneumonia, liver disorders, neurological damage, adrenal toxicity, reduced reproductive rates, and changes in immune function (Geraci and St. Aubin 1990; Schwacke et al. 2013; Venn-Watson et al. 2015; de Guise et al. 2017; Kellar et al. 2017). Exposure can also result in death and long-term effects on population viability (Matkin et al. 2008; Ziccardi et al. 2015).

3.5.1 Status of SRKW Designated Critical Habitat

Critical habitat for the SRKW DPS was first designated on November 29, 2006 (71 FR 69054) in inland waters of Washington State (Figure 3.5-2). NMFS published a final rule to revise SRKW critical habitat in 2021 (86 FR 41668; August 2, 2021). This rule, which became effective on September 1, 2021, maintains the previously designated critical habitat in inland waters of Washington (Puget Sound, see 71 FR 69054; November 29, 2006) and expands it to include six additional coastal critical habitat areas off the coast of Washington, Oregon, and California, an additional approximately 15,910 square miles (mi^2) (Figure 3.5-3). Critical habitat includes approximately 2,560 square miles of inland waters of Washington in three specific areas: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca (Figure 3.5-2), as well as 15,910 mi^2 (41,207 square kilometers (km^2)) of marine waters along the U.S. west coast variably between the 20-feet (ft) (6.1-m) depth contour and the 656.2-ft (200-m) depth contour from the U.S. international border with Canada south to Point Sur, California. Based on the natural history of SRKWs and their habitat needs, NMFS identified the following physical or biological features essential for the conservation of SRKWs: (1) Water quality to support growth and development; (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) Passage conditions to allow for migration, resting, and foraging.

Additional information on the physical or biological features essential to conservation can be found in the 2006 critical habitat final rule (71 FR 69054, November 29, 2006) and the recent 2021 critical habitat expansion final rule (86 FR 41668, August 2, 2021), and is incorporated into information provided in the status for the species. We briefly summarize information on each of the three features here and more detailed descriptions based on recent research findings are also included in the Final Biological Report that supports the 2021 critical habitat rule (NMFS 2021b).

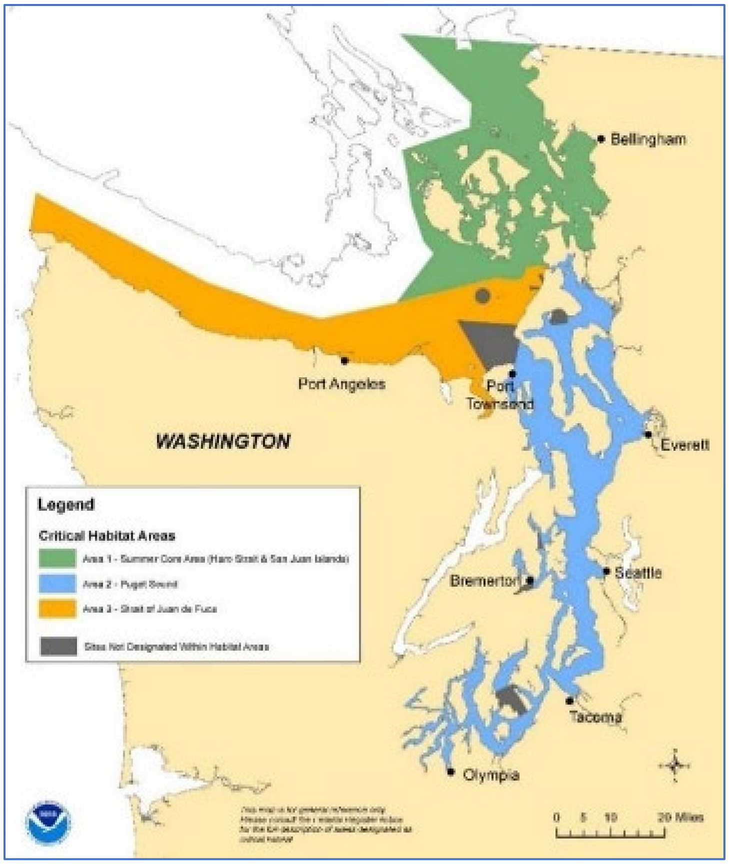


Figure 3.5-2. SRKW 2006 critical habitat designation. Note: Areas less than 20 ft deep (relative to extreme high water) are not designated as SRKW critical habitat.

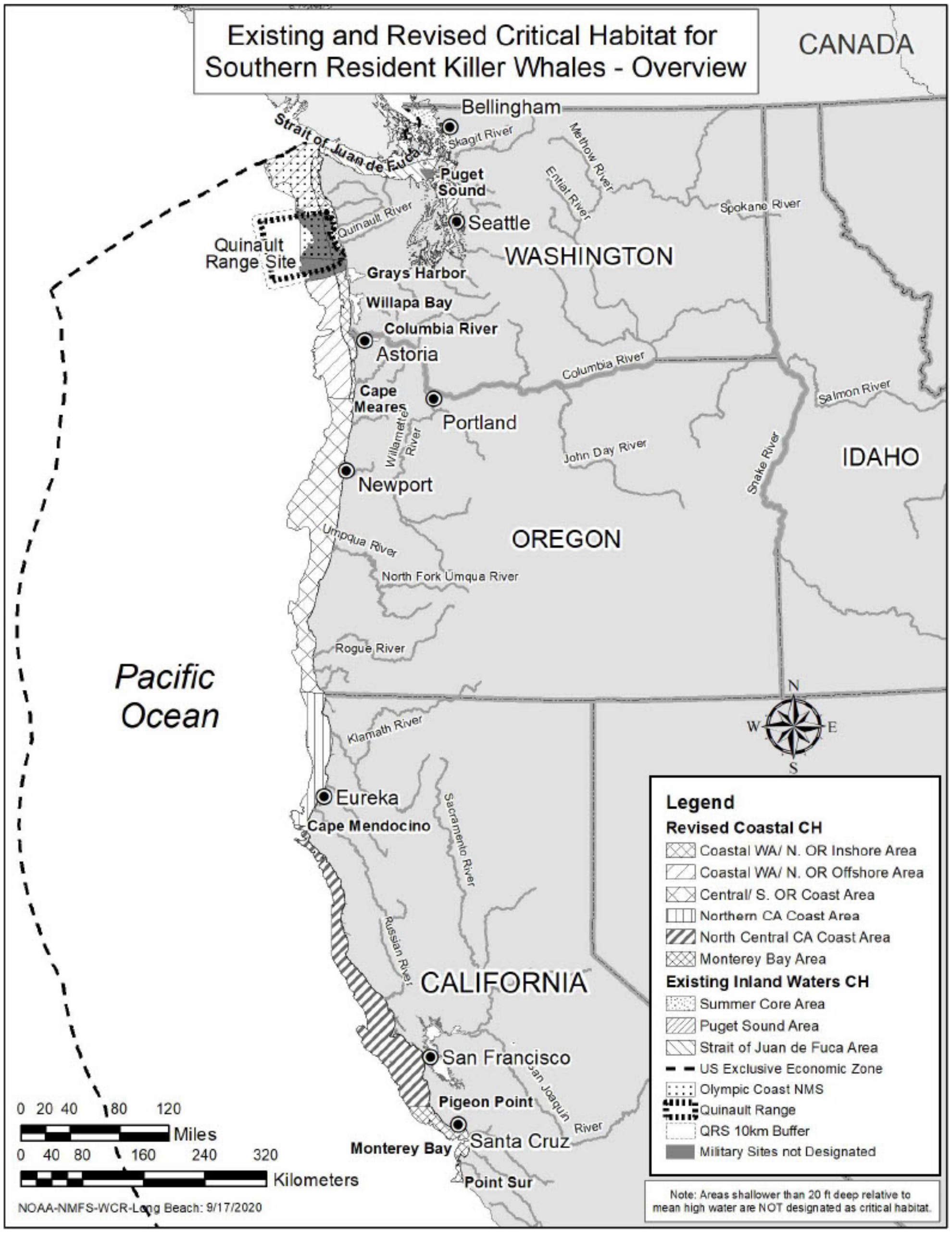


Figure 3.5-3. Specific areas of coastal critical habitat containing essential habitat features (86 FR 41668, August 2, 2021).

Water Quality

Water quality is essential to SRKW conservation, given the population's present contamination levels, small population numbers, increased extinction risk caused by any additional mortalities, and geographic range (and range of their primary prey) which includes highly populated and industrialized areas. Water quality is especially important in high-use areas where foraging behaviors occur and contaminants can enter the food chain. For example, toxicants in Puget Sound persist and build up in marine organisms including SRKWs and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. Also, oil spill risk exists throughout the SRKW's coastal and inland range. The Environmental Protection Agency and U.S. Coast Guard oversee the Oil Pollution Prevention regulations promulgated under the authority of the Federal Water Pollution Control Act. There is a Northwest Area Contingency Plan, developed by the Northwest Area Committee, which serves as the primary guidance document for oil spill response in Washington and Oregon.

Prey Quantity, Quality, and Availability

Prey species of sufficient quantity, quality, and availability are essential to conservation as SRKWs need to maintain their energy balance all year long to support daily activities (foraging, traveling, resting, socializing), as well as gestation, lactation, and growth. Most wild salmon stocks throughout the whales' geographic range are at fractions of their historic levels and 28 ESUs and DPSs of salmon and steelhead are listed as threatened or endangered under the ESA. Historically, overfishing, habitat losses, and hatchery practices were major causes of decline. Poor ocean conditions over the past two decades have reduced populations already weakened by the degradation and loss of freshwater and estuary habitat, fishing, hydropower system management, and hatchery practices. In addition to sufficient quantity of prey, fish need to be accessible and available to the whales, which can be related to the density and distribution of salmon, and competition from other predators and fisheries. The size of Chinook salmon is also an important aspect of prey quality (i.e., SRKWs primarily consume large Chinook), so changes in Chinook salmon size (for instance as shown by Ohlberger et al. (2018)) may affect the quality of this feature of critical habitat.

Passage

SRKWs require open waterways that are free from obstruction (e.g., physical, acoustic) to move within and migrate between important habitat areas throughout their range, communicate, find prey, and fulfill other life history requirements.

3.5.2 Climate Change Implications on SRKW

The potential impacts of climate and oceanographic change on marine mammals would likely involve effects on habitat availability and food availability. Although few predictions of climate impacts on SRKWs have been made, it seems likely that any changes in weather and oceanographic conditions resulting in effects on salmon populations would have consequences for the whales (for climate change effects on salmon, see Section 2.2.4). SRKWs might shift their distribution in response to climate-related changes in their salmon prey. Persistent pollutant bioaccumulation may also change because of changes in the food web (e.g., Alava et al. (2018); Carretta et al. (2023)).

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages (e.g., ISAB (2007); Lindley et al. (2007); Crozier et al. (2008b); Moyle et al. (2013); Wainwright and Weitkamp (2013); (Crozier et al. 2021). Studies examining the effects of long-term climate change to salmon populations have identified a number of common mechanisms by which climate variation is likely to influence salmon sustainability. These include direct effects of temperature such as mortality from heat stress, changes in growth and development rates, and disease resistance. Changes in the flow regime (especially flooding and low flow events) also affect survival and behavior. Expected behavioral responses include shifts in seasonal timing of important life history events, such as the adult migration, spawn timing, fry emergence timing, and the juvenile migration. Indirect effects on salmon mortality, growth rates and movement behavior are also expected to follow from changes in the freshwater habitat structure and the invertebrate and vertebrate community, which governs food supply and predation risk (ISAB 2007; Crozier et al. 2008b).

In the marine ecosystem, salmon may be affected by warmer water temperatures (in both marine and freshwater environments), increased stratification of the water column, intensity and timing changes of coastal upwelling, loss of coastal habitat due to sea level rise, ocean acidification, and changes in water quality and freshwater inputs (ISAB 2007; Mauger et al. 2015). Salmon marine migration patterns could be affected by climate-induced contraction of thermally suitable habitat (Crozier et al. 2021). Abdul-Aziz et al. (2011) modeled changes in summer thermal ranges in the open ocean for Pacific salmon under multiple Independent Panel on Climate Change (IPCC) warming scenarios. For chum, pink, coho, sockeye and steelhead, they predicted contractions in suitable marine habitat of 30-50% by the 2080s, with an even larger contraction (86-88%) for Chinook salmon under the medium and high emissions scenarios. Northward range shifts are a climate response expected in many marine species, including salmon (Cheung et al. 2015). However, salmon populations are strongly differentiated in the northward extent of their ocean migration, and hence would likely respond individualistically to widespread changes in sea surface temperature.

4 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions, and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

4.1 General Willamette River Basin & Willamette River Mainstem Baseline

The following section presents an assessment of the condition of the listed species in the Willamette River mainstem, and in the Willamette Basin, in general, and their designated critical habitat.

The proposed action affects many streams and major sub-basins in the Willamette River Basin (Figure 4.1-1) including the Willamette River mainstem. Because the WVS dams work as a system there are system-wide effects impacting the entire Willamette River basin.

The diversity of habitats, ranging from the cold, snow-melt headwater streams in the Cascade Mountains downstream to the meandering and highly complex Willamette River, produced diverse and productive populations of salmon and steelhead.

Historical populations had multiple juvenile life-history types and adults returned at higher ages than is currently the case (Willis et al. 1995). Juvenile salmon and steelhead reared in the headwater streams and the mainstem Willamette River. Juveniles emigrated to the ocean over a number of months, with spring and fall migrations predominating.

The Willamette Valley supports more than 70 percent of Oregon's human population and is the primary producer of Oregon's agricultural crops. The Portland metropolitan area, Salem, Corvallis, and Eugene are major cities all within the Willamette Valley (NMFS 2019b).

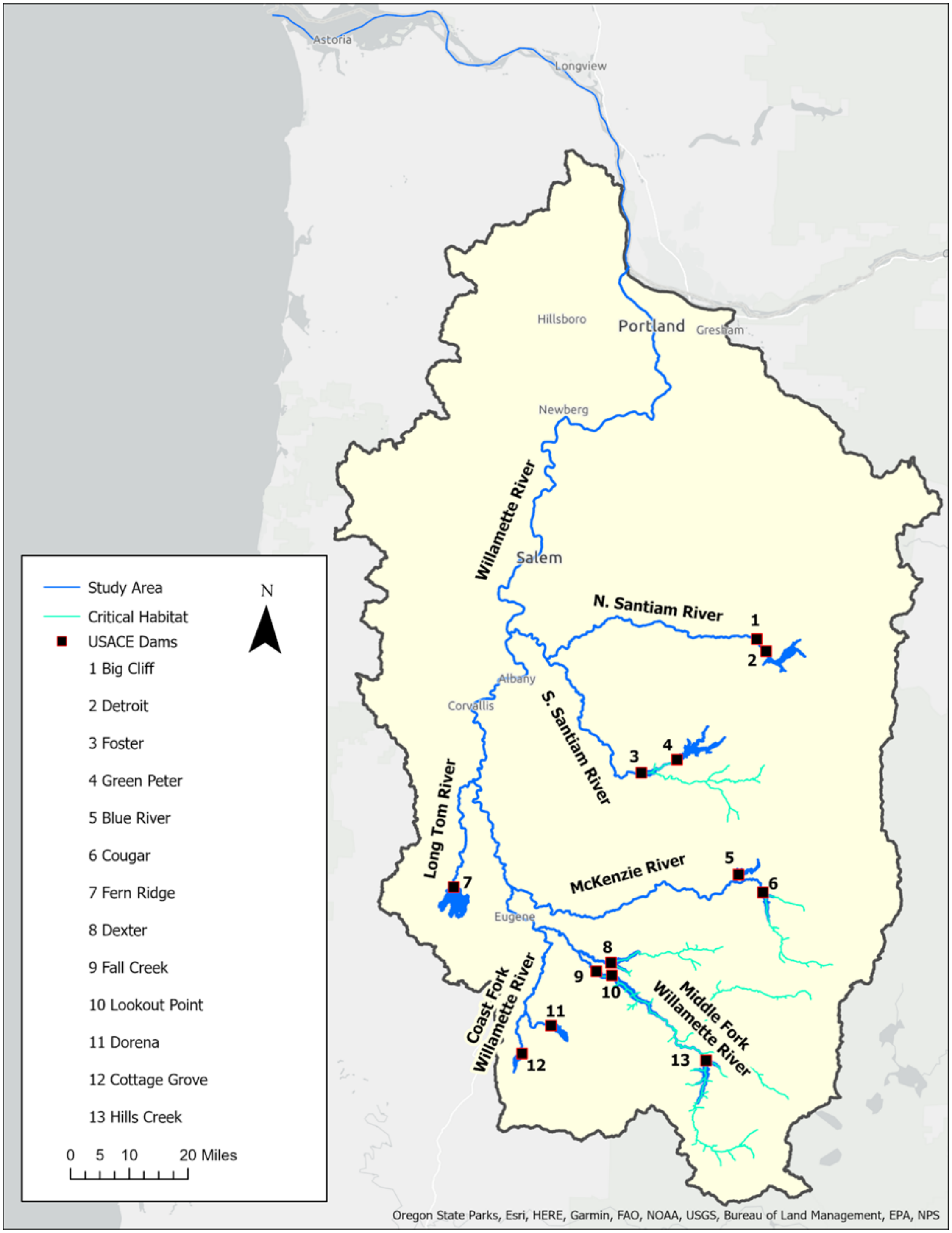


Figure 4.1-1. Map of the Willamette River basin including the action area in blue (not including Lower Columbia River estuary and SRKW critical habitat in coastal waters), all 13 USACE dam projects in the Willamette Valley System, and all current, volitionally-inaccessible critical habitat in green.

4.1.1 Historical Populations of Anadromous Fish in the Willamette Mainstem

As a whole, this (affected) action area historically supported large numbers of spring Chinook salmon and winter steelhead, and currently supports all populations of UWR Chinook salmon and UWR steelhead.

4.1.2 Current Populations of Anadromous Fish in the Willamette Mainstem

Both UWR Chinook salmon and steelhead species migrate downstream through the Willamette River mainstem on their migration to the ocean as juveniles and back through the mainstem as adults returning to their natal tributaries. For the juveniles this is an important rearing and migration corridor. Three populations of Lower Columbia River ESA-listed salmon and steelhead species (ESUs or DPSs) similarly migrate through the lower Willamette River mainstem from the Clackamas River confluence (below Willamette Falls) out to the Columbia River mainstem (and back again). These three populations are part of the following ESUs and DPS:

- Lower Columbia River Chinook salmon (fall Chinook)
- Lower Columbia River coho salmon
- Lower Columbia River steelhead
  *There was once a Lower Columbia River chum salmon population in the Clackamas River though it is now thought to be extinct.

It is possible that other ESA-listed salmon and steelhead species from the following Columbia and Snake River ESUs and DPSs explore the lower Willamette mainstem at its confluence with the Columbia River on their migrations to and from the ocean:

- Mid-Columbia River steelhead
- Snake River fall Chinook salmon
- Snake River spring-summer Chinook salmon
- Snake River sockeye salmon
- Snake River steelhead
- Upper Columbia River spring Chinook salmon
- Upper Columbia River steelhead

4.1.3 Environmental Conditions

4.1.3.1 Habitat Access and Fish Passage Conditions

Construction of the 13 WVS dams (in six different sub-basins or tributaries to the Willamette mainstem) from the late 1940s through the 1960s blocked access to the majority of historical habitat for spring Chinook salmon and, to a lesser extent, winter steelhead. Under the environmental baseline, one of the greatest threats to Willamette Basin salmon and steelhead has been the loss of volitional access to critical habitat and the loss of important ecological and physical processes, and both are a result of dam construction. The Big Cliff and Detroit dams block access to 43 percent and 48 percent of historically available habitat for Chinook salmon and steelhead in the North Santiam subbasin, respectively; Foster and Green Peter dams block access to 40 percent of historically available habitat in the South Santiam for Chinook and 17 percent or more for steelhead; Cougar Dam blocks access to 9 percent of historically available habitat for Chinook salmon in the South Fork McKenzie; and the four WVS dams in the Middle Fork Willamette block access to over 70 percent of historical Chinook salmon habitat in that subbasin (ODFW and NMFS 2011). More importantly, the estimated amount of spawning habitat (or historic production) above these dam projects that Chinook salmon and steelhead have lost access to is significantly higher (71%, 85%, 25% and 95% loss for Chinook salmon in each of the four sub-basins) (ODFW and NMFS 2011). Since these estimates were made for the Upper Willamette River Chinook Salmon and Steelhead Recovery plan (ODFW and NMFS 2011), the NOAA Northwest Fisheries Science Center estimated spawning-ground habitat capacity for UWR Chinook salmon in reaches above the dams (and below) under current habitat conditions by coupling information used in the Recovery Plan assessment with hydrologic models including USFS stream temperature models (Bond et al. 2017). When limiting spawning-ground habitat capacity to areas that would not exceed 16 degrees Celsius in the month of September under future model projections, some potential reaches above dams became classified as unsuitable. This observed temperature effect was most pronounced in reaches above the South Santiam projects, especially under projections for year 2080, and less so in upper reaches of the McKenzie, the North Santiam and even in areas above Lookout Point and Hills Creek Dam in the Middle Fork Willamette (Bond et al. 2017).

Because these dams were high-head storage dams greater than 200 feet in height, volitional upstream fish passage (e.g. fish ladders) was considered to be infeasible and no fish passage facilities have been built at most of the dams (USACE 2000). These passage issues are discussed in much greater detail in each of the respective subbasin chapters, and historical details are provided in the General Baseline and Willamette Mainstem Baseline Chapters of the 2008 Biological Opinion (Section 4.1 and 4.10, NMFS 2008a).

The only dam on the Willamette River mainstem is located at Willamette Falls at river mile 26.6. Willamette Falls is a bedrock sill that adult salmon and steelhead were able to pass volitionally prior to dam construction during winter and spring high flows. Willamette Falls Dam, constructed in 1891 near the town of Oregon City, does currently provide volitional fish passage for migrating adults via a fish ladder and, to some degree, for juveniles as well. Downstream passage conditions for juveniles (and steelhead kelts) may not have always been ideal under natural, pre-dam conditions but were made less favorable when the dam was constructed, and the site was developed for power production.

Depending on river flows and dam operations, out-migrating juvenile Chinook salmon and steelhead may pass Willamette Falls Dam through one of the following routes: over the natural waterfalls, through the project powerhouse (turbines), or via the Sullivan powerhouse bypass system, which includes a siphon bypass spillway at the downstream end of the forebay to pass juvenile fish around the turbines. A flow-control structure was completed atop the Falls in 2007 to help direct waterfall flow toward safe fish landing areas.

4.1.3.2 Water Quantity/Hydrograph

Flows in the Willamette Basin have been greatly altered by the construction and operation of the 13 dams in the WVS. With the exception of a few run-of-river projects, these dams are typically "high-head" projects that are intended to capture and hold flow to release at desired times, as opposed to discharging outflow at the same rate inflows are received.

The Willamette Project's reservoirs have typically been drafted each fall to allow space for capturing large winter storm flows and refilled each spring for other uses (primarily recreation, and agricultural, municipal and industrial (M&I) water use). Seasonal storage and release of water has affected the streamflow characteristics of each affected tributary and the mainstem Willamette River. The projects can also cause unusually large discharge and river flow changes over very short periods. These hydrologic effects have seasonally and permanently modified fish habitat characteristics in the stream reaches downstream.

The figure below also demonstrates historical flows in the mainstem Willamette at Albany from 1892-1940 (pre-dam construction) and from 1968 to 2022 (post-dam construction) and measured flows in 2023, as well as flow targets from June to October. As in all flood-regulated tributaries to the Willamette mainstem, pre-dam flows in the mainstem were higher in late winter and spring months but lower in late summer and early fall months, as compared to post dam-construction flows (Figure 4.1-2).

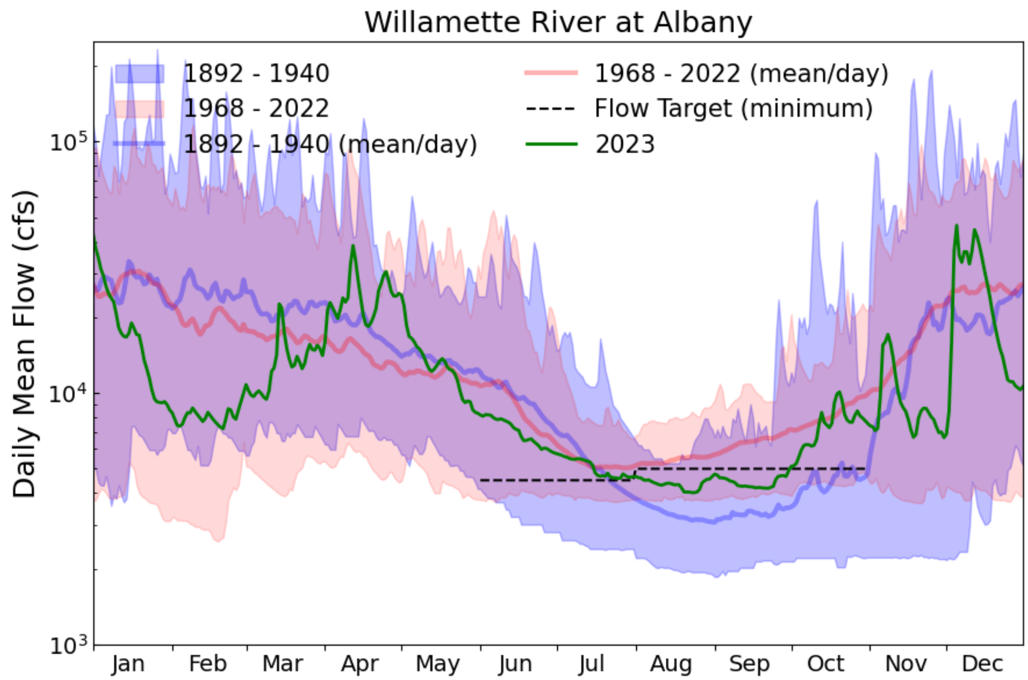


Figure 4.1-2. Historic and recent daily mean Willamette mainstem flow and flow ranges as measured at Albany, including current June to October flow targets. Daily mean flow and BiOp minimum instantaneous flow target for the Willamette River at Albany, 2023 compared to the range of measured conditions prior to construction of the WVS dams (1892-1940) and after (1968-2022). The blue and red lines indicate the average of those two periods, respectively.

Minimum flow targets for the mainstem Willamette River, which were established through the last NMFS WVS Biological Opinion RPA (NMFS 2008a), have not been met in all years since; however, in those instances USACE coordinates with NMFS to determine the best course of action to take in any given water year. For example, from 2009 to 2018, 50% of those years were classified as being “adequate” or abundant water storage years, in which minimum flow targets could be met. But in 3 of those 5 years, there were many days in May and June when the minimum flows (at Albany and Salem) were not met. In water year 2023 (October 2022-September 2023) mainstem flows measured near the town of Albany, Oregon were predominately below average due to the overall drier than average conditions. As a result, the minimum instantaneous flow target of 5,000 for August to October at Willamette River was not met successfully over several weeks (Figure 4.1-2, above).

Table 4.1-1. Mainstem Willamette Flow Objectives for “Adequate” and “Abundant” Years.

Time Period	7-Day Moving Average Minimum Flow at Salem (CFS) USGS 14191000	Instantaneous Minimum Flow at Salem (CFS) USGS 14191000	Instantaneous Minimum Flow at Albany (CFS) USGS 14174000
April 1-30	17,800	14,300	—--
May 1-31	15,000	12,000	—--
June 1-15	13,000	10,500	4,500
June 16-30	8,700	7,000	4,500
July 1-31	—--	6,000	4,500
August 1-15	—--	6,000	5,000
August 16-31	—--	6,500	5,000
September 1-30	—--	7,000	5,000
October 1-31	—--	7,000	5,000

Since the completion of WVS flood-control dams, the range of peak flows in the mainstem Willamette River has been greatly reduced relative to pre-dam conditions (Figure 4.1-3).

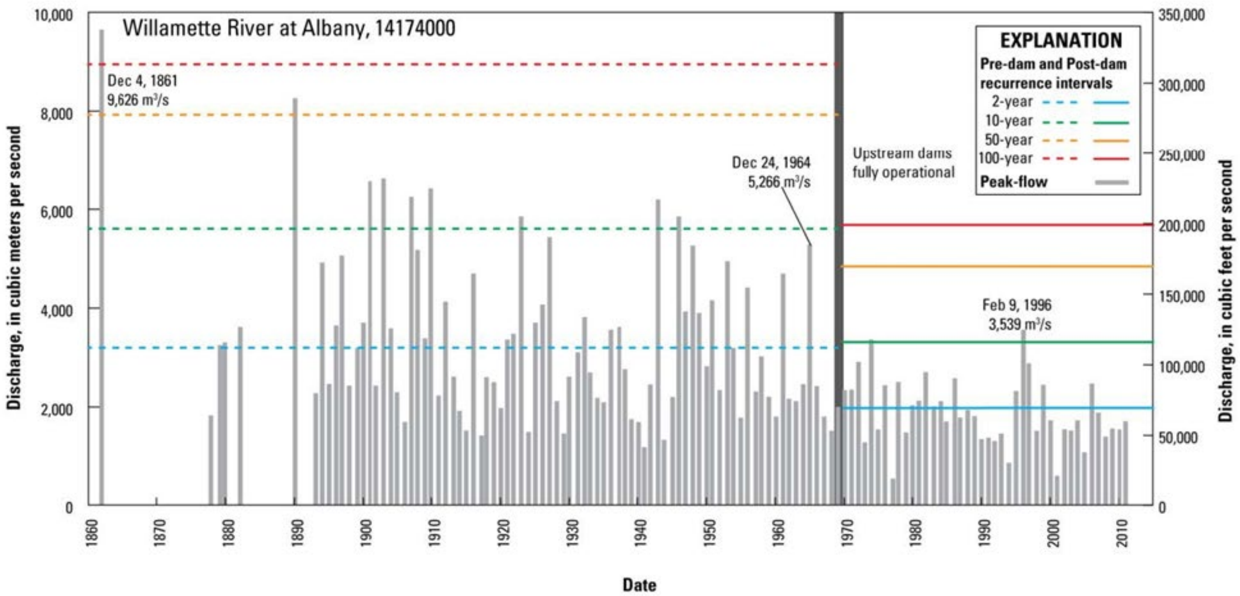


Figure 4.1-3. Peak annual discharge flow on the Willamette River mainstem measured by the U.S. Geological Survey (USGS) streamflow-gaging station at Albany, Oregon. Figure 18 from Wallick et al. (2013).

The life histories of native species are closely correlated with the pre-dam hydrograph (Poff et al. 1997). Current dam operations alter the magnitude of spring freshets, and thereby, contribute to habitat quality and access impairment for salmonids in the Willamette River. Natural spring freshets are also critically important because they are correlated with faster juvenile downstream travel times and earlier arrival times to critical rearing habitats in the estuary and ocean (Scheuerell et al. 2009). Scheuerell et al. (2009) found that this migration timing plays an important role in determining juvenile-to-adult survival for Columbia River Chinook salmon and steelhead, with early spring migrators typically experiencing much higher survival. Spring is also the ideal time of year for yearling steelhead and Chinook salmon to head downstream to the estuary, and ultimately, toward the ocean (as nearshore productivity typically peaks in the summer through seasonal upwelling events) (Tomaro et al. 2012).

Willamette Basin Review

A NMFS Biological Opinion assessing an action called the "Willamette Basin Review" (WBR) was completed in 2019 (NMFS 2019b). The proposed action involved water storage and water-use contract limits put forth by the Bureau of Reclamation in the Willamette Valley (made available through water stored in USACE WVS reservoirs). Until a new Biological Opinion for the next Willamette Basin Review is completed, estimated to occur in 2025, the Bureau of Reclamation may continue issuing new contracts to agricultural users for the use of WVS conservation storage as they have under the existing 2008 Biological Opinion (NMFS 2008a). Mechanisms currently exist for these contracts to be issued and no new actions or allocations are needed for additional storage contracts. Under the existing limit of 95 kAF, the Bureau of Reclamation has issued water service contracts for 84,349 acre-feet of water from the WVS (June 2024); though the exact value varies from year to year as contracts are executed or expire. The effects of issuing water contracts up to the 95 kAF limit on the Willamette mainstem and on

UWR Chinook and steelhead in particular include reductions in the amount of water that may be available instream; however, the 2019 RPA measures are designed to avoid effects that would jeopardize the species or adversely modify critical habitat.

In addition to 2008 WVS Biological Opinion minimum flow targets, flow-management measures were also put forth in the 2019 WBR Biological Opinion (NMFS 2019b). This WBR consultation by NMFS resulted in an RPA) with stipulations for future storage supply agreements with municipal and industrial (M&I) users in the WVS. The 2019 WBR RPA included the following: 1) the need to specify restrictions in the agreements, some of which are equivalent to those currently applied to new and renewed water use contracts issued by the Bureau of Reclamation; 2) communicating with new water contract applicants to make certain they are aware that requested water releases may be curtailed or completely cut off if the existing NMFS minimum flow objectives are not met at any point in the coming year; 3) written agreement from NMFS that processes are in place for instream flow protection; 4) determining whether 2008 BiOp minimum flow objectives will be met in the coming year given the reservoir fill and amount of water available, when forecasting the available water in April of each year; 5) managing uncontracted water to meet 2008 Biological Opinion minimum flow objectives (or as revised by future consultations), if NMFS (2008a) minimum flow objectives are predicted to not be met in the April forecast, or the Corps must make more stored water available to meet 2008 BiOp minimum flow objectives by reducing stored water available for AI and M&I contracts or using water currently stored for power production; 6) coordinating these decisions with the Flow Management Water Quality Team (FMWQT).

4.1.3.3 Water Quality

Water Temperature

Water temperatures in the Willamette mainstem often exceed ideal thresholds (68°F) for salmonid species in the summer months, when adult Chinook salmon are migrating upstream to their spawning grounds and juveniles may still be rearing and migrating downstream in the mainstem (Figure 4.1-4) The US EPA (Environmental Protection Agency) recommended a 7-DADM (day average daily maximum) limit of 20°C (68°F) for waterbodies that are used almost exclusively for migration to protect migrating juveniles and adults from lethal effects, but acknowledges that long-term exposures to temperatures at or near 20°C can still cause adverse effects such as disease, decreased swimming performance in adults and impaired smotlification, reduced growth and also increased disease in juveniles. High water temperatures are found to be one cause for the high levels of pre-spawning mortality rates among returning spring-run Chinook salmon adults (Bowerman et al. 2018; Shreck et al. 2013). Figure 4.1-4 below demonstrates recent daily average temperatures in the mainstem Willamette (at Keizer, near Salem) but does not include daily maximums. Measured temperatures near Keizer, Oregon show that even the daily average often begins to exceed 68°F in early June, when UWR Chinook salmon adults are still passing Willamette Falls dam and many are still present in the mainstem above the dam. Willamette mainstem temperatures typically increase from the headwaters to the mouth, especially in the summer months (USACE 2024b).

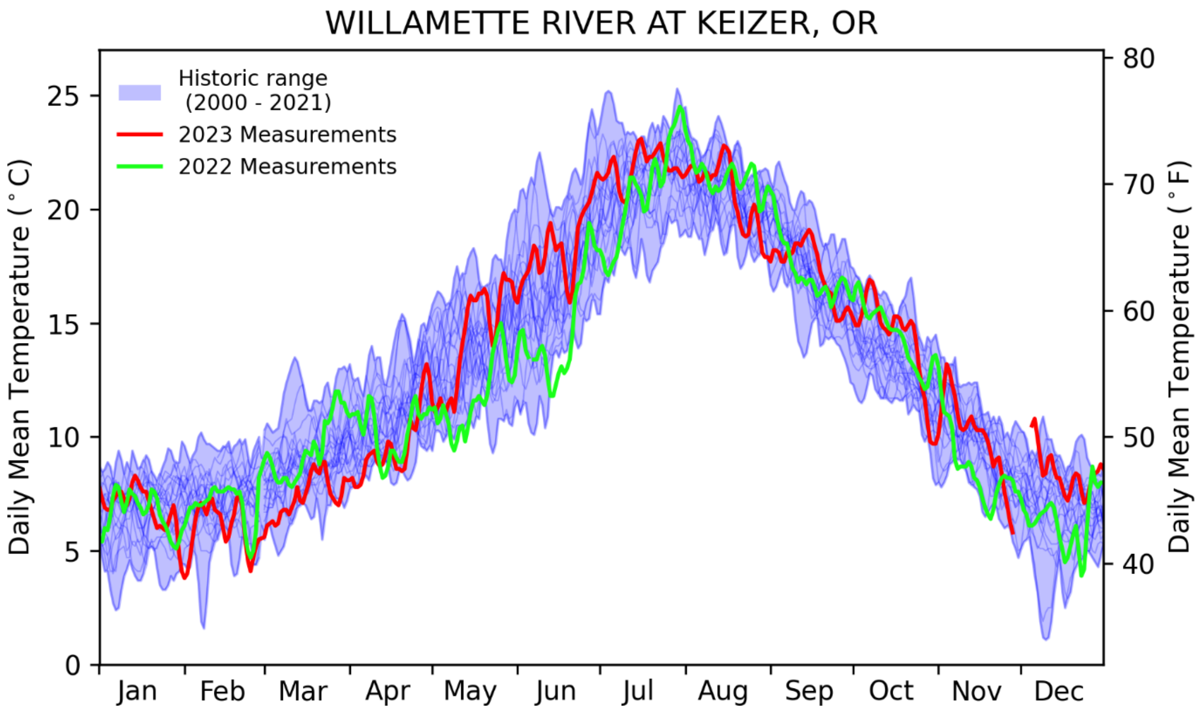


Figure 4.1-4. Daily mean Willamette mainstem water temperatures (2000-2023) as measured near Keizer, Oregon (close to Salem). Source (USACE 2024b).

Water development, in general, influences water temperatures through storage, diversion, and irrigation return flows. These changes in water temperatures have significant implications for anadromous fish survival. Among the primary water temperature effects of WVS operations is how it has altered the seasonal timing of downstream water temperatures in the tributaries. These changes are due to stratification of water temperatures in the reservoir during the summer months and existing elevations in stratified reservoirs that outlets can draw from. During typical WVS operations, water released in the late-spring and early summer is cooler than what it would be in a natural, unregulated riverine system, and then warmer in the fall once warm water near the reservoir surface can be discharged. Cooler water temperatures in late-spring and early summer can delay upstream migration of UWR Chinook salmon. Eggs from spring spawning UWR steelhead also develop more slowly at reduced temperatures. For fall-spawning species like UWR Chinook salmon, warmer fall temperatures can greatly increase pre-spawn mortality rates above and below the dams (Carey et al. 2024). It may also delay spawning and accelerate egg incubation. Warmer fall temperatures can also exceed the thermal tolerance for incubating eggs, thereby reducing their viability, and increase thermal stress on adults holding below the dams. For UWR Chinook and steelhead, these temperature effects modify emergence timing such that newly hatched alevins are exposed to conditions for which they are not evolved, as the availability of food, water velocities, predator abundance, and feeding efficiency vary seasonally. Therefore, variations in water temperatures resulting from dam operations reduce the potential value of rearing habitat downstream of dams by causing a temporal mismatch between alevin emergence and the availability of conditions and resources necessary for their growth and survival.

Another concern about rising temperatures in the mainstem Willamette River is how it can increase the prevalence of parasites. At water temperatures above 15ºC, a parasitic myxosporean, *Ceratomyxa shasta*, becomes highly virulent. Research has shown that the risk of juvenile salmonids succumbing to *C. shasta* infection can double as temperatures rise from 13 to 15°C, and then multiply again by a factor of approximately five between 15 and 18°C (Ray et al. 2013)

The effects of dams on seasonal temperature conditions in the Willamette Basin are variable among subbasins and have been partially addressed in some areas. Beginning in 2017, a multi-agency team including ODFW and NMFS helped develop fish temperature targets (WFOP Chapters 2-5; Table 4.1-2). Temperature-control operations to help meet these temperature targets, such as mixing warm reservoir surface water with cooler lower-dam-outlet water to more closely emulate normative downstream temperatures, have been implemented at Detroit Dam in the North Santiam River, Fall Creek Dam in the Middle Fork Willamette River, and also through the construction of a water-temperature-control tower at Cougar Dam in the McKenzie basin. Such operations are able to partially compensate for the effects of the dams immediately downstream by providing warmer water temperatures in the early summer months and preserving cooler reservoir water to be released during the fall drafting period. However, the ability to provide these temperature benefits is limited by the reservoir elevation and existing infrastructure, because once water elevations fall below surface outlets such operations are no longer possible.

Table 4.1-2 Downstream minimum and maximum water temperature targets for each tributary. Daily average target temperatures originally developed by the resource agencies (NMFS, USFWS, ODFW) for the McKenzie River below Cougar Dam, and modified for the North and South Santiam River and Fall Creek). *No resource agency targets were developed for the Middle Fork Willamette below Dexter Dam; only ODEQ TMDL temperature targets (7 day average) are used in that location.

	North Santiam Below Big Cliff		**South Santiam Below Foster**		**SF McKenzie Below Cougar**		**Fall Creek (MF Will. Tributary) below Fall Cr. Dam**		**Middle Fork Willamette Below Dexter***	
Month of Year	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
January	38	42	40.1	40.1	40.1	40.1	40.1	40.1	-	-
February	38	42	41	42.1	41	42.1	41	42.1	-	-
March	42	44	41	42.1	41	42.1	41	42.1	-	-
April	42	46	43.2	45.1	43.2	45.1	43.2	45.1	43.7	43.7

	North Santiam Below Big Cliff		South Santiam Below Foster		SF McKenzie Below Cougar		Fall Creek (MF Will. Tributary) below Fall Cr. Dam		Middle Fork Willamette Below Dexter*	
May	46	50	46	49.1	46	49.1	46	49.1	47.5	47.5
June	48	54	51.1	56.1	51.1	56.1	51.1	56.1	55.8	55.8
July	52	55	54.1	61.2	54.1	61.2	54.1	61.2	63.3	63.3
August	52	55	54.1	60.3	54.1	60.3	54.1	60.3	61.7	61.7
September	48	54	52.3	56.1	52.3	56.1	52.3	56.1	57	57
October	46	52	< 50	< 50	47.1	49.1	< 50	< 50	50.4	50.4
November	42	46	<50	<50	43.2	44.1	<50	<50	50.4	50.4
December	41	46	41	41	41	41	41	41	-	-

Other Water Quality Constituents

Spill operations (and regulating outlet flow operations) at WVS dams can cause downstream waters to become supersaturated with dissolved atmospheric gasses. Supersaturated total dissolved gas (TDG) conditions can cause gas bubble trauma (GBT) in adult and juvenile salmonids resulting in injury or death (Weitkamp and Katz 1980). Biological monitoring at nearby dams on the Columbia and Snake rivers shows that the incidence of GBT in both migrating smolts and adults remains between 1–2 percent when TDG concentrations in the upper water column do not exceed 120 percent of saturation (NMFS 2020a). When those levels are exceeded, there is a corresponding increase in the incidence of signs of GBT symptoms (NMFS 2020a). At times, TDG in WVS dam discharges exceeds 120 percent of saturation concentration, and this has occurred when both juvenile and adult life stages of UWR Chinook salmon and steelhead are present or attempting to migrate downstream or upstream. For juveniles, water conditions downstream of dams become supersaturated where water flows over the spillway or is released under pressure from regulating outlets. Juveniles that pass through these dam outlets will be subject to any gas supersaturation created by dam operations. In addition, eggs, alevins, and juveniles that were incubating or rearing downstream are also subject to gas supersaturation. The downstream extent of any supersaturation created by dam operations depends on the topography of the river (rapids tend to release gas). Similarly, adults moving upstream congregate near the base of some dams prior to adult collection (as at Foster, Cougar, Fall Creek, or Dexter Dam) or spawning. The duration of exposure can vary considerably.

Toxic contaminants from urban and industrial practices reduce habitat quality for UWR steelhead and spring UWR Chinook parr and smolts. Toxic contaminants are a problem in the lower Willamette River and other sites of intense urban or industrial development. An intensive study of sediments in Portland Harbor (the stretch of the Willamette River from Sauvie Island to the Fremont Bridge) has reported pesticides, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbon (PAHs), and other chemicals at levels that exceed state and federal sediment quality screening levels, and are harmful to the ecosystem and salmonid (Lundin et al. 2019; Lundin et al. 2021). Wastewater runoff and discharge from agricultural and urban land uses also degrades habitat quality in the Willamette basin, particularly in downstream reaches. The mid-Willamette River is currently listed on the Oregon Department of Environmental Quality (DEQ) Clean Water Act 303(d) list of water quality limited water bodies. DEQ-listed water quality problems identified in the action area include bacteria (fecal coliform), lead, mercury, dissolved oxygen, and temperature. Wastewater treatment effluents and runoff from agricultural lands contribute to nutrient loads (Oregon Department of Agriculture [ODA] 2016) that promote harmful bacteria or algal blooms. Municipal and industrial wastewater discharges and runoff from urban or suburban areas can be sources of metals, pesticides, and other toxics, with toxic equivalents increasing with increasing urbanization (i.e., population density, road density) (Waite et al. 2008). Research into the discharge of total nitrogen, total phosphorous, and suspended sediment loads by USGS from 1993–2003 showed large inputs from the point sources of municipal wastewater treatment plants and industrial outfalls. Nonpoint sources also contributed to a steady increase down the Willamette River mainstem, with the largest increase between Salem and Portland (Wise et al. 2007).

Oils, greases, and other lubricants (derived from animal, fish, vegetable, petroleum or marine mammal origin) are used at each of the WVS projects including, but not limited to: hydropower turbines, hydraulic systems, lubricating systems, gear boxes, machining coolant systems, heat transfer systems, transformers, circuit breakers, and electrical systems. Leakage of oils, greases, or other lubricants into rivers has the potential to affect salmon and steelhead, and could result in exposure to toxic compounds, behavioral avoidance of contaminated water or sediments, or even, in some circumstances, death. Oil and grease are not naturally occurring substances, and the toxicity varies among different types of oils and greases (EPA 2018). Fish may be exposed to oil and grease through their gills or through food. Toxic effects include delayed growth, decreased survival, and carcinogenic and mutagenic activity, and are particularly damaging when fish are exposed during early life stages (Perhar and Arhonditsis 2014).

The extent to which leaked grease or oil from the projects has affected the behavior, health, or survival of UWR Chinook salmon and UWR steelhead in the Willamette basin (or LCR species in the Lower Willamette River) is unknown, and small leaks into the large volumes of flowing water around projects would be difficult to detect and quantify. Any effects of past leakages on survival would be reflected in juvenile or adult reach survival estimates.

The USACE Portland District does have a documented Spill Response Plan in the event of a large leak or spill from one of the projects, as has been put into action after large spills at their Lower Columbia River projects.

4.1.3.4 Physical Habitat Characteristics

Historically, the Willamette River consisted of an intact and productive mainstem that was dominated by ecological features such as gravel bars, islands, runs, pools with backwaters, side channels, and sloughs. These combined features increased overall habitat complexity and ecosystem function (Gregory *et al.* 2002; Benner and Seddell 2018). Prior to the construction of the 13 hydropower projects and 42 miles of USACE operated revetments out of the 96 total miles of revetments (USFWS 2008), the Willamette River and its tributaries flowed without constraint. Dam construction, related infrastructure, and continuing WVS project operations and maintenance, have degraded river habitats and diminished aquatic (e.g., migratory fishes) species populations. Reservoirs were created when the dams were built between 1941 and 1969 (USFWS 2008), which inundated riverine habitats covered by the reservoirs and at the confluence of tributaries to the reservoirs. In addition, overallocation of water resources in the Willamette basin have substantially reduced available riverine habitat (OSU 2022). Climate change will increasingly impact aquatic resources; warmer temperatures will reduce winter snowpack and will further impact overall water availability and water quality for aquatic species (OSU 2022).

Historically, the alluvial lowlands of the Willamette Valley were a highly complex, dynamic mosaic of braided riverine channels with extensive off-channel and wetland habitats surrounded by riparian forests up to 3 km wide (Sedell and Froggatt, 1984). Geomorphic processes, such as erosion, avulsion, and deposition, during flood events created new off-channel habitats as the river network meandered through the floodplain, contributing substantial inputs of large wood and coarse sediment. Wetland habitat was created through vegetative succession of alluvial remnants and maintained by frequent disturbance processes. Willamette Valley off-channel and wetland habitats support diverse communities of plant and animal species that are restricted to these habitats or depend on them for a portion of their life history. Extensive human activities in the Willamette River Basin have substantially reduced off-channel and wetland habitats. Starting in the 1830s, wetlands were ditched, tiled, filled, and drained for agriculture. Miles of revetments were constructed to further increase the agricultural and urban use of former floodplain habitats, along with logging of the floodplain forests. Reduction of peak flow events by dam operations, along with diking and levee/revetment construction, has all but eliminated connections to the floodplains in the Willamette River. The loss of overbank flows has restricted fish access to off-channel areas that historically contained seasonal wetlands and forested backwaters, reduced large-woody-debris recruitment, and contributed to a change in food web structure and function.

Current dam operations may continue to disrupt ecological processes and further impact aquatic species populations. More specifically, the channelization of riverine habitats, the network of revetments and infrastructure, reduced sediment transport, reduced flood magnitude, and lack of large wood input have inhibited the fluvial geomorphic processes that foster a healthy functional river system and create new off-channel habitat. As natural riverine processes continue to be altered, there is continual loss of habitat diversity overtime that impacts native aquatic species populations.

Based on research by Gregory and Wildman (2007), floodplain alcoves in the mainstem Willamette River can provide fish with critical "coldwater refuges"—waters that are defined as being 2°C colder (or more) than the mainstem. As of 2015, Gregory and Hulse (2016) found that

39 percent of Willamette River mainstem floodplain alcoves met this criterion, but none of the side channels measured met these criteria. Some of these alcoves were low in dissolved oxygen (DO), though 80 percent contained adequate dissolved oxygen (DO). Additionally, they found that one-third of the sloughs in Willamette River mainstem met both cold-water refuge and DO criteria for native fishes. This also meant that twice as many sloughs in the Willamette River mainstem did not meet these criteria and provided more favorable habitat for introduced non-native species (in warmwater sloughs fish communities were 85 percent non-native). Salmonids were ten times more abundant in coldwater sloughs versus warm, highlighting their critical importance in salmon habitat conservation and restoration (Gregory and Wildman 2007; Gregory and Hulse 2016).

Healthy riparian vegetation increases habitat complexity, protects banks from erosion, provides nutrients, and filters runoff (ODFW 2016). Fallen trees create large woody debris that enables the establishment of riparian forests by stabilizing bars and islands and redirects flow toward the floodplain to create variable hydraulic and substrate environments (Wallick, et al. 2013). Woody debris also creates important habitat for fish as well as beaver, amphibians, turtles, and aquatic invertebrates (Pollock et al., 2017). Shading and cover from riparian vegetation maintains favorable water temperatures for fish, and beaver dams can buffer base flows by creating groundwater storage (Beechie et al. 2013). Under natural conditions on unregulated rivers, upland species are prevented from encroaching on the riparian corridor by periodic flooding and the highwater table.

Under current conditions, riparian forests have succeeded to upland forests because of the altered hydrograph that prevents the ecological processes that form and maintain riparian communities (Dykaar and Wigington 2000; Fierke and Kauffman 2005). Habitat connectivity has also been reduced with the degradation of riparian habitat or the continued installation (and repair) of levees and revetments that disconnect lowland and riparian habitats. Revetments currently line a large portion of streambank in the following river sections: North Fork Santiam River from Stayton to the Willamette confluence, South Fork Santiam from Lebanon to the Willamette confluence, the McKenzie River from the Mohawk River confluence to the Willamette mainstem, the Middle Fork Willamette just above the Fall Creek confluence down to the Willamette mainstem, and major portions of the mainstem Willamette River (see USACE Figure 4.1-5 below). The mainstem channel has been constrained by revetments in 96 out of 187 river miles (Hulse et al. 2002) (about half of those constrained miles include USACE constructed and operated revetments).

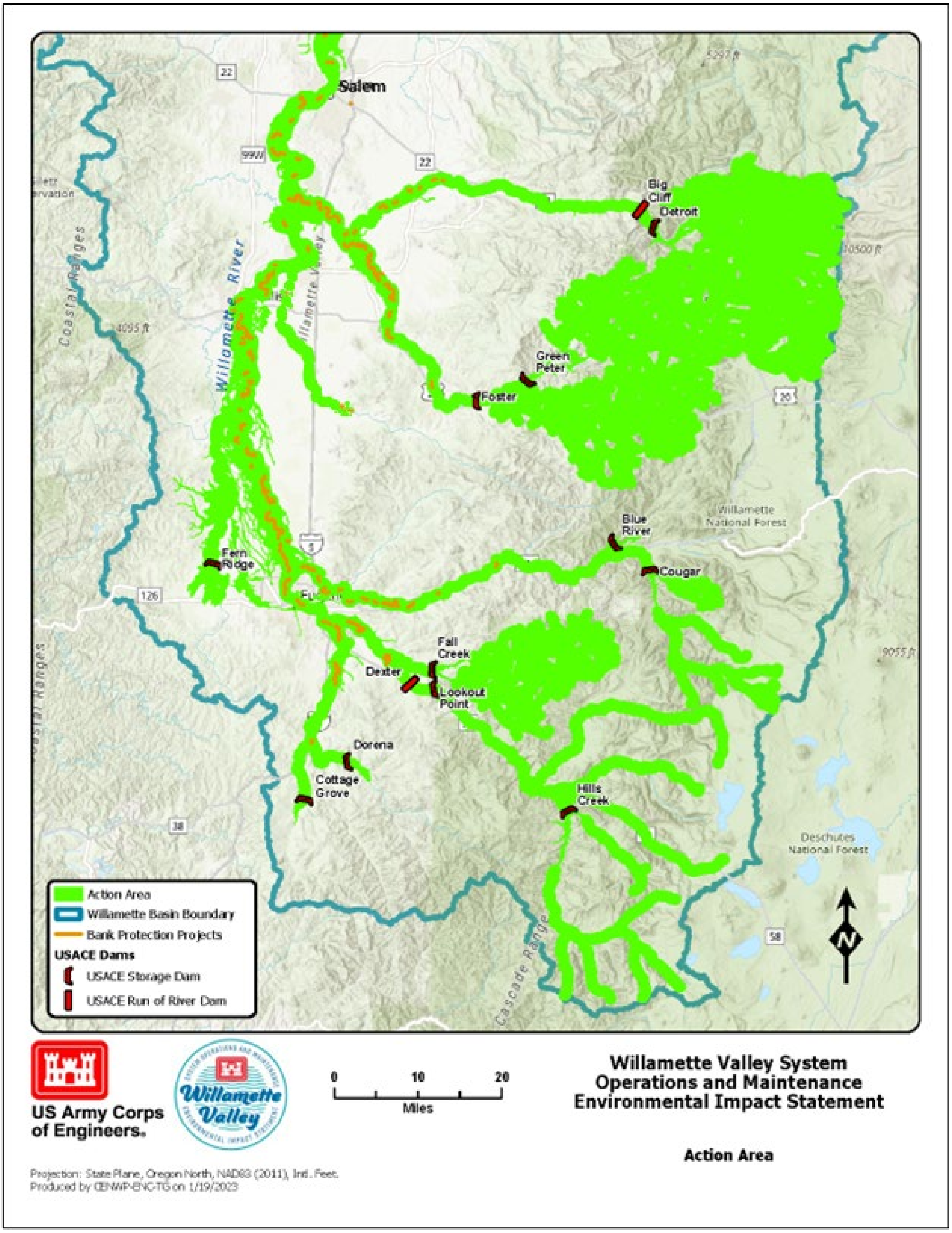


Figure 4.1-5. Map of action area in the Willamette basin including locations of all USACE owned revetments or "bank protection projects" in yellow (USACE 2023a).

Peak flow events occurring at different times can alter the reproduction timing of riparian plant species. The life histories of native species are closely correlated with the pre-dam hydrograph (Poff et al. 1997). Altered peak flow event timing can also alter plant reproduction timing, inhibit regeneration of native vegetation, and benefit invasive species (i.e., reed canary grass inhibiting cottonwood understory re-initiation) (Fierke and Kauffman, 2005). Suppressing regeneration of riparian forests can lead to a widespread loss in structural complexity of riparian forests, as well as a loss of native species diversity resulting from the invasion and establishment of non-native plant species (Theobold et al. 2010).

There have been an unusual number of large wildfires in the Willamette basin in recent years (Figure 4.1-6, USDA 2024). Large wildfires on the east side of the Cascade mountain range were relatively uncommon until recently. Large and severe fires in the Pacific Northwest are associated with warm and dry conditions, and such conditions will likely occur with increasing frequency in a warming climate. While salmonids have evolved to survive natural disturbance regimes, the full effects of increased wildfire frequency are not well studied. Some studies have shown that wildfire has the potential to increase habitat quality and quantity through increased delivery of wood, while also negatively affecting egg and fry habitat due to the introduction of fine sediments (Flitcroft et al. 2016).

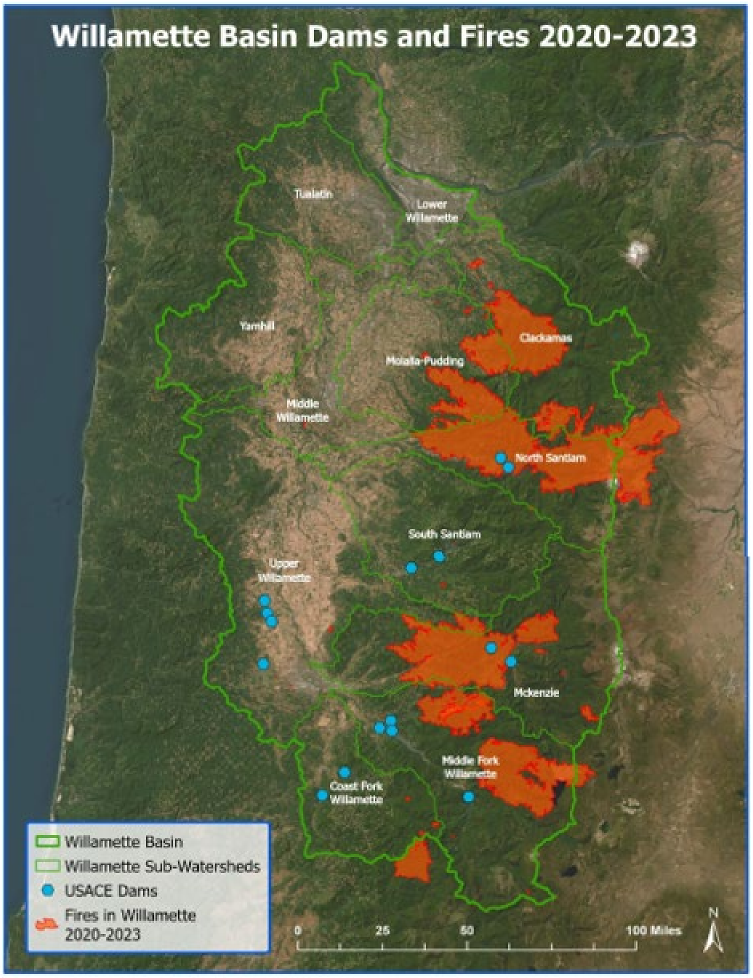


Figure 4.1-6. Notable wildfires that occurred in the Willamette Basin between 2020 and 2023

Willamette Habitat Restoration Projects Since 2008

The Willamette Bi-Op Habitat Restoration Project seeks to increase and enhance habitats for ESA-listed spring Chinook salmon and steelhead in the Willamette River mainstem and below the major federal dams in the following tributaries: McKenzie River, North and South Santiam Rivers, and Middle Fork Willamette River. The Project was developed to meet the requirements of Reasonable and Prudent Actions (RPA 7.1.2 and 7.1.3) of the 2008 WVS Biological Opinion. Through 2024, the program has been administered by OWEB, which is a state grant-making agency, in partnership with BPA's Habitat Technical Team (HTT). The HTT reviews and recommends projects for funding one time per year, and as required under RPA 7.1.3 the program funds at least two habitat restoration projects per year. In the past, project proposals have been ranked using the following guidelines.

- Occur in the 2-year flood inundation zone of an anchor habitat.
- Work at scale across contiguous acres.
- Support native fish species identified in federal recovery plans.

- Address one or more of the following objectives:
    - Increased channel complexity and length;
    - Improved connectivity between the river and its floodplain; and,
    - Expanded geographic extent and improved health of floodplain forests.

Between 2008 and 2023, the project accomplishments include more than 450 acres of floodplain reconnected, and more than 5200 acres of floodplain and riparian forest restored which sounds significant (Hoffert and Williams 2024). However, this is not necessarily restoring and protecting the type of critical habitat that Chinook salmon and steelhead need the most, as these floodplains and riparian forests may not flood more than once every two years. For example, two of the three projects funded by the program in 2023, include the Confederated Tribes of the Grand Ronde Chahalpam Reforestation project and the Willamette Greenbelt Trust mainstem floodplain forest enhancement project. The Chahalpam project was funded to restore 46.5 acres of floodplain forest on a 462-acre conservation site converting farmed land to riparian forest located along the North Santiam River. The Willamette Greenbelt Trust mainstem floodplain forest project involved a large amount of acreage, as the goal was to convert previously farmed land to forest at three different sites along the Willamette River. The third project that received funding in 2023 was for habitat effectiveness monitoring at a previously restored locations in the McKenzie sub-basin, the "Quartz Creek Stage 0 and Finn Rock Reach Stage 8 (Floodplain Restoration) Project Effectiveness Monitoring." There was for a total of $700,000 of funding granted for these three projects, which is the maximum amount of funding granted by the BPA HTT program annually. The third project reviewed restoration that more directly benefits Chinook salmon and steelhead due to extensive floodplain reconnection. In other cases, the projects are expected to be inundated by flows with 2-year return intervals.

In terms of BPA's HTT funding accomplishments since 2008, in addition to floodplain forest restoration projects, the 23 plus miles of side-channel enhancement and 0.33 mile of modified revetments will directly increase critical habitat. In contrast the floodplain forest funding is often for purchasing land that will require further funding to fully restore habitat that would be accessible at higher flow events. UWR Chinook salmon and steelhead would benefit most from additional habitat restoration projects in the Willamette basin, including projects that restore hyporheic flow connections and provide cold-water refugia habitat along the Willamette mainstem (DEQ 2020).

Additionally, after the release of the 2008 Biological Opinion, the BPA signed a formal Memorandum of Agreement with the State of Oregon in 2010 to meet the needs of the Oregon Department of Fish and Wildlife's (ODFW's) Oregon Conservation Strategy and Habitat Mitigation Policy and continued "wildlife" mitigation responsibilities related to the WVS dams and revetments through the Willamette Basin "Wildlife" Mitigation Project (WWMP). The MOA included an agreement to give BPA mitigation credit for funding the acquisition of the 1,271-acre Willamette Confluence Project at the confluence of the Coast and Middle Fork Rivers (hereafter Willamette Confluence Project), making The Nature Conservancy the owner and manager. The MOA also included a provision that BPA and the State of Oregon ensure that over the 15 year duration of the WWMP, 10% of the funding go towards "dual benefit" projects - benefitting both wildlife and ESA-listed anadromous species.

At this same time, the Action Agencies requested NMFS' support of the MOA in terms of how it would provide anadromous fish habitat protection and restoration. NMFS recognized that acquiring the Wildish property for the Willamette Confluence Project had both fish and wildlife benefits, and agreed to give the Action Agencies credit for four years of their required habitat restoration commitment (at least 2 projects per year) under the 2008 RPA 7.1, but no further credit for future habitat restoration projects conducted on the property. NMFS also considered giving an additional two years of credit toward required RPA mitigation for the acquisition and restoration of a few other properties. Evidence for any direct benefits that these property acquisitions provided to ESA-listed Chinook salmon and steelhead in the Willamette basin do not exist. In NMFS letter of support for the 2010 MOA, NMFS also acknowledged the "dual benefit" provision but with the understanding that BPA would fund these dual benefit projects "in addition to providing dedicated funding under the Opinion". For projects funded by the WWMP categorized as "dual benefit," upland acres that were protected may have an indirect effect to the riparian area of the acquired lands, but may not equate to fully benefiting UWR Chinook salmon and steelhead, without further restoration work. WWMP has funded 3,039 acres at a total project cost of $20,116,774 on projects that have been determined by the HTT to be "dual benefit" projects since 2010. In several cases (Willamette Confluence Project, Finn Rock), NOAA Restoration Center funding has provided a significant uplift to complete the necessary work: https://www.fisheries.noaa.gov/feature-story/habitat-restoration-benefit-threatened-chinook-salmon-willamette-river-basin
https://www.fisheries.noaa.gov/data-tools/noaa-restoration-project?4519

4.1.4 Hatchery Programs

Several hatcheries were built in the upper Willamette Basin for spring UWR Chinook and steelhead production to mitigate for lost access to a significant proportion of the historical spawning habitat and resulting losses in natural fish production, and to help sustain local fisheries. These hatcheries are owned by the USACE and operated by the ODFW. Recent monitoring for compliance with Hatchery and Genetic Management Plans (HGMPs) and ESU population status were reported in Sharpe et al. (2017a, 2017b), where specific metrics were monitored, and management goals were set to minimize potential negative genetic effects of hatchery-origin fish (HOR) on populations of natural-origin (NOR) spring UWR Chinook salmon and steelhead. The Willamette Hatchery Program includes the production of Chinook salmon in addition to summer steelhead and rainbow trout. The current operations were assessed by NMFS in 2019 through a Biological Opinion (NMFS 2019a). All of the hatcheries and release locations occur on tributaries to the Willamette River mainstem and are discussed in further detail in each of the corresponding baseline sub-chapters under the "Hatchery Program" sections.

4.1.5 Fisheries

Because of their ESA-listed status, natural-origin UWR spring Chinook salmon are not directly harvested in recreational fisheries of the Willamette River mainstem but directed fisheries for hatchery-origin spring Chinook do occur here. Due to this reason, natural-origin Chinook are subject to hook and line mortality by the mainstem Willamette and tributary spring Chinook fisheries. In other words, this fishery is directed at hatchery production, but still affects natural-origin adults. It was not until the late 1990s that ODFW began mass-marking the hatchery production, and recreational fisheries within the Willamette River switched over to retention of only hatchery fish with mandatory release of unmarked fish (Ford ed. 2022). This "selective marking" has allowed for a relatively higher harvest rate on hatchery-origin fish and, therefore, a higher encounter rate for natural-origin fish. From 2001–2019 an average of 11.6 percent of the Willamette Falls count of spring-run Chinook salmon was harvested above the falls (ODFW and Washington Department of Fish and Wildlife [WDFW] 2020). Population-specific rates exist for some of the UWR populations. The recreational catch-and-release fishery for unmarked (natural-origin) fish results in an incidental (hooking, landing) mortality of 12.2 percent for the Willamette River fishery (ODFW 2020), with encounter rates based on hatchery-origin fish harvest rate. Overall, freshwater mortalities for the UWR spring-run Chinook salmon (hatchery and natural origin) average 21.2 percent (2001-2019).

In recent years, the lower Willamette River (downstream of Willamette Falls, including Multnomah Channel and the Clackamas River downstream of the Highway 99 Bridge) opened for retention of spring Chinook salmon 7 days per week effective January 1 with a two-fish daily bag limit under permanent mark-selective (adipose fin-clip) regulations. The 2022 estimate of the lower Willamette River recreational harvest was 9,028 adipose fin-clipped jack and adult spring UWR Chinook salmon (kept and release mortalities), which was more than the previous 5-year average of 6,173 fish. Willamette River anglers harvested 16.5 percent of the total return in 2022, which is higher than the recent 5-year average of 15.1 percent (ODFW and WDFW 2023).

The 2021 upper Willamette mainstem recreational fishery (from Willamette Falls upstream to the mouth of the McKenzie River) was open 7 days per week with regulations consistent with the lower Willamette River. Participation in the upper Willamette River recreational fishery is typically much less than what occurs in the lower Willamette River (ODFW 2022). The estimated 2021 catch of adult spring Chinook salmon in the mainstem Willamette River above Willamette Falls was 435 fish (ODFW 022). Of the total, an estimated 386 (89 percent) adipose fin-clipped adults were kept and 49 (11 percent) were released as unmarked adults. Applying the standard post-release mortality rate for the Willamette River of 12.2 percent, the estimated mortality of wild spring Chinook salmon from the 2021 sport fishery in the upper Willamette River was six adults (ODFW 2022).

The recreational fishery for spring Chinook salmon above Willamette Falls is not sampled for catch or effort during the season so estimates of harvest are derived using angler catch records. Catch estimates above Willamette Falls are derived by combining individual estimates of harvest for each specific location (e.g., river or river section) for a total cumulative harvest estimate. The primary locations that harvest is occurring above Willamette Falls are the mainstem Willamette River, Santiam River (north and south forks), and the McKenzie River. For 2022, the estimated harvest of spring Chinook salmon above Willamette Falls (including the tributaries) is 4,574 fish (ODFW and WDFW 2023).

Harvest rate for winter steelhead are generally thought to be modest in general (NWFSC 2022). Although there is a recreational fishery for hatchery-origin summer steelhead in the Willamette River mainstem, there is no retention allowed in the mainstem for any unmarked (natural-origin) steelhead. Although, cause of the overlap in adult return timing of summer-run (all marked, hatchery-origin) and winter-run steelhead, there is a minor encounter and hooking injury or mortality risk for some natural-origin winter steelhead on the Willamette River mainstem. The sport fishery mortality rate since ESA listing is estimated at 0-3 percent (ODFW and NMFS 2011). There is additional incidental mortality in the commercial net fisheries for Chinook salmon and steelhead in the lower Columbia River. Tribal fisheries occur above Bonneville Dam and do not impact UWR steelhead (Ford ed. 2022).

4.1.6 Predation & Competition

Other than northern pikeminnow, all of the abundant piscivorous warmwater fish species found throughout the Willamette River mainstem, and now throughout large parts of the entire basin, are introduced. All of these species are known to prey on small fish, but studies have shown that certain species seem to target juvenile salmonids more than others (i.e. smallmouth bass, largemouth bass, crappie, northern pikeminnow, and walleye) (Friesen and Ward 1999; Winther et al. 2019; Murphy et al. 2021). Hatchery rainbow trout and hatchery summer steelhead found in the Upper Willamette Basin are not part of the ESA-listed UWR winter steelhead DPS, though they do have impacts on ESA-listed species in the basin. For more details on these interactions please refer to Predation and Competition sections in other sub-basin baseline chapters (4.2-4.9).

Alterations to instream water temperature regimes, combined with climate change and sediment and large wood starvation, continue to negatively impact instream conditions (e.g., habitat suitability and availability), providing more opportunities for non-native species to become dominant. Piscivorous warmwater fish species that prey upon juvenile salmonids are now abundant in both the mainstem Willamette River and lower tributary reaches (J. Ziller, personal communication, November 21, 2022). As temperatures warm up seasonally and generally over time, the distributions of these warmwater fish species are likely to extend further upstream. There were several studies conducted in the Lower Willamette River by Friesen (2005) that found that smallmouth bass, given their relative abundance, diet, and ubiquity, posed the most significant potential threat to juvenile salmonids in terms of predation in the lower Willamette River. Walleye appeared to be too rare in the lower Willamette River at that time to have an effect on salmonid survival, and neither northern pikeminnow nor largemouth bass appeared to prey on salmonids (Friesen 2005). Since then, there is evidence that some of these species' populations have grown quite significantly in the Columbia and Snake rivers (which are connected to the lower Willamette) (Winther et al. 2019). In the nearby Lower Columbia River, the native northern pikeminnow has long been identified as the most significant predator of juvenile salmonids followed by non-native smallmouth bass and walleye (in Friesen and Ward 1999; ISAB 2011, 2015). However, Winther et al. (2019) reported smallmouth bass as having the greatest overall predatory impact of all piscivorous species monitored by the state agencies in the Columbia and Snake rivers. USGS models of smallmouth bass and juvenile salmon habitat overlap predicted that 60 percent of Chinook salmon fry habitat overlaps with smallmouth bass habitat in the Willamette River mainstem (White et al. 2022). In their study of warmwater predators in the Middle Fork Willamette reservoirs, Murphy et al. (2021) surprisingly found that bass and crappie (*Pomoxis spp*)., preyed more heavily on Chinook salmon fry in the spring than native fish predators (including northern pikeminnow), and of the native species in the reservoirs, only rainbow trout were found to predate on Chinook salmon.

Friesen (2005) found that in terms of competition with juvenile salmonids for food resources in the Lower Willamette River, introduced resident fishes did not pose a threat. The high abundance of prey items, especially *Daphnia*, was predicted to preclude competition even if the diets of the various species did overlap. But in a resource-limited environment, smallmouth bass and hatchery-origin salmonids seemed most likely to compete with naturally produced salmonids. Diets of unmarked and hatchery Chinook salmon did overlap significantly, though unmarked fish exhibited a more selective feeding behavior and consumed larger amounts of prey.

Recent research suggests that predation pressure on ESA-listed salmon and steelhead from seals, sea lions, and killer whales has been increasing in the northeastern Pacific over the past few decades (Chasco et al. 2017). Models developed by Chasco et al. (2017) estimate that consumption of Chinook salmon in the eastern Pacific Ocean by three species of seals and sea lions and fish-eating (Resident) killer whales may have increased from 5 to 31.5 million individual salmon of varying ages since the 1970s, even as fishery harvest of Chinook salmon has declined during the same time period (Marshall et al 2016; Chasco et al 2017; Ohlberger 2018). During the 2016–17 return year, pinniped predation at Willamette Falls became a concern. Increases in the pinniped population at the falls, in conjunction with low steelhead return, resulted in an estimated 25 percent predation rate on winter steelhead (Steingass et al. 2019).

Management efforts are underway to reduce pinniped predation on Pacific salmon and steelhead in the Columbia River Basin, including the Willamette River. Since 2018, NMFS has issued authorizations under Marine Mammal Protection Act Section 120 and 120(f) to remove sea lions at Willamette Falls. Under the Section 120 authorization, Oregon state removed (killed) 37 California sea lions (Anderson 2024). Under the Section 120(f) authorization, which is for the Columbia River Basin (not just Willamette Falls), the state and tribes have removed (killed) 68 California sea lions and 78 Steller sea lions. The current removal authorization expires on August 14, 2025. Since implementation of the sea lion removal program, sea lion predation on UWR steelhead has fallen from a high of 24.7 percent in 2017 to a low of 0.9 percent in 2023, and sea lion predation on UWR Chinook salmon has fallen from a high of 9.1 percent in 2015 to a low of 1.9 percent in 2023. Pinniped control efforts combined with improved ocean conditions for steelhead are both possible explanations for the strong winter steelhead return observed in 2024 at Willamette Falls, largest run since 2004, likely from five subsequent cohorts of primarily four-year-old age class returns.

4.1.7 Research and Monitoring Evaluations

Funding for spawning ground surveys above and below federal high-head dams in the four major affected sub-basins has been discontinued in recent years. Since 2018, ODFW has focused its remaining resources on a limited set of spawning ground surveys. As a result, data reported in the following baseline sub-sections, for the years 2018–2023 have limited value compared to metrics reported for 2015-2017 in Sharpe et al. (2017a, 2017b).

Genetic pedigree studies of adults returning to USACE tributary dams in the UWR Chinook salmon ESU's range have been ongoing at Detroit Dam (North Santiam River), Foster Dam (South Santiam River), Cougar Dam (McKenzie River), and Fall Creek Dam (Middle Fork Willamette River); (Banks et al. 2014a, Evans et al. 2016, O'Malley and Bohn 2017, O'Malley et al. 2017; O'Malley et al. 2022; O'Malley et al. 2023; O'Malley et al. 2024a and 2024b). These studies provide information on the productivity and cohort replacement rates for adults transported above impassable dams and are critical in evaluating the success of juvenile-fish-passage systems. Collection of tissues for genetic analyses is ongoing at adult collection facilities associated with trap-and-haul programs at high-head dams and from natural fish collected during spawner surveys. However, not all tissue samples have been genetically analyzed each year. Archiving tissue samples further delays any assessment of reproductive success.

In 2023 and 2024, the court-ordered Injunction research and monitoring evaluation (RME) plan called for the release of large amounts of PIT-tagged hatchery Chinook salmon above and between the dam projects, plus nearly year-round reservoir distribution monitoring and rotary screw trap (RST) monitoring (above and below dam projects) to recapture the bulk released fish and/or to capture naturally-produced fish. According to the most recent biweekly "bulk marking and reservoir distribution report for the October 16th to October 31st, 2024 period, the full 2023 and 2024 bulk mark and release schedule included the following total releases per sub-basin: 39,000 hatchery Chinook salmon released in 2023 and 45,000 in 2024 in the North Santiam sub-basin for a total of 84,000; 36,000 hatchery Chinook salmon released in 2023 and 55,000 in 2024 in the South Santiam basin, for a total of 91,000; 39,000 hatchery Chinook salmon released in 2023 and 10,000 released in 2024 in the South Fork McKenzie, for a total of 49,000; and finally, 67,000 in 2023 and 49,000 in 2024 for the Middle Fork Willamette sub-basin, for a total of 116,000 (Cramer Fish Sciences 2024). However, due to the oftentimes incredibly low trapping efficiencies of the RSTs, especially in locations not particularly suitable for RST monitoring, not enough fish were recaptured to fully determine the effects of the court-ordered Injunction operations at the dam projects (for fish passage) with statistical significance (McCallister et al. 2024). Some of the pulses of fish captures in the RSTs did match up with certain dam operations in certain locations. Notes regarding such observations have been minimally reported in the Annual and Bi-Annual contractor RST monitoring reports (EAS 2024a, 2024b, and 2024c), and here in the following environmental baseline and effects chapters.

Passive Integrated Transponder (PIT) tag detectors at WVS projects (and below) are not nearly as common as they are in the Federal Columbia River Power System (FCRPS), and the PIT tag detectors that have been installed have experienced damage or long-term outages (Lebanon Dam array in the South Santiam), are not consistently uploading data to PTAGIS because of internet connection issues (Cougar Dam tailrace), or are out of service and in need of repair (Willamette Falls adult ladder). The lack of PIT tag arrays has limited the ability to collect fish survival, migration, and movement data for salmonids in the Willamette Basin on a consistent and annual basis, which would allow for inter-annual and inter-sub-basin comparisons, and allow for a more comprehensive analysis of how environmental factors and dam operations affect these populations, especially during upstream and downstream migration periods. Most of the passage survival studies that have been conducted focused on survival through specific dams and use acoustic tags that have shortened battery lives, unlike PIT tags. The recent development of new PIT tag array technologies has improved the feasibility of installing PIT tag detector arrays within and below dams and throughout the action area (Ohms et al. 2023; Holcombe et al. 2019; Axel et al. 2005).

4.2 Middle Fork Willamette Sub-Basin

The action area includes the Middle Fork Willamette River from Hills Creek Reservoir to the confluence with the Willamette; Fall Creek Reservoir to the confluence of Fall Creek with the Middle Fork Willamette; as well as adult release locations above the projects. The following section presents an assessment of the condition of the listed species and its designated critical habitat in the Middle Fork Willamette sub-basin portion of the action area.

The Middle Fork Willamette River watershed is the largest tributary watershed in the Willamette River basin and drains approximately 1,569 square miles on the western slopes of the Cascade Mountain range. Average daily discharge is 7,210 cfs (range, 9–20,200 cfs), and the overall length of the river is 115 mi (U.S. Geological Survey 2016a, 2016b; USGS stream gage 14152000). Major tributaries include Fall Creek, the North Fork Middle Fork Willamette River, Salmon Creek, Salt Creek, and Hills Creek. Most of the sub-basin is within the Willamette and Umpqua National Forests and is predominantly forest land cover type. Eighty-two percent of the watershed is under public ownership (NRCS 2006a). The private land is predominantly located at the lower end of the watershed below Dexter Dam near the city of Eugene.

Water originating from the Middle Fork Willamette River's headwaters passes through three consecutive USACE dam projects: Hills Creek (constructed in 1961), Lookout Point (constructed in 1954), and Dexter dams (constructed in 1954). Dexter is the re-regulating dam for Lookout Point, enabling power-peaking operations. USACE also owns and operates Fall Creek Dam (constructed in 1966) located on a tributary to the Middle Fork Willamette (which enters below the lowest mainstem project, Dexter Dam), which impounds Fall Creek and Winberry Creek (Figure 4.2-1). Willamette Hatchery, operated by ODFW on Salmon Creek, is the primary hatchery in the Middle Fork Willamette River subbasin.

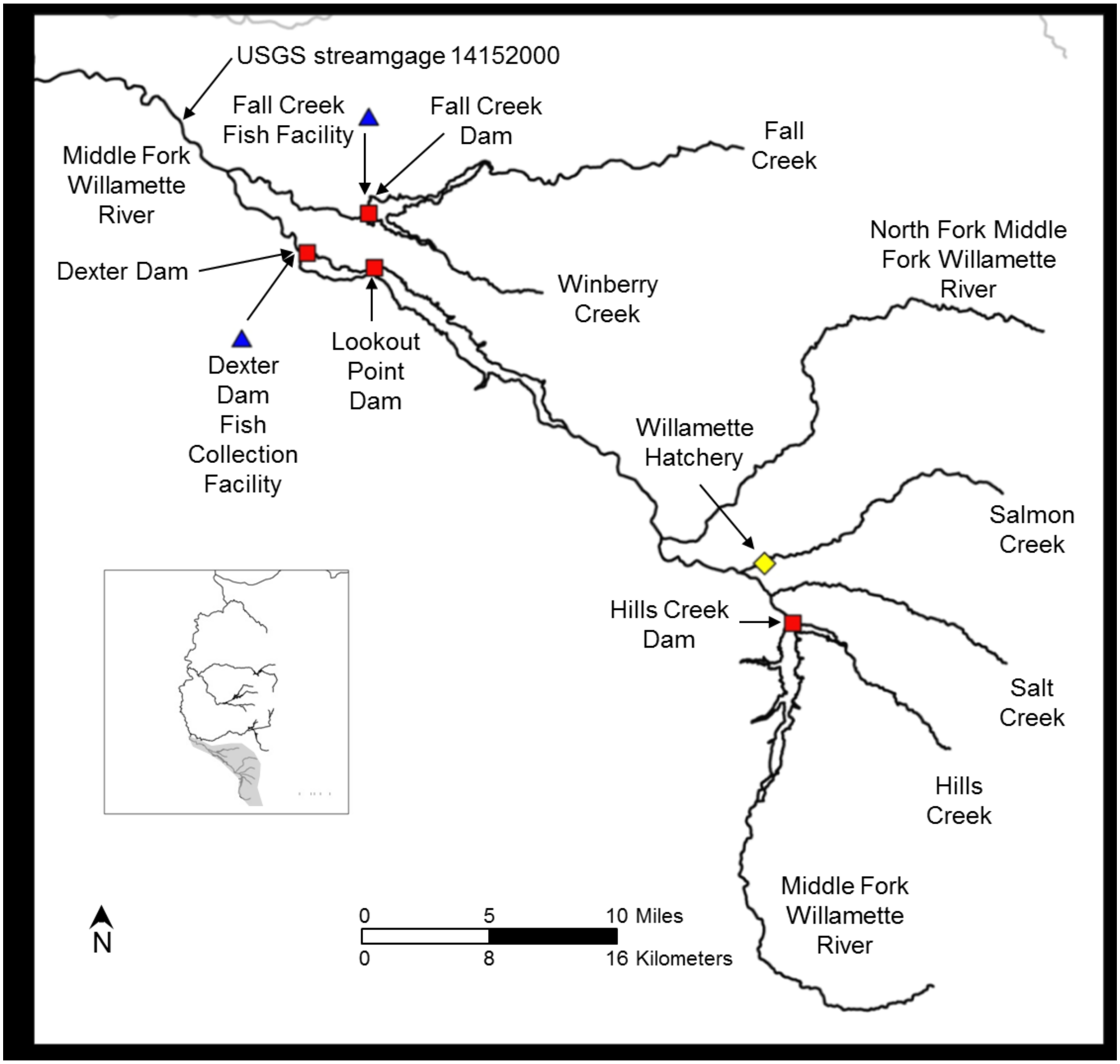


Figure 4.2-1. Map (from Hansen et al. 2017) showing primary rivers in the Middle Fork River Willamette subbasin (black lines), U.S. Army Corps of Engineers (USACE)-owned dams (red squares), fish hatchery (yellow diamond), and adult fish facilities (blue triangles), Willamette River Basin, Oregon. Other rivers in the Willamette Basin but not in the Middle Fork Willamette subbasin are in gray. Inset of the Willamette River Basin with the Middle Fork Willamette subbasin shaded in gray is in the middle left.

4.2.1 Historical Populations of Chinook Salmon in the Middle Fork Sub-basin

The Middle Fork Willamette River subbasin is home to a native run of UWR Chinook salmon but is not thought to be within the natural distribution of UWR steelhead. Historically, the run of

UWR Chinook salmon in the Middle Fork Willamette River may have been the largest population of UWR Chinook salmon above Willamette Falls (Hutchison et al. 1966; Thompson et al. 1966). Mattson (1948) and Parkhurst et al. (1950) reported spawning aggregations of Chinook salmon in Fall Creek, Salmon Creek, the North Fork of the Middle Willamette River, the mainstem Middle Fork Willamette River, and Salt Creek. Mattson (1948) estimated that 98 percent of the 1947 run in the Middle Fork Willamette River system spawned upstream of the Lookout Point dam site and the remaining 2 percent spawned upstream of the Fall Creek dam site.

McElhany et al. (2007) have suggested that the Middle Fork Willamette River subbasin once likely produced tens of thousands of adult spring Chinook salmon. Based on egg collections for the Willamette River Hatchery (at Dexter Ponds; 1909 to the present), the largest egg collection, 11.3 million in 1918 (Wallis 1962), would correspond to 3,559 females (at 3,200 eggs/female) that escaped intense fisheries downstream in the lower Willamette and Columbia rivers. This leads to an estimated minimum adult return to the subbasin of approximately 7,100 adult Chinook salmon for the area that is now above Lookout Point Dam (assuming a 1:1 sex ratio). This estimate does not include fish that spawned downstream of Dexter Dam in the lower mainstem Middle Fork Willamette River or in the Fall Creek watershed. Mattson (1948) estimated adult returns of 2,550 naturally produced spring Chinook salmon to the Middle Fork subbasin in 1947. In the years immediately prior to Fall Creek Dam construction in 1966, there were approximately 450 spring Chinook salmon spawning in Fall Creek above the dam site USFWS (1962).

From 1953 through 1966 (after construction of Dexter and Lookout Point Dams blocked access to most of the Middle Fork Willamette River population's historical spawning grounds), an average of 3,502 Chinook salmon were caught in the trap at the base of Dexter Dam (Wallis 1962; Hutchison et al. 1966). These total counts likely included some hatchery-origin fish. Thompson et al. (1966) estimated a total population of 6,100 naturally and artificially produced adults in the Middle Fork Willamette River subbasin below the dams in the mid-1960s.

The Middle Fork Willamette is not thought to have supported a historical population of UWR winter steelhead.

4.2.2 Current Status of Middle Fork Willamette Chinook Salmon Population and Importance to Recovery

The Middle Fork Willamette Chinook salmon population's limited natural abundance and productivity have put it at a very high risk of extinction since it was assessed in the early 2000s. This is an issue of particular concern given that it has been identified as a core UWR Chinook salmon population and as being critical to the long-term persistence of the ESU (McElhany et al. 2007).

Adult UWR Chinook salmon returning to the Middle Fork Willamette subbasin are counted at Dexter Dam, the upper limit of habitat that is now volitionally accessible in the mainstem Middle Fork Willamette River, and also at Fall Creek Dam. Adults collected at Dexter Dam are used as hatchery broodstock and many are outplanted at adult-release sites in areas above Lookout Point Dam. However, the proportion of natural-origin returns released is quite small.

Abundances of natural-origin adults that return to the river and to the adult fish facility below Dexter Dam have continued to remain low since the 2008 Biological Opinion, and use of natural spawning areas below Dexter Dam, and also at adult release sites above Dexter Dam, has been dominated by fish of hatchery origin (Schroeder et al. 2006). Natural spawning did not occur in the mainstem below Dexter Dam before the dam was built (Lindsay et al. 1999). Some natural-origin UWR Chinook salmon spawning also occurs above Fall Creek Dam where adult releases have been re-established since the completion of the NMFS 2008 biological opinion (NMFS 2019a).

The number of adult UWR Chinook salmon that have been collected and counted at Dexter and Fall Creek dams / adult fish facilities are given in Figures 4.2-2 and 4.2-3.The proportion of natural-origin Chinook salmon adults collected at the Dexter Adult Fish Facility has not been provided, but data found on the USACE WFPOM website for fish counts indicates that over the last 5 years (2020–2024), the percent of natural-origin fish in total adult returns to Dexter Dam has ranged between 2.4 percent and 9 percent, with total adult NOR female returns ranging between 31 and 105 fish and total adult NOR male returns ranging between 49 and 134 fish.

Annual counts at Dexter Dam (mostly hatchery-origin fish) have varied since the mid-1980s, though prior to 2005, there were several years when returns exceeded 8,000 total adults including 3 very strong years between 1988 and 1990 (14,000+ to 18,000). Since 2005, total returns to Dexter Dam have rarely exceeded 8,000 and since 2016 the total has remained at or under 4,000 returns (Figure 4.2-2). Annual returns to Fall Creek Dam averaged approximately 300 fish in the 1980s and about 150 fish during the 1990s, before exhibiting a recent upswing in the early 2000s (NMFS 2008a). Since 2005, Fall Creek Dam returns have averaged 394 (2005–2023), and the recent 5-year average return has been 291 fish (2019-2023), though the percentage of natural-origin adult returns has remained strong in the last decade (Figure 4.2-3). Prior to 2009, adult counts at Fall Creek Dam have been a mixture of naturally produced adult returns combined with hatchery-origin fish. Since 2009 only natural-origin returns have been transported above the dam.

Natural-origin spawner abundance is represented by redds surveyed below Dexter Dam and above Fall Creek Dam. During the 2015–19 review period, the geomean dropped to 20, a 78 percent decrease in abundance. Natural-origin spawners are limited to spawning in the mainstem Middle Fork Willamette River below Dexter Dam, below Fall Creek Dam and Little Fall Creek, where conditions were especially poor during 2015–2019, and above Fall Creek Dam where the majority of natural-origin fish are released (Sharpe et al. 2017b). Results of geometric means of abundance estimates from past spawning surveys show 92 NORs of 1209 spawners from 2010–2014 and 20 NORs of 407 spawners from 2015–2019. Twenty natural-origin spawners puts this population at 0.3 percent (less than 1 percent) of the population recovery goal.

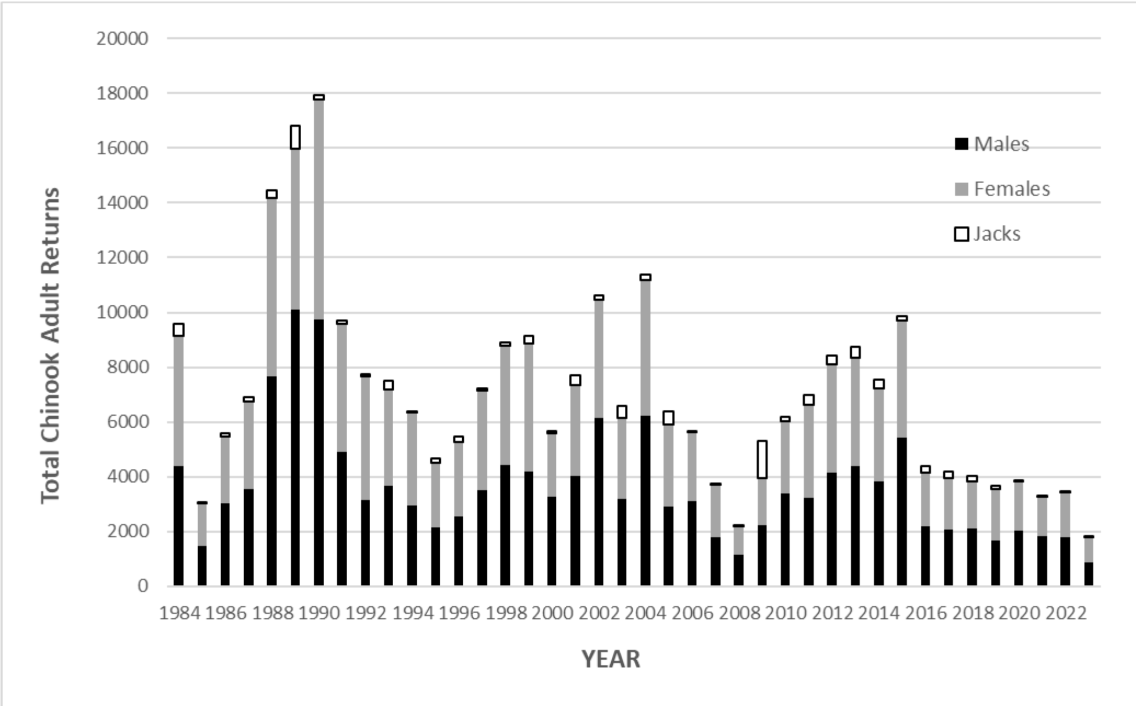


Figure 4.2-2. Total annual adult Chinook salmon returns to Dexter Fish Facility. Total numbers include hatchery origin and natural-origin fish, though it is assumed that the natural-origin proportion continues to remain low (ranging between 2.4 and 9.0% of all returns in years 2020-2024).

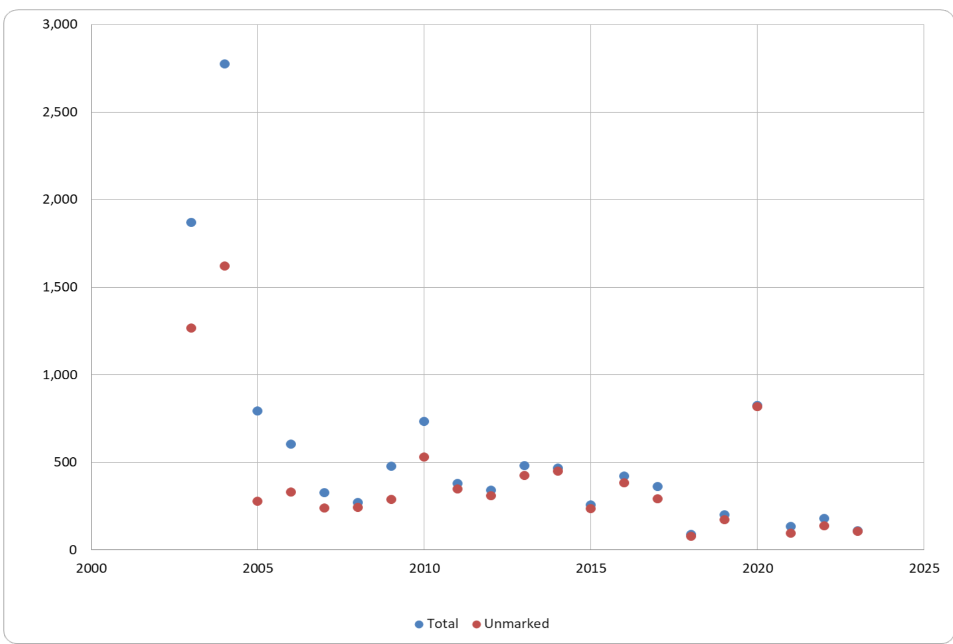


Figure 4.2-3. Total annual adult Chinook salmon returns to Fall Creek Dam in the Middle Fork Willamette watershed including total hatchery and natural-origin fish combined (blue dots) and natural-origin only totals (red-dots).

The Middle Fork Willamette River Chinook salmon population is at a very low abundance, even with the inclusion of natural-origin spring-run Chinook salmon spawning in Fall Creek. While returns to Fall Creek Dam number in the low hundreds, prespawn mortality rates are very high in the basin. The viability assessments for the UWR Chinook salmon ESU conducted for the recovery plan (ODFW and NMFS 2011) and by McElhany et al. (2007) put the Middle Fork Willamette population at a very high risk of extinction. Though the most recent NMFS status review did not provide updated assessments for each UWR Chinook salmon population, current hatchery-origin adult abundance in the Middle Fork Willamette is now lower than it was in the 2000s, and natural-origin abundance has not improved (NMFS 2024a). Therefore, the Middle Fork Willamette Chinook salmon population likely remains at a very high risk of extinction and thousands of fish below its recovery goal (of 5820 natural-origin spawners).

4.2.3 Environmental Conditions

4.2.3.1 Habitat Access and Fish Passage Conditions

Adult Fish Passage

Currently, almost all of the historical spawning and rearing habitat is volitionally inaccessible to Chinook salmon. Dexter and Lookout dams are a high-head dam complex that obstructs passage beyond the lower Middle Fork Willamette River, and farther upstream beyond the North Fork Middle Fork Willamette River, Hills Creek Dam redundantly blocks access to the uppermost reach. It is likely that returns of wild Chinook salmon declined precipitously shortly after the dams were built because more than 90 percent of their historical habitat was lost (NMFS 2008a).

Access to spawning areas above USACE dams for upstream-migrating salmon is by trap-and-haul from either Fall Creek or Dexter Adult Fish Facility. There is an ongoing issue of holding and pre-spawn mortality for UWR hatchery Chinook salmon adults collected at Dexter Adult Fish Facility and transferred to Willamette Hatchery near Oakridge, Oregon. These transfers include adults that are outplanted to spawn above Lookout Point and Hills Creek dams. The holding facility at the Willamette Hatchery is a converted earthen juvenile rearing pond from the original hatchery. It is inadequate for current adult holding needs; consequently, the adults are overcrowded in the pond, not easily captured, and highly stressed, which contributes to a high pre-spawn mortality rate that often exceeds 70 percent. NMFS' 2019 Biological Opinion on hatchery programs in the Upper Willamette River Basin includes a Term and Condition (#2F) to improve broodstock holding at Willamette Hatchery. This improvement is not part of the proposed action for this consultation.

Adult Chinook salmon are collected below Dexter Dam at an outdated facility optimized for collection of hatchery broodstock in conditions where temperatures and densities of hatchery origin fish are high, which contributes to high rates of pre-spawn mortality (Bowerman et al. 2018). The NMFS 2008 Biological Opinion RPA required that the facility below Dexter Dam be updated (NMFS 2008a; RPA 4.6). The upgrade is in construction and the new facility will become operational in 2026. USACE has also improved release sites upstream of Lookout Point and Fall Creek dams to facilitate successful spawning of transported and outplanted adult fish in historical habitat upstream of the dams in compliance with the 2008 RPA 4.7, Adult Fish Release Sites above Dams (NMFS 2008a).

Currently, predominantly hatchery-origin adult Chinook salmon are transported to adult release sites above Dexter/Lookout and Hills Creek dams, as the few natural-origin adult returns to the Dexter Fish Facility are all presently incorporated into the broodstock. Releasing mostly adult hatchery-origin Chinook salmon above Lookout Point and Dexter dams has resulted in extremely low numbers of natural-origin adults returning (Ford ed. 2022). Habitat below dams in the Middle Fork Willamette River subbasin also does not sustain a naturally-produced population (Myers et al. 2006).

Prespawn mortality rates are generally very high below Dexter Dam, often near 100 percent, and also quite high in adult release areas above Hills Creek Dam (89%) (Sharpe et al. 2017b, NAI 2019, 2020). In 2015 and 2016 prespawn mortality rates at adult release sites in the North Fork Middle Fork were significantly lower (30%) (Sharpe et al. 2017b). From 2012 to 2014, of the hatchery-origin adults transported above Dexter Dam, pre-spawning mortalities for fish transported above Hills Creek Dam were 49.3 percent for 2012–14) compared to the 39.0% North Fork Middle Fork Willamette River (NMFS 2019a). Longer transportation times to Hills Creek are thought to be partially responsible for these differences (Naughton et al. 2015). Prespawn mortality rates below Fall Creek were estimated at 60% and 15% in 2015 and 2016, respectively (Sharpe et al. 2017b).

Genetic parentage analysis was completed to evaluate the contribution of (natural-origin only) Chinook salmon reintroductions above Fall Creek Dam in 2011 and 2012 to subsequent adult recruitment to Fall Creek in 2014 and 2015 (O’Malley and Bohn 2017). The 2011 preliminary cohort replacement rates were 0.32 (males only) and 0.46 (females only). Just recently, results for this analysis have been extended by assigning the 2016 – 2020 adult salmon returns to salmon reintroduced above Fall Creek Dam in 2011 – 2017 (O’Malley et al. 2024a). The inferred age structure based on the genetic parentage analysis results indicates that most salmon return to Fall Creek at age-3 and age-4 with few age-5 salmon. Total cohort replacement rate (CRRtotal) was generally much less than one in most years from 2011 – 2015, indicating that the reintroduced population above Fall Creek Dam is not replacing itself. However, in 2012, CRRtotal was 1.49 indicating that replacement had been met. The minimum CRRtotal of 0.21 was observed in 2014. The effective number of breeders (Nb) above Fall Creek Dam from 2011 – 2015 tracked with the number of candidate parents that produced one or more adult offspring (nsuccess), but these two values almost seemed inversely related to the number of possible “candidate” parents (or total number of adults released above the dam). The findings of O’Malley et al. (2024a) suggest that basin-wide and/or ocean conditions may have been the primary factor(s) influencing productivity in three of the four river systems from 2011 – 2016 (including Fall Creek, and the North and South Santiam reintroduced population).

Accessible habitat in the Middle Fork Willamette River is very limited and current productivity estimates are strongly negative. Until effective upstream and downstream passage past the dams is developed, it is unlikely that abundance will improve markedly (Ford ed. 2022). Although current productivity is low, historically the Middle Fork Willamette River was thought to be the major producer of Chinook salmon (Mattson 1948, Parkhurst et al. 1950).

Juvenile Fish Passage

Downstream passage at Fall Creek Dam is accomplished by way of drafting the reservoir to the riverbed annually in late fall. Downstream passage at other Middle Fork Willamette sub-basin dams (Hills Creek, Lookout Point and Dexter) occurs, with most opportunity for juvenile passage occurring when Hills Creek and Lookout Point dam are drawn down to minimum conservation pool in autumn or when surface spill occurs at Lookout Point Dam in the spring or summer (Keefer et al. 2012; PNNL 2019).

A solid body of literature is available on general patterns of downstream passage in the Middle Fork Willamette River subbasin, but less is known about route-specific passage and survival than in other subbasins (Hansen et al. 2017). One passage study reported a 59% total project mortality rate for Hills Creek Dam and a 25% mortality rate through Lookout Point dam (Keefer et al. 2012), while others showed much higher morality when including Dexter Dam and reservoir passage. Keefer et al. (2012) also determined that mortality was higher for larger fish and at high reservoir elevations.

Juvenile Passage through Hills Creek Dam and Reservior

There are strong indications that current downstream passage conditions are poor and will not support the establishment of an UWR Chinook salmon population above the dam. This is further compounded by the fact that juvenile anadromous fish that successfully pass downstream of Hills Creek Dam still need to successfully pass both Lookout and Dexter projects on their downstream migration to the Willamette River mainstem.

Juvenile Chinook salmon emigrating into Hills Creek Reservoir, which are naturally spawned progeny of hatchery-origin adult Chinook salmon outplanted above Hills Creek, enter the reservoir from February to June with the peak fry migration during March. A portion of the fish rear in the stream above the reservoir before beginning migration later in the year. Limited information is available for Hills Creek with regard to reservoir rearing, travel times, survival, and dam passage. Downstream migrating fish must pass through the regulating outlet or turbine via penstocks at Hills Creek Dam.

At Hills Creek Dam, spring Chinook salmon (101–406 mm long) were 1.5 times more likely to pass through turbines than through ROs and to be collected in screw traps from July 1999 to January 2000 (Larson, 2000). Mortality through Hills Creek Dam was 53.2 percent during 2003–04 (Keefer et al. 2012). Larson (2000) reported that 59 percent of the fish that passed through the powerhouse were killed in 1999 compared to 32 percent for RO-passed fish.

Juvenile Passage through Lookout Point Dam

Downstream passage and survival through Lookout Point Dam depends on passage routes, reservoir elevations, discharge, and depths to passage routes. A study in 2012 found that Lookout Point Dam total dam passage mortality was 25.2 percent and increased as fish size and reservoir elevations increased (Keefer et al. 2012). Passage and survival studies have also been conducted at Lookout Point Dam in 2010 (Khan et al. 2012), 2016 (Fischer et al. 2018), and 2017 (Fischer et al. 2018 and 2019a) to estimate the proportion of fish passing per each potential route and route-specific survival (for juvenile Chinook salmon). Fish passage rates for fish >90 mm and < 300 mm were highest in the winter when reservoir elevations were at minimum conservation pool elevations and lowest in mid-summer when reservoir elevations were at maximum conservation pool elevations. However, these passage rates were obtained before the more recent passage operations began.

In 2017 and 2018, PNNL conducted a follow-up to the 2016 and 2017 studies (Fischer et al. 2019a). During the fall, 1,507 sub-yearling Chinook salmon were released while 1,527 yearling Chinook salmon were released, and the only available passage routes were the turbines operated in the morning and evening. Passage rates for fish released in October and December ranged from 18 percent to 43 percent with dam passage efficiency ranging from 31 percent to 58 percent. Survival for fish released in October and December ranged from 77.9 percent to 82.3 percent. During the spring study, only 18 percent of the February releases were detected passing the dam and 3 percent of the April-released fish. Dam passage efficiency ranged from 27 percent to 5 percent for fish released in February and April. Overall, only 33 fish passed the spillway and 94 fish passed the turbines. Concrete survival through the two available passage routes during the study was estimated as 78.4 percent through the turbines and 98.7 percent through the spillway. These studies indicate that passage efficiencies were slightly better in the spring though still generally low through this project.

A paired-released study between Chinook salmon released upstream of Lookout Point Dam and downstream of Dexter Dam demonstrated that fish released in Lookout Point reservoir had significantly higher growth rates than fish released in the Dexter tailrace, and more fish released in the reservoir generally returned to Willamette Falls than fish released in the tailrace (Brandt et al. 2016). Though some may find these results as evidence for the benefits of rearing in these reservoirs, rather than downstream of dams, it discounts the level of mortality that occurs for fish rearing in reservoirs (waiting to find their way downstream) because of parasites, predators, and other conditions. USGS researchers assessed survival of Chinook salmon in Lookout Point Reservoir over 2 years (Kock et al. 2019a). These researchers reported 18.8 percent survival of fish released as fry in Lookout Point Reservoir. Fry were genetically tagged and released in the reservoir in April, May, and June (Table 4.8-4) at sizes that would be representative of natural out-migrating fish in the reservoir. The early releases in April were fry size, while the May and June releases were subyearling size. Two different models were used to calculate reservoir survival for fish released during the spring. The cumulative survival was 23.3 percent and the overall survival was 18.8 percent. Several piscivorous fish species are found in Lookout Point Reservoir (Brandt et al. 2016), including white crappie (*Pomoxis annularis*), largemouth bass (*Micropterus salmoides*), walleye (*Sander vitreus*), and northern pikeminnow (*Ptychocheilus oregonensis*). These piscivorous species may have reduced juvenile Chinook salmon survival rates in Lookout Point reservoir as hypothesized by USGS.

Observations from sampling in 2012 and 2013 found that fish passed in the summer when spill occurred at the Lookout Dam tailrace (Keefer et al. 2013). In years when no spring/summer spill occurred and water primarily passed through the turbines, Chinook salmon passage occurred predominantly in the fall months (Romer et al. 2013).

Juvenile Passage through Dexter Dam

Few to no studies have been conducted to assess specific concrete survival rates through Dexter Dam or route-specific proportions. Fish passage routes include turbines or the spillway (when in operation), and there are no regulating outlet structures at Dexter Dam.

Juvenile Passage through Fall Creek Dam

Since 2011, the Fall Creek reservoir has been drawn down to minimum passage pool elevations in the fall and early winter. In 2012 studies were conducted with radio tagged juvenile fish (Nesbit et al. 2014) released fish into the reservoir at different reservoir elevations to estimate reservoir survival and passage survival at Fall Creek. Elevations 728 ft. and 703 ft. were tested during the study. More than 95 percent of tagged fish passed within 48 hours of release when the reservoir elevation decreased from 720 to about 700 ft and the average RO gate opening was 5–7 ft (Nesbit et al. 2014). Survival during the two treatments was reported as 73.9% during the first treatment targeting elevation 728 ft, and 97.5% for the second treatment targeting elevation 703 ft. Nesbit et al. (2014) observed that all study fish passed downstream from the forebay within 48 hours at the lower elevation treatment and within one week at the higher elevation treatment however a storm influence may have prolonged passage of study fish in higher elevation treatment.

Similarly, during the drawdowns from 2011 to 2013, Chinook salmon collection in a downstream trap peaked when pool elevation was decreasing rapidly and near 728 ft (Hansen et al. 2017). In the fourth year of deep drawdown, the percentage of fish (by species) collected in the downstream trap was about 50 percent Chinook salmon compared to less than 10 percent between 2006 and 2012 (Hansen et al. 2017). The count of crappie (*Pomoxis* spp.) collected in the same trap was about 3,500–8,500 prior to deep drawdowns and less than 10 after 2 years of the winter reservoir lowering strategy. After the 2015 drawdown, no yearling Chinook salmon were collected in the downstream trap indicating that most yearling Chinook salmon passed during the drawdown (Romer et al., 2016).

Injunction Passage Operations

USACE used the Hills Creek Dam RO (non-turbine-outlet) during the nighttime from 1 January 2023 through 23 April 2023 to improve downstream fish passage (with daytime only turbine operation). This operation occurred from 1800 to 2200 hours while the reservoir was low. Elevations were much lower in the winter and spring of 2023 as compared to 2022, remaining below minimum conservation pool elevations (EL 1,448 feet) from 10 January to 12 April. Low reservoir elevations were due to precipitation events consisting mainly of snow instead of rain.

The WVS also operated the Lookout Point and Dexter Dams for nighttime downstream fish passage by using the spillway gates. Due to dry conditions in the late winter/early spring Lookout Point did not refill to above spillway crest (EL 887.5 feet) until 15 April. Once above spillway crest, the reservoir was held at a steady elevation for a month while the spillway gates were pulled out of the water for ungated and continuous surface spill operation. During this time all flow was released through the Dexter Dam spillway in conjunction with not using the turbines at either project (15 April to 19 May). The Lookout Point spillgates were placed back in the water and continuous ungated spill operation concluded and nighttime surface spill operation began, from 19 May to 1 June.

The Lookout Point ROs were used from 13 July 2023 through November for downstream water temperature management, and also to test for downstream passage. The Lookout Point turbines were used occasionally throughout the summer and were shut off when the reservoir was drafted below minimum power pool (El. 819 ft.) on 9 September. Lookout Point reached the targeted fish passage drawdown elevation of El. 750 ft on 2 November. This was the first time since Lookout Point Dam became operational in 1954 that USACE had drawn down Lookout Point Reservoir to this level. Typically, USACE does not draw down Lookout Point Reservoir below the minimum power pool elevation of 819 ft, or the minimum conservation pool elevation of 825 ft. Lookout Point Reservoir was held at El. 750 ft until early December when a large atmospheric river entered into the region, when inflows into Lookout Point Reservoir peaked.

At Fall Creek, interim measure 20, the deep drawdown and delayed refill operation was implemented at Fall Creek Reservoir for much of the winter (2022) and spring (2023) to improve downstream fish passage. The winter deep drawdown/run of river operation was implemented from 1 January through 18 January 2023 when the reservoir was refilled to El. 700ft. The elevation was held until 13 March, then refilled to minimum conservation pool (El. 720 ft) and held until 5 May. At this time a joint decision between USACE and NMFS was made to conclude the delayed refill operation in order to improve the likelihood of the refill of the reservoir which would allow for the operation of the Fall Creek Adult Fish Facility throughout the summer. Fall Creek was not able to refill adequately and elevation was about 80 feet lower as compared to elevations in 2022 (El. 750 ft).

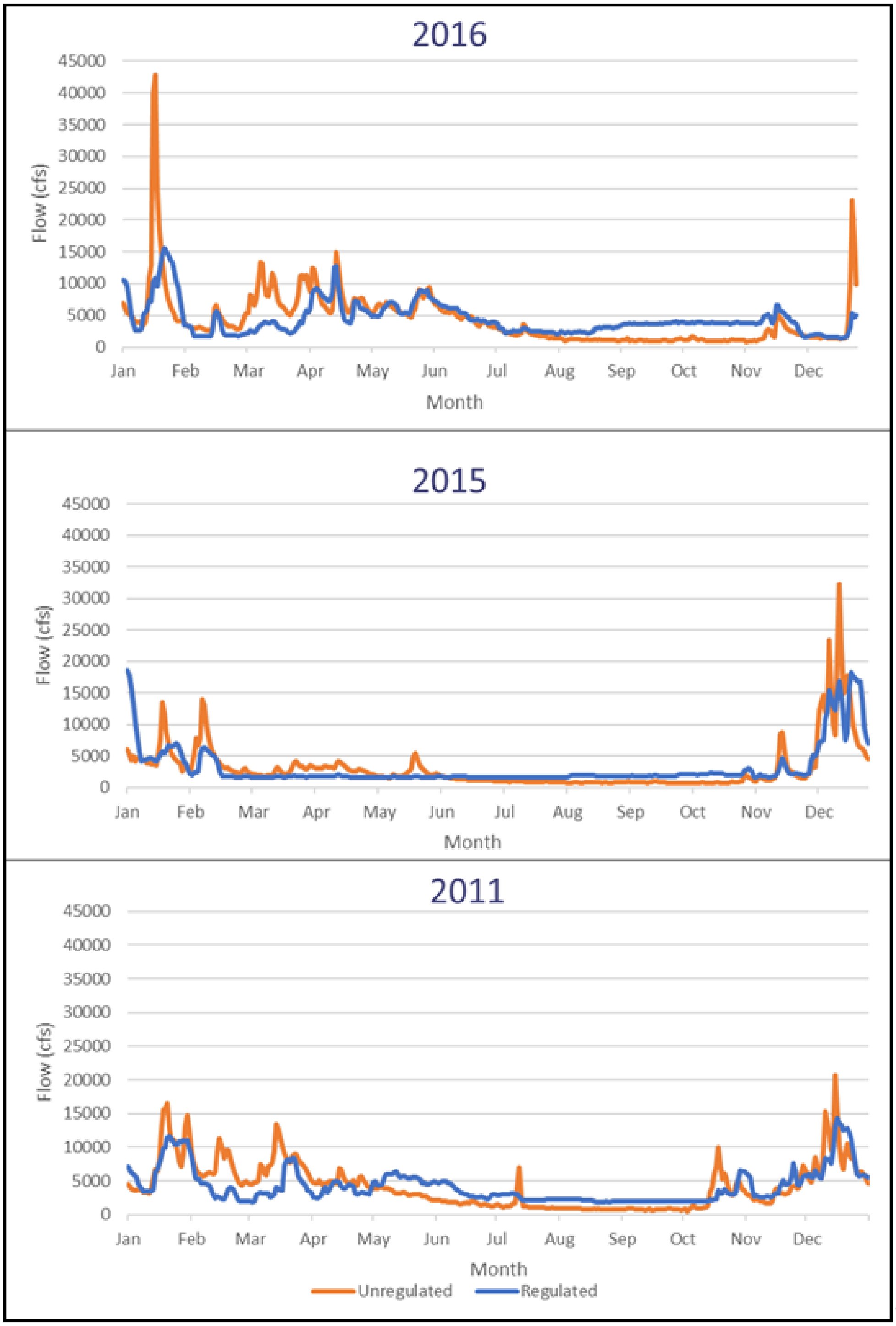
Preliminary monitoring of these operations and how they affected fish passage are summarized in the RME section below (4.2.7). However, the efficacy of deep drawdowns to pass juvenile fish is still being assessed. Results are mixed and more study is needed to determine whether these operations are effective at providing safe passage for juvenile UWR chinook.

4.2.3.2 Water Quantity/Hydrograph

The 2008 NMFS biological opinion describes the historic and current environmental baseline condition for the hydrology of the Middle Fork Willamette River and is incorporated by reference (NMFS 2008a, section 4.2.3.2). The past operations of Middle Fork Willamette River projects and their effects on flows are part of the environmental baseline. Similar to other subbasins affected by flood-control operations, the largest differences between regulated and unregulated flows are peak flow reductions, generally decreased flows from February to May, and generally increased flows from July to January. Figure 4.2-4 shows how the project operations have modified flows for representative water years (2011, 2015 and 2016) by comparing observed flows at the nearest downstream control point to the modeled unregulated flows for the same years.

The effects of reducing late-winter and spring flows on UWR spring Chinook salmon have not been effectively monitored, but studies in other Columbia River basin watersheds found that freshets are critically important because higher spring flows are correlated with faster downstream travel times and earlier (typically more ideal) arrival times to critical rearing habitats in the estuary and ocean (Scheuerell et al. 2009). Scheuerell et al. (2009) found that this migration timing plays an important role in determining juvenile-to-adult survival for Columbia River Chinook salmon and steelhead, with early migrators typically experiencing much higher survival.

Dam discharges are managed to meet the project's authorized purposes while also achieving flow targets prescribed by the 2008 NMFS biological opinion to the extent possible (NMFS 2008a, RPA 9.2). Since 2008, flow targets for the Middle Fork Willamette River below Lookout Point Dam have not been missed in any year for most target periods (every 15 days between February 1st and November 30th). In years where it has been missed, it has been during the late winter and early spring months, and only for a median number of 1 to 5 days per period (USACE 2023a, Appendix K).



Series

Figure 4.2-4. Middle Fork Willamette (MFW) River at Jasper, OR, Flows Across the Water Year. The orange lines are for observed flows from 2011, 2015 and 2016. Blue lines are modeled flows for the unregulated hydrology for the same years**.**

4.2.3.3 Water Quality

Water temperature

Water temperatures measured in the Middle Fork Willamette mainstem below Dexter Dam consistently exceed TMDL targets in August, September and October as they did in 2023 (Figure 4.2-5), and 7-day average daily maximums often reach 68°F or higher, both below Dexter Dam (in August and September) and in the North Fork Middle Fork Willamette (in July and August) (Figure 4.2-6). Temperatures also often exceed TMDL targets and fish agency targets below Fall Creek Dam in July, August, September and October as they did in 2023 (Figure 4.2-7). Because of the significant temperature problems, successful natural reproduction below Dexter and Fall Creek dams is minimal by Chinook salmon of either hatchery- or natural-origin.

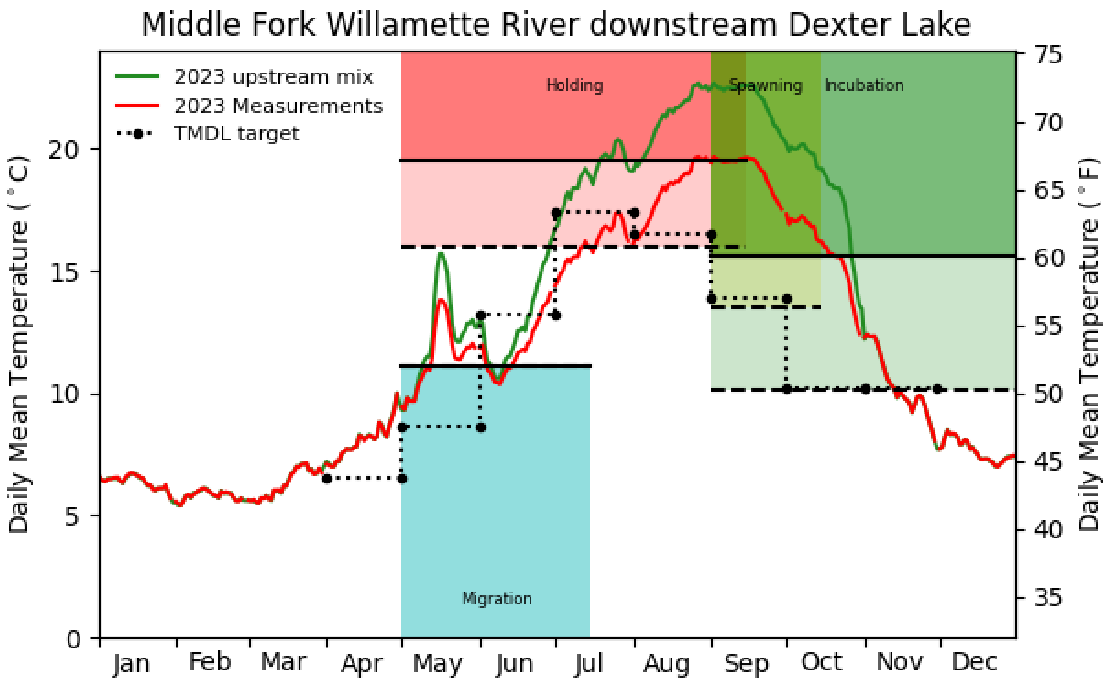


Figure 4.2-5. Daily mean outflow temperatures measured below Dexter Dam. Lookout Point / Dexter (bottom) Reservoirs daily mean outflow temperatures (bold line) measured in the Mid. Fork Willamette R. in 2023 compared to upstream mix conditions (fine line) (including N. Fork of Mid. Fork Willamette R. and Hills Crk.), ODEQ's total maximum daily load (TMDL) monthly median target temperatures (dotted line), and water temperature evaluation criteria with primary salmonid life stage of concern.

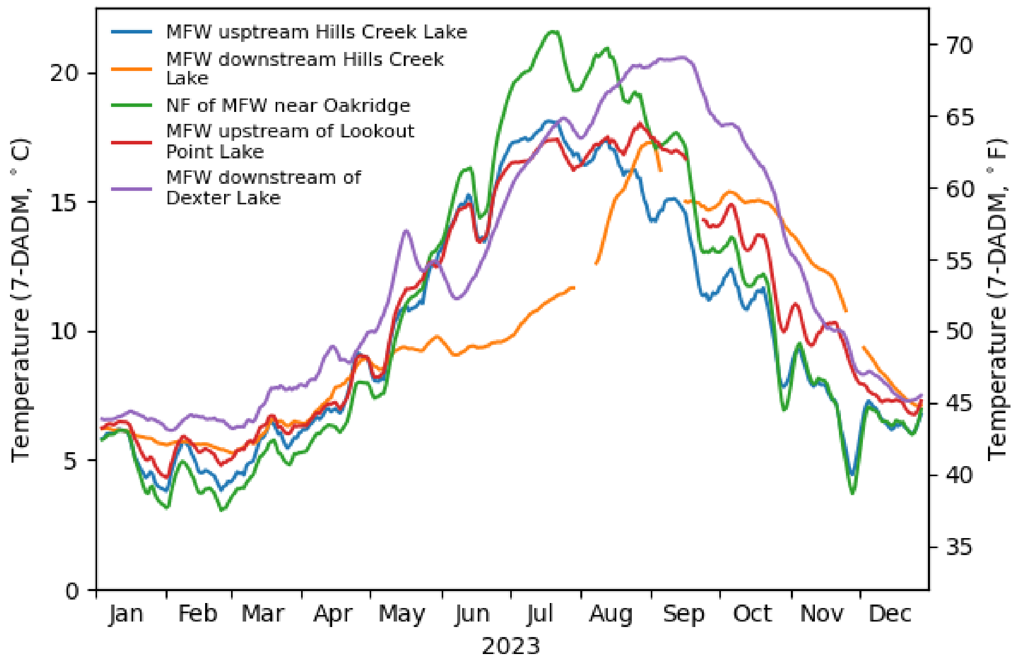


Figure 4.2-6. Outflow temperatures measured at Hills Creek, Lookout Point, and Dexter Dams (7-DADM) compared to Middle Fork Willamette River upstream temperatures, 2023.

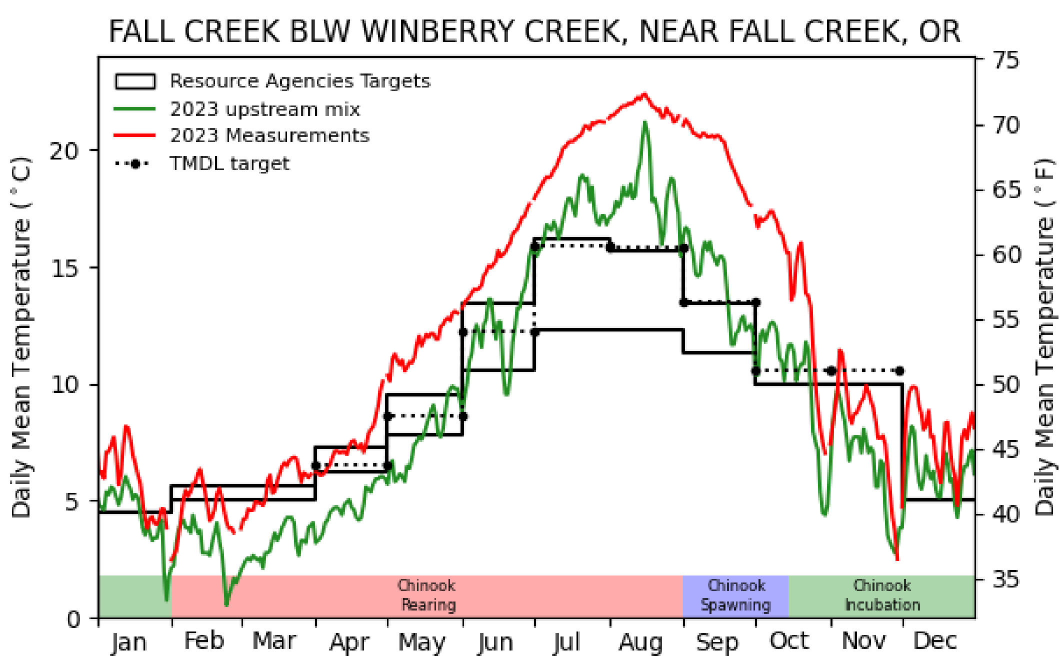


Figure 4.2-7. Daily mean outflow temperatures below Fall Creek Dam, compared to upstream mix, ODEQ's TMDL monthly median, and resource agencies biologically supportive target temperatures (original North Santiam targets used as surrogates), and primary salmonid life stage of concern.

During the first deep drawdown of Lookout Point Reservoir in 2023, the Lookout Point Reservoir become less stratified and temperatures in the upper half of the reservoir exceeded 17 °C in August and September. This resulted in total loss of stratification in Dexter Reservoir (just below) and temperatures exceeded 17 °C at all depths in August and September, providing no thermal refuge for juveniles passing downstream through the dams during the drawdown operation (USACE 2024b).

While Fall Creek reservoir can provide a thermal refuge from summer temperatures when stratified and providing enough cool water at depth, Fall Creek and Winberry Creek, which drain into the reservoir, experience relatively high temperatures during adult pre-spawn holding. Little of the Fall Creek watershed lies in the snow zone (above 1200m), with most of this subbasin in the transitional or rain zone. Geologically it lies in the less permeable Western Cascade province (Tague and Grant 2004).

Other Water Quality Constituents

In 2023 TDG values below Dexter dam exceeded 115% saturation at the end of April and for many days in December, but did not exceed 120% at all. Both coincided with large spill flow releases at Dexter Dam.

Based on initial, provisional information from the U.S. Geological Service, turbidity levels peaked to 2,710 formazin nephelometric units (FNU) directly downstream of Lookout Point Dam, as the reservoir was first drawn down in early November followed by a second notable spike in turbidity in early December during a heavy rain event. For comparison, turbidity downstream of Lookout Point Reservoir during the winter normally ranges from 5-100 FNU.

Based on initial, provisional information from the U.S. Geological Service, turbidity levels were nominal during the first drawdown of Fall Creek Reservoir in October 2023. This is likely due to the fact that the reservoir was drawn down to El. 700 ft. versus the injunction-targeted level of EL. 680 ft., an elevation known to liberate sediment. During the second drawdown (IM 19), which overlapped with a large atmospheric rain event, turbidity peaked to 2,720 FNU directly downstream of Fall Creek Dam. After that, turbidity levels reduced, fluctuating between 0 and 500 FNU with the exceptions of a few larger spikes.

Failure to avoid increased suspended sediment is likely to result in gill irritation or abrasion, which can reduce respiratory efficiency or lead to infection, and a reduction in juvenile feeding efficiency due to reduced visibility. Compromised gill function is likely to increase juvenile mortality. An increase in turbidity from suspension of fine sediments can adversely affect fish and filter-feeding macro-invertebrates downstream from the action area. At moderate levels, turbidity has the potential to reduce primary and secondary productivity; at higher levels, turbidity may interfere with feeding and may injure and even kill both juvenile and adult fish (Berg and Northcote 1985, Spence et al. 1996). However, Bjornn and Reiser (1991) found that adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that may be experienced during storm and snowmelt runoff episodes.

Exposure duration is a critical determinant of the occurrence and magnitude of physical or behavioral effects caused by turbidity (Newcombe and Jensen 1996). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such seasonal high pulse exposures. However, research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Servizi and Martens 1991). In a review of 80 published reports of fish responses to suspended sediment in streams and estuaries, Newcombe and Jensen (1996) documented increasing severity of ill effects with increases in dose (concentration multiplied by exposure duration).

4.2.3.4 Physical Habitat Characteristics

The lower subbasin contains only a small fraction of the original floodplain forest. Remaining floodplain forests are interspersed with areas of farmland, pastureland, highways, residences, and other development. Roads next to stream channels have increased channel confinement and reduced riparian vegetation and canopy cover. As a result of these land alterations, riparian vegetation within 100 feet of the small tributaries of the lower Middle Fork Willamette River is generally in poor condition. Changes in riparian canopy cover have increased summer high water temperatures on some tributary streams (WRI 2004).

In addition, the Jones Fire in the Fall Creek watershed in 2017 likely had immediate and long-term effects on fish survival in the basin. Similarly, areas burned in the Willamette River basin in 2019 and 2020 will suffer from the loss of riparian habitat and the deposition of sediment and ash from denuded hillsides.

4.2.4 Hatchery Programs

Mainstem Middle Fork Willamette

Hatchery Chinook salmon were first released in the Middle Fork Willamette subbasin in 1919 (ODFW 1990a). Before 1950, two temporary adult-collection facilities were set up in the Middle Fork each year, one approximately 2 miles above the town of Oakridge and the other 1 mile above the mouth of Salmon Creek (Mattson 1948; ODFW 1990a). Little is known about the contribution of hatchery releases to natural production during this period, but few adults are thought to have returned from releases made before the 1960s because of poor hatchery practices (Howell et al. 1985; ODFW 1990a).

The Willamette Hatchery was built to mitigate lost natural production of spring Chinook salmon in the Middle Fork Willamette resulting from the construction and operation of Fall Creek, Dexter, Lookout Point, and Hills Creek dams and reservoirs. The original hatchery program was initiated to support harvest in freshwater and ocean fisheries. However, following the listing of the species as threatened under the ESA, efforts began to transform the program into a conservation/supplementation role because of the poor status of this population. The current hatchery program is being used to evaluate the potential for the reintroduction of Chinook salmon to their historical habitat above the dams (Usace 2007).

Hatchery fish returns constitute a greater and greater proportion of the return to the Middle Fork Willamette. Presently, nearly all of the Chinook salmon are of hatchery-origin; although some natural-origin fish do return to Fall Creek. Hatchery-origin fish represent nearly all of the spawners observed below Dexter and Fall Creek Dams. Due to extremely poor natural reproduction and the dominance of hatchery-produced fish in the run, hatchery-origin fish likely contain the only genetic remnants of the historic run available. These fish are the only remaining source of fish for outplanting efforts. The results of the outplanting program have been mixed (Beidler and Knapp 2005). Natural reproduction by hatchery-origin fish has been observed in historical habitat upstream of the dams. However, prespawning mortality of the adults trapped at the base of the dams, trucked upstream, and released has been very high. This results in fewer successful redds in habitat above the dams and is currently limiting the productivity of this reintroduction program.

The Middle Fork Willamette hatchery program is also being reformed into an integrated broodstock where the broodstock incorporates natural-origin fish on a regular basis so that the hatchery broodstock is as similar as possible to the natural-origin population (NMFS 2019a). However, because of the extremely low numbers of natural-origin fish observed recently in this population, significant improvements are needed in the key and secondary limiting factors before this broodstock can be fully integrated. In the past less than 1 percent of the broodstock has been natural-origin fish (Schroeder et al. 2006), and due to the low numbers of natural-origin adult returns in the recent past, few natural-origin fish have been incorporated into the broodstock here for quite some time. Hatchery programs in the Middle Fork Willamette continue to pose risks and provide benefits to natural-origin Chinook salmon in outplanting above USACE dams. Having all hatchery-origin fish marked since 2001 has facilitated determining the status of natural-origin fish in this population. Hatchery-origin fish will continue to represent the majority of natural spawners in this population until other limiting factors are addressed that allow natural production to increase.

Fall Creek

The original construction of Fall Creek Dam included an adult Chinook salmon collection facility that has been used to trap-and-haul spring Chinook salmon to other hatcheries or above the reservoir. It was rebuilt in 2021 to improve fish health and worker safety as part of the 2008 NMFS RPA. Prior to 1998, most adult spring Chinook salmon and some introduced winter steelhead trapped at Fall Creek Dam were trucked to McKenzie and other hatcheries. Some fish were released at a site 2 miles above the head of the reservoir. Since 1998, all natural-origin spring Chinook salmon (unmarked) returning to the Fall Creek collection facility have been released above the dam. Under the current fish disposition, marked hatchery-origin spring Chinook salmon are not transported or outplanted above Fall Creek Dam, therefore, the current Fall Creek population is now sustained by the transport of putative natural-origin adult Chinook salmon released upstream annually. Upstream migrants can experience abrasion, mechanical injury, stress, migration delay, disease, and low dissolved oxygen concentrations if crowded in the trapping and transport facilities. Trapping and handling facilities are now state-of-the-art; however, prespawn mortality rates for adults transported upstream remain high (Peterson et al. 2022). Recent improvements to fish collection facilities in combination with changes in handling, holding, and release protocols could help reduce handling and holding stress, descaling, and temperature exposure, thus reducing prespawn mortality (USACE 2023a).

4.2.5 Fisheries

In addition to the information provided in the General Baseline and Willamette Mainstem Baseline Chapter 4.1 regarding fisheries, the Middle Fork Willamette and tributaries have year-round rainbow trout (and general trout) fishing opportunities, including allowable trout harvest between May 22 and October 31, and catch-and-release fishing only through the rest of the year. It is also open to hatchery Chinook and coho salmon and summer steelhead all year round, with no annual limit. The harvest of all wild salmon and steelhead is prohibited. Harvest below Fall Creek dam is open to wild steelhead larger than 24 inches. Please refer to Fisheries Section in the Willamette Mainstem and Basin baseline chapter for further information (Chapter 4.1).

4.2.6 Predation & Competition

The Middle Fork Reservoirs are currently a haven for introduced, piscivorous fish species. Dexter Reservoir hosts abundant populations of northern pikeminnow, smallmouth bass, and walleye. In Lookout Point Reservoir, piscivorous fish primarily consist of smallmouth bass followed by walleye and smaller numbers of northern pikeminnow and white and black crappie (Murphy et al. 2021). Finally, Hills Creek reservoir hosts a popular white and black crappie fishery as well as largemouth bass and a small, native bull trout presence. A recovering and reintroduced bull trout population is present above Hills Creek, similar to Cougar Reservoir, but bull trout are a native, ESA-listed species, and so their predation on juvenile salmonids is viewed as a more favorable and natural (deleterious) effect on salmonids, whereas predation by the non-native warmwater species is not.

Past reservoir sampling and predator studies found a greater number and higher abundance of piscivorous species were present in Lookout Point Reservoir than in Cougar or Detroit Reservoirs (Monzyk, Romer, et al. 2011a, 2012). Few walleye (*Sander vitreus*) were collected at the time, but they were found to consume the greatest number of juvenile salmonids per predator (Monzyk et al. 2012). Recent reports from field sampling teams indicate that there are now a large number of walleye present below Lookout Point Dam, likely predating heavily upon disoriented or injured juvenile salmon as soon as they make their way through the spillways, turbines or regulating outlets (D. Alegre, personal communication, December 12th, 2024). In past studies northern pikeminnow were found to have a larger effect on the juvenile salmon population because they were the most numerous of the piscivorous species (Monzyk et al. 2011a, 2012, 2013, 2014). Most of the Chinook salmon consumption was in spring and was estimated to be 0.160–0.188 fish per day per predator for northern pikeminnow, largemouth bass, and walleye (Monzyk et al. 2013). More recent studies in Lookout Point and HIlls Creek reservoirs found that bass and crappie preyed more heavily on Chinook salmon fry in the spring season compared to northern pikeminnow (Murphy et al. 2021).

A large number of hatchery-origin summer steelhead smolts are released into the Middle Fork Willamette River below Dexter Dam. The effects of these releases on juvenile Chinook salmon are not well documented. These hatchery steelhead are believed to migrate downstream relatively quickly. However, there is also evidence for potential residualization of hatchery-origin steelhead and potential resulting predation on competition with juvenile Chinook salmon (Johnson et al. 2021). Hatchery rainbow trout are released into Fall Creek Reservoir, Hills Creek Reservoir, and Salmon Creek (near Lookout Point), and their effect on juvenile Chinook salmon could be significant (Murphy et al. 2021) but has not been tracked.

4.2.7 Research and Monitoring Evaluations

Hills Creek Dam and Reservoir

Injunction operations have required regulating outlet prioritization (of discharge) from 6:00 p.m. to 10:00 p.m. when the elevation is less than 1,460 feet in the months of November to March.

Two rotary screw traps (RSTs) sampled in the tailrace of Hills Creek Dam in 2023. One is a 5-foot trap positioned below the confluence of the RO and powerhouse (PH) outlet channels and is referred to as the RO trap. This trap captures fish from both outlets, and thus, juvenile Chinook salmon encountered in this RST cannot be assigned to a route of passage. The other RST is an 8-foot trap positioned in the outlet of the PH and is referred to as the PH trap. Because of the inability to assign a passage route to fish caught in these traps, it was difficult to determine if the regulating outlet operations improved passage efficiency for juvenile Chinook salmon in Hills Creek reservoir (EAS 2024a; EAS 2024b; EAS 2023c).

Lookout Point Dam and Reservoir

Recent injunction operations have included the use of the spillway from mid-March to May or June and use of the regulating outlets in the late summer for downstream temperature management and, later for downstream passage conditions when drawdown operations attempt to reach 750 feet in elevation and hold that elevation from November 15th to December 15th if possible under flood risk management or other constraints.

The 2023 RST monitoring results for the Lookout Dam tailrace demonstrated that catch coincided with surface spill in spring and early summer, but trapping efficiencies at this site are poor. Unfortunately, the trap located closest to the spillway can also catch fish passing through the powerhouse and vice versa; therefore, route of passage cannot be determined with certainty (EAS 2024).

Fish passage during the Lookout Point Reservoir summer and fall drawdown operation was monitored by USGS in 2023 using acoustic tags and arrays. Receivers were installed below Lookout Point Dam, above Dexter Dam, near the confluence with the Willamette, and at Willamette Falls. All fish were released in the head of the Lookout Point Reservoir. The tagged fish were not fully representative of either reservoir-rearing fish or fall migrants. Most fish released at the start of the drawdown from mid-August to mid-September did not move, and only 11 percent ultimately made it to Dexter Dam. The latest release group, which occurred when the reservoir elevation became closest to the regulating outlets (and the minimum drawdown point), had 84 percent detected at Dexter Dam, and half of these fish were also detected all the way down to Willamette Falls Dam. Survival through the dam decreased with fish size and increased with proximity of reservoir elevation to the regulating outlet elevation. A few fish still passed once the 750-foot minimum elevation was reached. It is possible that some of the early released fish did not pass the dam because of very poor temperature conditions in the reservoir in late summer, which were worsened because of the drawdown operation.

Dexter Dam

Few studies specific to Dexter Dam distinguish effects of passage from Lookout Point Dam through Dexter reservoir and the dam under spill or turbine operations). However, in the first year of Lookout Point drawdown for operational passage, montiroing by Hance et al (2024) found additional "mortality and delay in and through Dexter reservoir and dam."

4.3 McKenzie River Sub-Basin

Within the McKenzie subbasin the action area includes: 1) the mainstem McKenzie River from the South Fork confluence to the confluence with the Willamette mainstem; 2) the Blue River from Blue River reservoir to the mainstem McKenzie River; and 3) the South Fork McKenzie River from Cougar Reservoir to the mainstem McKenzie River; and 4) adult release site locations above Cougar Dam. The following section presents an assessment of the condition of the listed species and its designated critical habitat in the McKenzie River sub-basin portion of the action area.

The McKenzie River drains approximately 1,337 square miles on the western slopes of the Cascade Mountain Range in northwestern Oregon. The mainstem river is 90 miles long and has an average daily discharge of 8,500 cfs (range, 2,410–29,900 cfs; U.S. Geological Survey, 2016a, U.S. Geological Survey, 2016b; USGS streamgage 14165500) as measured near the mouth.

Much of the subbasin is mountainous, though there are flat bottomlands along the lower McKenzie and the Mohawk rivers. About 70 percent of the subbasin is federal forestland, with the Willamette National Forest accounting for nearly the entire area above the Blue River confluence, except for private in-holdings near the mainstem McKenzie River. Forested tributaries to the McKenzie River below Blue River, particularly below Vida (at RM 41), have mixed to strongly private ownership as the river flows to and through Willamette Valley bottomlands that begin near Deerhorn Bridge at RM 32. Much of the valley floor below this bridge has been converted to agriculture or put to residential use (MWC 1996).

A total of six major dams are present in the subbasin, four of which are owned by the Eugene Water and Electric Board (EWEB). EWEB's Smith River Dam, Carmen Diversion Dam, and Trail Bridge Dam on the upper McKenzie River are not part of the action area but do presently block UWR Chinook salmon from historical spawning habitat. EWEB also owns Leaburg Dam on the lower McKenzie River at approximately RM 29, which was originally constructed to divert water into a power canal as part of the Leaburg-Walterville Hydroelectric Project. Leaburg Dam does not block fish passage when the adult fish ladders are operating. The two remaining dams, Cougar Dam on the South Fork McKenzie River (constructed in 1963) and Blue River Dam on the Blue River (constructed in 1969), are owned by the USACE (Figure 4.3-1). Two hatcheries are operated, Leaburg and McKenzie Fish Hatcheries.

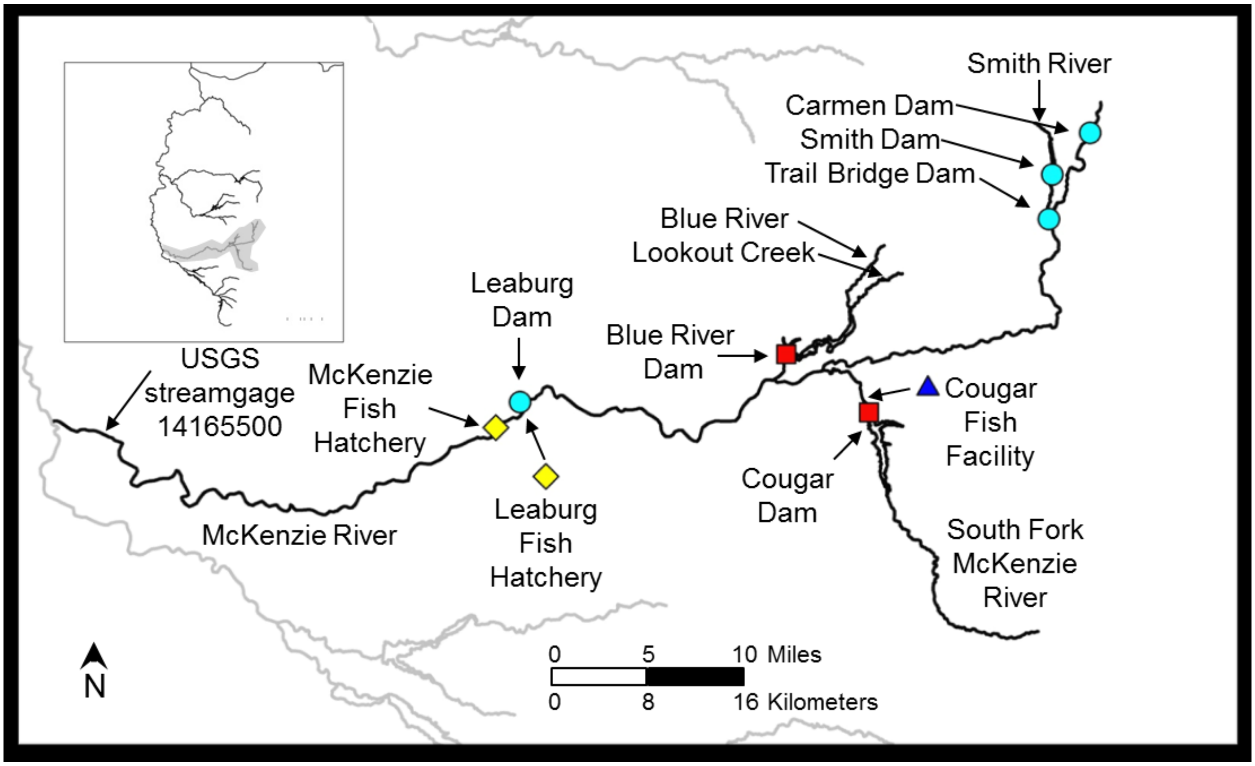


Figure 4.3-1. Map showing primary rivers in the McKenzie River subbasin (black lines), U.S. Army Corps of Engineers (USACE)-owned dams (red squares), non-USACE dams (blue circles), fish hatcheries (yellow diamonds), and adult fish facility (blue triangle), Willamette River Basin, Oregon. (Figure from Hansen et al. 2017.)

4.3.1 Historical Populations of Anadromous Fish in the McKenize River Sub-basin

Historical spawning areas for UWR Chinook salmon within the McKenzie subbasin included the mainstem McKenzie River, Smith River, Lost Creek, Horse Creek, the South Fork, Blue River, Gate Creek, and Mohawk River (Mattson 1948, Parkhurst et al. 1950). Habitat that remained suitable for and available to these fish in the 1940s was estimated to have the capacity to support approximately 80,000 spawners (Parkhurst et al. 1950). However, adult runs this large were never documented. The Oregon Fish Commission estimated that the largest run of UWR Chinook salmon into the McKenzie River subbasin for which it had data was one of approximately 46,000 adults in 1941. This estimate assumed that 39 percent of the UWR Chinook salmon adults counted passing over Willamette Falls were bound for the McKenzie subbasin (Mattson 1948, USACE 1995). Estimated run sizes of UWR Chinook salmon returning to the McKenzie subbasin from 1945–1960 averaged 18,000 adults (USACE 1995). A run of 4,300 adult Chinook salmon escaped to spawn in the South Fork alone in 1958 (USFWS 1959).

UWR steelhead are sometimes found within lower elevation areas of the McKenzie subbasin, but these areas are not thought to have supported a historical population of the species.

4.3.2 Current Status of UWR Chinook Salmon McKenzie Population and Importance to Recovery

In 2005, a Biological Review Team (BRT) considered updated abundance information, habitat accessibility analyses, and the results of preliminary Willamette–Lower Columbia Technical Recovery Team (WLC-TRT) analyses. These analyses supported previous BRT conclusions that the majority of populations in the UWR Chinook salmon ESU were nearly extirpated, and the McKenzie River population was identified as potentially self-sustaining, and increases in abundance were noted for this population in the most recent returns available at the time (2000 and 2001). However, the BRT was concerned about the long-term potential for this population.

The McElhany et al. (2007) status assessment of UWR Chinook salmon rated the McKenzie population as being at moderate risk of extinction based on an evaluation of its abundance, productivity, spatial structure, and diversity. Within-subbasin contributors to this risk include habitat degradation associated with USACE dams, land use, and the ecological and genetic effects of a very large fish hatchery program within the subbasin (WLCTRT 2003).

New information considered for the 2010 and 2015 status review updates did not indicate a change in the overall biological risk category for the UWR Chinook salmon ESU; however, the apparent decline in the status of the McKenzie River DIP was a source of concern in the 2015 review, given that this population was previously seen as a stronghold of natural production in the ESU (Ford ed. 2022). Through 2017, ODFW conducted comprehensive spawner surveys (redds and carcasses) both below and above dams in the McKenzie River basin, and more comprehensive surveys were done in 2018 and 2019. Only partial surveys could be done in 2020, which included the restoration area in the South Fork McKenzie River. Direct adult counts are also made at Leaburg and Cougar Dams and the McKenzie Hatchery (McKenzie River) (Ford ed. 2022). The estimated 5-year geometric mean of these McKenzie spawner counts from 2005 through 2019 remained stable for natural-origin adults: 1,794 for 2005–2009, 1,479 for 2010–14, and 1,664 for 2015–19 (Ford ed. 2022).

The latest 5-year status review for UWR Chinook salmon also assessed the McKenzie population as being relatively stable, and it remained at a low-to-moderate risk of extinction (NMFS 2024a). However, looking at the estimated natural-origin adult UWR Chinook salmon count at Leaburg Dam, returns appeared “stable” in 2020 (1502), 2022 (1779) and 2023 (1531) but were significantly lower in 2021 (668) and 2024 (565) (Figure 4.3-2). Adult UWR Chinook salmon returns to Leaburg Dam were so low in 2024, that no adults were transported to spawning areas above Cougar Dam. Despite having volitional access to a higher proportion of its historical spawning habitat (compared to the Santiam and Middle Fork Willamette populations), the McKenzie population remains well below its recovery goal (NMFS 2024a). Possible further declines in abundance over the last 10 years provides further incentive to improve conditions in the South Fork McKenzie and downstream juvenile survival through Cougar reservoir and dam.

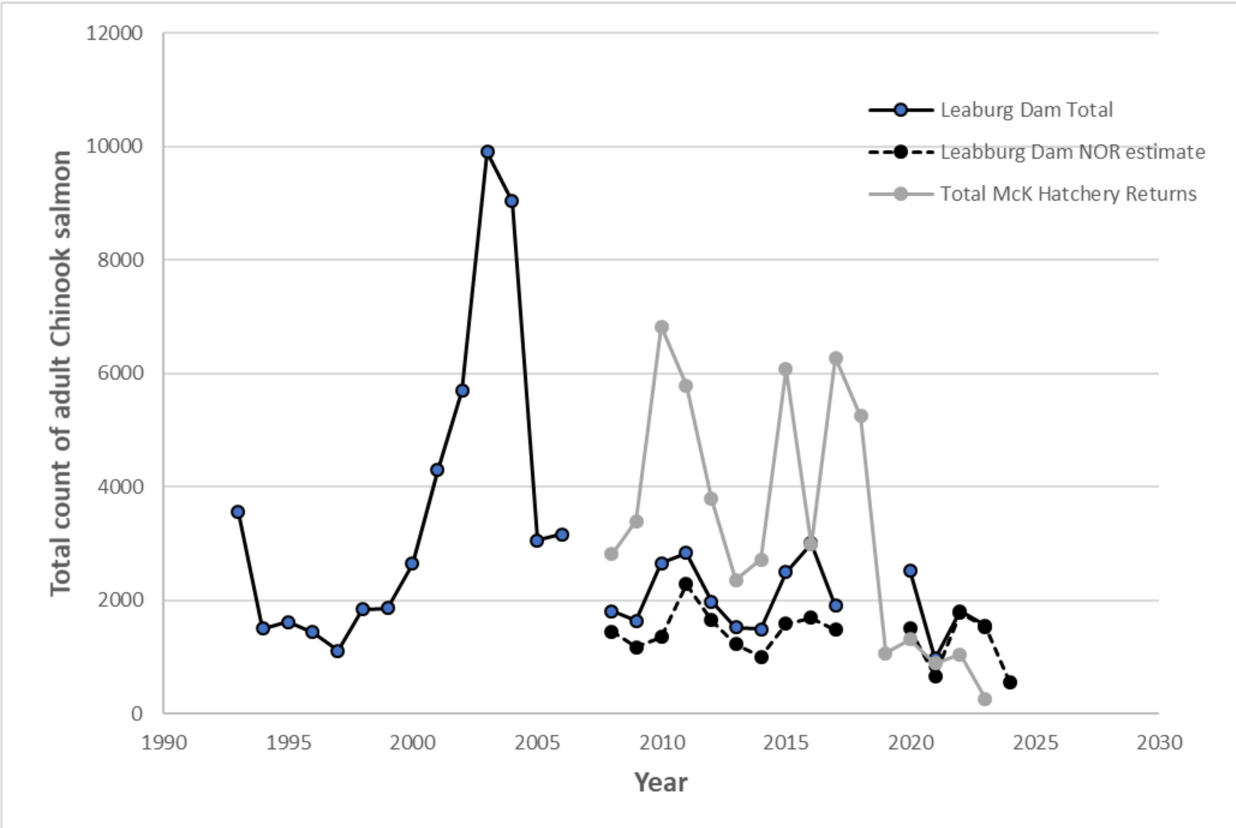


Figure 4.3-2. Total annual count of adult Chinook salmon returning to the McKenzie River at Leaburg Dam, to the two hatcheries located below Leaburg Dam (mostly HORs), and total annual count of natural-origin adult Chinook counted at Leaburg Dam. Beginning in 2023, in order to reduce the percentage of hatchery fish on spawning grounds above Leaburg Dam, ODFW began sorting fish at Leaburg Dam, and restricting the passage of returning clipped, hatchery-origin adult Chinook (by returning them to areas below the dam).

4.3.3 Environmental Conditions and Climate Change

4.3.3.1 Habitat Access and Fish Passage Conditions

In contrast to most of the other populations in the UWR Chinook salmon ESU, McKenzie River Chinook salmon have access to a higher proportion of their historical spawning habitat, although access to high-quality habitat above Cougar Dam, in the lower South Fork McKenzie River, is limited because of a lack of volitional passage for adult UWR Chinook salmon and poor downstream juvenile passage conditions.

Adult Passage

A proportion of adult UWR Chinook salmon collected at the McKenzie River hatcheries (mostly hatchery-origin), and all of the Chinook collected at the adult fish facility below Cougar Dam (mostly natural-origin) are transported via fish transport truck to release sites above Cougar Dam in the South Fork McKenzie River. However, a large proportion of returning adults will spawn in the mainstem McKenzie River (including natural-origin and hatchery-origin fish in areas below Leaburg Dam), and in the South Fork McKenzie River below Cougar Dam (mostly natural-origin only now) (see Figure 4.3-1 for location references).

Past spawning surveys below Leaburg Dam in 2015 and 2016 produced pre-spawning mortality rates of 48% and 17%, respectively. Pre-spawning mortality rates for adult release areas above Cougar Dam were 9% in 2015 and 0% in 2016 (Sharpe et al. 2017b). A summary of all spawning survey data and pre-spawn mortality rates estimated over the course of 14 years, showed that the average rate was higher in the lower McKenzie (31%, ranging from 9 to 60%) than the upper McKenzie (6%, ranging from 1 to 17%), and that the 7 day-average-daily-maximum temperature during the spawning season for those same years was typically higher in the lower McKenzie at 17.8℃ (ranging from 16 to 19.2℃) than in the areas surveyed in the upper McKenzie (16.2℃, ranging from 14.8 to 17.2℃) (Bowerman et al. 2018).

USACE improved release sites upstream of Cougar dam to facilitate successful spawning of transported and outplanted adult fish in historical habitat upstream of the dams in compliance with RPA 4.7, Adult Fish Release Sites above Dams. A genetic parentage analysis for natural origin (NOR) adults collected at the Cougar trap in 2010–2012 estimated the total lifetime fitness (TLF) of 2007 adult outplants. On average, adult Chinook salmon outplanted earlier in the season of 2007 were more successful at producing adult returns. Also, the mean TLF of spring Chinook salmon outplanted at Slide Creek in 2007 was higher than at other outplant sites. In 2010, the mean recruit to spawner ratio (R/S) of NOR males was greater than that of hatchery origin (HOR) males but that the mean R/S of NOR females was less than that of HOR females. Using adult-to-adult assignments, the female cohort replacement rate (CRR) was estimated at 0.38 and the effective population size (Ne) at 184 (95 percent CI: 166-204). These estimates suggested that the spring Chinook salmon population above Cougar Dam is not replacing itself, but short-term negative effects associated with genetic drift on the population are unlikely to occur (Banks et al. 2014a). O'Malley et al. (2023) provided updated CRR values of total cohort CRR values that ranged from 0.1 to 0.67, for 2011-2015 outplants in the most recent pedigree analysis.

Leaburg Dam does have volitional upstream passage for adults including ladders on both riverbanks; however, the attraction and passage efficiency through the ladder on river right is much higher than at the river left ladder. Since 2023, due to an effort to reduce percent hatchery fish on spawning grounds (pHOS) in the McKenzie River, during the peak of adult upstream Chinook salmon migration, the river right ladder is closed and the river left ladder is operated as a trap to sort and pass only natural-origin adults and move them upstream, while routing hatchery-origin fish back to the river below the dam or holding for broodstock. It is possible that this ladder attraction issue may have reduced the passage of natural-origin fish above Leaburg Dam in recent years, which is not an ideal outcome given higher observed pre-spawning mortality rates and also because it could limit the success of establishing a natural-origin population above Cougar Dam.

Though not considered part of the action area, volitional adult passage is also blocked at Trail Bridge Dam in the upper McKenzie (owned by EWEB and not part of the proposed action), and the new adult trap below Trail Bridge Dam has not yet proven effective at attracting and collecting adult Chinook salmon for transport above Trail Bridge Dam. Therefore, a self-sustaining naturally spawning Chinook salmon population above Trail Bridge has yet to be established. Anadromous fish populations are not present upstream of Blue River Dam (a WVS project and part of the proposed action) (see Figure 4.3-1). Please refer to the 2008 NMFS WVS Biological Opinion for more information on the history of adult passage issues in the McKenzie sub-basin (NMFS 2008a).

Cougar Dam

Cougar Dam is 1,600 ft long, 452 ft high, and is primarily comprised of a rock-fill structure that spans the valley floor. Structures for passing water (and fish) are located on the sides of the dam. On the east side of the dam is an emergency spillway that only serves to pass water during extreme flood events, and on the west side (in a cul-de-sac) is a water-intake tower that passes water to the RO or the powerhouse that was modified in 2004 when a water temperature control tower (hereinafter "temperature control tower") was constructed. The temperature control tower can be used to selectively withdraw water from different depths in the reservoir to control downstream water temperatures during periods when reservoir elevations exceed 1,561 ft. At the intake tower, water can be bypassed around the powerhouse through the RO or passed into the powerhouse through a penstock. The powerhouse contains two Francis turbines capable of producing 25 MW of power (1,050 cfs). Water elevations undergo substantial changes during the year and generally ranged from 1,532 ft in winter to 1,690 ft in summer. However, in recent years, reservoir elevations have been as low as 1,450 ft during winter to facilitate maintenance and construction projects at the dam. Fish passing through the current temperature control tower enter the tower at the various elevations and then sound down as much as 270 ft to the elevation of the RO (1,485 ft) or penstock chute (1,425 ft). Fish passing the RO exit the chute in the RO outfall adjacent to the powerhouse tailrace. During extensive reservoir drawdown, fish passage through the gated diversion tunnel is possible, with fish entering the tunnel outside the cul-de-sac and exiting the tunnel in the powerhouse tailrace.

Juvenile Migration

Much is known about juvenile fish growth and movement in Cougar Reservoir and at Cougar Dam. Fry emerge from redds in February and March and move downstream into the reservoir primarily during March–May. Juvenile Chinook salmon have long residence times in Cougar Reservoir, where growth rates are moderate compared to other reservoirs in the WVS. Passage rates are low at Cougar Dam and fish that reside for long periods in the reservoir are susceptible to copepod infection.

Several studies have provided information about the timing of emergence and downstream dispersal of juvenile Chinook salmon in Cougar Reservoir. An RST was operated 0.6 river miles upstream of Cougar Reservoir for several years (2010-2015) prior to more recent Injunction monitoring collecting data on downstream dispersal timing and fish size. Results from these studies showed that collection typically began in February and continued through December, and most fish were captured moving downstream between March and May during pool refill or full conservation pool (Monzyk et al. 2012; Zymonas et al.2011; Romer et al. 2012, 2013, 2014, 2015, 2016). The median emigration date was estimated to occur between late April and mid-May (Monzyk et al. 2011b; Romer et al. 2012, 2013, 2014, 2015). The earliest median emigration date was April 9 in 2015, likely due to warmer than average temperatures (Romer et al. 2016). Chinook salmon fry that were captured in February had fork lengths of 40 mm or less, and most fish captured in December were yearlings (with fork lengths of about 100 mm).

Studies conducted in Cougar Reservoir showed that juvenile Chinook salmon primarily were distributed in the upper part of the reservoir early in the year but then moved downstream towards the dam as the year progressed. Monzyk et al. (2011a) and Monzyk et al. (2013, 2014, 2015a) reported that most (69.0–79.0 percent) of the juvenile Chinook salmon that were collected in nearshore and offshore areas with box traps and small Oneida Lake traps in April were located in the upper one-third of the reservoir. By June, as much as 40.2 percent of the fish were collected in the lower one-third of the reservoir, near Cougar Dam (Monzyk et al. 2014, 2015a). Monzyk et al. (2012) reported that "the wide range of sizes of subyearlings collected near the head of the reservoir suggest that some juvenile fish likely rear in these areas after reservoir entrance." Researchers also reported seasonal differences in behavior that may be related to water temperature. Chinook salmon were collected along shorelines in traps as fry but then moved offshore by June as water temperatures increased (Monzyk et al. 2013, 2014). In fall, when surface temperatures dropped to 17°C, Monzyk et al. (2011b) observed actively feeding schools of fish 3–23 ft from shore.

Acoustic cameras were mounted on floating platforms in front of the water temperature control tower in multiple years to quantify fish movement. From March 1, 2010, to January 31, 2011, Khan et al. (2012a) reported that juvenile fish abundance was correlated to forebay elevation, velocity over the tower intake gate weirs, and reservoir inflows. Abundance of detections peaked for all fish between 6:00 a.m. and 6:00 p.m. in spring and fall of 2013 (Adams et al. 2015). In spring 2013, fish greater than (>) 300 mm were deeper than fish 30–60 mm, 60–90 mm, and 90–250 mm during all hours except the crepuscular periods (Adams et al. 2015). In fall, all fish 30–300 mm were less than 12 ft deep between 11:00 a.m. and 4:00 p.m., whereas fish >300 mm were deeper in the other hours (Adams et al. 2015).

Fish that pass the dam do so primarily during nighttime hours. Fish depths varied throughout the year and diel period. Fish tended to be deeper at night than during the day (Beeman et al. 2016b; Ploskey et al. 2012). As shallow water temperatures warmed in summer and cooled in winter, fish depth followed a preferred water temperature range. From September to October 2015, when surface water temperature was as high as 20°C, acoustic tagged fish generally were approximately 27 ft deep (Beeman et al. 2016a). Habitat preference indices indicated that acoustic-tagged fish in the cul-de-sac preferred 13–15°C in the summer, which corresponded to a mean depth of 29–54 ft (Beeman et al. 2016b). Deeper nets deployed in Cougar Reservoir collected more juvenile Chinook salmon than shallower nets during summer (Ingram and Korn, 1969; Monzyk, et al. 2011a; Monzyk et al. 2012).

The prevalence and intensity of copepod *(S. californiensis*) infection in Cougar Reservoir was high, whereas predator presence was low. Less than 10 percent of the fish sampled in a trap located above the reservoir (in the free-flowing river) were infected during July–November, whereas 13–89 percent of the fish trapped in the reservoir were infected during a similar time period (Monzyk et al. 2012, 2013, 2014, 2015b). Most of the reservoir fish had parasites attached on the branchial cavities (Beeman et al. 2015; Monzyk et al. 2013, 2015b), whereas in-stream fish had attachments on fins (Monzyk et al. 2015b). As time and fish size increased, infection intensity increased (Monzyk et al. 2013, 2014, 2015b). Seven percent of yearling fish had 20 or more parasites on their branchial cavities (Monzyk et al. 2013). The presence and intensity of copepods in branchial cavities may affect long-term movements of fish in reservoirs, based on data collected using acoustic-tagged fish (Beeman et al. 2015).

A wealth of information is available on route-specific passage of juvenile Chinook salmon at Cougar Dam. Results from several studies indicate that passage is highest through the RO. Passage of unclipped fish was evaluated using traps downstream of Cougar Dam, where researchers determined that a total of 71 percent of the juvenile Chinook salmon collected were in the trap located in the RO channel (Taylor, 2000). Similarly, an estimated 84.9 percent of live subyearling Chinook salmon collected in the downstream screw traps in 2015 were collected in the RO trap (RO, 33,078 [95-percent CI of ±5,211]; powerhouse, 5,862 [95-percent CI of ±2,036]; Romer et al. 2016). The RO provides a shallower passage route from the reservoir than the powerhouse, which likely contributes to higher passage through that route. Romer et al. (2012) reported that 91 percent of the fish passed through the RO when discharge was similar between the two routes, but RO passage decreased to 44 percent when two-thirds of the discharge was passed through the powerhouse (Romer et al. 2012). Studies by Monzyk et al. (2011b) and Zymonas et al. (2011) also indicated that RO passage increased with increasing discharge through the route.

Along with reservoir fluctuations, conditions at the tower entrance also seem to affect fish passage because many juveniles congregate near the tower entrance in spring and fall. Several studies to measure the route of passage of tagged fish were conducted where marked fish were released directly in front of the temperature control tower. Fish predominantly passed through the RO—about 51 percent of the fish passed through the RO when discharge was 530 cfs through the RO and 100–1,060 cfs through the powerhouse; 64 percent of the fish passed through the RO when RO discharge increased to 2,700 cfs and powerhouse discharge was 1,080 cfs (Monzyk et al. 2011b). Both tests occurred during winter low pool (about 1,540 ft) and PIT-tagged fish were about 110–210 mm (Monzyk et al. 2011b). Radio and acoustic-telemetry studies produced similar results. During 1 week in early November 2011 when discharge was about 500 ft3/s through each route, 94 percent of the radio-tagged fish passed through the RO at a mean forebay elevation of 1,579.78 ft (mean fish size 132.4 mm [range 102–166 mm]; Beeman et al. 2012). Passage probabilities of radio-tagged fish during 1 week in early November 2012 were 92 percent through the RO and 8 percent through the powerhouse (mean fish size 148.2 mm [range 105–179 mm]; Beeman et al. 2014a). Mean forebay elevation was 1,588.6 ft and mean discharge split was 1,000 cfs powerhouse/547.7 cfs RO during the day and 228.0 cfs powerhouse/1,333.4 cfs RO during the night (Beeman et al. 2014a). Romer et al. (2012, 2013, 2014) reported that fry-sized fish passed Cougar Dam through both routes and were influenced by increased total discharge.

Some fish entered the temperature control tower and returned to the reservoir. Beeman et al. (2014a) reported that 31 percent of the acoustic tagged fish in their fall study entered the temperature control tower and returned back upstream to the dam forebay. Of these fish, 48 percent eventually passed through the tower. Few fish exhibited this behavior in spring (Beeman et al. 2014a). The rate of entering and returning from inside the tower was greatest when discharge was low and the depth over the weir gates was high—generally in fall and prior to the end of downstream temperature mitigation when reservoir elevations were about 1,561 ft (often prior to early October). The rate of this behavior was 90 percent higher during the day than the night and primarily occurred when discharge was at a mean of 460 ft^3/s (range 420–540 ft^3/s; Beeman et al. 2014a). Juvenile tagging studies indicate that total survival through Cougar Reservoir and Dam has been poor (Beeman et al. 2013).

The diversion tunnel is rarely used at Cougar Dam, but it is occasionally operated to draw the reservoir down for construction or maintenance needs. In some instances, research was ongoing when the diversion tunnel was accessible for fish passage, which provided useful information. The diversion tunnel was used prior to and during construction of the water temperature control tower and during trash rack repair at the base of the tower in early 2016. Prior to construction of the temperature control tower, the reservoir was drawn down and water was discharged through the diversion tunnel. Zymonas and et al. (2011), reported that "appreciable numbers" of Chinook salmon fry were collected after passage through the diversion tunnel during April–June 2002 and February–May 2003. Few tagged fish with live tags were in the reservoir during the drawdown in early 2016 and no fish were detected downstream, although detection probabilities of the acoustic sites in the tailrace were poor during high flows (Beeman et al. 2016a). No acoustic-tagged fish were detected at downstream PIT sites during this period.

Collection of juvenile Chinook salmon through the Portable Floating Fish Collector (PFFC) was evaluated during 2 years and was very low. During spring 2014, 397 acoustic-tagged fish were detected in the forebay of Cougar Dam but only 1 was collected in the PFFC (0.2 percent; Beeman et al. 2016b). Modifications to the PFFC in winter 2014–15 included raising the trap 1.5 ft, changing the anchor locations to move the PFFC closer to the tower, and modifying the dewatering screens to reduce vibration (Beeman et al. 2016a). These changes had little effect on improving performance, as only 1 percent of acoustic-tagged fish were collected in the PFFC during fall 2015 (Beeman et al. 2016a). Subyearling and yearling Chinook salmon were PIT-tagged and released (N=3,002) at the head of the reservoir in spring and fall 2014 and 2015, and less than 1 percent of these were eventually collected in the device (Beeman et al. 2016a, 2016b). Positioning of acoustic-tagged fish showed that juvenile Chinook salmon were temporarily concentrated in the outflow of the PFFC, which was aimed toward the intake of the temperature control tower rather than in front of the PFFC entrance (Beeman et al. 2016a). Two of the six acoustic-tagged fish that were collected in the PFFC entered the device during daylight hours (Beeman et al. 2016a, 2016b). Acoustic camera evaluations at the PFFC entrance showed that fish of all size groups (30–300 mm) were detected in greatest numbers during crepuscular periods (Beeman et al. 2016b).

Seasonal and Diel Patterns

Downstream fish passage has been intensively studied at Cougar Dam, and results from these studies show that changes in water level elevations have a strong effect on passage. Water level elevations in the reservoir generally are high during late spring and summer, and multiple studies have shown that few fish pass under these conditions. Results from acoustic telemetry studies conducted in 2011, 2012, and 2014 showed that only 0.111–0.333 of the tagged fish passed Cougar Dam during spring. Fish passage in this period primarily occurred during April–July and generally peaked during periods of increasing discharge (Beeman et al. 2013, 2016b; Beeman et al. et al. 2014a). These findings support studies conducted shortly after the construction of Cougar Dam. Ingram and Korn (1969) reported that the normal outmigration period for juvenile Chinook salmon in Cougar Reservoir likely ended by June 30. Juvenile Chinook salmon were detected passing Leaburg Dam in spring (Schroeder et al. 2016). Some Chinook salmon fry passed Cougar Dam and were collected in screw traps (Zymonas et al. 2011; Romer et al. 2016). The earliest capture of fry downstream of Cougar Dam was on January 21, 2015, when reservoir elevation was low (small area compared to high pool), water temperature was warmer than average, and the PFFC was in operation (Romer et al. 2016).

Several studies have shown that downstream fish passage increases during fall as reservoir water elevations decrease (Romer et al. 2016). Beeman et al. (2013, 2016b) and Beeman et al. (2014a) reported that 0.244–0.652 of the juvenile hatchery and unclipped Chinook salmon that were monitored passed Cougar Dam during fall. Acoustic-tagged subyearling Chinook salmon passage occurred in November and December but extended into March when discharge rates were greater than 1,000 ft3/s (Beeman et al. 2013, 2016a, 2016b; Beeman et al. 2014a). This finding was supported by results from several other studies (Taylor, 2000; Romer et al. 2013, 2015) in which researchers reported that dam passage increased during fall, when reservoir water elevations were low and discharge through the dam was increased. The reported catch of yearling Chinook salmon downstream of Cougar Dam occurred during January–July (Monzyk, 2010; Zymonas et al. 2011; Romer et al. 2012, 2013, 2014). Catch of subyearling Chinook salmon in downstream traps peaked during November–February (Zymonas et al. 2011; Romer et al. 2012, 2013, 2014). Romer et al. (2015) reported that 83 percent of the subyearling Chinook salmon passed in November 2014 during RO discharge and low reservoir elevations. Numerous yearlings exited the reservoir in November 2013 (8-fold increase compared to other years), which was speculated to be the result of a deep drawdown that occurred in 2013 followed by a period of low discharge (Romer et al. 2014, 2015). Prior to construction of the temperature control tower, 21–28 percent of fish released in front of the fish horns and upstream of Cougar Reservoir passed the dam in late fall or early winter (Ingram and Korn, 1969).

Most fish passage at Cougar Dam seems to occur at night. Beeman et al. (2013) and Beeman et al. (2014a) reported that 74–94 percent of the acoustic-tagged fish that passed Cougar Dam during spring and fall 2011 and 2012 did so during the night. In two studies, diel releases of tagged fish occurred at the upstream edge of the Cougar Dam forebay and in front of the water temperature control tower, and most of the fish (93 percent and 87 percent, respectively) that passed the dam from these releases did so during the night (Beeman et al. 2012; 2014a). Beeman et al. (2014a) conducted an analysis of covariate effects on passage at Cougar Dam, which indicated that passage of acoustic-tagged fish in fall was “about 36 times greater at night than during the day, and increased 29.5 percent for each 10 ft decrease in forebay elevation.” They also noted that passage rate increased within increasing fork length but did not report differences between hatchery and natural-origin fish (Beeman et al. 2014a).

Downstream Juvenile Survival

Route-specific passage survival has been evaluated multiple times at Cougar Dam. In the 1960s, Ingram and Korn (1969) studied mortality of juvenile Chinook salmon passing through the fish horns and reported that 68 percent of the fish were killed from the point of horn entry to the end of the RO tailrace. The fish horn entrances were 10–45 feet while fish collected in gill nets were at a depth of 0–15 feet (Ingram and Korn 1969). The deep entrances to the fish horns likely influenced the low numbers of fish passing the dam. Only 28.2 and 21.1 percent of hatchery Chinook salmon released at the head of Cougar Reservoir passed the dam in spring 1965 and 1966, respectively (Ingram and Korn, 1969). Taylor (2000) evaluated passage mortality during 1998–99 and noted that 7 percent of the fish died while passing through the powerhouse compared to 32 percent passing through the RO. The authors also observed that mortality increased with increasing fish size (Taylor 2000). Zymonas et al. (2011) collected fish in the RO tailrace and powerhouse tailrace and documented post-collection mortality rates. They reported that 18 percent of the fish that passed through the powerhouse died compared to 42 percent of the fish that passed through the RO. Additionally, the authors reported that 27 percent of the fish that were collected at rm 2.8 did not survive (Zymonas et al. 2011). Mortality of fish held 72 h after passage was higher in the RO (36 percent) than in the powerhouse (19 percent) and was influenced by a combination of low reservoir elevation, discharge, and fish length for each route (Zymonas et al. 2011).

Injury and direct survival through the RO and powerhouse was measured using mechanical sensor fish and balloon-tagged Chinook salmon during December 16–18, 2009, and January 18–21, 2010, respectively (table 23). Fish in the RO study were a mean length of 172 mm (range 127–209 mm), and in the powerhouse study were a mean length of 179 mm (range 124–230 mm; Normandeau Associates, Inc. 2010). Study conditions included a 1.5-ft RO opening at 440 ft^3/s and 3.7-ft RO opening at 1,040 ft^3/s when the reservoir elevation was near winter low pool (1,532–1,541 ft; Normandeau Associates, Inc. 2010; Duncan, 2011). The turbine evaluation included three separate treatment conditions for unit 2: 1) minimum wicket opening and 340 ft^3/s, 2) maximum wicket opening and 550 ft^3/s, and 3) peak efficiency wicket opening and 455 ft^3/s (Normandeau Associates, Inc. 2010). Duncan (2011) used sensor fish and reported a high incidence of one or more significant strike, collision, or shear events (acceleration magnitude greater than 95 g) in the RO and powerhouse outlets (more than 92 percent). Nearly 86 percent of trials resulted in multiple significant events during passage through the powerhouse and RO. Most of the events experienced by the sensor fish during RO passage were on the RO chute. All the sensor fish experienced more than one significant event of collision or shear during powerhouse passage, and all events were in the runner region.

During powerhouse passage, 80 percent of the most severe events were a collision or strike event during the minimum wicket gate opening. Shear events increased during maximum and peak efficiency operation and blade strike increased with fish size (Duncan, 2011). Mortality through the RO and powerhouse was delayed 24–48 h after passage. Normandeau Associates, Inc. (2010)

reported that 1-h direct survival using balloon tags was about 92 percent through the RO and 58–65 percent through the powerhouse, depending on operation. However, 48 h after passage, survival of fish that passed through the RO was 85–88 percent, depending on treatment. In contrast, direct survival 48 h after passage was 36–42 percent through the powerhouse (Normandeau Associates, Inc. 2010). Survival and malady-free rate through the RO at a 1.5-ft opening was higher for smaller fish (<160 mm) than for fish larger than 160 mm (Normandeau Associates, Inc. 2010). Results were not significantly different through the RO at a 3.7-ft opening. The malady-free rate was less than 36 percent for each of the turbine operating conditions (Normandeau Associates, Inc. 2010). Fish smaller than 160 mm had higher 48-h survival and malady-free rates during some of the turbine conditions. A similar study using PIT-tagged fish and screw traps in the tailraces was conducted concurrently. Relative survival of PIT-tagged fish to Leaburg Dam was 85 percent at the 1.5-ft RO opening compared to 104 percent at the 3.7-ft RO opening (Monzyk 2010). In a separate study, Romer et al. (2012) reported greater mortality of PIT-tagged fish through the RO during discrete drawdown flow conditions in November 2011.

Estimated survival of fish passing through the temperature control tower to 2.4 river miles downstream of the dam was about 40 percent for both routes (Beeman et al. 2012). Survival of tagged fish that passed through the RO and were detected at Leaburg Dam was 19.3 percent in November 2011, 47.2 percent in November 2012, and 55.9 percent in December 2012 (table 23; Beeman et al. 2012; Beeman, Evans, et al. 2014). Assessment of barotrauma and mechanical damage after passage through the RO and powerhouse was evaluated for fish collected in screw traps in 2012. A total of 74.4 percent of Chinook salmon had barotrauma after RO passage compared to 43.6 percent after powerhouse passage (Romer et al. 2013). Mechanical damage was evident in 52.1 percent of RO fish and 69.2 percent of powerhouse fish (Romer et al. 2013). Combined barotrauma and mechanical damage were present in 23.5 percent of Chinook salmon (Romer et al. 2013).

Live fry collected in downstream traps during March–June in multiple years showed that some fry can traverse the reservoir and pass through the RO or the powerhouse and survive (Romer et al. 2012, 2013, 2014, 2015, 2016). Zymonas et al. (2011) also reported fry collected in downstream traps in early spring regardless of reservoir elevation. In 2015, an estimated 17.7 percent (95-percent CI of 4.5–37.3 percent) of juvenile Chinook salmon survived from the screw trap upstream of Cougar Reservoir to the screw traps downstream of Cougar Dam (Romer et al. 2016). A similar estimate was reported in 2013, but may have been overestimated (17.5 percent; 95-percent CI of 11.6–25.0 percent; Romer et al. 2016). The authors note that the estimates include “natural mortality incurred through predation, stochastic environmental conditions, parasites, disease while rearing in the reservoir, and dam-associated mortality” but not “delayed dam passage mortality from potential complications such as mechanical injuries, barotrauma and gas bubble disease or complications facilitated by reservoir rearing such as increased parasite infection intensity” (Romer et al. 2016).

4.3.3.2 Water Quantity/Hydrograph and Climate Change

The environmental baseline description of hydrology for the McKenzie River provided in the 2008 NMFS biological opinion remains accurate except where noted below (NMFS 2008a, section 4.3.3.2). There have been no significant changes to the operations of Blue River Dam and the past and present impacts described in the 2008 NMFS Biological Opinion remain valid.

This watershed is the most stable in terms of seasonal flows and interannual differences in the hydrograph from the large amount of hyporheic input from large springs across much of the watershed, as demonstrated in the figures below for flow by date at the town of Vida on the mainstem McKenzie River (Figure 4.3-3). The operation of dams on the McKenzie River, including the non-federal projects, has resulted in a modified hydrograph. These changes have included reducing or eliminating large winter floods and reducing the frequency, duration, and intensity of smaller winter floods. The influence of the Carmen-Smith complex (in the upper McKenzie) on reduced peak flows is small relative to the USACE projects because they are smaller projects and operated essentially as run-of-the river projects. Cougar and Blue River dams' effects of reducing late winter and spring flows on UWR spring Chinook salmon have not been effectively monitored, but studies in other Columbia River basin watersheds found that freshets are critically important because higher spring flows are correlated with faster downstream travel times and earlier (typically more ideal) arrival times to critical rearing habitats in the estuary and ocean (Scheuerell et al. 2009). Scheuerell et al. (2009) found that this migration timing plays an important role in determining juvenile-to-adult survival for Columbia River Chinook salmon and steelhead, with early migrators typically experiencing much higher survival.

The USACE dam operations on the McKenzie River have also increased minimum flows in summer, as well as shifted the lowest annual streamflow date from September to March (Risley et al. 2010). In the South Fork McKenzie River, the lowest pre-dam average daily flow was 200 cfs. During winter high-flow events, Cougar Dam discharge rates may decrease to about 100 cfs to reduce flooding in the McKenzie and Willamette rivers, but in recent years, flows lower than 200 cfs downstream from Cougar Dam have been rare. The increase in late-summer and early-fall flows provided by flow augmentation operations likely benefits juvenile salmonids by increasing habitat area and reducing the rate that water temperature responds to thermal loads.

More recently required Injunction operations have also altered flows. In summary, these operations require USACE to delay the refilling of the reservoir in the spring and to draw the reservoir down further in the fall. To maintain a lower pool from February to mid-May, the project must pass a higher volume of flows than what was typical prior to 2021. This could result in flows closer to the historical spring flows but cause a reduction in flows during late summer and early fall below Cougar Dam. Because the refilling of the reservoir is delayed, there is also a higher potential that Cougar Dam will not be able to meet minimum flow targets in the summer and fall.

Previous risk of entrapment, stranding, and redd desiccation below Cougar Dam has been largely reduced through the processes established by the NMFS 2008 RPA, which regulates ramping rates and interagency coordination when there are ramp rate exceedances (NMFS 2008a, RPA 9.1 & 9.2).

The USACE attempts to meet below dam flow targets established in cooperation with fisheries agencies. At Cougar Dam these flows are 400 cfs year-round. At Blue River Dam, these flows are 50 cfs year-round. However, the USACE has reduced flows below these target minima when necessary to reduce downstream flood risks and during other emergencies. Maximum flow targets have also been set for the fall for UWR Chinook salmon spawning below Cougar Dam, which has resulted in increased discharges in July and August and lower flows in September and October. Since 2008 these flow targets have not been met in the June target periods (June 1-15 and June 16-30) in 4 or 5 different years, and not in the July and August target periods of just one year. During the years and target periods that these target flows were not met, it was often for most of the days in that target period (USACE 2023a, Appendix K).

Relationships between flow and habitat availability below WVS dams for UWR Chinook salmon spawning and incubation were developed to address NMFS 2008 RPA (R2 2013; River Design Group and HDR 2015). The primary analytical method used for making this evaluation was the Physical Habitat Simulation (PHABSIM) approach, as described by Bovee et al. (1998). This method has been widely used in assessing flow regulation effects (Annear et al. 2004). For most of the mainstem McKenzie River, spawning habitat conditions within the 90th percentile of peak spawning habitat were estimated to occur from approximately 1,400 cfs to 3,300 cfs. In the South Fork McKenzie River, spawning habitat conditions within the 90th percentile of peak spawning habitat is associated with flows ranging from 283 cfs to approximately 700 cfs.

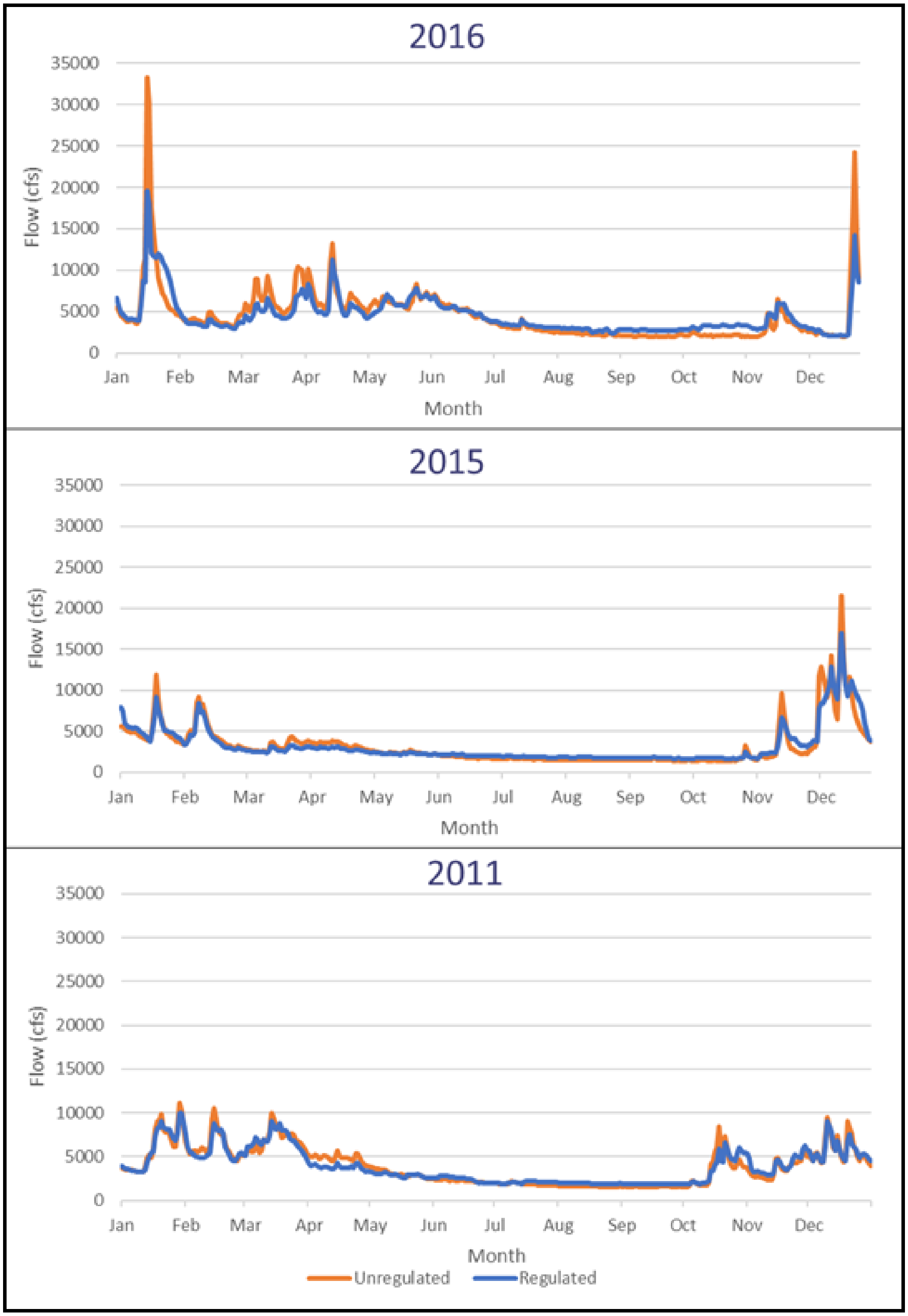


Figure 4.3-3. McKenzie River at Vida, OR. Flows across the water year. The orange lines are for observed flows from 2011, 2015 and 2016. blue lines are modeled flows for the unregulated hydrology for the same years. (From USACE 2023a)

The McKenzie River has been extensively developed to supply water for agricultural, municipal, and industrial land uses. Almost all of the water diverted for hydropower use and roughly half the water diverted for other uses returns to the river downstream from the point of diversion. Flows in the river reaches between the point of diversion (e.g., the Leaburg and Walterville canals) and the point of return (e.g., Leaburg and Walterville powerhouse tailraces) are, at times, substantially reduced.

To learn more about the effects of non-federal dams on the McKenzie River, please refer to the 2008 WVS Biological Opinion (NMFS 2008a).

4.3.3.3 Water Quality

Water temperature

Since its initial operation in January 2005, theWTC structure has substantially shifted Cougar Dam's discharge thermal regime toward natural conditions for the South Fork of the McKenzie River downstream from the dam. Cougar Dam is the only federal project in the Willamette Basin with temperature control capability. The installation of a temperature control structure in Cougar Dam in 2005 was thought to benefit downstream salmonid spawning and rearing success.

Until 2006, both the USACE's Cougar and Blue River projects substantially altered downstream water temperatures in the lower South Fork McKenzie and Blue River, respectively, and, to a lesser extent, in the mainstem McKenzie River downstream to below Leaburg Dam (RM 38). Outflow temperatures were cooler than inflow in the late spring and summer and warmer than inflow in fall and early winter (USACE 2000). By the time water reached the mainstem McKenzie River, the effect of temperature shifts resulting from USACE operations was moderated by flows originating above the mouth of Blue River as well as equilibration between stream and ambient air temperatures over 8 miles between the mouth of Blue River and Leaburg Dam (USACE 2000). This tendency for large reservoirs to offset natural water temperature regimes by a month or more is often termed "thermal inertia" and is more severe downstream from reservoirs that thermally stratify and have fixed hypolimnetic discharge intakes. Thermal inertia has an array of implications for anadromous fish survival, particularly by disrupting natural reproduction schedules (e.g., delayed spawning, accelerated incubation).

Outflow temperatures for Cougar Dam are generally higher than the DEQs TMDLs from April through August, except for the 2011 temperatures, which were closest to the TMDL's. In 2015, water temperatures were the warmest due to extreme drought conditions when compared to 2011 (wet) and 2016 (normal) (USACE 2023a). Typically, Blue River outflow water temperatures are nearest to the TMDLs from April through May and warmer from August through November (USACE 2023a).

When comparing the 2023 and 2022 Cougar Dam discharge daily mean temperatures measured at the USGS gage downstream of Cougar Dam, temperatures were somewhat similar throughout most of the year; however, 2022 downstream temperatures were warmer (6 °F) in late-March and cooler (8 °F) in June as compared to 2023 downstream temperatures. As observed, both the 2023 and 2022 temperatures were often in the mid to upper range of the Resource Agency (RA, i.e. targets agreed upon by the USACE and fisheries agencies) targets from June through September.

In addition, both 2023 and 2022 temperatures either briefly met or were warmer than the autumn RA maximum targets starting in October.

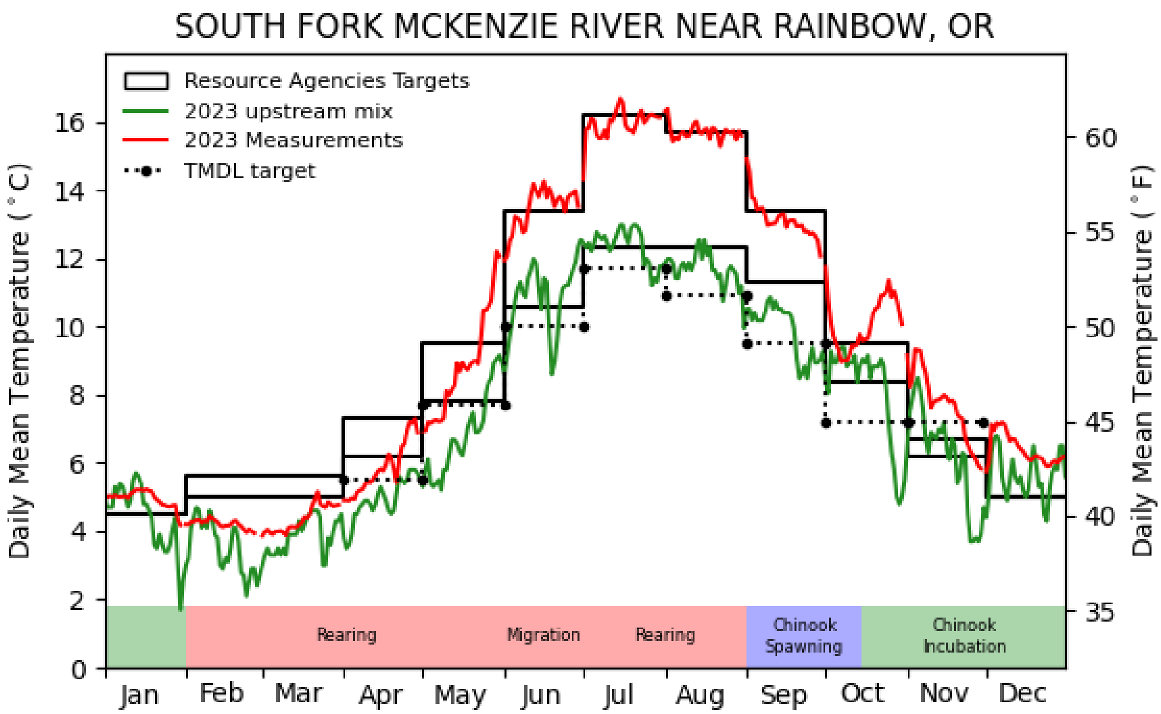


Figure 4.3-4. Cougar Reservoir water temperature control tower performance in 2023 with daily mean outflow temperatures measured in the South Fork McKenzie River compared to upstream mix conditions, ODEQ's TMDL monthly median and resource agencies target temperatures, and primary salmonid life stage of concern. (USACE 2024b)

Compared to the historical range of the Cougar WTC tower operations (2005 to 2021), the 2023 downstream temperatures during these operations were average to warmer-than-average through most of the year. Lower overall pool elevations and flows (due to delayed refill and fish passage operation defined in injunction measure IM 15a) resulted in the 2023 downstream temperatures staying in the mid to warmer range through most of the year as well. Temperatures were cooler in late October 2023 as compared to 2022, both years then cooled in November and December.

When comparing historical discharge temperatures below Blue River Dam, the same trends have occurred over the years since 1966. Temperatures are much cooler in the summer and warmer in the late summer and early fall than the RA target temperatures because there are no temperature operations at this project. Overall, the 2023 temperatures were similar to 2022 temperatures, with exceptions from June through September and briefly in October where 2022 temperatures were approximately 3 °F warmer than 2023 (USACE 2024b). General climate conditions, including precipitation levels and ambient temperatures, were the main reasons for these differences in downstream temperatures over the past years because there are no temperature control operations at Blue River Dam.

Other Water Quality Constituents

Past water-quality monitoring has shown that RO discharges between 500 and 700 cfs can produce TDG production above the 110 percent State of Oregon water quality standard below Cougar Dam. For this reason, a permanent and real-time TDG sensor was installed in 2012 at the USGS Cougar gaging station (CGRO) in the South Fork McKenzie River (near Rainbow) downstream of Cougar Dam. This gaging station reports continuous TDG data.

Data from the TDG gage below Cougar from 2012 to 2020 demonstrates that TDG levels often exceed the 110 percent maximum TMDL; however, no records show that it had ever exceeded 120 percent in that time period. The highest exceedances during this time period often occurred in the winter and spring from December to May, though it is possible that under more frequent prioritization of the RO, exceedances may occur more frequently in the fall.

In 2023, despite meeting the State of Oregon TDG criteria for most of the year below Cougar Dam, the water quality standards were exceeded briefly on January 12 (112 percent), brief occurrences from April 8 to April 31 (111 - 114 percent), through May 1 to May 26 (111 percent to 115 percent), October 13 to October 31 (111 - 114 percent), November 1 to November 3 (111 - 113 percent), December 8 to December 12 (111 - 115 percent). The Cougar Dam TDG exceedances in January and March were due to total outflow that exceeded powerhouse capacity.

Turbidity is generally very low in the South Fork and mainstem McKenzie rivers; background levels are less than 5 NTU.

4.3.3.4 Physical Habitat Characteristics

Recent agreements to meet minimum streamflows at the Leaburg-Walterville Project, Blue River Dam, and Cougar Dam have likely provided sufficient flow for UWR Chinook salmon upstream migration and juvenile rearing habitat requirements. However, human-caused alterations of the hydrologic regimes of the lower McKenzie River and its principal tributaries have generally diminished flow-related habitat quantity and quality and have likely reduced the abundance, productivity, and life history diversity of UWR Chinook salmon and limited the production potential of accessible habitat in much of the basin. Flood control operations have reduced the magnitude and frequency of large flow events in the mainstem McKenzie River, preventing channel-forming processes that maintain complex habitat for rearing UWR Chinook salmon. Reductions in peak flows have contributed to the loss of habitat complexity in the McKenzie River by substantially reducing the magnitude of the channel-forming dominant discharge (i.e., the 1.5- to 2-year flood) and greatly extending the return intervals of larger floods. Over time, flood control tends to reduce channel complexity (e.g., reduces the frequency of side channels, and woody debris recruitment) and reduces the movement and recruitment of channel substrates. Side channels, backwaters, and instream-woody-debris accumulations have been shown to be important habitat features for rearing juvenile salmonids. Wallick et al. (2018) provided an overview of environmental flows for habitat and migration responses in the Willamette. They described how flow affects channel dynamics:

> Water-surface elevations along with water depth, spatial and temporal extent of inundation, and activation of secondary channels and other habitat features, vary in response to specific flow characteristics and geomorphic changes in underlying channel morphology. This has important implications for habitat availability, species movement and life-history patterns, and water-quality conditions… Spring flows, including rate of change, control downstream migration of salmon and access to off-channel habitat. Summer flows provide rearing habitat and influence water-quality conditions such as temperature.

The operation of USACE's Blue River and Cougar dams is only partly responsible for the reduction in channel complexity noted in the McKenzie River. Bank stabilization measures and land-leveling and development in the basin have directly reduced channel complexity and associated juvenile salmon rearing habitat. Changes in channel form in response to reductions in peak flows are much higher in the South Fork McKenzie, and then in the unconfined portions of the channel, which extend from near Vida to the river's confluence with the Willamette River in Springfield, Oregon.

Streambank armoring, in the process of increasing the dominant substrate particle sizes, also reduces the availability of suitable spawning substrates. EA Engineering (1991) and Minear (1994) have documented channel armoring in the lower McKenzie River.

These effects in the McKenzie River downstream from Blue River and Cougar dams persist unabated through most of the river downstream from Blue River, Oregon, because of the lack of sizable downstream tributaries that could replenish flows or sediment and woody debris loads. These effects are exacerbated by storage of sediment and woody debris in the Leaburg Dam pool. Controlling peak flows beneficially reduces the potential for scouring UWR Chinook salmon redds during extreme flow events.

Efforts to improve the environmental baseline of physical habitat conditions have included the 2008 RPA 9.2.7 environmental flows in the Sustainable Rivers program (SRP) described briefly in White et al. (2023). This program via a partnership with The Nature Conservancy, funded collaborative workshops resulting in opportunities for the USACE to implement environmental flow strategies at select dams. The SRP series of environmental flow workshops led to recommendations for the North Santiam, South Santiam, Santiam (Bach et al, 2013), McKenzie, South Fork McKenzie (Risley et al, 2010), and Middle Fork Willamette Rivers (Gregory and Wildman 2007). By July of 2015, USACE water control manuals were updated for "the most attainable of the SRP environmental flow recommendations, but [did] not include all 63 of the stakeholder-generated environmental flow recommendations" (White et al. 2023).

There has also been large scale habitat restoration by the USFS, McKenzie Watershed Council, et al. in the South Fork McKenzie, at Finn Rock Reach in the mainstem McKenzie, and near the confluence of Quartz Creek and the McKenzie River (USDA 2022, for South Fork McKenzie). These projects process-based restoration to restore and enhance both side-channel and main-channel habitats, with approximately 784 acres along 4.5 miles of the floodplain restored in the lower South Fork McKenzie project (USDA 2022; Powers, Helstab, and Niezgoda 2019). This restoration, in combination with the environmental flows, are anticipated to significantly improve the environmental baseline for the lower South Fork McKenzie River below Cougar Dam. It may be some years before the full measure of success for this effort can be evaluated. However, redd counts in the restoration area dramatically increased in 2018 and 2019.

Cougar Dam continues to inundate approximately 5 miles of the South Fork McKenzie River, eliminating it as potential spawning habitat for UWR Chinook salmon. The rest of the watershed remains as described in the 2008 NMFS biological opinion (NMFS 2008a), except for the effects from numerous recent wildfires in the area. See 4.17.3 for a general description of the impacts from wildfire on the environmental baseline.

4.3.4 Hatchery Programs

The production goal for McKenzie Hatchery is 610,00 spring Chinook salmon per year, for release in the McKenzie mainsteam. Summer steelhead, cutthroat trout (*Oncorhynchus clarkii*), and triploid rainbow trout are reared at the Leaburg Hatchery. Cutthroat trout and triploid rainbow trout are produced to support in-basin mitigation fisheries, and summer steelhead smolts are produced and released in the McKenzie River each year during April. In the past, both McKenzie and Leaburg hatcheries conducted incubation and rearing for Chinook salmon, summer steelhead and rainbow trout. Both Leaburg and McKenzie hatcheries have been temporarily closed in 2024 due to water quality issues and being out of compliance with ODEQ. Adult Chinook salmon were therefore transported to Minto Hatchery in the North Santiam in 2024 for broodstock collection, and a high percentage died prior to broodstock collection at the Minto Facility. Juvenile hatchery trout and spring Chinook are still scheduled for releases in the McKenzie in 2025. These juveniles will be returned to the McKenzie facilities in November 2024 and operations at the hatcheries will return to normal.

The risk of genetic introgression from interbreeding with hatchery-origin Chinook salmon has been a key threat to the McKenzie River UWR Chinook salmon population. The McKenzie Hatchery Chinook salmon program once greatly increased the number of spawners below and above Leaburg Dam. From 2001 to 2004, hatchery-origin fish comprised 30 to 34 percent of the natural spawners above Leaburg Dam (Schroeder et al. 2007). In 2003, hatchery-origin fish comprised more than 70 percent of the natural spawners below Leaburg Dam (Firman et al. 2004, cited in NMFS 2004). Though this level of hatchery fish on the spawning grounds may be representative of what occurred over the last few decades, in 2022, ODFW staff found a way to significantly reduce hatchery-origin spawners above Leaburg Dam. As noted above, they installed an exclusion grate in the river right-bank ladder, forcing salmon to pass through the river left-bank ladder, and then ran a newly designed sorter table from June to August at the river left-bank ladder. Using this operation and the sorter table, staff removed 1,193 hatchery-origin Chinook salmon and returned all of the natural-origin Chinook salmon to the river (above the Dam) while reducing pHOS above Leaburg to an estimated 3 percent. If the sorter had not been in place to remove adipose-clipped Chinook salmon, the resultant pHOS would have been 23 percent in 2022 (J. Ziller, personal communication, November 21, 2022). One unfortunate cost of operating the sorter may be lower passage of natural-origin adult Chinook salmon above Leaburg Dam, due to poor attraction and passage conditions on the river right-bank ladder, as compared to the left-bank ladder (where fish prefer to pass when it is operating, but where logistics made a sorter installation and operation less feasible).

4.3.5 Fisheries

Recreational fisheries are open all year round for hatchery Chinook salmon in the mainstem below Leaburg Dam, and all year for trout, hatchery steelhead and wild steelhead (greater than 24 inches) throughout the sub-basin. Total freshwater mortalities from 2009–2019 averaged 8.35 percent for Chinook salmon in the McKenzie River (ODFW 2020) for natural-origin adults.

The estimated 2021 catch of spring Chinook in the McKenzie River was 1,099 adult fish. Of the total 861 (78%) were kept adipose fin-clipped and 238 (22%) were released unmarked fish. The estimated mortality of wild spring Chinook in the McKenzie River was 29 adult fish (ODFW 2022). Percent mortality on NORs from 2009–2019 in the McKenzie River ranged from 0.2 to 1.3 percent (ODFW 2020). Overall, freshwater impacts for the Upper Willamette River spring-run Chinook salmon (hatchery and natural origin), including tributaries, average 21.2 percent (2001-2019). For more information, please refer to the Fisheries Section in the Willamette Mainstem and Basin baseline chapter (Chapter 4.1).

4.3.6 Predation & Competition

Spotted bass and largemouth bass are both present in Cougar Reservoir, and a recovering reintroduced bull trout population is present above and below the reservoir. Bull trout are a native, ESA-listed species; therefore, their predation on juvenile salmonids is viewed as a favorable and natural (deleterious) effect on salmonids in the McKenzie basin, whereas predation by the non-native warmwater species is not.

A large number of hatchery-origin summer steelhead smolts are released into the McKenzie River below Leaburg Dam each spring. A large proportion of these fish are not thought to predate on Chinook salmon fry; however, it is possible that a percentage of them do not migrate out to the ocean and instead choose to residualize, which does create the potential for negative ecological interactions with Chinook salmon (Sharpe et al. 2008; Harnish et al. 2014). Similarly, hatchery rainbow trout are released into the McKenzie River below the Blue River confluence, and their effect on juvenile Chinook salmon could be significant (Murphy et al. 2021). Native wild rainbow trout populations found higher in the McKenzie River would also be likely to prey upon small juvenile Chinook salmon, but few Chinook salmon are present in these reaches at present.

In addition to competition issues associated with hatchery-released steelhead (noted in similar sections above), McKenzie UWR Chinook salmon juveniles may also be impacted by competition with residualized hatchery-origin steelhead or the juvenile offspring of any hatchery-origin steelhead (that return and spawn prior to being caught or trapped). These natural-origin steelhead juveniles would be rearing in the system, similar to any natural-origin UWR Chinook salmon juveniles and competing for similar food resources.

4.3.7 Research and Monitoring Evaluations

Injunction monitoring efforts in 2023 and 2024 included bulk releases of tagged hatchery-origin Chinook salmon and RST monitoring at multiple locations. One trap was installed at the head of Cougar Reservoir and three in the tailrace—one below the RO outfall and two below the turbines.

Cougar Fall Passage Injunction Operation 2023

In 2023, drawdown of Cougar Reservoir to an elevation of 1505 feet occurred from from November 15th to December 15th, and RO prioritization began when the reservoir elevation reached 1571 feet. Four bulk releases occurred at the head of Cougar Reservoir (37,000 subyearling Chinook salmon total) from late August to early October. All of the fish recaptured in any of the tailwater RSTs were captured when the reservoir reached full drawdown, and flow was prioritized through the regulating outlet. RST catches from July to November consisted of brood year 2020, 2021, and 2022 fish. 97.2 percent of fall RST captures were in the RO trap. Capture data shows significant increase in the RO channel trap upon the initiation of RO flow in October and a further increase as the forebay drops to 1,532 feet and below.

Cougar Spring Passage Injunction Operation

This operation includes delayed refill and RO prioritization from February to May or June 2023. From January to June, during delayed refill and RO flow prioritization operations, peak capture occurred at the tailrace powerhouse traps occurred in June and in the RO tailrace channel trap in March (when RO flow increased), but a far higher percentage were captured in the RO tailrace trap (91.6 percent). Most were 2021 brood year yearlings (92.8 percent), and the rest were brood year 2022 subyearlings. Of note, catch of yearling UWR Chinook salmon below Cougar Dam during this 2023 spring period was significantly higher this year than had been observed in the past by previous monitoring efforts (Romer et al. 2016; CFS, 2024), which could be due to increased RO outflows compared to previous years

Peak capture of UWR Chinook salmon below Cougar Dam in 2023 coincided with spring and fall RO operations. Unfortunately, injury rates in captured fish passing through the RO were worse in 2023 and were positively correlated with RO spill. Injuries in captured fish that passed through the RO included more operculum damage and gas bubble disease compared to fish captured in the powerhouse tailrace traps. As with other observations made in this report, and similar to findings from both Big Cliff Dam Tailrace and Green Peter Dam Tailrace, Chinook salmon less than 60 mm were found to exhibit fewer injuries than their larger counterparts ranging from 60 mm to 100 mm and greater than 100 mm. Also of note, in the 24-hour holds, 10.2 percent of RO fish died and 8.8 percent of powerhouse fish died. Of the PIT-tagged fish detected below Cougar Dam in an RST early in the year, six were detected downstream in the Columbia River estuary between April and May. Recaptured fish tagged at the head of reservoir trap or from bulk released groups (in the reservoir) took an average of 50 days to get to the RSTs below Cougar Dam (ranging between 7 to 103 days) (EAS 2024a, EAS 2024b).

Trapping efficiency trials conducted at regulating outlet trap and at powerhouse traps totaled 8 and 9 (combined) throughout the year, usually with a minimum release of 500 fish. Trapping efficiency ranged from 0-8.5% in RO channel and 1 to 19.1% in the PH channel (EAS 2024a, EAS 2024b).

Genetic pedigree studies of adults returning to tributary dams in the UWR Chinook salmon ESU's range have been ongoing at Cougar Dam (McKenzie River) (O'Malley et al. 2022). These studies provide information on the productivity of adults transported above impassable dams and are critical in evaluating the success of juvenile-fish-passage systems. Collection of tissues for genetic analyses is ongoing at adult collection facilities associated with trap-and-haul programs at high-head dams and from natural fish collected during spawner surveys. However, not all tissue samples have been genetically analyzed each year. Archiving tissue samples further delays any assessment of reproductive success.

4.4 Calapooia Sub-Basin

Due to the presence of revetments constructed and maintained by the USACE, the lowest 33.5 river miles of the Calapooia River are considered to be within the affected "action area" for the proposed action. No USACE dam projects exist within the Calapooia River subbasin. The following section presents an assessment of the condition of the listed species and their designated critical habitat within the Calapooia sub-basin portion of the action area.

The Calapooia River flows out of the Cascade Mountains from an elevation of just over 5,000 feet to join the Willamette River at the City of Albany at an elevation of approximately 200 feet. It is the smallest of the six east-side and upper Willamette River subbasins located above Willamette Falls. Winter precipitation usually falls as rain in the lower elevations of the subbasin and snow in the mountainous areas above 3,500 feet (NMFS 2008a). Cool rainy winters, and hot, dry summers characterize the climate of the sub-basin.

The subbasin encompasses approximately 375 square miles of land evenly divided between agricultural use at lower elevations and forest or shrub at higher ones. Major population centers within the subbasin include the southern portions of the cities of Albany, Lebanon, and Sweet Home.

For more detailed information about the sub-basin's physical characteristics and land use, see section 4.4 of the 2008 WVS Biological Opinion (NMFS 2008a).

4.4.1 Historical Populations of Anadromous Fish in the Calapooia Sub-basin

Both UWR Chinook salmon and UWR steelhead occur in the Calapooia River subbasin. Historically, the spring Chinook salmon run in the Calapooia River may have been in the hundreds and the winter steelhead run size may have been in excess of 1,000 adults. Mattson (1948) estimated the adult run of spring Chinook salmon to the Calapooia River in 1947 was approximately 30 fish. Spawning surveys in the 1960s and 1970s indicated that very few spring Chinook salmon were returning to the Calapooia River. The 1969 to 1974 average run size was estimated to be 18 fish, and in 1975 and 1976, no redds were found (Wevers et al. 1992). By the 1970s, the Calapooia River population of spring Chinook salmon probably was no longer viable (CWC 2004). From the 1970s to the late 90s, hatchery-origin spring Chinook salmon (from the South Santiam River) were released to reestablish naturally reproducing populations. Large-scale releases were last made in 1997, although small numbers of fry (<50 mm) were released through 2008.

4.4.2 Current Status of Sub-basin Population and Importance to Recovery

4.4.2.1 UWR Chinook salmon

There has been limited monitoring of UWR Chinook salmon in the Calapooia River basin, in part because of the low numbers of adults returning to the basin. Supplementation efforts have been terminated, and large-scale releases were last made in 1997, although small numbers of fry (<50-mm) were released through 2008. None of the fish that were radio-tagged at Willamette Falls in 2012–14 were detected entering the Calapooia River (Jepson et al. 2015). A few adult Chinook salmon were observed in snorkel surveys in 2012, but it is unclear if they successfully spawned. Since 2012, neither juvenile nor adult Chinook salmon have been observed in annual snorkel surveys in the Calapooia River. Based on the limited information available, it would appear the Calapooia River UWR Chinook salmon population is at a critically low level, at or near zero.

Historically, UWR Chinook salmon used the Calapooia mainstem between Holley (RM 45) and just upstream from the confluence with United States Creek (RM 80) for spawning and rearing (which is located above the defined “action area” for this proposed action).

The Calapooia population of the UWR Chinook salmon ESU is not one of the four core populations as defined in the assessment by McElhany et al. (2007). However, the 2011 UWR recovery plan for UWR Chinook salmon determined that to move the entire ESU into a recovered status, the Calapooia population would need to move from being at a “very high” risk of extinction to a “high” risk of extinction and increase by at least 590 adult spawners (ODFW and NMFS 2011). Similarly, ODFW developed objectives for recovering the Calapooia River spring Chinook salmon population. The long-term objective (2020) was 650 adults returning to the subbasin; the interim objective (2006) was for 100 returning adults.

4.4.2.2 UWR Winter Steelhead

Adult winter steelhead are present in the Calapooia River during February through May, with peak spawning in April and May (Wevers et al. 1992). Most of the winter steelhead spawning takes place in the river channel and tributary streams above Holley (NMFS 2008a), which is outside of the action area considered in this opinion.

The Calapooia River population of the UWR steelhead DPS is not one of the two “core” populations as defined in the assessment by McElhany et al. (2007). However, the 2011 UWR recovery plan for UWR steelhead determined that to move the entire DPS into a recovered status, the Calapooia River population would need to move from being at a “low” risk of extinction to a "very low" risk of extinction, and increase by at least 1,212 adult spawners (ODFW and NMFS 2011).

Since the recovery plan was drafted, redd counts per mile have ranged between 3 and 21 (Ford ed. 2022). The abundance time-series below indicates that the Calapooia River winter steelhead population has, on average, demonstrated some resiliency over time (Figure 4.4-1). Results for 2015 and 2016 generally reflected good ocean and freshwater conditions. As with other UWR steelhead populations, counts were extremely low 2017- 2019. The improvement in abundance estimates in 2020 suggests some underlying productivity; however, the average over time has not met recovery goals.

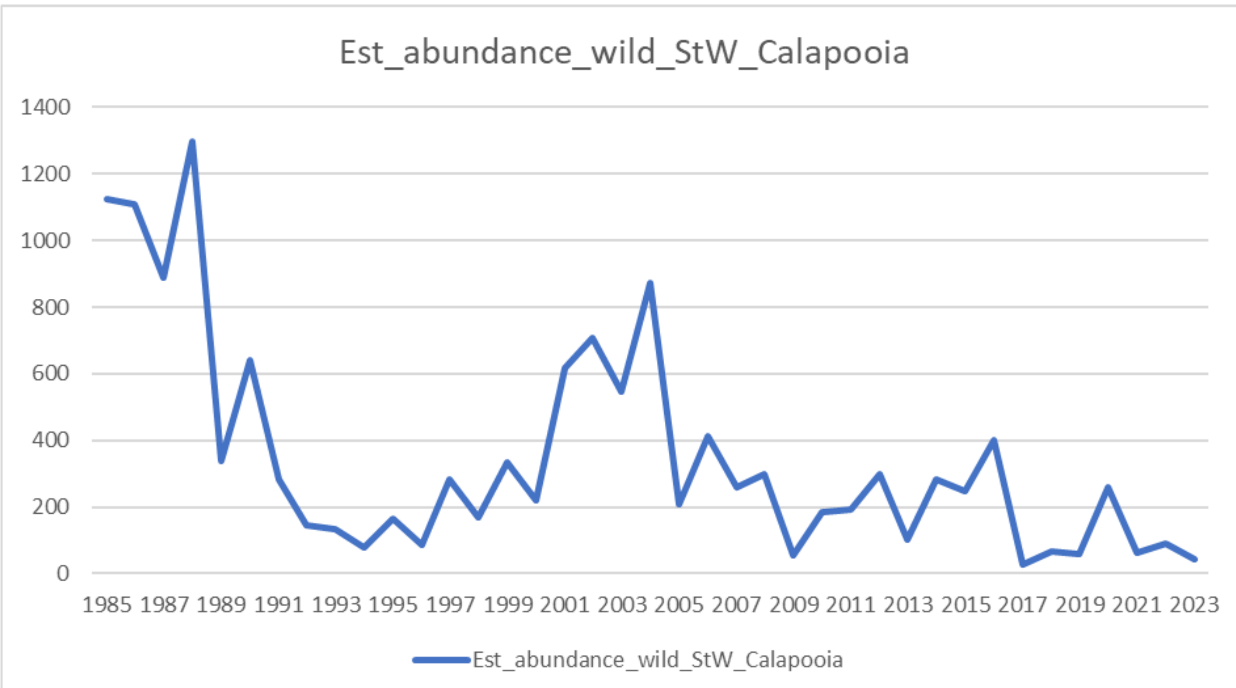


Figure 4.4-1. A time-series of estimated abundance for winter steelhead in the Calapooia River sub-basin runs from the year 1985 to 2023 (Falcy 2017, Dr. M. Sabal, personal communication, November 2nd, 2024).

4.4.2.3 Limiting Factors and Threats to Recovery

Key limiting factors contributing to population decline of both UWR Chinook salmon and steelhead in the Calapooia River basin include reduced and altered flows in the mainstem Willamette River, loss and impairment of habitat resulting from land-use practices, elevated water temperatures, and impaired water quality. In addition, several predatory non-native species are now present in the watershed (see predation section below). For more details on key and secondary limiting factors, see this section in the 2008 WVS Bi-Op (NMFS 2008a) or the Willamette Chinook Salmon and Steelhead Recovery Plan (ODFW and NMFS 2011).

4.4.3 Environmental Conditions

4.4.3.1 Habitat Access / Passage

No habitat or passage issues currently exist within the lowest 33.5 mile of the Calapooia River subbasin. In 2007- 2012, the Sodom Dam Removal project undertaken by the Oregon State Parks Department and partially funded by NOAA Restoration Center, removed three dams, and restored access to 8 miles of fish habitat in the Calapooia River in Oregon. The project included the construction of engineered riffles and large wood jams to maintain grade control and to maintain even flow between the Sodom Ditch and the mainstem Calapooia River.

4.4.3.2 Water Quantity/Hydrograph

The environmental baseline description of hydrology for the Calapooia River provided in the 2008 NMFS biological opinion remains accurate (NMFS 2008a). In general, this is a smaller, lower-elevation basin that is more rain-driven than some of the other sub-basins that drain the Cascade Mountains. There have been some reach-scale modifications to flow from the numerous dams and diversions, especially in the lower Calapooia River.

The USGS gage for the Calapooia River at Albany (14173500) has been recording most recently since the end of September 2023 when it was recording a river height of approximately 1.22 feet. Previously there was a long-term data set of daily flow and peak flows from 1940-1980. In November 2023, river height pulsed up 5 feet, and by 10 feet in early December and early March, with a high of near 18 feet in mid-January After January 2024, it remained above 4 feet until April, falling to below 2 feet in summer.

4.4.3.3 Water Quality

Water temperature

The Oregon Department of Water Quality has listed the Calapooia River and some tributary streams as water quality limited for both temperature and bacterial contamination. The Oregon DEQ reported the highest value of the 7-day moving average of the daily maximum temperature on the Calapooia River at river mile 0.1 (near the mouth) as 23.1°C (before 6/4/2001 to after 9/28/2001) and 23.1°C (before 6/5/2002 to 9/16/2002) and that the TMDL for temperature was exceeded 86+ and 85+ times, respectively (see Table 303(d) Listings for the Willamette Basin, ODEQ, 2006). In July-August 2024 means and maximum temperatures exceeded 25°C (USGS gage 14173500). More than likely, the temperature TMDL exceedances in the lower Calapooia have increased in the last 20 years with warming average air temperatures.

Naturally low flows in the subbasin are aggravated by water withdrawals, which increase water temperatures (because lower flows result in shallower depths which can warm faster during warmer, sunnier periods). Water temperatures exceed criteria in the Calapooia River and some tributaries, particularly in the lower subbasin (CWC 2004). Elevated water temperatures above 18°C can decrease survival and/or growth of juvenile Chinook salmon and increase prespawning mortality of adult Chinook salmon, and can cause earlier emergence from steelhead redds.

Other water quality constituents

Long-term monitoring of bacteria in the Calapooia River at the Queen Avenue Bridge (in Albany downstream of Oak Creek) by the Oregon Department of Environmental Quality has also indicated chronic high levels of *E. coli* (CWC 2004).

4.4.3.4 Physical Habitat Characteristics

The lower subbasin is characterized by wide floodplain forests with numerous side channels and ponds along the river. The valley is broad and flat in this portion of the subbasin, with less than a 0.1 percent gradient.

Flow modifications and channel confinement (through streambank armoring, revetments etc. and loss of floodplain connectivity) and in-stream barriers have reduced access to off-channel habitats essential for juvenile salmonid rearing and winter refuge, decreased connectivity between habitats throughout the subbasin, and curtailed the dynamic processes needed to form and maintain habitat diversity (WRI 2004). Reduced floodplain connectivity can also reduce nutrient and prey exports from the floodplain to the river (Reid et al. 2012). Two types of USACE constructed revetments or bank protection structures are in the entire baseline action area, those which they maintain (83 total) and those which non-federal sponsors own and maintain (105); generally, those with non-federal sponsors were built after 1950. The effect of the revetments, in conjunction with other WVS operations is to simplify the prior complex meandering, braided mainstem rivers with extensive floodplain forests on both banks particularly "in the southern reaches of the Willamette River and lower reaches of its major tributaries, all of which were historically more complex and dynamic" (Hulse et al 2013).

Modification or removal of these revetments requires permits under the Clean Water Act and the Rivers and Harbors Act. USACE administers these permits but considers them outside the scope of this action. The extensive revetments that were built as part of the WVS were intended to respond to floods that could cause bank erosion. In the previous supplemental BA (Usace 2007), USACE proposed to identify and prioritize revetments where removal or modification may be feasible to improve habitat for ESA-listed salmonids, and the 2008 RPA measure 7.4 required a report to assess and prioritize USACE-maintained revetments. This document was intended to provide specific sites where modifying or removing revetments would restore natural river function (Hulse et al 2013). The authors worked to geographically distribute ecological benefits of revetment removal or modification. From the final list of 12 high priority zones, only four individual revetments were recommended for detailed consideration.

The continued maintenance and presence of this system of revetments has degraded rearing and migration habitat in the lower tributary reaches via reduced floodplain connectivity and channel complexity. In addition to reducing floodplain connectivity, other effects of revetments on the ecosystem include (Fischenich 2003):

1. Reduced morphological evolution of a river. Stream lateral migration and riparian succession are necessary processes in maintaining appropriate energy levels in a system. The ability of a stream to convert energy between its potential and kinetic forms through changes in physical features, hydraulic characteristics, and sediment transport processes is important in creating complex habitats generating heat for biochemical reactions, and reoxygenating flows.
2. Impacts on hydrologic balance.
3. Impacts on sediments, or reduction of sediment yields and thus the generation of scour / erosion at sites immediately downstream.
4. Impacts on habitat. Riprap provides a substrate that usually differs from local material of the channel, and offers a different habitat condition.
5. Impacts on chemical and biological processes including important nutrient cycles. They can also create barriers to natural plant and animal migration.

Lacking any modifications to offset major adverse impacts of the WVS revetments on important elements of critical habitat, the continued maintenance of the revetments has continued to degrade rearing and migration habitat in the mainstem Willamette and lower reaches of its tributaries via reduced floodplain connectivity and channel complexity.

4.4.4 Hatchery Programs

The potential risk of genetic introgression resulting from interbreeding has diminished since adult outplanting and juvenile hatchery releases were discontinued in the early 2000s. Hatchery-origin salmon outplants into the Calapooia River ceased over two generations ago when habitat improvements to the Calapooia River were made. Fixes were implemented on several low-head dams on the Calapooia River that helped move Chinook salmon upstream past the obstructions. UWR Chinook salmon abundance has not increased since.
Several stakeholders have expressed the need to supplement the Calapooia River using hatchery-origin fish to jumpstart the UWR Chinook salmon population because of demographic risks (too few returning fish).

4.4.5 Fisheries

Fishery harvest was not determined to be a key threat to recovery for Calapooia River steelhead and Chinook salmon populations (ODFW and NMFS 2011).

4.4.6 Predation

Several predatory non-native species that could prey on juvenile salmonids are present in the watershed including: largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), yellow bullhead catfish (*Ameiurus natalis*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), crappie (black) (*Pomoxis nigromaculatus*), and brown bullhead catfish (*Ameiurus melas*) (Runyon, Andrus, and Schwindt 2004).

4.4.7 Research Monitoring and Evaluation

There are currently no known research or monitoring efforts being conducted in the Calapooia sub-basin for UWR Chinook salmon or steelhead that are related to the proposed action.

4.5 South Santiam Sub-Basin

The action area in the South Santiam sub-basin includes the mainstem South Santiam River from Foster Reservoir to the confluence with the North Santiam and Willamette River mainstem and the Middle Santiam River from Foster Reservoir to Green Peter Reservoir, and adult release site locations in the South Santiam above Foster Dam and in the Middle Fork Santiam and Quartzville Creek above Green Peter Dam. The following section presents an assessment of the condition of the listed species and their designated critical habitat in the South Santiam sub-basin portion of the action area.

The South Santiam River drains approximately 640 mi^2 on the western slopes of the Cascade Mountain Range in northwestern Oregon, with the headwaters dominated by forestlands. Average river daily discharge is 5,940 cfs (range, 106–22,100 cfs), and major tributaries include the Middle Santiam River and Quartzville Creek (U.S. Geological Survey, 2016a; USGS streamgage 14187500) (Figure 4.5-1). Approximately 32 percent of this subbasin is in public ownership, including headwaters in the Willamette National Forest (ODFW 1990b). Some land in the lower portion of the subbasin is managed by the BLM (Salem District), but most of the area that contributes flow to the river downstream of the lowermost USACE dam (Foster) is private.

The South Santiam River is impounded by three dams including Green Peter Dam (construction completed in 1966) and Foster Dam (completed in 1968), which are both owned and operated by the USACE. Lebanon Diversion Dam is located downstream of Foster Dam and is owned by the City of Albany (Figure 4.5-1). South Santiam Hatchery is located on the South Santiam River, downstream of Foster Dam, 5 mi east of Sweet Home, Oregon. The hatchery began operation in 1968 to mitigate for the development of Foster and Green Peter dams.

The South Santiam’s headwaters are characterized by steep forested drainages that originate on basalts and andesites (materials of volcanic origin) and then flow through narrow valleys toward the broader alluvial valley in the lower subbasin. Larger drainages above Foster Dam include the South Santiam mainstem, the Middle Fork, and Quartzville Creek. Channel slopes along the mainstem decline in the downstream direction to approximately 0.4 percent between Foster Dam and Lebanon and less than 0.1 percent in the alluvial valley below. Wiley Creek joins the South Santiam immediately downstream of Foster Dam, while Crabtree and Thomas creeks enter the South Santiam near the river’s confluence with the North Santiam River.

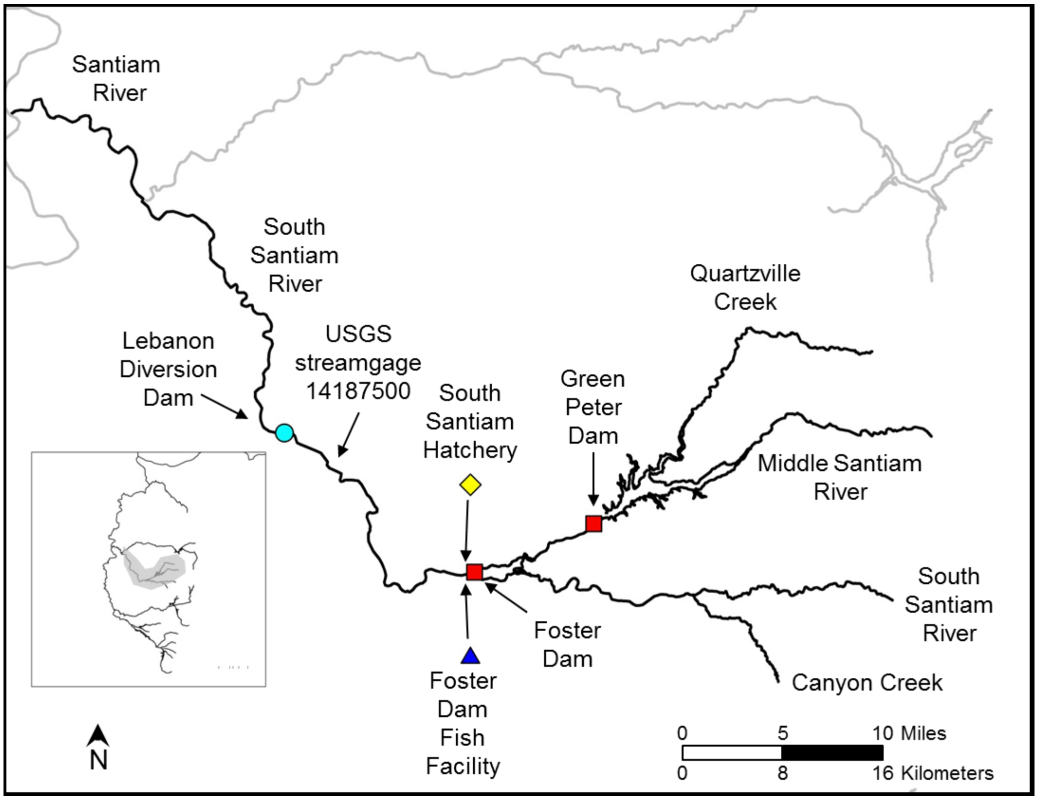


Figure 4.5-1. Map showing primary rivers in the South Santiam River subbasin (black lines), U.S. Army Corps of Engineers (USACE)-owned dams (red squares), non-USACE dam (blue circle), fish hatchery (yellow diamond), and adult fish facility (blue triangle), Willamette River Basin, Oregon. (Figure from Hansen et al. 2017.)

4.5.1 Historical Populations of Anadromous Fish in the South Santiam Sub-basin

UWR Chinook salmon are native to the South Santiam River and once spawned in the mainstem South Santiam, the Middle Santiam, and in all major tributaries including Wiley, Thomas, Crabtree, Quartzville, and Canyon creeks (Willis et al. 1960; Thompson et. al 1966; Fulton 1968; WNF SHRD 1995, 1996). Chinook salmon returns to the river had declined substantially by the mid-1900s but were still estimated to include approximately 1,300 spawners in 1947, with the most heavily used spawning areas located above the town of Foster (Mattson 1948). The species' access to much of the area where Mattson (1948) observed spawning during 1947 has been either blocked or impaired since completion of Foster and Green Peter dams by the USACE in 1968. USFWS (1963) reported an annual spawning run of approximately 1,400 Chinook salmon above to the location of what is now Foster Dam (built in 1968). It is estimated about 70 percent of these returns spawned in the Middle Santiam River (currently blocked by Green Peter Dam), 23 percent in the South Santiam River above Foster, and the remaining 7 percent in the Middle Santiam River, which is now part of Foster Reservoir.

UWR steelhead are also native to the South Santiam subbasin. These fish historically spawned in upper portions of the subbasin, above the sites of Foster and Green Peter dams, as well as in downstream tributaries (Olsen et al. 1992). No estimates of pre-1960s abundance are available for the subbasin's native winter steelhead. However, ineffective downstream passage at Foster and Green Peter dams, and inadequate upstream passage at the latter facility, are believed to have caused up to a 75 percent reduction in the native steelhead population in the upper subbasin over time (USACE 2000). After the dams were constructed, Buchanan et al. (1993) estimated that 2,600 winter steelhead spawned in the entire South Santiam River basin, including the upper mainstem above the dams and in Thomas, Crabtree, McDowell, Wiley, Canyon, Moose, and Soda Fork creeks.

4.5.2 Current Status of Sub-basin Population and Importance to Recovery

4.5.2.1 UWR Chinook salmon

In the 2005 NMFS status of the species report, the South Santiam UWR Chinook salmon population was not deemed viable. More rigorous assessments followed in 2007 and 2011 (based on population abundance, productivity, spatial structure, and diversity information), and both determined that the South Santiam UWR Chinook salmon population was at a very high risk of extinction in the next 100 years. However, it has also been considered one of the four core populations in the ESU (McElhany et al. 2007; ODFW and NMFS 2011).

Since the 1960s, Chinook salmon adults have been collected and counted at Foster adult fish facility (AFF). Since factors affecting the number of adults returning to the facility each year may vary inter-annually, it does not provide an accurate abundance index for the population, but it does provide some information about general long-term trends (Figure 4.5-2). ODFW's comprehensive spawner surveys (redds and carcasses) conducted both below and above dams in the South Santiam and in some of the major spawning tributaries (Schroeder et al. 2006; McLaughlin et al. 2008), provide another abundance index. After 2019, spawner surveys below dams in the North and South Santiam rivers, previously funded by USACE, were terminated, and ODFW continued with surveys, although on a more limited scale. Different methodologies were employed during spawning surveys in 2018 and 2019, making the interpretation of spawner abundance estimates from those years more difficult.

The NMFS 2022 Viability Assessment determined that the "long-term trend" (2015–19) for South Santiam River natural-origin Chinook salmon had been negative, –3 percent (Ford ed. 2022). For the 2015-2019 period, the 5-year spawner abundance geomean for the entire South Santiam River was 337, a 45 percent decrease from 2010–14. The Foster Dam counts, which represent fish migrating to the upper South Santiam River, had a geomean of 305 for this same period; however, this does not account for prespawn mortality or fallbacks. A combination of both Foster AFF returns and spawner abundance estimates for areas below Foster Dam is found in Figure 4.5-3. Figures 4.5-2 and 4.5-3 provide evidence for decreasing abundance since the peak returns in 2011 (and 2004).

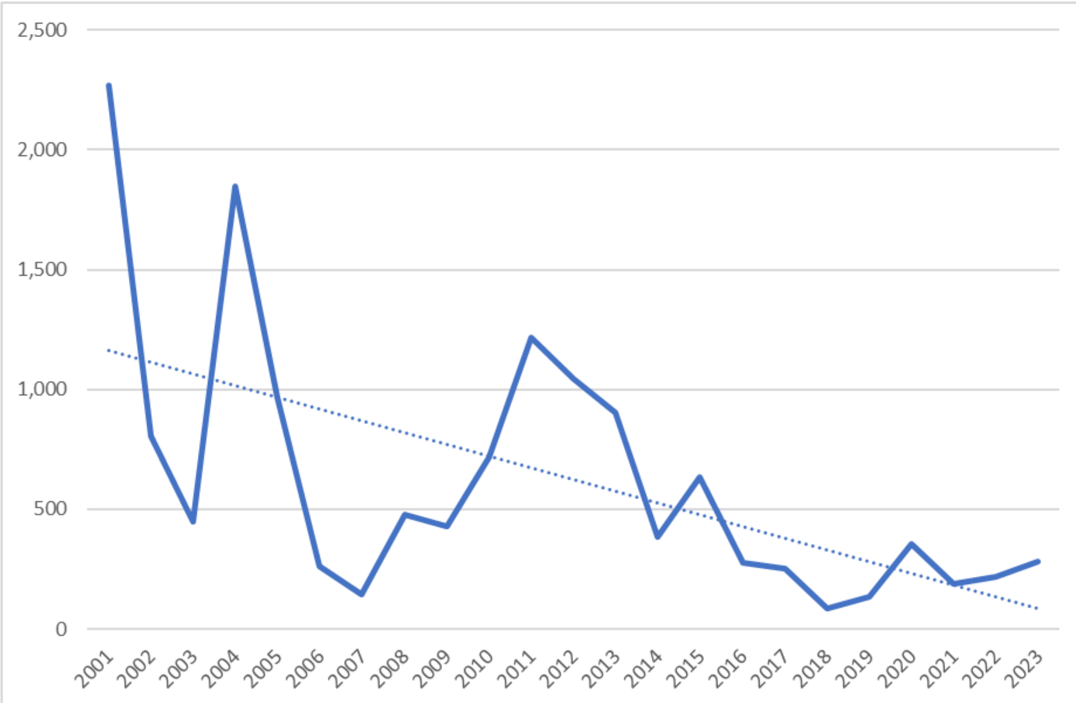


Figure 4.5-2. Total annual, natural-origin, adult Chinook salmon returns to Foster Dam adult fish facility from 2001 to 2023 and trendline.

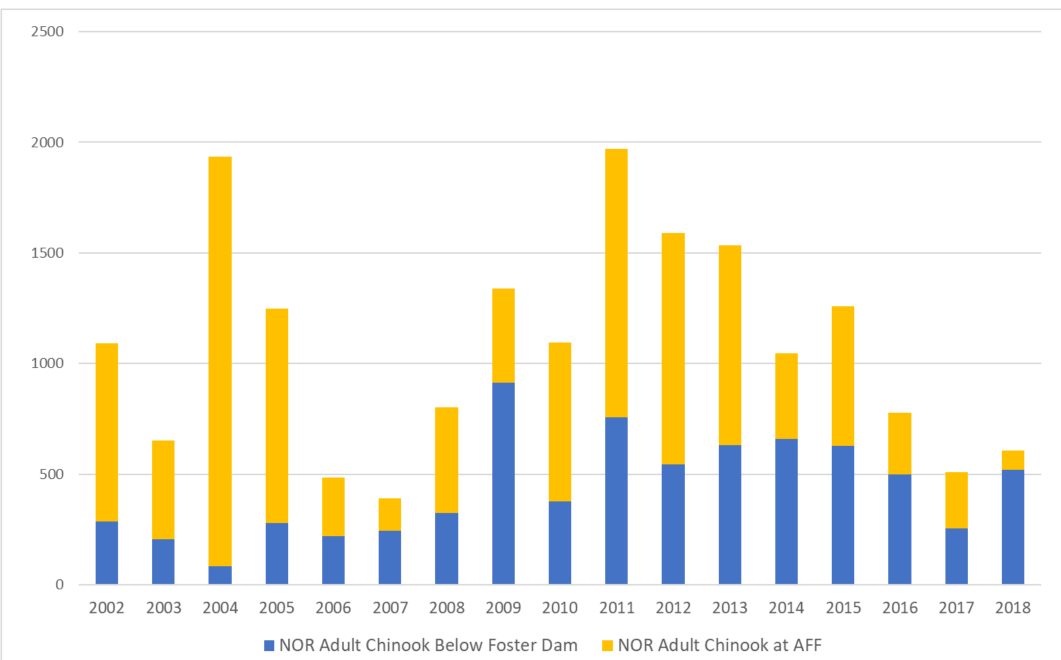


Figure 4.5-3. Total annual abundance estimates for South Santiam basin, natural-origin (NOR), adult Chinook salmon, including spawner estimates below Foster Dam and returns to the adult fish facility (AFF) at Foster Dam (2002 to 2018).

Based on spawning survey abundance estimates (2002–2018) and adult Chinook salmon counts at Foster Dam (2001–present), adult Chinook salmon returns (hatchery and natural-origin) were increasing for a few years beginning in 2010; however, since 2011, natural-origin returns have been in near steady decline (Figures 4.5-2 and 4.5-3). The estimated proportion of natural-origin adult Chinook salmon returns to the South Santiam spawning below Foster Dam during this time period (2002–2018), ranged between 22 and 65 percent and averaged 45 percent. Last year (2023), just 283 natural-origin Chinook salmon adults returned to Foster Dam's adult fish facility. Even if 65 percent (the highest proportion observed, based on past estimates from 2002–2018) of all 2023 natural-origin returns to the South Santiam basin spawned below Foster Dam, the 2023 natural-origin run size for this population would be less than 800 UWR Chinoook salmon. Low counts in 2024 showed only 145 natural-origin UWR Chinook salmon adults returned to Foster Dam by the end of September (ODFW 2024).

In the 2007 extinction risk assessment, McElhany et al. (2007) estimated that the most likely scenario for restoring the UWR Chinook salmon ESU to a recovered status would include recovery of the South Santiam population to a "moderate" extinction risk category, which in their estimate, would require a population increase of at least 3,100 individual returning adults (above mid-2000s abundance). Natural-origin adult Chinook salmon returns to the Foster adult fish facility in 2007 totaled 146 fish, and an additional 245 were estimated to have spawned below the dam (total of 391). Since then, the highest number of natural-origin returns to Foster Dam has been 1,215 fish (2011), and an additional 756 were estimated to have spawned below the dam in that same year (for a total return of 1,971 fish). This does not equate to an increase of 3,100 individuals above 2007 return totals or to recovery, and the population likely remains at a high risk of extinction, if not still very high.

For more information on the history of the South Santiam UWR Chinook salmon population viability metrics, refer to the baseline section in the 2008 WVS Bi-Op.

4.5.2.2 Winter Steelhead

Prior to 1966, 2,600 steelhead passed the Foster Dam site. Wade et al. (1987) reported that in 1971, the wild winter steelhead count at Foster Dam was 4,254 fish (approximately one-quarter of the Willamette Falls count for that year). Extinction risk assessments conducted in 2007 (McElhany et al. 2007) and 2011 (NMFS 2011b) (based on population abundance, productivity, spatial structure, and diversity information) determined that the South Santiam UWR steelhead population was at a low to moderate risk of extinction (in the next 100 years) (McElhany et al. 2007; NMFS 2011b). McElhany et al. (2007) estimated a geometric mean of 2,302 winter steelhead spawners in the South Santiam basin and a long-term geometric mean of 2,727 spawners, making it one of the strongest populations in the UWR steelhead DPS at the time, though there was likely still some hatchery release influence at that time (winter steelhead hatchery releases were discontinued in 1999). The South Santiam UWR steelhead population, along with the North Santiam population, was also defined as a core population for the DPS. The Santiam populations are the two most critical populations in the UWR steelhead DPS in terms of achieving recovery goals (McElhany et al. 2007). McElhany et al. (2007) estimated that the most likely scenario for elevating the UWR steelhead DPS to a recovered status would require recovering the South Santiam population to a "very low" extinction risk category, which in their estimate, would require the population to increase by at least 1,212 individual fish above the 2007 estimated abundance. Abundance data for this population over time has been sparse, and conducting spawning surveys for winter steelhead is known to be a challenging endeavor because of the inclement conditions in the early spring. However, based on the trends observed, there is some evidence that the South Santiam UWR steelhead population has been in decline over the last 15 years. This decline has also been noted in the last two 5-year status reviews for UWR steelhead (NMFS 2024a; NMFS 2016a, Ford ed. 2022).

Past survey data suggest that greater numbers of natural-origin winter steelhead return to spawn in the lower South Santiam subbasin each year than return to the Foster adult fish facility, but these surveys have been discontinued. From 2000 to 2006, annual estimates of spawners in the subbasin averaged 1,953 fish, with an average of 1,236 (63 percent) spawning downstream of Foster Dam (NMFS 2008a). But past spawning surveys in these (below Foster) reaches were not conducted using consistent methodologies. Mapes et al. (2017) demonstrates temporal differences in the index reaches surveyed and the conditions under which surveys were undertaken, making the standardization of data among tributaries very difficult. In 2016 and 2017, there was more systematic monitoring of the South Santiam River (Mapes et al. 2017) and winter steelhead abundance was estimated at 1,480 ± 721 in 2016, and 157 ± 60 in 2017 (a record low return year in which only 18 fish returned to Foster adult fish facility). Mapes et al. (2017) provided a comparison of survey methodologies and suggested a total subbasin population of approximately 1,000 spawning adults (in 2016 and 2017).

Foster-Dam-fish-facility counts provide the most continuous, long-term dataset available for tracking South Santiam UWR steelhead trends over time; however, only a subset of South Santiam UWR steelhead adults return to the Foster adult fish facility each year (and are subsequently transported and released to areas in the South Santiam River above Foster Dam to spawn). The number that return to the adult facility is also influenced by a variety of factors, and therefore does not provide the most accurate index of annual population abundance. Figure 4.5-4 presents annual counts of the native late-winter run of these fish returning to Foster Dam from 1967 to 2023. Releases of hatchery winter steelhead in the South Santiam River ended in 1998, so since 2003, adult returns to the Foster adult fish facility outplanted above the reservoir have been 100 percent natural-origin winter steelhead. Numbers for these returning spawners fell from a maximum of 1,016 fish in 2004 to a low of 18 fish in 2018.

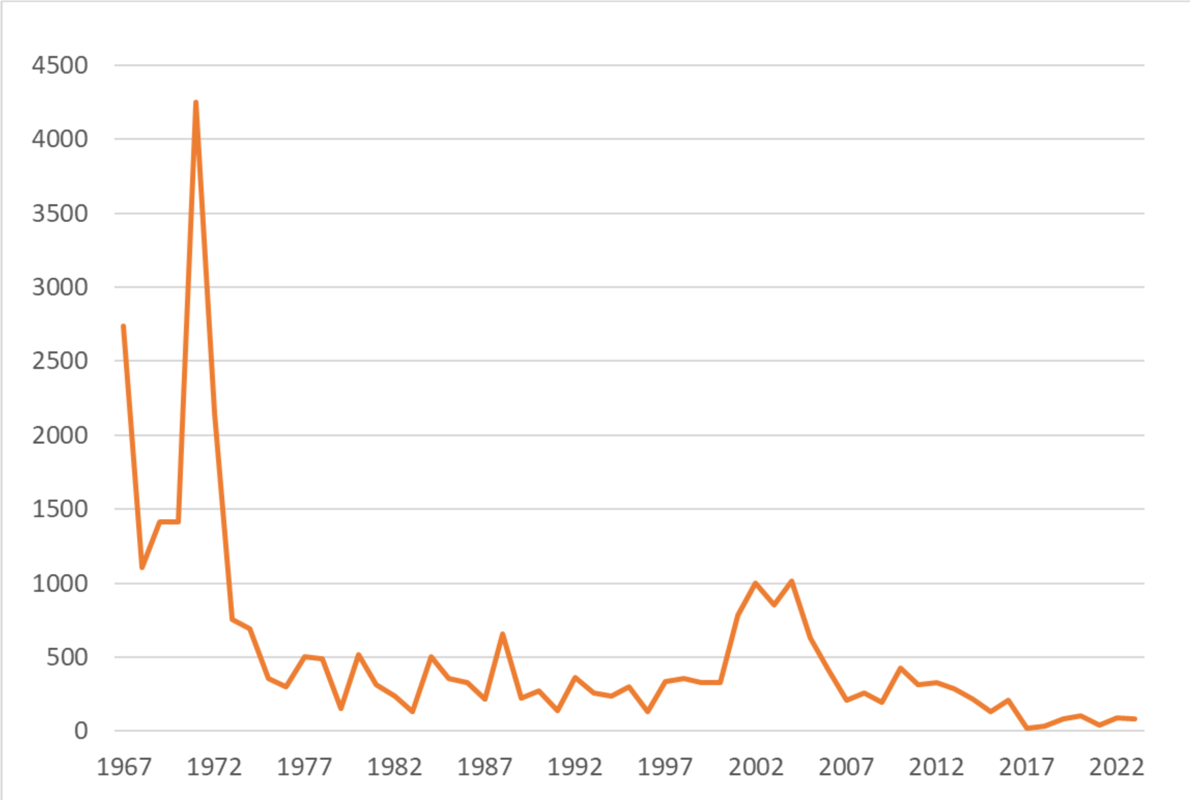


Figure 4.5-4 Total adult winter steelhead returns to Foster Dam in the South Santiam River by year (1966-2023). The final year of winter steelhead hatchery releases was 1998, and 2003 was the first year when returns were 100% natural-origin.

For the Foster-adult-fish-facility time series, the most recent 10-year geometric mean (2010-2019) has been 141 returning winter steelhead, with a negative trend in the abundance over those years. The more recent 5-year geometric mean, from 2019–2023, is less than 100 individuals. It is possible that a higher proportion of fish returning to the basin are spawning downstream, compared to past years, as the Foster adult fish facility has also failed to successfully attract returning fish (into the ladder and trap) in some years (see adult passage section below for further details). Based on spawning survey totals and adult facility counts from years 2000–2006, the percentage of adult returns spawning downstream of Foster ranged from 51 to 78 percent. Even under the best-case scenario (where up to 80 percent of total population returns are spawning below Foster and not returning to the adult facility), it is likely that total South Santiam UWR steelhead abundance levels have remained around 500 individuals for the last 7 years. This estimate aligns with the most recent set of South Santiam winter steelhead abundance estimates provided by ODFW (Figure 4.5-5; Falcy 2017; Dr. M. Salab personal communication, November 2nd, 2024) including spawners and returns to Foster Dam. These recent downward trends at the Foster facility also reflect the general trend observed for winter steelhead at Willamette Falls in recent years.

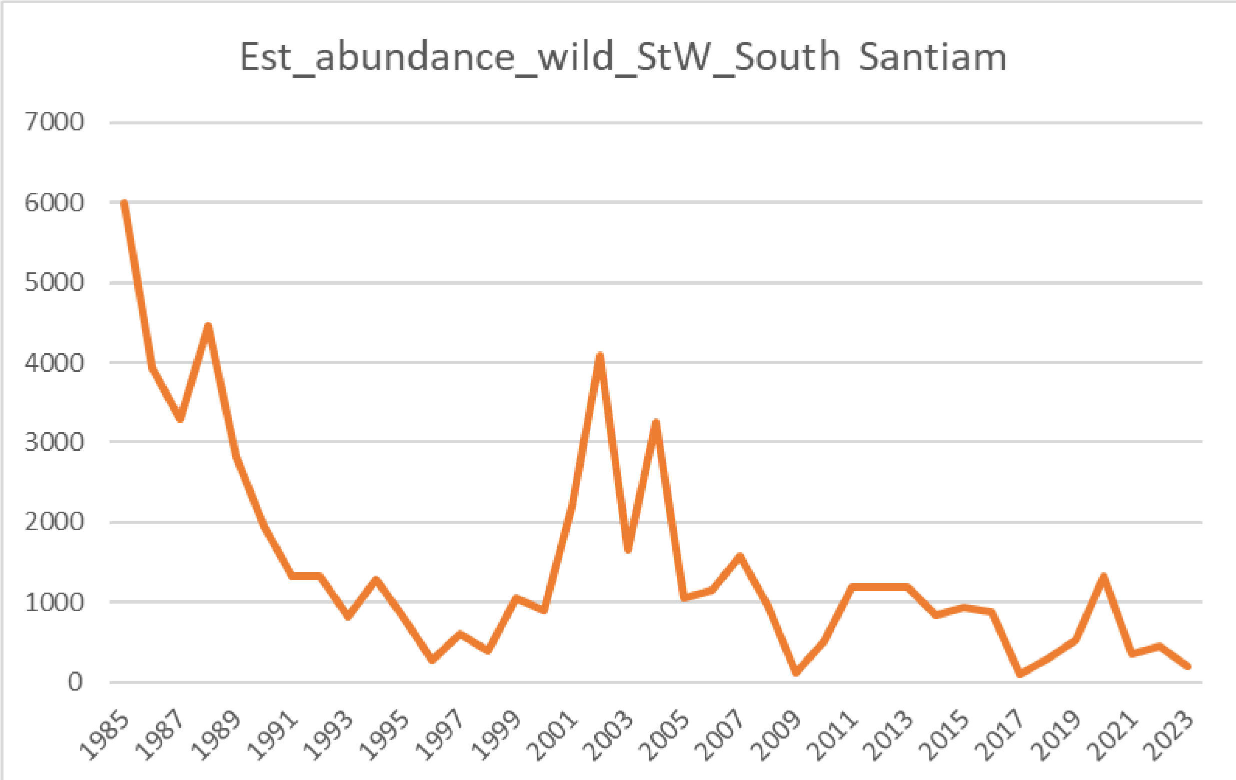


Figure 4.5-5. Long-term population abundance estimate index for winter steelhead in the South Santiam sub-basin (Falcy 2017, Dr. M. Sabal, personal communication, November 2nd, 2024).

For more information on the history of the South Santiam UWR steelhead and UWR Chinook salmon population viability metrics, refer to this baseline section in the 2008 WVS Opinion (NMFS 2008a).

4.5.2.3 Limiting Factors and Threats to Recovery

ODFW summarized factors adversely affecting the status of the South Santiam population of UWR Chinook and steelhead for the Recovery Plan (ODFW and NMFS 2011). Key limiting factors and threats to both species included a variety of dam effects, large hatchery programs developed partly to help offset dam effects, and the cumulative effects of multiple land and water use practices on aquatic habitat. Further details on the historical limiting factors and threats can be found in the 2008 WVS Biological Opinion (NMFS 2008a) or the ODFW report (ODFW and NMFS 2011).

4.5.3 Environmental Conditions and Climate Change

4.5.3.1 Habitat Access and Dam Passage Conditions

Adult Passage and Habitat Access to Spawning Grounds: Chinook salmon

The South Santiam Basin contains two major impassable dams, a low-head dam (Foster Dam) that blocks volitional access to the upper South Santiam River and a high-head dam (Green Peter Dam) that currently blocks access to Quartzville Creek and the Middle Santiam River. These dams block or limit volitional access to an estimated 85 percent of the historical production area for UWR Chinook salmon and steelhead (ODFW and NMFS 2011). For Chinook salmon specifically, ODFW (2005) estimated that 70 percent of the subbasin's population once spawned in areas that are (volitionally) inaccessible now, and McElhany et al. (2007) noted that the inaccessible areas held some of the best habitat for the species.

The 8-foot-high Lebanon Dam at RM 21 is no longer a barrier to either adult Chinook salmon or steelhead passage. The dam is equipped with several new fish ladders that allow passage of adult fish, but the dam may still delay some migration or injure adult fish seeking the entrances. Small dams, irrigation diversions, road crossings, and other land-use-related passage impediments restrict steelhead access to habitat in wadeable-sized tributaries. Numerous partial and complete fish passage barriers at culverts on tributary streams limit juvenile upstream movement into rearing and refuge habitat.

An adult fish facility (AFF) is located below Foster Dam, where natural-origin Chinook salmon (and steelhead, see next section) are collected and transferred to areas in the South Santiam branch of the river (which enters above Foster Reservoir and below Green Peter Dam). Some hatchery-origin Chinook salmon adult returns have also been released in areas above Green Peter Dam since 2022. The AFF has had past issues attracting adult salmon and steelhead to the ladder under certain conditions and times during the adult migration and collection periods that are in the process of being resolved through improved water temperature control capabilities at the facility. The attraction issues have resulted in more fish spawning below Foster Dam in potentially less desirable habitat and potentially higher prespawn mortality rates for the population. Adding another layer to Foster AFF adult ladder returns, is the fact that cooler river temperatures have kept fish from migrating up the South Santiam River far enough to reach the ladder entrance. Thus, the action agencies and partners agreed on moving flow through the Foster Dam fish weir (spillway) from June to September to increase temperatures in the river and get fish to the ladder. Reintroduction of Chinook salmon above Foster Dam on the South Santiam River using a combination of hatchery and natural-origin fish has occurred since 2002 (Evans et al. 2015, Evans et al. 2016). Between 2002 and 2008, only hatchery-origin Chinook salmon were released above Foster Reservoir, with an average of 838 annually (range of 385 to 1,850). Between 2006 and 2021, only natural-origin adults were released above Foster Reservoir, with an average of 424 annually (range of 18 to 1,215). Beginning in 2022, hatchery-origin Chinook salmon adults returning to the Foster AFF have been outplanted above Green Peter reservoir (200 in Quartzville Creek and 600 in the Middle Santiam River). Adult outplanting above Green Peter Dam was not conducted in the past because of poor downstream juvenile passage conditions and high predation, but recent interim operations were aimed at improving these conditions. Recent past and current downstream juvenile passage conditions are discussed in the following section.

Spawning surveys and genetic pedigree studies conducted over the years both provide important information on how current adult passage conditions may be affecting the South Santiam UWR Chinook salmon population and its ability to successfully reproduce and recover, including prespawn mortality rates and population replacement rates (both above and below the dam). Prespawning mortality estimates above and below Foster Dam have varied over time. Sharpe et al. (2017b) estimated total prespawn mortality below Foster Dam at 12 percent in 2015 and 4 percent in 2016 and total prespawn mortality above Foster Dam in the South Santiam River reach at 40 percent in 2015 and 11 percent in 2016. The most recent Chinook spawning surveys both above and below Foster Dam were conducted in 2018–2020 between the end of July or beginning of August and the first half of October (Whitman et al. 2022). Peak spawning periods, both below and above (i.e. South Santiam reach) Foster Dam, were typically observed in the last week of September, sometimes into the first few days of October, and typically began 2 to 5 days earlier and ended up to 9 days later in the areas surveyed above Foster (Whitman et al. 2022). In general, in all three survey years, the highest redd densities were observed just below Foster Dam ranging from 19.2 to 51.7 redds per kilometer. The highest redd densities for the South Santiam River reach above Foster Dam occurred above the release site and were often highest above the Soda Fork (Creek confluence) (Whitman et al. 2022). Prespawn mortality rates were generally highest in 2018 (for all reaches), followed by 2019 and 2020. Prespawn mortality rates were also lowest for locations above Foster dam (though not by much in 2018); however, sample sizes for the above Foster area were also much lower (Table 4.5-1). The estimated percent hatchery fish on spawning grounds (pHOS) below Foster Dam for years 2018–2020 was 91.5 percent, 55.4 percent, and 57.4 percent, respectively (Whitman et al. 2022).

Table 4.5-1 Estimated percentage of prespawn mortality of spring Chinook by South Santiam basin management reach, 2018-2020 from Whitman et al. (2022). Estimate is based on visual inspection of female carcasses (n). Any female carcass containing more than an estimated 50% of its eggs was counted as a prespawn mortality.

	2018 (n)	**2019 (n)**	**2020 (n)**
Below Foster (from Pleasant Valley to Waterloo)	90.0 (32)		
Below Foster Dam (from Pleasant Valley to Dam)	17.5 (394)	9.5 (42)	4.2 (71)
Above Foster in South Santiam Reach	12.5 (8)	0(5)	0 (17)

Genetic tissue samples have been collected from returning adult UWR Chinook salmon in the South Santiam River since 2011 to help determine what proportion of returning adults are able to produce at least one offspring that survives to adulthood and returns to the South Santiam basin to spawn (calculated as the cohort replacement rate, CRR, and total life fitness, TLF). This has included samples from adults being outplanted and spawning above Foster Dam, as well as adults spawning below Foster Dam. Adult salmon returning in years 2016 to 2020 were successfully assigned to parents from previous years at the following rates: 48 percent in 2016, 73 percent in 2017, 43 percent in 2018, 64 percent in 2019 and 68 percent in 2020 (O'Malley et al. 2024b). Results from spawning adults (or parents) above Foster Dam sampled from 2011 to 2015 indicate that NOR spawners usually had higher success (or average total life fitness rates) than HOR spawners, but not in every year, although the sample sizes for the HOR parents were much lower. Results also indicated that in both sexes TLF increased with later release days (and potentially, release location), but this association was markedly stronger for females (O'Malley et al. 2024b). Most importantly, total cohort replacement rate (CRR total) for outplanted adults was far less than one in all years from 2011–2015, ranging from a minimum of 0.04 (2014) to a maximum of 0.16 (2013). This indicates that the population above Foster Dam is not replacing itself. In addition, the estimated number of effective breeders has continued to decline since genetic monitoring of the (above Foster Dam) Chinook salmon reintroduction program began in 2007, which equates to an increasingly lower level of genetic diversity (O'Malley et al. 2024b).

Chinook salmon spawning surveys have also been conducted in Quartzville Creek (above Green Peter Reservoir, where 200 adults have been released each year) for the first 2 years of adult Chinook salmon outplanting above Green Peter (2022 and 2023). However, surveys in the Middle Santiam River reach (also above Green Peter, where 600 hatchery-origin adults are being outplanted, and which also contains four times more potential spawning habitat) have yet to be conducted because of landowner-permission issues. Surveys are being conducted on a portion of the Middle Santiam River spawning habitat reach in 2024. In 2022, 200 hatchery-origin adults were released at Miner's Camp on Quartzville Creek on September 8, and each of five stream reaches (ranging between 3.3 and 5.3 km in length) located above the release location were surveyed weekly for redd counts, carcasses, and carcass data collection for the following 5 weeks (Cramer Sciences 2023). Most of the live adults observed in this time stayed in the lowest Quartzville Creek reach and Canal Creek reach, but a few were observed in the second week at the highest Quartzville reach. Only 27 total redds were observed over the entire 5 weeks, 14 in the lowest Quartzville reach and 9 in the Canal Creek reach (and all were created between the first and third week of surveys); however, 74 salmon carcasses were recovered in total (36 females and 34 males; 48 in lowest Quartzville reach, followed by 14 in Canal Creek, and 10 in second lowest Quartzville reach) (Cramer Science 2023). Overall prespawning mortality was estimated to be 11.1 percent. Additionally, surveyors determined that the amount of preferable Chinook salmon spawning habitat in Quartzville Creek is limited and observed an abundance of hatchery-origin rainbow trout (potential predators of fry) in addition to high densities of spawning kokanee in Quartzville Creek (Cramer Fish Sciences2023).

Results from 2023 Quartzville Creek spawning surveys (conducted by EAS, Inc.) are not yet available for citation, but based on preliminary reports, there were some similarities and some differences. The surveys were conducted from September 24 to November 18 in the same reaches and began a bit later than 2022. A total of 85 carcasses were recovered but were heavily skewed toward females in 2023 (52 vs. 26 males), and nearly all but 1 were recovered in the lower two Quartzville reaches and the Canal Creek reach. Overall, the prespawn mortality rate was 7.7 percent (lower than 2022).

USACE recently improved adult-release sites upstream of Foster Dam to facilitate successful spawning of transported and outplanted adult fish in historical habitat upstream of the dams in compliance with RPA 4.7, Adult Fish Release Sites above Dams. In the past, bank erosion at the critical Riverbend release site in the South Santiam above Foster Dam created issues with releasing fish at lower river flows, when the end of the release pipe would become perched too high over the water.

Adult Passage and Habitat Access to Spawning Grounds: Winter steelhead

Winter steelhead historically spawned throughout much of the upper South Santiam subbasin above the sites of Foster and Green Peter dams in Thomas, Crabtree, McDowell, and Wiley creeks and many smaller streams in the lower subbasin (Willis et al. 1960). Fish access to historical habitats above Foster Dam has been impaired by USACE dams, but access to habitat in lower portions of the South Santiam subbasin remains unaffected by these dams (McElhany et al. 2007). With the cessation of original attempts to outplant adults above Green Peter Dam in 1988, natural winter steelhead spawning (not including successful adults outplanted above Foster Dam) has been limited to the mainstem South Santiam River below Foster Dam and Thomas, Crabtree, and Wiley Creeks.

Wade et al. (1987) suggested that prior to the construction of the Foster and Green Peter dams in 1968, two-thirds of the steelhead passing the Foster Dam site were destined for the Middle Fork Santiam River (above Green Peter Dam), though early counts of winter steelhead at Green Peter Dam (StreamNet trend 50300) only accounted for up to 30 percent of the run above Foster Dam (during the first few years after dam completion). ODFW (2005b) estimates that 17 percent of the entire South Santiam sub-basin habitat historically available to winter steelhead is now blocked by Green Peter Dam. Because of poor downstream juvenile passage conditions through Green Peter, adult winter steelhead are not currently transported from the Foster adult fish facility and outplanted above Green Peter to spawn. Romer et al. (2016) note that tributaries above Green Peter Dam in the Middle Santiam River may have more habitat for rearing than occurs in the South Santiam River above Foster Dam.

Winter steelhead collected at the Foster facility are all transported to the South Santiam River reach above Foster Dam. None of the winter steelhead that now return to the Foster adult fish facility are needed for hatchery broodstock so nearly 100 percent get outplanted. No genetic parentage analysis has been conducted to assess the performance of this natural-origin winter steelhead outplanting effort.

There is no basinwide time series for South Santiam UWR steelhead abundance. Steelhead spawning survey data (index redd counts) are available for a number of tributaries to the South Santiam River; in addition, counts are available for winter steelhead transported above Foster Dam (same as Figure of Foster Dam AFF returns above). Temporal differences in the index reaches, and the conditions under which surveys were undertaken, make the standardization of data among tributaries very difficult. Mapes et al. (2017) provides a comparison of survey methodologies and suggests a current total subbasin population of approximately 1,000 spawning steelhead adults, except in 2017. For the Foster Dam collection time series, the most recent 10-year geometric mean of winter steelhead returns (2010-2019) has been 141, with a negative trend in the abundance over those years.

Kelt Passage

In the past, mortality of steelhead kelts occurred during downstream passage through turbines or because they were unable to locate downstream passage facilities. A study in 1970 resulted in 41 percent mortality for steelhead kelts through the Foster powerhouse (Wager and Ingram 1970). Since 2019, USACE has conducted special spill operations for downstream fish passage beginning in May. This operational fish passage has improved efficiency and survival for juveniles, but injury and mortality continue for steelhead kelts (USACE 2023a).

Juvenile Passage - Green Peter Dam & Reservoir

Green Peter Dam originally included both juvenile and adult passage systems that were considered state of the art in the late 1960s during the dam's construction. Use of these facilities ceased in the late 1980s, ending any up or downstream passage of Chinook salmon and steelhead at the dam. A USACE (1995a) study concluded the original juvenile and adult passage facilities constructed at Green Peter Dam did not function as they were designed. The report summarized that the temperature of the water discharged from the adult ladder at Green Peter Dam was too cold during the spring and summer, which prevented the adult fish from moving into the facility. The report further concluded, based on the available data at the time, that juvenile fish passage at Green Peter Dam was impeded by their inability to locate the existing bypass at the face of the dam. The authors believed that the extremely slow water velocities and a long-convoluted shoreline delay juvenile salmonid migration from upstream tributaries to the dam. Also, predators in the reservoir, such as northern pikeminnow and largemouth bass, were thought to feed heavily on juvenile salmonids. Measures to improve juvenile passage considered in the report focused on collecting juvenile fish before they enter Green Peter Reservoir and building an improved collector at the dam face. For a detailed summary on the juvenile survival studies conducted through the Green Peter Dam fish horn routes (for which the infrastructure still exists) see Hanson et al. (2017). While survival through these fish horns has proven to be high, if fish are not attracted to the face of the dam and into the horns, the use of these would not provide full, effective passage.

The current downstream passage routes at Green Peter Dam are the surface spill bays, regulating outlets, and turbine units. There currently is no upstream passage provided at this dam. Recent fish passage evaluations for spring spill and fall drawdown operations at Green Peter Dam are summarized in the Research and Monitoring Evaluation section below.

Mortality of UWR Chinook salmon and steelhead juveniles often occurs during downstream passage through turbines and other outlets at South Santiam dams or because they are not able to locate downstream passage routes and are consumed by predators (or die from parasites, pathogens, etc.). Attempts to reintroduce Chinook salmon above Green Peter Dam and provide passage occurred from the 1960s to 1990s (when adults could be lifted over the dam from a ladder into a hopper system). During these years, juvenile survival through the entire reservoir and through the dam was extremely low (ranging between 1 percent in the 1980s to 12 to 23 percent in the 1960s) (Buchanan et al. 1993; USACE 1995). At the time, juveniles could pass Green Peter Dam through one of possibly four different routes including two turbines; two spillways; two regulating outlets; four 12-inch-diameter steel fish bypass pipes at elevations of 910, 935, 960. and 985 feet; and the "fish horn". The use of this juvenile bypass system was discontinued in 1987 because of poor collection efficiency (USACE 1995). However, more recently, passage-survival studies for the juvenile bypass system at Green Peter Dam have been conducted using sensor fish (Duncan 2013; Deng et al. 2015) and live juvenile Chinook salmon and steelhead (Deng et al. 2015). The first sensor-fish study demonstrated that a higher flow (7.5 ft^3/s) through the 24-inch pipe (where all four 12-inch pipes join together) created significant events for at least 23 percent of the fish, including shear and collision forces (Duncan 2013). The sensor-fish study by Deng et al. (2015) was run parallel to a live-fish-survival study using both juvenile Chinook salmon and steelhead and compared differences in passage conditions between passage for two elevation openings (at 910 and 935 ft.; low reservoir elevations only allowed for evaluation at these two of the four) and four gate valve openings (fully open, and 25 percent, 50 percent, or 75 percent closed). Flow through the bypass was held at 4.8 ft^3/s. Sensor results indicated that the best hydraulic conditions for fish would be achieved when the gate is opened 75 percent or more (or closed 25 percent or less) and found no significant difference between orifice elevations at these gate openings (Deng et al. 2015). These conclusions were in agreement with the live-fish-survival studies conducted by Normandeau Associates in 2013, 2014, and 2015, which concluded that the configuration of the 12-in and 24-in bypass pipes at Green Peter should be able to safely pass ≥96 percent of juvenile salmonids (Chinook salmon and steelhead), provided the flow control valves are ≥50 percent open (Normandeau Associates, Inc. 2015; Deng et al. 2015). For a similar study conducted at Green Peter Dam, the 24 ft additional operating head (in 2016 vs. 2015) did not result in higher injury or mortality at valve openings greater than or equal to 50 percent; however, a valve opening of 29 percent in 2016 inflicted considerably more injury and mortality than 25 percent valve opening in 2015 (Hansen et al. 2017).

Beginning in 2022, Chinook salmon outplanting efforts above Green Peter Reservoir were reinitiated, and new Injunction operations for downstream juvenile passage were being tested and evaluated at Green Peter Reservoir. The studies related to these Injunction operations, and preliminary results are described in the next section.

Juvenile Passage - Foster Dam and Reservoir

There have been a significant number of fish passage studies conducted at Foster Dam since the 2008 Biological Opinion. Foster Dam fish weir (spill) operations targeting two reservoir elevations (615 ft MSL and 635 ft MSL) began in 2013. A sensor-fish study was conducted by Duncan (2013) in December of 2012 to assess passage conditions through the Foster weir and 81 percent of sensor-fish releases experienced at least one major strike, collision, or shear event at various locations over the concrete passage structure (chute, spillway, and stilling basin). These "events" occurred at all elevations and release locations tested (Duncan 2013). For sensor-fish released through turbine 1, 62 percent experienced at least 1 major event, 24 percent experienced multiple events, and 25 percent were lost or damaged. Most occurred in the wicket gate-runner region regardless of pool height and generation watts. This study was conducted under the same set of conditions as the Normandeau Associates, Inc. (2013) radio-tag study that estimated actual juvenile Chinook salmon and steelhead (and kelt) weir and turbine survival (after being held 48 hrs post passage). Juvenile weir survival was higher at low elevations (99.5 percent at 616ft) vs. higher (94.4 percent at 634 ft.). Adult steelhead (kelt) weir survival was 100 percent at low pool, vs. 77.5 percent at high. Juvenile steelhead survival through turbine 1 ranged from 79 to 85.4 percent at 616 ft. elevation (and lower head) versus 75.9 to 88.2 percent survival at the 634 ft. reservoir elevation (so it is very similar). Given that the Duncan study had such high numbers of sensor-fish experiencing a strike through the weir (81 percent) and turbine (62 percent), it is surprising that the survival rates for live fish were so high in the Normandeau (2013) study.

A new weir was developed as part of the 2008 NMFS RPA requirements and installed in 2018. Liss et al. (2020) evaluated Chinook salmon and steelhead downstream passage at Foster Dam with operation of the new weir as compared to passage at the old weir using radio-tagged fish. Their report summarized the following overall at dam survival for 3 years of study fish (2015, 2016, 2018).

- Dampassage survival for yearling Chinook salmon was best at high pool (635) (64.6–84.4 percent) vs. 61.1–62.7 percent at low pool (613). Yearling Chinook salmon also had highest survival rates through the spillbays.
- Dam passage survival for 2-yr winter steelhead was best at high pool (71.5–80.8 percent) vs. 47–61.4 percent at low pool.
- Dam passage survival for subyearling Chinook salmon was only done at low pool (75.5–85.5 percent).
- The new weir design improved yearling Chinook salmon attraction to the route, and Chinook were equally attracted to the spillway and the weir at low pool. For the same treatment at high pool, weir passage was higher across all years. Unfortunately, survival rates are lower through the weir for yearling Chinook salmon vs. the spillway but are improved at higher pool.
- Passage was much better for subyearling Chinook salmon through the weir vs. turbines once the weir was fixed in 2018. However, they survive better than other groups through the turbines with similar survival rates through the weir and spillway.
- Juvenile steelhead were more likely to use weir passage vs. the turbines at high pool, and, if all three routes were available, they are more likely to be pulled to the turbines. If flow is only going through the spillway and weir (no turbines), the steelhead will use the weir more often at high pool and the spillway more often at low pool. Unfortunately, survival rates through the weir are lower than through the spillbays for steelhead.
- Prior to 2018 weir adjustments, spillway passage was generally the most effective passage route, especially at high pool, and then the weir became more effective after adjustments (in terms of passage efficiency).
- It is possible that when the weir and spillway are opened simultaneously without turbines at high pool, that improves passage for UWR Chinook but reduces UWR steelhead survival.

4.5.3.2 Water Quantity, the Hydrograph and Climate Change

The 2008 NMFS biological opinion describes the environmental baseline condition for the hydrology of the South Santiam River and is incorporated by reference (NMFS 2008a, Section 4.5.3.2). The operations and flows since 2008 fall within the effects analyzed, with the largest differences below Foster Dam between regulated and unregulated flows being peak flow reduction, decreased flows from February to May, and increased flows from July to January (see Figure 4.5-5).

Positive effects of regulated flows occurring in the South Santiam River below Foster Dam include increased (augmented) flows above those that would naturally occur in the summer and fall (in some years). These do not outweigh the negative effects of decreased habitat accessibility resulting from a reduction in peak flows, decreased habitat quality and complexity from reduced gravel and LWD transport from sources upstream of Foster Dam, and bed armoring and stabilization of the channel.

The effects of reducing late-winter and spring peak flows on UWR spring Chinook salmon have not been effectively monitored, but studies in other Columbia River basin watersheds found that freshets are critically important because higher spring flows are correlated with faster downstream travel times and earlier (typically more ideal) arrival times to critical rearing habitats in the estuary and ocean (Scheuerell et al. 2009). Scheuerell et al. (2009) found that this migration timing plays an important role in determining juvenile-to-adult survival for Columbia River Chinook salmon and steelhead, with early migrators typically experiencing much higher survival.

Below Foster Dam, entrapment, stranding, and redd desiccation have been largely reduced through the processes established by the 2008 RPA measure 9.2.4 which set minimum and maximum tributary flows, and measure 9.2.6 which restricts down-ramping rates and requires interagency coordination when there are ramp rate exceedances (NMFS 2008a).

The magnitude and frequency of flow fluctuations may have rendered the length of the Middle Santiam River between Green Peter Dam and Foster Reservoir unsuitable for fish habitation (USACE 2000). The modifications to flow below Green Peter Dam are quite different from those seen below Foster Dam due to incorporation of hydropower peaking operations, which cause daily and hourly flows to be substantially more variable. The habitat in this reach is also severely degraded by the lack of gravel and finer sediment input as a result of the dam and reservoir. Ramping rates below Green Peter Dam are unrestricted and highly variable, causing water levels in Foster Reservoir to change by 5 to 15 feet per day (USFWS 1961; USACE 1989).

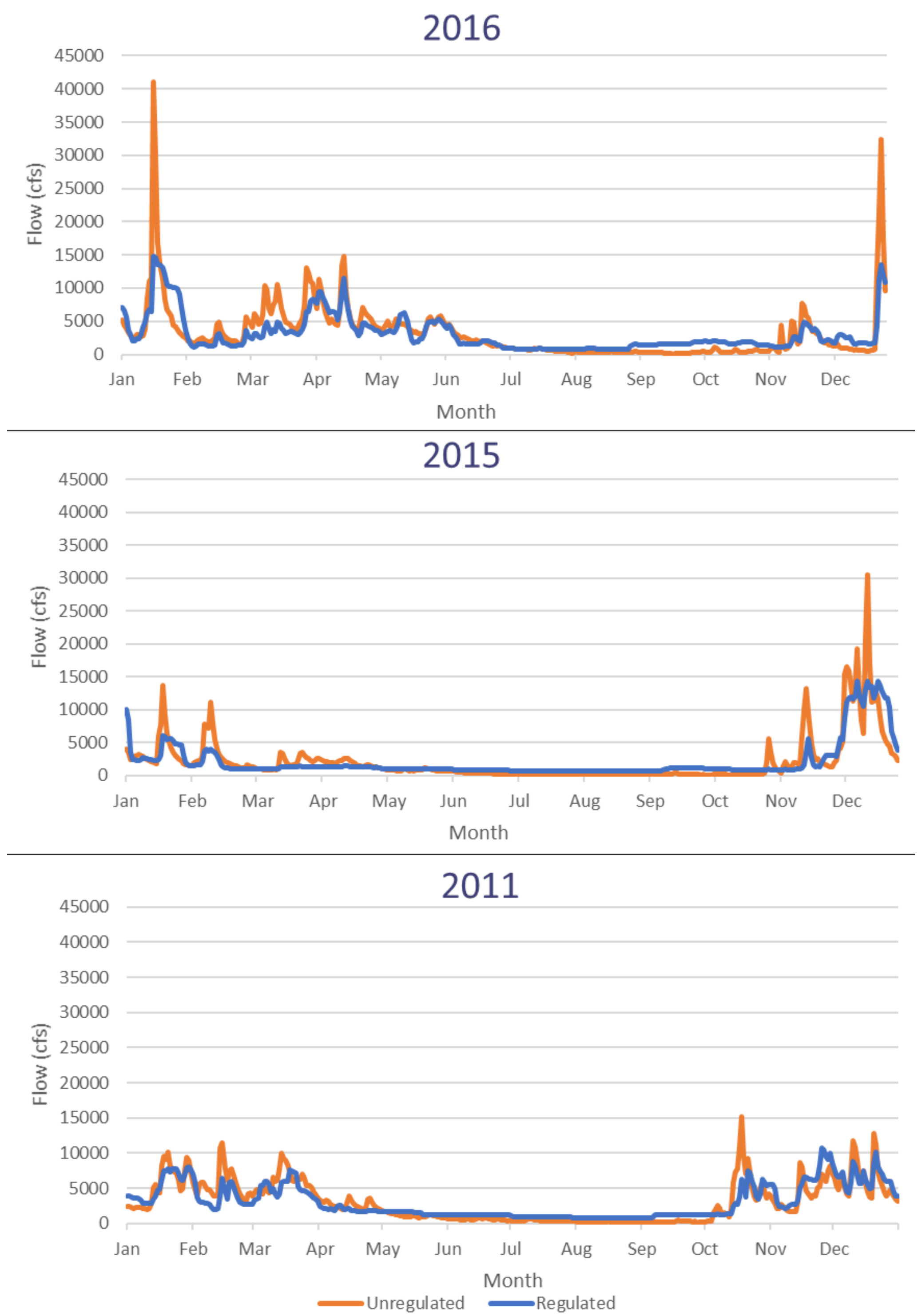


Figure 4.5-6 Hydrograph for the South Santiam River at Waterloo, OR for different "water years". The orange lines are for natural flows in 2011, 2015 and 2016. Blue lines are actual flows under dam operations for the same years.

Other Water Quantity Considerations in the Sub-Basin

Water withdrawals for irrigation, domestic, and industrial uses contribute to low-flow conditions in the South Santiam River and its tributaries, particularly in late summer and early fall. This loss of streamflow affects steelhead productivity by reducing rearing habitat availability and quality for fry and summer parr.

4.5.3.3 Water Quality

Water Temperature

The South Santiam River reach that is least influenced by high water temperatures lies below Foster Dam where temperature increases are buffered by releases of deep cold water from Green Peter Reservoir. In contrast to the North Santiam Basin (highly permeable geology with sustained base flows), the South Santiam Basin is of low permeability, tends to quickly transition precipitation to runoff, and is considered flashy in nature (Tague and Grant 2004).

Resource Agency (RA, developed between USACE and fisheries agencies) targets have not been developed for the South Santiam subbasin; but the original McKenzie and modified North Santiam Subbasin RA targets are used as a surrogate. It is worth noting that the South Santiam subbasin has very different summer conditions both upstream (much warmer) and downstream (much cooler when the source is the lower elevations) compared to the McKenzie and North Santiam subbasins (Rounds, 2010).

During the spring spill injunction operational passage at Green Peter Dam in 2023, downstream water temperatures did not always stay within downstream temperature targets (Figure 4.5-7). Temperatures gradually warmed during the spring before drastically cooling off when spill operations concluded. The Foster Dam average outflow temperatures measured at the gage station on the South Santiam below Foster were within targets in April, 7 °F or more above the minimum target in May (2021, 2023-2024), but generally within within the targets for June. October temperatures regularly exceed upper targets (Figure 4.5-7). From June 16 through August 1, the Foster fish weir is currently used for downstream temperature management to better match temperatures at the adult ladder to improve adult fish migration. The deep drawdown of Green Peter Reservoir caused an increase in downstream water temperatures below Foster Dam in October and water temperature impacts were reported by ODFW, who manage the fish hatchery located below Foster Dam. USGS modeling predicted high water temperatures from a deep drawdown at Green Peter Reservoir using Corp of Engineers Quality Width averaged 2D (CE-QUAL W2). Those modeling results indicated that water temperatures below Green Peter and Foster dams would exceed 60°F during the drawdown as was observed in 2023, unless changes in start timing and elevations were able to modulate the highest levels (USACE 2023c, and Stratton Garvin et al. 2023) (Figure 4.5-7). Average outflow temperatures were less than the minimum target in July, August, and September and greater than the maximum target in October by 10°F before decreasing to below the RA target in November (Figure 4.5-7).

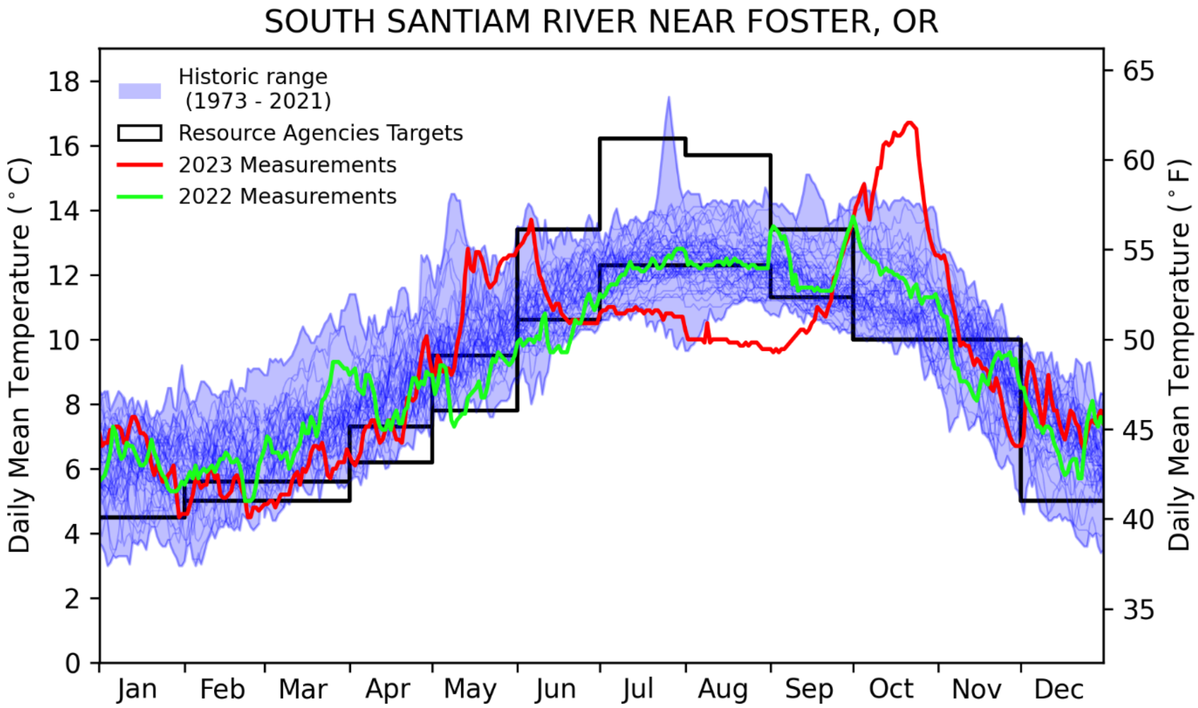


Figure 4.5-7 Foster Reservoir daily mean 2022 and 2023 outflow temperatures compared to resource agencies target temperatures and historical temperature ranges during 1973 to 2021.

Other Water Quality Constituents

The USACE funded USGS to conduct real-time turbidity monitoring and sampling at Green Peter and Foster dams starting in August 2023. Dissolved oxygen (mg/L) was also monitored at the sites listed below (except for the Foster Lake site). Monitoring locations going from upstream to downstream include:

- Middle Santiam River below Green Peter Dam near Foster, OR (141862000)
- Foster Lake Below Gedney Creek at Foster, OR (442453122394900)
- South Santiam River near Foster, OR (14187200)
- South Santiam River at Waterloo, OR (14187500)

In 2023, turbidity was monitored in real-time downstream of Green Peter and Foster dams throughout the drawdown, and this monitoring will continue throughout the remainder of the year and next year. Based on initial, provisional information from the USGS, turbidity levels peaked to 1,380 formazin nephelometric units ("FNU") directly downstream of Green Peter Dam as the reservoir was first drawn down in early November, followed by a second notable spike in turbidity in early December during a heavy-rain event. High levels of turbidity were measured all the way downstream to Waterloo and observed even further downstream where the North and South Santiam Rivers converge. Downstream communities reported that turbidity associated with the Green Peter Reservoir deep drawdown impacted drinking water facilities. The City of

Sweet Home reported the need to alter operations as a result of the turbidity to keep up with water-supply demands (operating for extended hours and changing how they treat the water).

Turbidity levels indicate that sediment from the drawdown at Green Peter Dam is being transported below Foster Dam to the confluence of the South and North Santiam rivers (Figure 6-14). At this time, it is uncertain if this sediment is impacting Chinook salmon eggs in gravels ("redds") below Foster Dam.

Since 2015, TDG has been monitored downstream of Foster Dam. This data is used to monitor TDG produced from dam operations and compare to the State of Oregon water quality standards for TDG (Oregon Administrative Rules 340-041-0031). Elevated TDG levels can occur when the outflow of water exceeds the powerhouse capacity and spillway discharge. Elevated TDG levels can cause gas bubble formation in the gills, bloodstream, and swim bladder, which can in turn, adversely affect swimming.

TDG below Foster often remains below 110 percent. TDG concentrations above the State of Oregon water quality standards of 110 percent occurred in the spring for a large percentage of days between mid-April and mid-June (though did not exceed 115 percent), a short event in August, and during spill events that occurred through October to December. The spring events occurred during high-flow events and spillway discharges for operational downstream fish passage in excess of 3,000 cfs and also while the Green Peter Reservoir spill was occurring. The highest TDG saturation occurred around December 13 with saturations peaking to approximately 116 percent.

4.5.3.4 Physical Habitat Characteristics

Past management of riparian areas and stream-cleaning practices have led to reduced large wood in streams. Mature riparian forests now make up a very small proportion of the floodplain and riparian vegetation along the river and tributaries in the lower basin, particularly in areas where there is the largest amount of agricultural use. Riparian conditions are better in the upper subbasin than in the lower, but proportions of mature and old-growth coniferous forests are reduced (Corps 2001, cited in WRI 2004).

There is limited natural spawning in the lower South Santiam River, Thomas and Crabtree creeks, and Wiley Creek, with the majority of spawning occurring below Foster Dam. Reproductive success in many of the reaches below Foster Dam is likely limited by habitat degradation, although even historically, the majority of the Chinook salmon spawning was above the site of Foster Dam (Mattson 1948, Parkhurst et al. 1950a).

Conditions in the South Santiam River above Foster Reservoir may be limiting because of high (>20°C) prespawning holding temperatures and poor incubation and rearing habitat conditions (the river is prone to scour during flood episodes). For example, 2010 was a poor year for salmonid spawning because of scouring floods that occurred during egg incubation. Alternatively, historical habitat (Quartzville Creek and the Middle Santiam River) above Green Peter Dam may provide better spawning and rearing habitat than the upper South Santiam River.

Previous surveys suggest that the Middle Santiam River and its tributary, Quartzville Creek, were historically preferred steelhead spawning habitat (Parkhurst 1950, Wagner et al. 1963).

A second spatial structure concern is the availability of juvenile rearing habitat in side-channel or off-channel habitat. River channelization and shoreline development have constrained habitat in the lower tributary reaches and Willamette River mainstem, in turn limiting the potential for fry and subyearling "movers" emigrating to the estuary (Schroeder et al. 2016).

4.5.4 Hatchery Fish Management

Hatchery broodstock collection efforts for Chinook salmon within the subbasin began in 1923 at a weir placed across the river near the town of Foster (Wallis 1961). The South Santiam Hatchery began operations in 1966 to mitigate the loss of Chinook salmon production in areas above Foster Dam (passage was ineffective at Foster).

Between 2002 and 2008, only hatchery origin Chinook were released above Foster Reservoir, but since 2009, only natural-origin Chinook salmon are now transported to the South Santiam above Foster reservoir, and since 2022, some hatchery-origin adults are being released in areas above Green Peter Dam as part of a new reintroduction research effort. Both natural- and hatchery-origin Chinook salmon can be used as hatchery broodstock. At least 650 adults must return to Foster Dam before 2 percent of the natural-origin returns can be used for broodstock (NMFS 2019a). The current production goal for spring Chinook salmon at the South Santiam hatchery (for South Santiam releases) is 1,021,000 fish.

Recent improvements (2014) at the Foster Dam fish collection facility offered the potential for collecting more hatchery-origin adults and removing them from the naturally spawning component of the populations. However, the facility appears to require further modifications to improve collection efficiency. The influence of hatchery-origin Chinook salmon on the spawning grounds has not shown great improvements because of attraction issues at the newer adult fish facility (Keefer et al. 2018b), leaving more hatchery-origin fish to spawn below Foster Dam. Reducing hatchery influence on the natural-origin population of South Santiam Chinook salmon is further complicated by Foster Dam AFF ladder attraction issues and because not all fish produced upstream of the dam are being effectively attracted to the trap each year, on a consistent basis. Additionally, some of the NORs that enter the trap may be the offspring of hatchery-origin spawners from reaches below the dam, or from the adults recently being released above Green Peter. Reintroducing adult populations above Green Peter will add a new layer of complexity to the reintroduction efforts above dams in the South Santiam sub-basin.

Spring-run Chinook salmon adults returning to the South Santiam River were once monitored via redd counts and carcass recoveries in the mainstem South Santiam. Carcass recoveries are used to estimate the proportion of NOR and hatchery-origin return (HOR) spawners. The current estimate for the proportion of hatchery-origin Chinook salmon on spawning grounds for the South Santiam River is 65 percent, and the long-term target is 30 percent (NMFS 2019a).

4.5.5 Fisheries

Recreational fisheries are open for hatchery Chinook salmon and all coho salmon in the mainstem below Foster Dam year-round other than September 1st to October 14th, for hatchery trout from May 22 to October 31st, and all year for hatchery steelhead. Harvest for unclipped (natural-origin) salmon and steelhead is prohibited except for the months of July and August. Please refer to Fisheries Section in the Willamette Mainstem and Basin baseline chapter for more information on fisheries effects to UWR Chinook salmon and steelhead in the Willamette basin (Chapter 4.1).

4.5.6 Predation & Competition

Non-native smallmouth bass are present in Green Peter Reservoir and are thought to prey on juvenile Chinook salmon. However, no studies have been done to estimate the magnitude of predation.

The naturally produced progeny of non-native summer steelhead released in the subbasin are thought to compete with juvenile South Santiam UWR steelhead for habitat and food (NMFS 2004). This hatchery stock was introduced into the Willamette Basin from Skamania stock and is not part of the UWR steelhead DPS. Not all of the adult summer steelhead are harvested by anglers or removed at the Foster Trap, and some summer steelhead have been observed spawning in the mainstem South Santiam River as well as Wiley, Crabtree, and Thomas Creeks. Studies in the Clackamas River have shown adverse effects from non-native Skamania summer steelhead on native steelhead (Chilcote 2003, Kostow and Zhou 2006). One ecological factor that may impact juvenile winter steelhead is the earlier emergence of any naturally produced summer steelhead (from adults which have residualized), which may impart a competitive disadvantage to native fish if choice feeding territories are already occupied by summer steelhead (Kostow and Zhou 2006). Research conducted by Sharpe et al. (2008) demonstrated very low predation of hatchery summer steelhead releases on Chinook salmon fry; however, it is possible that a percentage of them do not migrate out to the ocean and instead choose to residualize, which does create the potential for negative ecological interactions with both UWR Chinook salmon and winter steelhead (Harnish et al. 2014).

In addition to competition and predation issues associated with residualized hatchery-released summer steelhead (noted in similar sections above), South Santiam UWR Chinook salmon and winter steelhead juveniles may also be impacted by the juvenile offspring of any hatchery-origin summer steelhead adults (that return and spawn prior to being caught or trapped).

Quartzville Creek spawning surveyors observed high densities of rainbow trout during their 2022 surveys, and Quartzville Creek was projected to receive 21,000 additional hatchery rainbow trout in 2023 (Cramer 2023). These hatchery trout will compete for resources and prey upon juvenile salmon that survive to become fry. Harvest, whether directed or from poaching, will continue to reduce the success of reintroduction of UWR Chinook salmon to Quartzville Creek.

Avian predation was originally reported for active tag survival studies in the Foster study area in the 2018 study (Liss et al. 2020) and was again observed in the 2022 study (Liss et al. 2023). The results indicated that spring-released steelhead suffered the greatest amount of predation (22.1% of detected fish), while fall-released subyearling Chinook salmon were predated the least (3.9%). Steelhead are disproportionately predated compared to other salmonids (Evans et al. 2018, Zamon et al. 2014).

4.5.7 Research, Monitoring and Evaluation (RME)

Monitoring Efforts

Passage studies have recently been conducted at both Green Peter and Foster dams to evaluate new spring-spill operations at both projects, as well as the fall drawdown operation at Green Peter (combined with Foster spill) (Liss et al. 2023; Larson et al. 2024).

The spring 2022 study included the release of 420 yearling Chinook in Green Peter Reservoir under two different spill treatments in the month of April (at full pool), and over 800 yearling Chinook and 1500 age-2 steelhead in Foster Reservoir under two different spill treatments and pool elevations in the months of March through mid-June. Green Peter reservoir survival estimates for yearling Chinook ranged between (63% and 71%). A total of 222 of the 420 Chinook passed Green Peter and their survival (from Green Peter Dam to the Sunnyside Array) was estimated at 69%. An estimated 43% of the fish that passed Green Peter survived to Foster, and only 32% that passed Green Peter made it to the lower Santiam River near the Willamette mainstem. From Green Peter, Chinook yearlings released during the nighttime spill treatment spent LESS time in the reservoir (though the discharge from Green Peter nightime spill was higher) but then traveled slower to all reaches downstream of the Sunnyside Array compared to fish released during the 24/7 spill treatment. Compared to previous study years at Foster, the 2022 Foster spring spill dam operations appear to have produced similar survival rates but also reduced reservoir residency times (Liss et al. 2023).

Results for the 2023 spring operations were similar for yearling Chinook and found that approximately 152 (36 percent) of the total active tagged-fish released at head- and mid-reservoir in Green Peter reservoir were not detected at Green Peter Dam. The fates of these fish were unknown. Thirty-seven fish were detected close to the dam, but these fish did not pass the dam. Two hundred and twenty-eight (55 percent) of the tagged fish passed Green Peter dam during the 30-day spillway evaluation. Project survival for yearling Chinook salmon at Green Peter Dam during 2023 spring spill operations ranged from 68 to 71 percent, and reach survival through Green Peter Dam all the way to Foster Dam ranged between 42 and 44 percent. Survival from Green Peter Dam to the confluence with the Willamette River ranged from 31 to 33 percent. Green Peter Dam passage efficiency estimates ranged between 78 percent (24/7 spill) and 85 percent (nighttime only spill) (Larson et al. 2024).

Green Peter Fall Reservoir Drawdown / Foster Spill Study

Results from the fall 2023 Foster low-pool interim spillway operations and Green Peter Reservoir drawdown RO operations indicate some success in attracting and passing juveniles. The intent was to evaluate passage of juvenile Chinook salmon (subyearlings) and juvenile winter steelhead (or appropriate surrogates), with results informing the timing of fall operations and adjustments for improved downstream fish passage through the South Santiam projects (Green Peter and Foster reservoirs and dams) (Larson et al. 2024). Nighttime spillway operations at Foster Dam occurred from October 1–December 15, and the fall Green Peter RO operations commenced when the reservoir began drawing down in the late summer to achieve an elevation of 780 feet by November 15. A total of 738 tagged Chinook salmon subyearlings were released at the head and in the middle of Green Peter Reservoir. Estimated survival rates through the Green Peter Dam (for the 313 fish that made it there and passed) were 69 percent and 74 percent per release group. Of the 313 fish that passed through Green Peter Dam, 22 percent made it downstream to the confluence of the Santiam rivers (Larson et al. 2024). For the 114 subyearlings originally released in Foster Reservoir (exact release date unknown), reservoir survival rates were 52 and 19 percent for the two different release groups. Foster Dam concrete survival for all fish that passed (from GPR and FOS releases) was 89 percent. Finally, of all the fish that passed Foster Dam (both GPR and FOS releases), 60 percent made it to the Santiam confluence (Larson et al. 2024). Age-1 steelhead were also released as part of this study but only in Foster reservoir. Reservoir- and dam-passage survival estimates were incredibly low in comparison to past survival studies for steelhead at Foster; however, past studies likely used age-2 steelhead, which is the age at which juvenile steelhead typically begin downstream migration.

4.6 North Santiam Sub-Basin

Within the North Santiam sub-basin, the action area includes the North Santiam River from Detroit Reservoir to the confluence with the Willamette, plus adult release sites in the upper North Santiam and Breitenbush River. The following section presents an assessment of the condition of the listed species and their designated critical habitat in the North Santiam sub-basin portion of the action area.

The North Santiam River drains approximately 654 mi^2 on the western slopes of the Cascade Mountain Range in northwestern Oregon. Average daily river discharge is 6,120 cfs (range, 471–25,500 cfs; U.S. Geological Survey [USGS] streamgage 14183000) and major tributaries include the Breitenbush River, Box Canyon Creek, Kinney Creek, and the Little North Santiam River (USGS, 2016a; Figure 4.6-1). Below the South Santiam River confluence, a river segment 11.6 miles long, known as the mainstem Santiam River, flows to the mainstem Willamette River.

The mainstem Santiam River is frequently included in discussions of the North Santiam River and in measuring river distances (RM) from the mainstem Willamette. The North Santiam River flows from headwaters in the Mount Jefferson Wilderness Area of the Willamette National Forest to its confluence with the South Santiam River near Jefferson, Oregon. Eighty-two percent of the contributing area is forested and 65 percent is in public ownership (NRCS 2006b).

The North Santiam River is impounded by five dams including Detroit Dam, Big Cliff Dam, Minto Dam, and Upper Bennett Dam/Lower Bennett Dam (hereinafter “Bennett Dam complex”; Figure 4.6-1). Detroit and Big Cliff dams (both completed in 1953) are owned and operated by the USACE. Minto Dam (and associated Adult Fish Facility) are owned by the USACE. The Bennett Dam complex is owned and operated by the Salem Water Control District. A single fish hatchery, Marion Forks Hatchery, is located on the North Santiam River tributaries of Marion and Horn Creeks, about 17 mi east of Detroit, Oregon (Figure 4.6-1). The Little North Santiam is the only major tributary that enters the North Santiam between the USACE's Big Cliff and Detroit Dams (located at RM 58.1 and 60.9, respectively) and the South Santiam River.

Above the reservoirs associated with Detroit and Big Cliff dams, the North Santiam drainage is characterized by steep, forested terrain that lies almost entirely within the Willamette National Forest, although there are some private in-holdings. Below the dams, the North Santiam River passes through a steep, forested canyon to approximately RM 50, near the town of Gates, where the canyon widens, the channel gradient decreases, and the river begins to meander (USACE 2000). The river valley widens and the channel gradient decreases further (to <0.3 percent) near Mehama (at RM 37, just downstream of the Little North Fork confluence). The North Santiam River channel becomes more sinuous below this point and was once described by the USACE (1947) as "crooked and frequently divided by large islands."

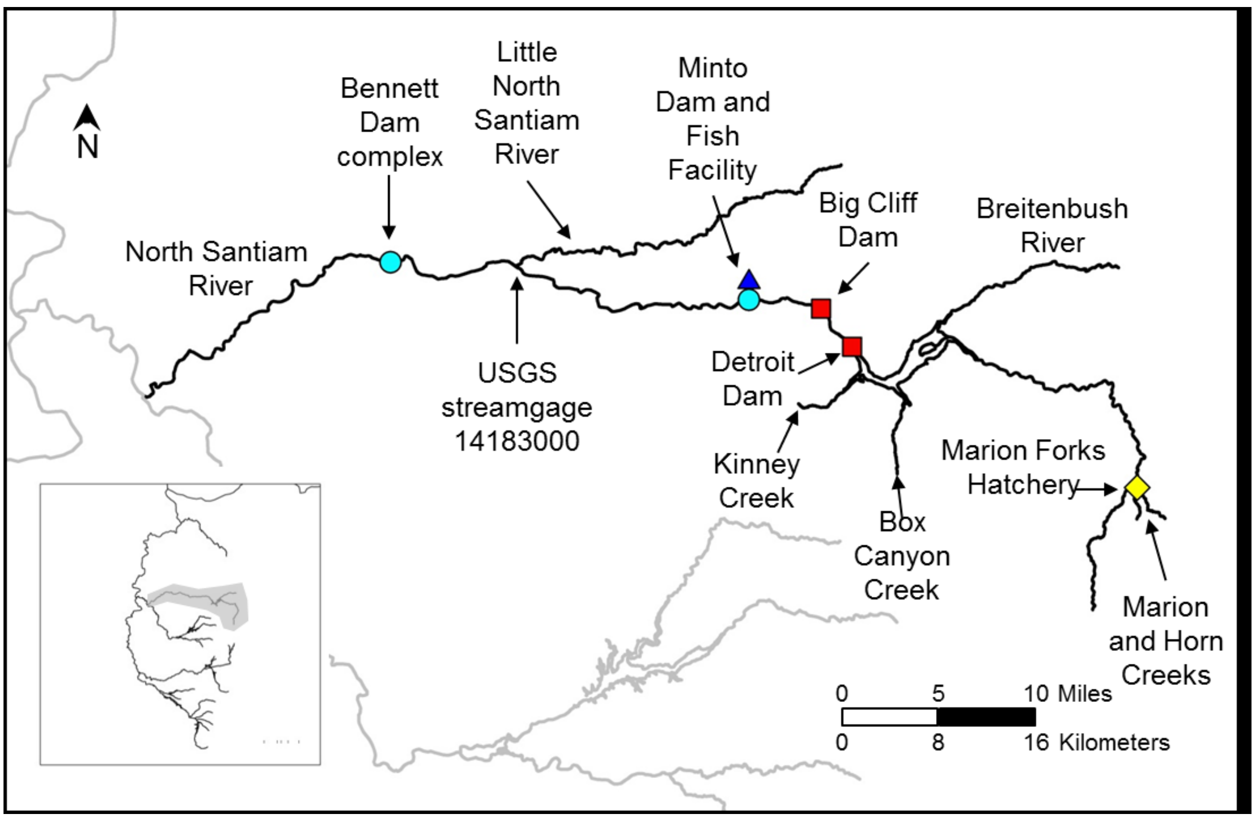


Figure 4.6-1 Map showing primary rivers in the North Santiam River subbasin (black lines), U.S. Army Corps of Engineers (USACE)-owned dams (red squares), non-USACE dams (blue circles), fish hatcheries (yellow diamonds), and adult fish facilities (blue triangles), Willamette River Basin, Oregon. Other Willamette Basin rivers outside of the North Santiam subbasin are in gray. Inset of the Willamette River Basin with the North Santiam subbasin shaded in gray is in the lower left. (Map from Hansen et al. 2017.)

4.6.1 Historical Populations of Anadromous Fish in the North Santiam Sub-basin

Before the USACE dams were constructed (completed in 1953), adult UWR Chinook salmon spawned in the upper reaches of the North Santiam River and in headwater tributaries such as Marion Creek, Breitenbush River, and Blowout Creek (WNF DRD 1994, 1996, 1997), as well as in the mainstem below the dam sites and in Little North Santiam River (Parkhurst et al. 1950). Historical estimates of the abundance of UWR Chinook salmon in the North Santiam subbasin range from 8,250 adults escaping to spawn upstream of what is now the current location of Detroit Dam in 1934, (Wallis 1963) despite intense downstream fisheries, to 2,830 spawners throughout the entire subbasin in 1947 (Mattson 1948). Parkhurst et al. (1950) estimated that there was sufficient habitat in the North Santiam River to accommodate at least 30,000 adults.

UWR steelhead are also native to the North Santiam subbasin. Surveys conducted in 1940, before the dams were constructed, led to estimates of at least 2,000 winter steelhead spawning in the mainstem North Santiam River, with additional runs to Breitenbush River; Marion Fork, Pamelia, and Blowout creeks; and the Little North Santiam (Parkhurst et al. 1950). The species also used many smaller streams in these and other tributary drainages (BLMS 1998; Olsen et al. 1992; WNF DRD 1994, 1995, 1996, 1997). After construction of the dams, Thompson et al. (1966) estimated that the entire North Santiam River subbasin supported a population of 3,500 winter steelhead in the 1950s and early 1960s, including an unknown proportion of hatchery fish and adults trapped at the Minto facility (below Big Cliff Dam).

4.6.2 Current Status of Sub-basin Population and Importance to Recovery

4.6.2.1 UWR Spring Chinook Salmon

Since the early 2000s, based on an assessment of its abundance, productivity, spatial structure, and diversity, the North Santiam population of UWR Chinook salmon has been assessed at a high risk of extinction (McElhany et al. 2007; ODFW and NMFS 2011). For the UWR Chinook salmon ESU to achieve recovery, the North Santiam population (one of four core populations in the ESU) must reach the status of a “low extinction risk” according to the UWR Chinook recovery strategy in the Recovery Plan (ODFW and NMFS 2011). It was estimated that to achieve this level, the natural-origin adult return would need to increase by 5,400 fish (above mid-2000s abundances).

Data available for the NMFS viability assessment in 2022 demonstrated that adult natural-origin returns to the North Santiam River, as measured at Bennett Dam and through redd and carcass surveys, exhibited a decrease in abundance and a strongly negative productivity (Ford ed. 2022). In this assessment, the 5-year average abundance (for 2015–2019) for natural-origin Chinook salmon spawners was 354 fish, a 12 percent decrease from the previous period (401 average spawners from 2010–2014), but similar to the average for 2005–2009 estimates (333). However, estimates of NORs at Bennett Dam from 2015–2019 ranged from 573 to 1,059 (geometric mean of 849), suggesting either considerable prespawning mortality or an undercount of spawners.

Since funding for spawning surveys was discontinued after 2019, the Bennett Dam counts provide the best long-term current abundance index for this population and the most recent data (though this effort was recently discontinued in November 2024 due to lack of funding) (Figure 4.6-2). This index indicates that the natural-origin adult returns have remained well below 2,000 since the first extinction risk assessment. Some minor gains have been observed since 2010, with peak returns in 2014 (1630) and 2020 (1638), but the last 5 years have been variable (ranging between 530 and 1638). Since the late 2000s, natural-origin adult Chinook salmon returns to Bennett Dam have consistently remained above 500 fish, but there has not been a marked increase observed since that time (Figure 4.6-2). The percentage of unmarked (presumably natural-origin) Chinook salmon passing Bennett Dam in the last 10 years has ranged between 13 to 28 percent of total returns.

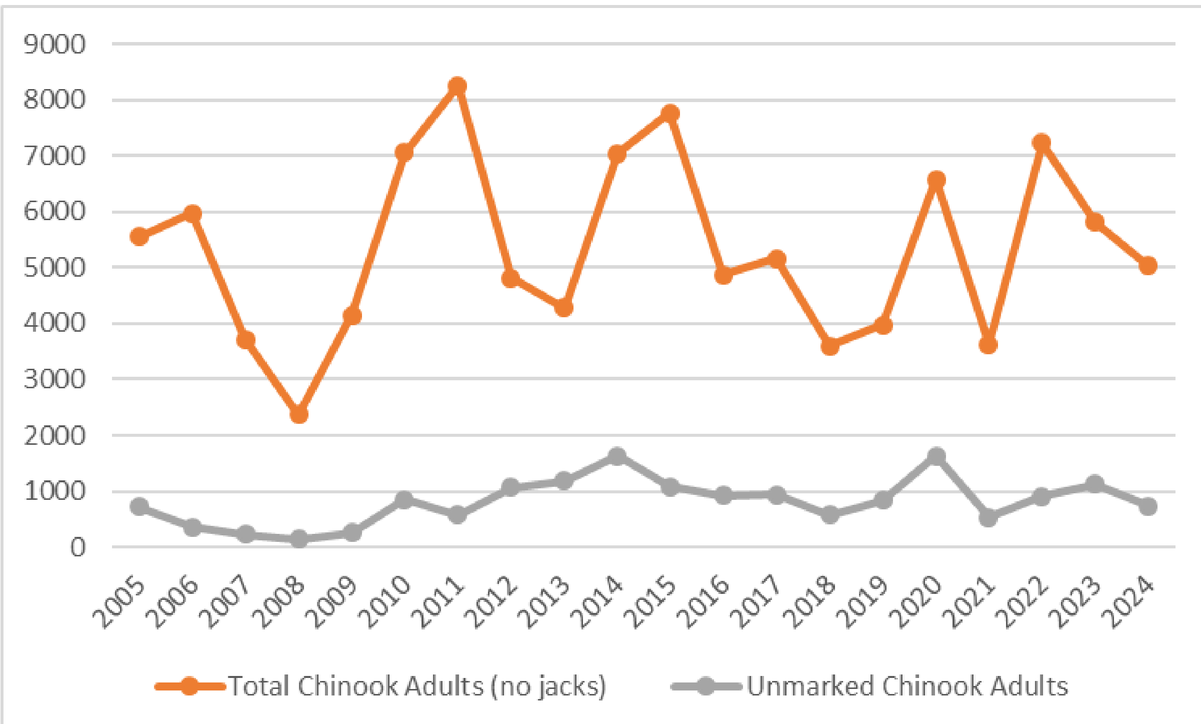


Figure 4.6-2 Total annual adult Chinook salmon (marked and unmarked) counted at Bennett Dam on the North Santiam River from 2005 to 2024, not including jacks, and total unmarked adult Chinook salmon annual counts.

4.6.2.2 UWR Winter Steelhead

In the original risk assessment, McElhany et al. (2007) rated the North Santiam population of UWR steelhead as being at low to moderate risk of extinction with considerable uncertainty, and indicated a goal of adding 4,687 returning adult spawners to the population to reach a very low risk of extinction (in order to achieve recovery for the UWR steelhead DPS). The North Santiam UWR steelhead population is considered to be a core population component of the DPS. Though abundance data is limited for estimating trends, the general opinion is that the UWR steelhead population has been in steady decline since listing (Ford ed. 2022). Releases of hatchery winter steelhead ceased in 1999, which confounds the analysis of abundance trends if not considered. Further confounding the population's status is the fact that Johnson et al. (2021) found that over half of the unmarked juvenile steelhead sampled below Big Cliff Dam were genetically assigned as non-native early-winter steelhead (see status of species section for UWR steelhead for more information about genetic influences on the DPS over time).

Winter steelhead spawn throughout the North Santiam River basin, except for reaches above the Big Cliff/Detroit Dam complex. Currently, the best measure of this steelhead population's abundance is the count of returning winter-run adults to Upper and Lower Bennett dams, but the time series only goes back to 2013. Recent passage improvements at the dams and an upgraded video-counting system have contributed to a higher level of certainty in adult estimates (though this effort was recently discontinued in November 2024 due to lack of funding).

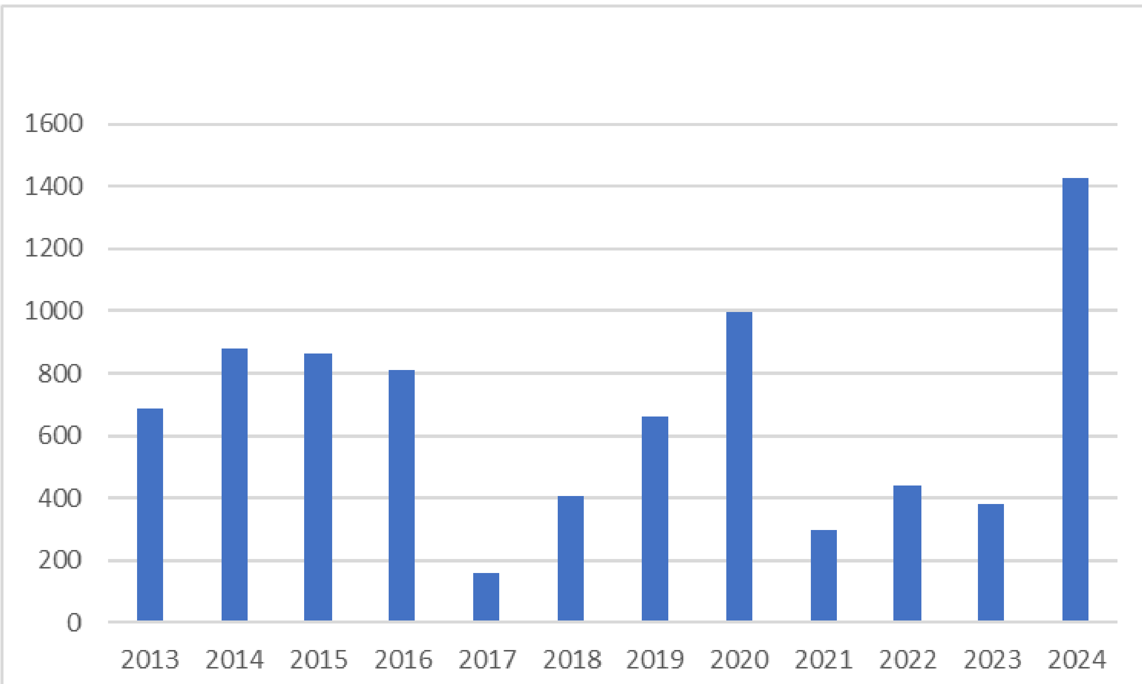


Figure 4.6-3 Total annual adult winter steelhead counts at the Bennett Dams on the North Santiam River (2013-2024).

Figure 4.6-4 provides a longer time series for winter steelhead abundance estimates that ODFW originally developed for the annual abundance of total spawners and has since been updated (Falcy 2017; Dr. M. Sabal, personal communication, November 2nd, 2024). This figure demonstrates that since the last winter steelhead hatchery adults returned (around 2003–2004), there is a general observed decline in abundance. Abundance did increase markedly in 2011 but has since declined precipitously. The most recent adult spawner estimates (over the last 5 years) are now lower than estimates made for the mid-2000s (during the time of the McElhany et al. (2007) risk assessment and the 2008 NMFS Opinion). However, the Bennett Dam counts for the year 2024 were much higher than observed in 2019–2023 (Figure 4.6-3); spawner abundance estimates have yet to be produced for 2024.

Key chronic risk factors for UWR steelhead include reductions in spatial structure caused by USACE dams, reduced habitat diversity, genetic legacies of past hatchery programs, and potential competition with the juvenile offspring of hatchery-produced summer-run steelhead of non-native stock.

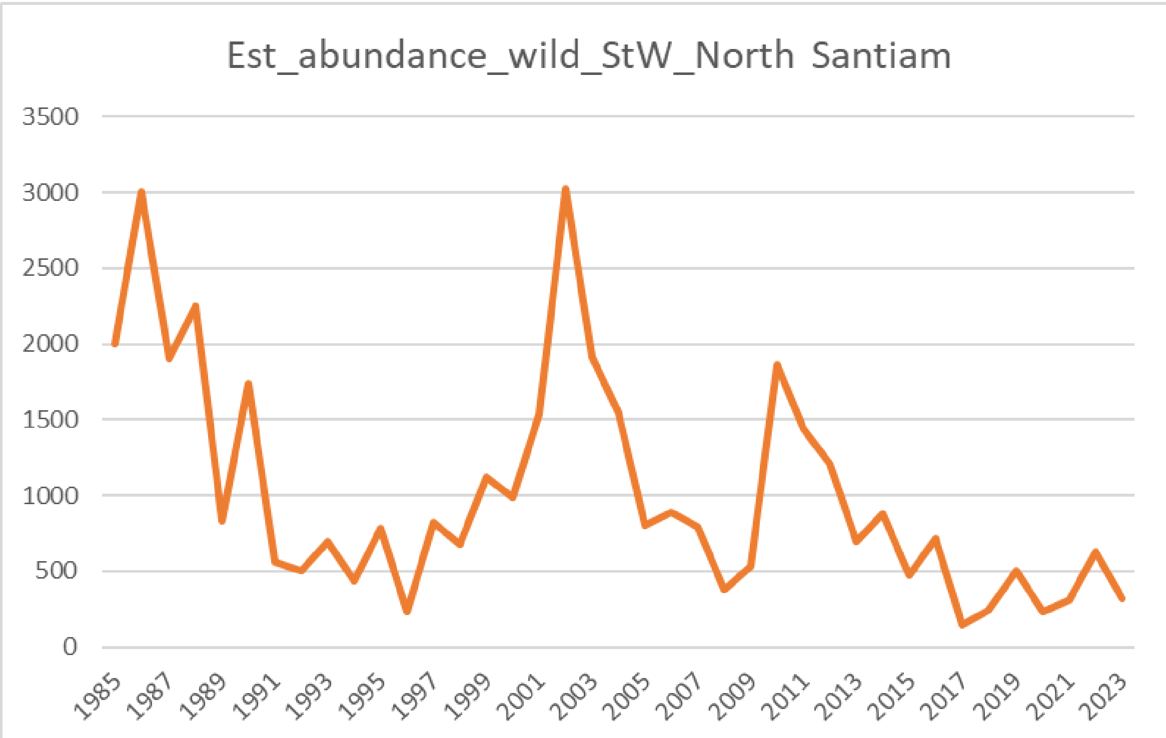


Figure 4.6-4 Estimated abundance of North Santiam natural-origin adult steelhead from 1995 to 2023 (Falcy 2017; Dr. M. Sabal, personal communication, November 2nd, 2024).

4.6.3 Environmental Conditions and Climate Change

4.6.3.1 Habitat Access and Fish Passage Conditions

Adult Fish Passage

In the action area, there is a complex of dams and water diversions at Geren Island near the town of Stayton, Oregon (Santiam River Mile 29). There are a total of five fish ladders at this location and two of them, the Upper and Lower Bennett fishways, pass the vast majority of adult salmon and steelhead arriving at this location. Improvements were made to the off-ladder fish trap as part of the USACE Minto adult fish facility construction in 2011. In 2011 and 2012, volitional passage at upper Bennett was blocked to facilitate collection and sorting of (hatchery steelhead) fish in the Bennett ladder trap, but it was discontinued because it caused delay and physical injuries to UWR Chinook salmon adults.

Mattson (1948) estimated that 71 percent of the spring Chinook salmon production in the North Santiam subbasin occurred in areas that have since been blocked by Detroit and Big Cliff dams. Minto Dam is located upstream of Packsaddle Park, not far below Big Cliff Dam, on the North Santiam River. The older Minto fish facility was upgraded to NMFS standards in 2013 and is located adjacent to Minto Dam on the north riverbank. Minto Dam creates an impassable barrier that encourages migrating fish into the facility's fish ladder. Presently, natural-origin fish that reach the fish handling facilities at Minto Dam are released above this fish barrier to spawn in the North Santiam River reach between Minto and Big Cliff Dams. While this "sanctuary" reach is populated with unmarked adult Chinook salmon, temperature and dissolved gas conditions may contribute to elevated prespawning mortality levels (Sharpe et al. 2017b). The recent rebuild of the Minto adult fish facility (required by NMFS 2008 RPA 4.6) also included improvements to Minto Dam to improve fish passage performance.

Between 2000 and 2021, only hatchery-origin Chinook salmon have been released above Detroit Reservoir, with the exception of years 2010 and 2015. Between 2000 and 2021, the number of hatchery-origin adult Chinook salmon transported above Detroit Reservoir averaged 1,329 fish, with a range of 148 to 2,884. In 2010, 49 natural-origin Chinook salmon were released above Detroit Reservoir, and in 2015, 474 natural-origin Chinook salmon were released above Detroit Reservoir. Winter steelhead collected at Minto AFF are still not transported upstream of Detroit dam and reservoir to spawn, mainly because of current poor downstream juvenile passage conditions. Recent genetic parentage analysis found that the mean total life fitness (TLF) of natural-origin (NOR) Chinook salmon reintroduced above Detroit Dam (1.21 ± 2.63) was greater than the mean TLF of the hatchery-origin (HOR) salmon released above Detroit Dam (0.69 ± 1.41) in the same years. The above Detroit Dam NOR adults also had a greater TLF than the NOR salmon reintroduced below Big Cliff Dam (0.84 ± 1.67) (O'Malley et al. 2023). Similar to other basins, prespawning mortality rates (PSM) (estimated during the ODFW spawning surveys conducted through 2019) have varied among years, but, generally, lower PSM rates have been observed in the North Santiam reaches. Above the Bennett dams (but below Minto Dam) PSM rates have ranged from 24 to 33 percent. The Minto to Big Cliff reach rates were 14 percent in 2014 (with a small sample size). Breitenbush River (above Detroit) rates ranged from 3 to 12 percent, and similarly, Upper North Santiam (above Detroit) rates ranged from 5 to 12 percent (Ford ed. 2022).

Two considerations for improving natural production and cohort replacement rates for Chinook salmon in the North Santiam sub-basin are apparent from recent genetic parentage results (O'Malley et al. 2023). First, the results suggest that the habitat capacity in the Minto to Big Cliff Dam reach may be exceeded in some years (i.e., the number of adults released in some years is oversaturating the available spawning habitat). The results mean female TLF was highest below Big Cliff in 2015 among the years analyzed, which was an extremely low, warm water year. Only 148 salmon were sampled and reintroduced below Big Cliff that year and the sex ratio was close to one. Second, transporting natural-origin Chinook salmon above Detroit Dam may produce more adult recruits than releasing them to spawn below Big Cliff Dam (despite poor downstream juvenile passage conditions through Detroit and Big Cliff).

Juvenile Fish Passage

The current lack of downstream passage provisions at the North Santiam dams results in migration delays and direct mortality of juvenile Chinook salmon. Any juveniles produced above these facilities must first find attraction flows at the face of the dams then pass through available routes (Beeman et al. 2014b).

Direct and delayed mortality through Detroit Dam occurs with passage over spillways (which can only open when water levels reach 1,541 feet or more), through the two Francis turbines, or through other project structures not designed for fish passage. Detroit Dam also has two sets of regulating outlets (ROs; upper at 1,340 feet and lower at 1,265 feet) that can be operated at anything less than 1,450 feet. The ROs are currently used for temperature management purposes in low water years. Since the turbine intake is located above both sets of ROs (at 1,395 feet) water drawn through the ROs can be cooler than water passed through the turbines. Juvenile spring Chinook salmon that are progeny of the adults outplanted above Detroit Dam can move through Detroit Dam via the spillway, which is used in the early summer, or through any number of routes during water-temperature-control operations in the fall. RO use is prioritized in the winter, but complete survival evaluations of these recent operations have not been conducted. Turbines at Detroit Dam are often being used in combination with the spillway or the ROs (for power production or to reduce / disperse high total dissolved gas (TDG)), and neither the ROs nor the spillways are designed for optimal juvenile fish passage conditions. Big Cliff Dam does not have downstream fish passage facilities, and juveniles must pass through one Kaplan turbine or one of three spillway gates (if they are open). No RO structures exist at Big Cliff Dam.

Khan et al. (2012b) reported that 72 percent of smolt-sized fish passed through the Detroit Dam spillway (vs. turbine) during an active hydroacoustic study in 2012 (Khan et al. 2012). USGS reported that 59 percent of Chinook salmon passed the spillway during a 2012 study (Beeman et al. 2014b). About 70 percent of Chinook salmon and steelhead passed Detroit Dam in a separate study in the spring of 2013, with over 94 percent of those fish passing through the spillway (Beeman and Adams, 2015). Survival though the Detroit spillway depends on the operation of the spillway and the gate openings. Fish released into the spillway at gate openings of 1.5 feet and 3.5 feet had survival rates of 81–84 percent and 64–67 percent, respectively (Normandeau Associates, Inc. 2010).

Beeman and Adams (2015) deployed acoustic telemetry monitoring sites from Detroit Dam to Portland, Oregon, during 2014 and monitored downstream movements of tagged fish. Migration rates and survival of juvenile Chinook salmon and steelhead that passed Detroit Dam were measured and analyzed. The juvenile salmonid migration rates in the Detroit Dam-to-Big-Cliff-Dam reach were much slower compared to other reaches in the study area. Survival estimates through this reach (2.8 river miles) were 72 percent for spring-released Chinook salmon, 78 percent for spring-released steelhead, and 62 percent for fall-released Chinook salmon. The total study area included 157 river miles (from the Detroit Dam tailrace to Portland, Oregon), and researchers determined that 60 percent of the mortality of spring-released Chinook salmon and steelhead and 80 percent of fall-released Chinook salmon occurred in the 6.8-river-mile reach between Detroit Dam and Minto Dam.

4.6.3.2 Water Quantity/Hydrograph

The 2008 NMFS biological opinion describes the historical and current environmental baseline condition for the hydrology of the North Santiam River and is incorporated by reference (NMFS 2008a, section 4.6.3.2). The operations and flows since 2008 fall are similar, with the largest differences between regulated and unregulated flows being peak flow reduction, decreased flows from February to May, and increased flows from July to January (see Figure 4.6-5).

The hydrology of the North Santiam River is heavily influenced by rain-on-snow events, dam operations, and, in the lower section, water use. Rain-on-snow events cause large peak flows. For the reach below Detroit and Big Cliff dams, project flood operations reduce peak-flow magnitudes. Large floods (greater than 10-year occurrence interval prior to regulation) are now largely eliminated. Also, the frequency and magnitude of smaller flood events has also been greatly reduced by the WVS (Wallick et al. 2013). The effects of reducing late-winter and spring flows on UWR Chinook salmon have not been effectively monitored, but studies in other Columbia River basin watersheds found that freshets are critically important because higher spring flows are correlated with faster downstream travel times and earlier (typically more ideal) arrival times to critical rearing habitats in the estuary and ocean (Scheuerell et al. 2009). Scheuerell et al. (2009) found that this migration timing plays an important role in determining juvenile-to-adult survival for Columbia River Chinook salmon and steelhead, with early migrators typically experiencing much higher survival. Project operations also augment flows in this reach below Big Cliff Dam during summer and late fall.

Dam discharges are managed to meet the project's authorized purposes while also achieving flow targets prescribed by the 2008 NMFS biological opinion to the extent possible (NMFS 2008a, RPA 9.2). Since 2008, flow targets for the North Santiam River below Big Cliff Dam have been missed for each target period (typically every 15 days between February 1st and November 30th) at least one year, and in some target periods, in 10 of those years (of 15 years in the period of record, 2008-2023). In many of the target periods, the flow target has not been met on almost all of the days in that target period (i.e. a median of 15-16 days): February 16-30, April 16-30, Jun 16-30, August 16-31, Nov 1-15). When releases have been below the 2008 RPA targets, the shortfall is typically 200-300 cfs, which is much lower than targets ranging between 1000 to 1500 cfs through the year (USACE 2023a, Appendix K).

Water management in the North Santiam basin is challenging because there are often adaptive management decisions that must be made to ensure the available water is used to provide the maximum biological benefit (fill to allow for passage spill or temperature management, or also regulating outlet use for fish passage or sometimes, temperature management operations), while also maintaining reservoir elevations needed to manage flood events and minimum pool requirements for dam operations.

Entrapment, stranding, and redd desiccation have been largely reduced through the processes established by the NMFS 2008 RPA, which regulates ramping rates and interagency coordination when there are ramp rate exceedances (NMFS 2008a, RPA 9.1 & 9.2).

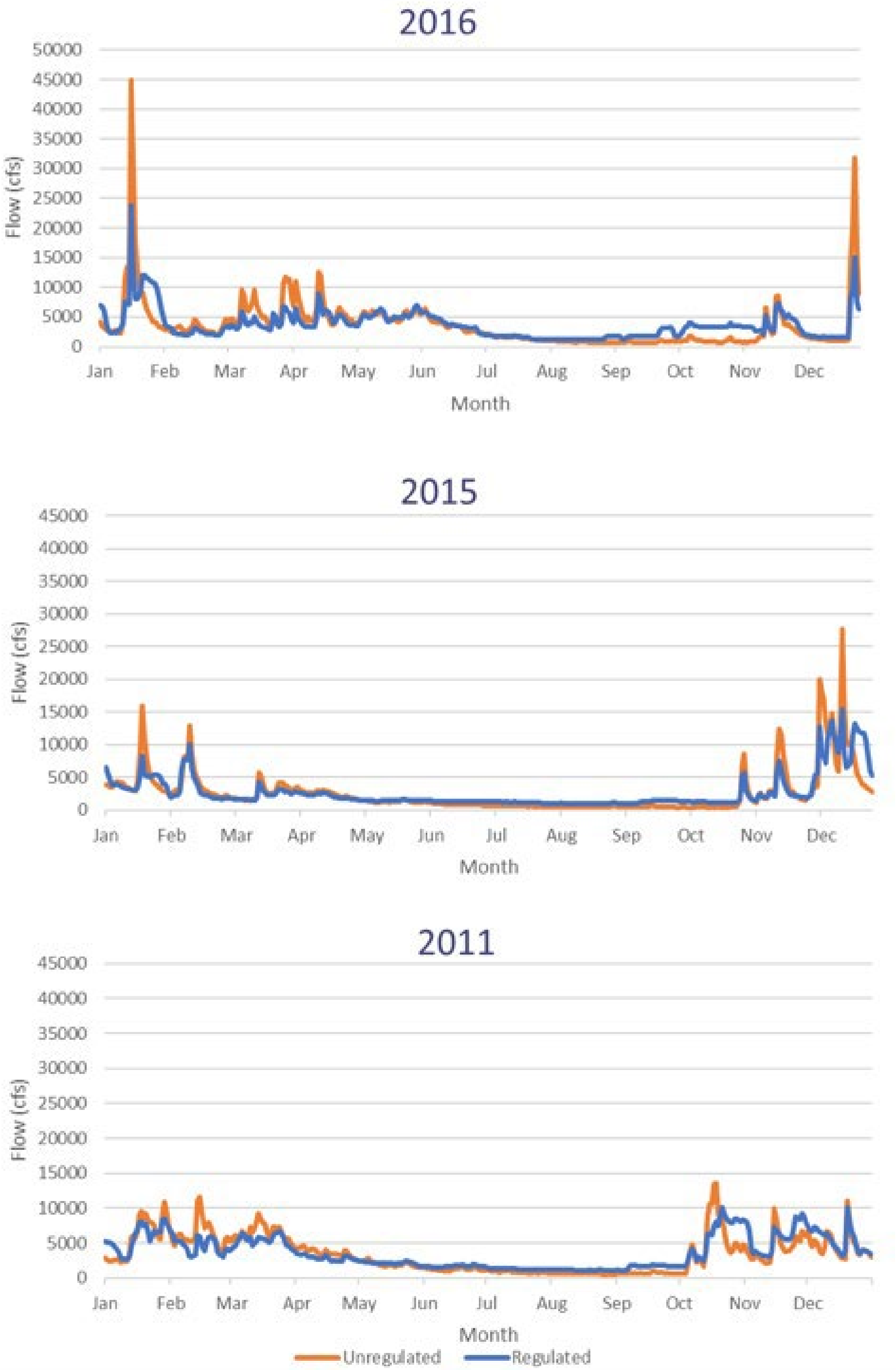


Figure 4.6-5 Hydrograph of the North Santiam River for three water years. The orange lines are for natural flows in 2011, 2015 and 2016. Blue lines are actual flows under dam operations for the same years.

Other Water Quantity Considerations in the Sub-Basin

Substantial water appropriations and withdrawals from the North Santiam River occur at and below the community of Stayton. During low-flow months (July through October), domestic water use, combined with irrigation withdrawals in the lower elevations of the watershed, may significantly reduce stream flows. In 1990, approximately 55 percent of the population of Marion County received its water supply from the North Santiam River. The communities of Idanha, Gates, Mill City, Stayton, Salem, Turner, and Jefferson all divert their supplies from the lower or middle reach of the river (or in the case of Jefferson, just below the confluence of the North and South Santiam Rivers) (Snyder et al. 2002). Above Stayton, appropriated water in the North Santiam River watershed represents only a small fraction of average flows; therefore, surface-water withdrawals are generally believed to have little or no effect on current in-stream habitats in the middle reach (Snyder et al. 2002).

4.6.3.3 Water Quality

Water Temperature

High summertime water temperatures have been a concern in the North Santiam River prior to dam construction, since at least 1940. During a 1940 survey, summertime water temperatures ranged from 14.4 to 22.2℃ in the North Santiam River downstream of the current location of the dams (McIntosh, Clarke, and Sedell 1990). Water temperatures were cooler upstream of this location and ranged from 7.8 to 12.8℃ (McIntosh, Clarke, and Sedell 1990).

Since the construction of Detroit Dam in 1953–1954, the seasonally filled Detroit Reservoir has affected water temperature downstream as solar radiation is absorbed in the summer and heat is released downstream later in the fall. This alteration (delay/shift) of the natural thermograph has negative consequences for threatened UWR Chinook salmon and steelhead by impacting their life cycle such as egg development and hatch timing. Prior to 2009, Detroit Dam discharges during the summer were largely through the power penstocks (accessing relatively deep, cool water) and were thought to delay upstream migration of adult spring Chinook salmon and reduce juvenile salmonid growth rates because the released water is 5 to 8°C cooler than historical river temperatures (ODFW 1990). In the fall, this trend was reversed and the temperature of the released water is as much as 1 to 5°C warmer than stream temperatures (ODFW 1990c, (Rounds 2010)).

For spring Chinook salmon eggs incubating in areas below the dams, water temperatures are typically much higher than those under natural conditions. Warmer water temperatures have sometimes resulted in earlier emergence of spring Chinook salmon fry below the dams or have possibly even been lethal to incubating eggs. For winter steelhead, the impacts on egg incubation are not as great because spawning is widespread throughout the entire population’s range (mainstem rivers and all tributaries). Most of the incubating eggs are not exposed to unnatural conditions. Winter steelhead also spawn in late winter/early spring after the peak of winter storm events.

Water temperatures in Detroit Reservoir depend largely on lake level (pool area), outflow operations, tributary inflow/temperature, and meteorology. Since 2009, USACE has used the spillway gates (elevation 1,541) to release warm water during the summer, to help minimize unseasonably warm temperatures later in the fall (Figure 4.12 6). Prior to 2009, releases from Detroit Dam were primarily from the power penstocks (invert elevation 1,395.5 ft.) year-round, which typically led to cooler releases in the summer.

USACE has performed temperature-control operations on the North Santiam River over recent years using water temperature targets based on those developed and implemented on the South Fork McKenzie River at Cougar Dam. These target temperatures were originally developed only for UWR spring Chinook salmon since no winter steelhead are present in the McKenzie subbasin. A comparison of these targets to literature-based thermal preferences for winter steelhead, indicate that these temperature targets are appropriate for the North Santiam River and meet the needs of both winter steelhead and spring Chinook salmon in the North Santiam basin. In a typical year, North Santiam water temperature targets are met during the summer and early fall months but trend higher than targets in the late fall and early winter (Figure 4.6-6). Outflow temperatures are very close to the TMDL temperature targets, except for October and November. This is because Detroit Reservoir is a large body of water and takes longer to warm in the spring and cool in the fall as compared to unregulated river systems. Therefore, a thermal lag is produced resulting in late fall/early winter water temperature objectives not being met. It is not until mid-winter that the reservoir loses all heat gained from the summer season and downstream water temperatures are again achieved.

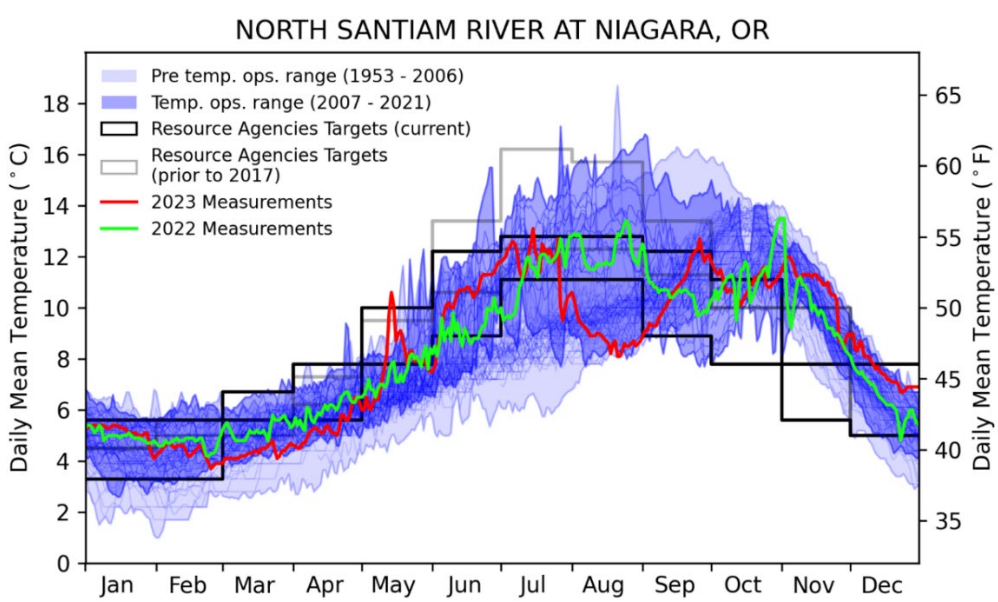


Figure 4.6-6 Daily mean outflow temperatures at Niagra, Oregon on the North Santiam River. Detroit / Big Cliff Reservoirs daily mean 2022 and 2023 outflow temperatures are compared to the current resource agencies target temperatures and prior to 2017 resource agencies target temperatures and temperature ranges before (1953 to 2006) and during (2007 to 2021) temperature control operation years.

Total Dissolved Gas

In September 2021, the USACE began spreading spill across multiple bays as part of the court-ordered injunction. The ability to spread spill across multiple spillbays is dependent on the volume of water passing through Big Cliff Dam. During the initial implementation of this operation, spill was spread across two bays in one of two higher flow events and resulted in a 5 percent decrease in TDG below Big Cliff Dam (USACE 2022a). During 2022, spreading spill across multiple bays did not prevent excess TDG from being generated (USACE 2022a; 2023a).

USACE (2009, 2010) documented the impact of Detroit and Big Cliff dam operations on TDG concentrations downstream and concluded:

- Combined releases from the Detroit spillway and ROs produced TDG concentrations that exceed 110 percent directly downstream of Big Cliff Dam.
- Big Cliff spillway operations result in TDG concentrations that exceed 110 percent directly downstream of Big Cliff Dam.
- Flow through the powerhouses at Detroit and Big Cliff dams result in TDG concentrations < 105 percent directly downstream of Big Cliff Dam.

Current temperature operations at Detroit use the spillway and upper RO, which, unfortunately, also create elevated TDG concentrations. Although TDG exceedances do occur on occasion from spill and maintenance operations at Detroit or Big Cliff Dams, TDG levels do dissipate with distance downstream. A previous TDG study had been conducted in the North Santiam River in 2010 (June to November) with TDG saturation measurements taken in the Detroit and Big Cliff dam tailraces and near Niagara, OR; Minto Fish Facility; and Mehama, OR (USACE 2011). Excess TDG saturation was found to dissipate significantly by the time that water reached Minto Dam (about 4 miles downstream of Big Cliff Dam). Exceedances generally occur in the fall and spring months when water is released for flood management because of precipitation events. In 2023, TDG measured at Niagara exceeded the State of Oregon water quality standard of 110 percent for most of the year, although briefly in some months (Figure 5-6). Notable events occurred in January (136 percent), May (124 percent), and early December (126 percent) (USACE 2024b). TDGs above 110 percent were commonly exceeded from October to December. For this reason, at the time of drafting this Opinion, a TDG abatement structure had been designed and is soon to be constructed below Big Cliff Dam.

The combination of temperature, dissolved gas, and altered discharge impacts have likely reduced spring Chinook salmon egg survival (and possibly steelhead egg survival, mainly because of TDG spikes) below Big Cliff Dam in the past.

4.6.3.4 Physical Habitat Characteristics

Most of the land along the reach of the North Santiam from Mehama to its confluence with the South Santiam River, as well as the 12-mile mainstem Santiam River, is used to grow agricultural crops or graze livestock. The remainder consists of urban areas, coniferous forests, mixed deciduous forests, and riparian forests that now comprise less than 7 percent of the vegetation (E&S 2002). Most of the subbasin's residential and rural-residential development is downstream of the USACE dams on the valley floor and in the foothills.

Reduced flood flow frequency and magnitude prevents important geomorphic processes that create and renew riparian habitat. This in combination with the trapping of large wood and sediment from reaches above WVS dams has heavily influenced the physical habitat in tributary reaches. The direct effects to fish and habitat are still occurring because of the modified flows below Detroit and Big Cliff dams. These include loss of habitat complexity, impacts to the quantity and types of riparian vegetation as well as recruitment and plant succession, reduced gravel and large woody debris recruitment, reduced avulsion, bed armoring, and stabilization of the channel. The consequences of these effects, despite flow-related reductions in the lower river's transport capacity, have been a loss of finer textured gravel bars below Big Cliff Dam and a scouring of some areas near this dam down to bedrock with scattered boulders. This type of channel coarsening reduces the diversity of riverbed substrates and the availability of spawning habitat for anadromous salmonids. The lower portion of the subbasin contains only 25 percent of the original extent of floodplain forest and there has been significant loss of wetland, floodplain, and off-channel habitats and associated habitat complexity.

The most significant large-scale environmental impacts since the finalization of NMFS 2008 Biological opinion were large wildfires in 2020 that burned the majority of the North Santiam subbasin (USDA 2024). Wildfires lead to short-term and long-term impacts on terrestrial and aquatic fauna as reviewed in Jager et al. (2021). Short-term impacts (months rather than years) on fish include pulses of ash that suffocate fish and increased sediment loading.

4.6.4 Hatchery Programs

Hatchery operations for Chinook salmon on the North Santiam River began nearly 100 years ago. The Willamette basin hatchery mitigation program's annual production goals for North Santiam Chinook salmon include producing 704,000 juvenile Chinook salmon at Marion Forks Hatchery and releasing them below Big Cliff Dam. In the recent Willamette hatchery Opinion, NMFS estimated that the current percent of hatchery fish spawning on natural spawning ground is 100 percent above Detroit (as expected) and 66 percent downstream of the dams, but the future target would be to have less than 10 percent pHOS above Detroit Dam and 21 percent below the dam (NMFS 2019a).

Hatchery winter steelhead releases were discontinued in the upper Willamette basin in 1999. However, there is still concern about natural production of non-native South Santiam stock summer steelhead adults, which remains a risk to the viability of the North Santiam UWR steelhead population (Johnson et al. 2021; NMFS 2004). This hatchery stock originated from Skamania stock and is not part of the UWR steelhead DPS. These fish are raised at South Santiam hatchery.

The UWR Recovery plan has noted a loss of population traits for both Chinook salmon and steelhead in the North Santiam because of hatchery fish interbreeding with natural-origin fish on spawning grounds. This has represented a key threat to the genetic characteristics of the natural-origin UWR Chinook salmon and steelhead populations.

4.6.5 Fisheries

Recreational fisheries are open for hatchery Chinook salmon and all coho salmon in the mainstem below Big Cliff Dam year-round other than September 1st to October 14th, for hatchery trout from May 22 to October 31st, and all year for hatchery steelhead. Harvest for unclipped (natural-origin) salmon and steelhead is prohibited except for the months of July and August.

The estimated 2021 catch of spring Chinook in the North Santiam River was 428 adult fish (ODFW 2022). Of the total 371 (87%) were kept adipose fin-clipped and 57 (13%) were released unclipped fish. Applying the standard post release mortality rate of 12.2%, the estimated mortality of wild spring Chinook in the North Santiam was 7 fish (ODFW 2022). Please refer to the Fisheries Section in the Willamette Mainstem and Basin baseline chapter for further information on fishery impacts (Chapter 4.1).

4.6.6 Predation and Competition

Monitoring of species that predate salmonids has not been conducted in the North Santiam basin, but ODFW has noted that largemouth bass seems to be quite abundant in Detroit Reservoir (Ziller, J. 2022). The extended rearing times of juvenile salmonids that use the reservoir increase the infection risk and exposure to parasitic copepods (Monzyk et al. 2015b).

A study conducted in the South Santiam subbasin by Harnish et al. (2014) demonstrated a residualization rate of 12.8 percent for hatchery summer steelhead releases. They also observed a strong overlap with their use of natural-origin juvenile steelhead habitat in both space and time, resulting in competition impacts that are likely detrimental to natural-original steelhead, and possibly to Chinook salmon as well.

As a result, some measures were taken through the hatchery program 2019 Biological Opinion (NMFS 2019a) to advance the spawn timing of hatchery summer steelhead by spawning broodstock earlier. The intent of these efforts was to minimize the spatial and temporal overlap of returning natural-origin winter steelhead adults and returning hatchery summer steelhead.

4.6.7 Research and Monitoring Evaluations

Rotary Screw Trap Monitoring

Interim Operations conducted at Detroit and Big Cliff dam in 2024 included:

- Detroit Dam - Spill in spring when possible for passage and also for temperature management through the spillway (when possible). Downstream temperatures have to be managed from mid-March to fall through a complex combination of spillway, turbine, and upper and lower regulating outlet (RO) flow.

- Detroit Dam - Nighttime dusk to dawn upper regulating outlet (RO) prioritization of downstream passage in the winter, which only occurs once the fall temperature management operations have concluded and the reservoir elevation reaches less than 1,500 feet.
- Big Cliff - No operations for passage. Spread spill across as many spillbays as safety protocols allow to reduce downstream TDG exceedances.

Contractors monitored the single 8-foot RST in the Big Cliff Dam Tailrace throughout 2023. Trap efficiency estimates ranged from 1.2 percent to 20.7 percent. Peak captures occurred in May, June, and October and coincided with spill operations in the spring at both Detroit and Big Cliff dams. The fall passage event occurred a couple of weeks after RO spill operations reached their highest outflow during the fall. Also, of note was that the forebay of Detroit Reservoir fell below 1,500 feet around this period and coincided with the increased capture of Chinook salmon in the trap below Big Cliff Dam Tailrace, suggesting that these fish likely passed through Detroit Dam during this event. However, these spill operations and periods of increased catch are also associated with high-flow events that could also contribute to the observed increase in catch.

O. mykiss (rainbow trout) peak captures occurred in July and with a spill operation in June. The first broodyear 2023 was captured on February 14, 2023. This early capture is from reservoir outplanted rainbow trout spawning and not UWR winter steelhead, as they are not outplanted above Detroit Dam.

A total of 40 Chinook salmon (6.9 percent) and ten *O. mykiss* (4.1 percent) were dead at the time the trap was checked. A total of 467 juvenile Chinook salmon (80.7 percent of total Chinook salmon catch) and 46 juvenile *O. mykiss* (18.7 percent of total *O. mykiss* catch) displayed at least one of the injury code conditions, other than copepods. Increases in the proportion of fish displaying injury often coincided with spill operations at Big Cliff Dam Tailrace (Figure 6). Preliminary findings illustrated that smaller Chinook salmon (<60 mm) were less likely to encounter injury during dam passage and subsequent RST capture. Descaling less than 20 percent, descaling greater than 20 percent, bruising, fin damage, and the presence of copepods were found to increase as fish grew in size. Additionally, EAS also observed 39 Chinook salmon (12.1 percent of total Chinook salmon catch) and 12 *O. mykiss* (15.6 percent of total *O. mykiss* catch) with evidence of gas-bubble disease (EAS 2024a, 2024b and 2024c).

A total of 53 fish were PIT tagged at the Big Cliff Dam Tailrace site in 2023, 50 juvenile Chinook salmon and three juvenile *O. mykiss*. The first 60 Chinook salmon and *O. mykiss* captured at this location every week are prioritized for the 24-hour hold study, which limits the numbers that are tagged. No PIT-tagged fish were detected downstream and no VIE-marked fish were detected at the site from upstream release sites. A summary of all tagged fish can be found in Appendix C.

Bulk Releases

Additionally, Cramer released large groups of PIT tagged fish in the North Santiam River basin in 2023. The RST below Big Cliff Dam captured 4 adipose-clipped and PIT-tagged Chinook salmon from these releases in October 2023. For more information regarding release groups, dates, and other redetections, please refer to Cramer Fish Science's Bulk Mark Release and Reservoir Distribution Study Annual Report and Rotary Screw Trap Monitoring Reports (EAS 2024a, 2024b and 2024c).

4.7 Molalla Sub-Basin

Because of the presence of USACE-constructed and maintained revetments, the lowest 20.2 river miles of the Molalla River are considered to be within the action area for the proposed action. No USACE dam projects exist within the Molalla River subbasin. The following section presents an assessment of the condition of the listed species and their designated critical habitat in the Molalla sub-basin action area.

The Molalla River flows out of the western Cascade Mountains to join the Willamette River north of the City of Canby. The Molalla River watershed (including its largest tributary, the Pudding River) encompasses approximately 2,206 km^2 (852 mi^2; 545,114 acres) of land and supports a variety of land uses and fish and wildlife habitats. The Molalla River is approximately 49 miles long and enters the Willamette River at RM 36; the Pudding River is 62 miles long and enters the Molalla River at RM 0.75. The mainstem Pudding River has lower flows and higher water temperatures than the Molalla River drainage. The lower 20 miles of the Molalla River has a gradient of 0.2 percent. Almost the entire Pudding River channel is within the flat Willamette Valley floor, with a gradient of 0.04 percent for the first 50 miles.

For more detailed information about the subbasin's physical characteristics and land use, see section 4.7 of the 2008 WVS Biological Opinion (NMFS 2008a).

4.7.1 Historical Populations of Anadromous Fish in the Molalla Sub-basin

There is very little information on the historical run size or distribution of the Molalla spring UWR Chinook salmon population, but it was estimated in the 1950s, there was sufficient habitat in the Molalla River subbasin to accommodate at least 5,000 fish (Parkhurst et al.1950). By 1903, the abundance of spring UWR Chinook salmon in the subbasin had already decreased dramatically (Myers et al. 2002). Surveys in 1940 and 1941 recorded 882 and 993 spawning spring Chinook salmon, respectively (Parkhurst et al.1950). Surveys in the 1940s observed 250 spring Chinook salmon in Abiqua Creek, a tributary to the Pudding River (Parkhurst et al. 1950). In 1947, Mattson (1948) estimated the run size to be 550.

There are no estimates of the historical winter steelhead production in the Molalla River subbasin, although spawning areas are dispersed over approximately 110 miles of mainstem and tributary streams in the Molalla River watershed and 57 miles in the Pudding River watershed (WRI 2004; NMFS 2008a).

4.7.2 Current Status of Sub-basin Population and Importance to Recovery

4.7.2.1 UWR Chinook salmon

The Molalla population of the UWR Chinook salmon ESU is not one of the four (of seven) "core" recovery populations as defined in the assessment by McElhany et al. (2007). However, the 2011 UWR recovery plan for UWR Chinook salmon determined that to move the entire ESU into a recovered status, the Molalla population would need to move from being at a "very high" risk of extinction to a "high" risk of extinction and increase by at least 696 adult spawners (ODFW and NMFS 2011).

A large majority of the Chinook salmon spawning in the Molalla are of hatchery origin, though recent studies for estimating pHOS have not been conducted (NMFS 2019a). Chinook salmon surveys were carried out from 2015–19. Low abundances (<100 redds) were observed. A radio-tagging study found that only 2 of the 300 returning Chinook salmon adults tagged at Willamette Falls were detected entering the Molalla River (Jepson et al. 2015). Coded-wire tags from juvenile releases in the Molalla River were recovered in the Molalla River in 2016 (Sharpe et al. 2017a). Abundance information is limited to anecdotal reports, recreational catch reports, and recent surveys, all of which are insufficient to provide a useful estimate of abundance; however, it is reasonable to assume that the abundance of natural-origin Chinook salmon is very low (Ford ed. 2022).

4.7.2.2 UWR Winter Steelhead

The UWR steelhead DPS's Molalla population is not one of the two (of four) "core" populations as defined in the assessment by McElhany et al. (2007) or the recovery plan (ODFW and NMFS 2011). However, all four populations in the DPS are part of one major population group. The recovery plan determined that in order to move the entire UWR steelhead DPS into a recovered status, the Molalla population would need to move from being at a "low-to-moderate" risk of extinction to a "very low" risk of extinction and increase by at least 557 adult spawners (ODFW and NMFS 2011).

Population abundance estimates based on spawner (redd) surveys for the Molalla River and associated tributaries (Pudding River, Abiqua Creek) through 2018 were reported in the recent NMFS viability report for ESA-listed salmon and steelhead (Ford ed. 2022). These estimates relied on a proportional apportionment of winter-run steelhead counts at Willamette Falls based on index redd counts in the four winter-run steelhead populations. Proportional allocation of Willamette Falls may be informative; however, comparisons using radio-tagged steelhead results (Jepson et al. 2013, 2014, 2015) suggest that the proportional assignment may overestimate abundance. In either case, there is considerable uncertainty in the abundance estimates since 2018, which is also due to the inherent difficulties in conducting winter steelhead spawning surveys. Given this, abundance estimate trends do show that the Molalla River steelhead population is maintaining some resilience (Figure 4.7-1). However, Weigel et al. (2018)

suggested that relatively high levels of summer steelhead hybridization (>20 percent of the sample) is occurring in the Molalla population (from hatchery summer steelhead release programs in other east-side tributaries).

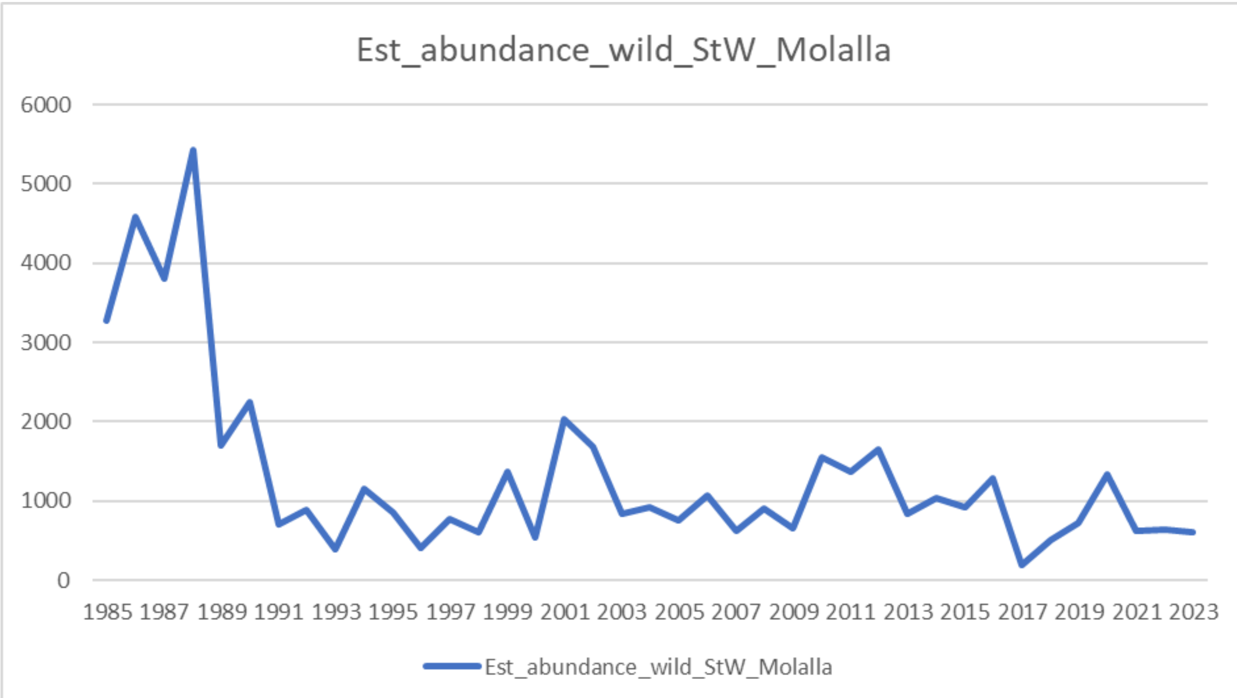


Figure 4.7-1 Estimated abundance of wild winter steelhead in the Molalla River sub-basin from 1985 to 2023 (Falcy 2017, Dr. M. Sabal, personal communication, November 2nd, 2024).

4.7.2.3 Limiting Factors and Threats to Recovery

Key limiting factors contributing to population decline of both UWR Chinook salmon and steelhead in the Molalla basin include land use, elevated water temperatures, habitat loss, water quality, the negative impacts of hatchery fish, and several predatory non-native species are now present in the watershed (see predation section below). For more details on key and secondary limiting factors, see this section in the 2008 WVS Biological Opinion (NMFS 2008a) or the Willamette Chinook Salmon and Steelhead Recovery Plan (ODFW and NMFS 2011).

4.7.3 Environmental Conditions

The Molalla River is a tributary in the Willamette subbasin without any USACE dams. There are no current, known passage issues on the mainstem Molalla River in the action area. Much of the accessible habitat in the Molalla River is degraded and under continued development pressure, and the remaining fish populations are constrained by habitat conditions.

Current habitat conditions are no longer found to be very productive, especially not for UWR Chinook salmon (Ford ed. 2022). Natural flows are reduced by water withdrawals, which contribute to increased summer water temperatures (NMFS 2008a). High water temperatures are also aggravated by loss of riparian cover, reduced wetland areas, channel simplification, and increased impervious surfaces. Channelization of tributaries; modification of runoff patterns as a result of agriculture, impervious surfaces, and urban/residential development; and loss of storage capacity in floodplains and wetlands have accelerated runoff and increased peak flows. Nutrient and toxic runoff from agricultural and urban areas is an issue in the Pudding River drainage. There has been extensive loss of wetlands and floodplain connection throughout the subbasin, which further aggravates water quality and quantity issues (i.e., storage and timing of peak and low flows) (NMFS 2008a).

Flow modifications and channel confinement (through streambank armoring / revetments, etc. and loss of floodplain connectivity) have reduced access to off-channel habitats essential for juvenile salmonid rearing and winter refuge, decreased connectivity between habitats throughout the subbasin, and curtailed the dynamic processes needed to form and maintain habitat diversity (WRI 2004). Reduced floodplain connectivity can also reduce nutrient and prey exports from the floodplain to the river (Reid et al. 2012).

The USACE placed 5.07 miles of revetments along streambanks in the Molalla subbasin between 1938 and 1982. Channels in the lower portions of the Molalla River, particularly near the city of Molalla (RM 20), and some tributaries have been simplified through placement of revetment and other actions. Two types of USACE constructed revetments or bank protection structures are in the action area, those which they maintained and those which non-federal sponsors own and maintain; generally, those not owned by USACE were built after 1950. The effect of the revetments, in conjunction with other WVS flood risk reduction operations, is to simplify the prior complex meandering, braided mainstem rivers with extensive floodplain forests on both banks particularly "in the southern reaches of the Willamette River and lower reaches of its major tributaries, all of which were historically more complex and dynamic" (Hulse et al 2013).

Modification or removal of these revetments requires permits under the Clean Water Act and the Rivers and Harbors Act. USACE administers these permits but considers them outside the scope of this action. The extensive revetments that were built as part of the WVS were intended to respond to floods that could cause bank erosion. In the previous supplemental BA (Usace 2007), USACE proposed to identify and prioritize revetments where removal or modification may be feasible to improve habitat for ESA-listed salmonids, and the 2008 RPA measure 7.4 required a report to assess and prioritize USACE-maintained revetments. This document was intended to provide specific sites where modifying or removing revetments would restore natural river function (Hulse et al 2013). The authors worked to geographically distribute ecological benefits of revetment removal or modification. From the final list of 12 high priority zones, only four individual revetments were recommended for detailed consideration.

The continued maintenance and presence of this system of revetments has degraded rearing and migration habitat in the lower tributary reaches via reduced floodplain connectivity and channel complexity. In addition to reducing floodplain connectivity, other effects of revetments on the ecosystem include (Fischenich 2003):

1. Reduced morphological evolution of a river. Stream lateral migration and riparian succession are necessary processes in maintaining appropriate energy levels in a system. The ability of a stream to convert energy between its potential and kinetic forms through changes in physical features, hydraulic characteristics, and sediment transport processes is important in creating complex habitats generating heat for biochemical reactions, and reoxygenating flows.
2. Impacts on hydrologic balance.
3. Impacts on sediments, or reduction of sediment yields and thus the generation of scour / erosion at sites immediately downstream.
4. Impacts on habitat. Riprap provides a substrate that usually differs from local material of the channel, and offers a different habitat condition.
5. Impacts on chemical and biological processes including important nutrient cycles. They can also create barriers to natural plant and animal migration.

Lacking any modifications to offset major adverse impacts of the WVS revetments on important elements of critical habitat, the continued maintenance of the revetments has continued to degrade rearing and migration habitat in the lower reaches of its tributaries via reduced floodplain connectivity and channel complexity.

4.7.4 Hatchery Programs

The current run of Chinook salmon in the Mollala River subbasin is primarily of hatchery origin. Up to 100,000 hatchery Chinook salmon produced at the Marion Fork Hatchery are released as smolts in the Molalla River annually, and no outplanting of adult salmon occurs at this time (NMFS 2019a). Hatchery-origin fish may spawn naturally if they are not harvested in sport fisheries and survive over the summer. Natural-origin returns in the Molalla River are very low. Consequently, any straying by hatchery-origin fish represents high pHOS because of low numbers of natural-origin spawners. Naturally spawning hatchery fish may be providing a demographic boost to the population; although, genetic pedigree analyses of natural production has not occurred in the Molalla like in other populations. It is expected that hatchery-origin Chinook salmon are producing the majority of first generation of offspring (F1) progeny based upon pHOS and the suitability of the habitat.

Hatchery winter and summer steelhead releases in the Molalla ended in 1996.

4.7.5 Fisheries

In addition to the information provided in the General Baseline and Willamette Mainstem Baseline Chapter 4.1 regarding fishery impacts, fishing is also open on the lower Molalla River for hatchery Chinook salmon, hatchery steelhead, and coho salmon all-year round (and for clipped and unclipped steelhead from July 1st to August 31st, when winter steelhead are unlikely to be present). Summer catch-and-release trout fishery anglers could potentially hook juvenile steelhead.

Fishery harvest was not determined to be a key threat to recovery for steelhead or spring Chinook salmon populations in the Molalla sub-basin (ODFW and NMFS 2011).

4.7.6 Predation

Several predatory non-native species that could prey on juvenile salmonids are present in the watershed including: largemouth bass (*Micropterus salmoides*), yellow bullhead catfish (*Ameiurus natalis*), bluegill (*Lepomis macrochirus*), crappie (black) (*Pomoxis nigromaculatus*), and brown bullhead catfish (*Ameiurus melas*) (ODA and Marion Co. SWCD 2010).

4.7.7 Research Monitoring and Evaluation

There is currently no known research or monitoring efforts being conducted in the Molalla subbasin for UWR Chinook salmon or steelhead.

4.8 Clackamas Sub-Basin

Because of the presence of USACE-constructed and maintained revetments, maintenance of which are part of the proposed action, the lowest 20.1 river miles of the Clackamas River are considered to be within the action area. No USACE dam projects exist within the Clackamas River subbasin, but the Portland General Electric (PGE) company operates a multi-dam hydroelectric complex within the Clackamas subbasin, with the lowermost dam (River Mill) at RM 23.3 of the mainstem Clackamas not far below the city of Estacada. The following section presents an assessment of the condition of the listed species and their designated critical habitat in the Clackamas sub-basin portion of the action area.

The Clackamas River enters the Willamette River at RM 25.1 (1.7 miles below Willamette Falls) after draining an area of 941 square miles and is the fourth largest of the Willamette River's tributaries. The Clackamas River arises from the southern flank of Mount Hood in the Cascade Mountains and has several major tributaries. The upper portion of the Clackamas River system, above River Mill Dam and Estacada, is characterized by moderate to high-gradient stream reaches within mountainous terrain, while more gently sloped stream channels and topography dominate in the lower portion. The upper portion of the subbasin is heavily forested and primarily within the Mont Hood National Forest. The lower portion, below Estacada, is more highly developed and includes a variety of forest, agricultural, rural-residential, urban, and industrial land uses.

For more detailed information about the physical characteristics and land use in this sub-basin, see section 4.8 of the 2008 WVS Biological Opinion (NMFS 2008a).

4.8.1 Historical Populations of Anadromous Fish in the Clackamas Sub-basin

The only population in this subbasin that belongs to an UWR listed group, is the spring Chinook salmon population. Approximately 8,000 adult spring Chinook salmon were harvested from the lower Clackamas River in 1893 and about 12,000 were taken in 1894 for hatchery broodstock (Murtaugh et al. 1992). These numbers only partly reflect the historical productive capacity of the system. Many of the river's spring Chinook salmon were also being harvested in fisheries on the lower Columbia River, and portions of the annual runs were avoiding fisheries and hatchery operations to spawn naturally in the Clackamas subbasin. Given that the spring Chinook salmon population in the Clackamas River is part of the ESA-listed UWR Chinook salmon ESU, which is the main focus of this Biological Opinion in addition to UWR steelhead, the Clackamas spring Chinook salmon population and critical habitat within the sub-basin will be the primary focus of this baseline chapter.

Other ESA-listed populations in this subbasin include: a fall Chinook salmon run, which is part of the Lower Columbia River (LCR) Chinook salmon ESU, a LCR winter steelhead population, and a LCR coho salmon population. The Clackamas subbasin also once supported an independent population of LCR chum salmon (Meyers et al. 2006). Historical information on abundance is incomplete. Prior to overfishing impacts and habitat damage to the Clackamas subbasin in the late 1800s, these populations were likely more abundant than they are at present. The distribution and abundance of the historical chum salmon population were never documented.

For more detailed information about the historical population abundance trends for the species and populations in this subbasin, see section 4.8 of the 2008 WVS Biological Opinion (NMFS 2008a).

4.8.2 Current Status of Sub-basin Population and Importance to Recovery

The Clackamas population of the UWR Chinook salmon ESU is one of the four (of seven) "core" recovery populations as defined in the assessment by McElhany et al. (2007). The 2011 UWR recovery plan for UWR Chinook salmon determined that to move the entire ESU into a recovered status, the Clackamas population would need to move from being at a "low to moderate" risk of extinction to a "very low" risk of extinction and increase by at least 946 adult spawners (ODFW and NMFS 2011). Based on recent adult returns of adult spring Chinook salmon to the North Fork Clackamas Dam, the Clackamas population is the only one of the four core UWR populations with an increasing abundance trend and is also close to meeting its recovery goal (Figure 4.8-2). Despite declining abundance trends for other spring Chinook salmon populations in the Upper Willamette River and Columbia River basin, the status of this population is on the rise, and the beginning of this increase coincides with the completion of major fish passage improvements at the PGE dams (2015). There is also an observable increasing trend in the juvenile bypass system's passage estimates around this same time (Figure 4.8-2). See habitat access section below for more details (4.8.3.1).

The total adult UWR Chinook salmon (all natural-origin) return to the North Fork Dam in 2024 is predicted to be between 3,800 and 4,100 fish, which is much higher than the current 10-year average of 3,026. The final tally for 2023–2024 winter steelhead is 3282, which is the largest return since 1971 (Figure 4.8-2). It is also predicted to be the second largest return for coho salmon this year, near 10,000. The fall run of Chinook salmon in the Clackamas subbasin has declined in the decades since hatchery supplementation ended, is quite small, and is not a primary focus of monitoring efforts. Within the Clackamas subbasin, these fish are largely confined to the mainstem below River Mill Dam and the lower reaches of the major tributaries (Deep, Clear, and Eagle creeks) to the lower river (NMFS 2008a).

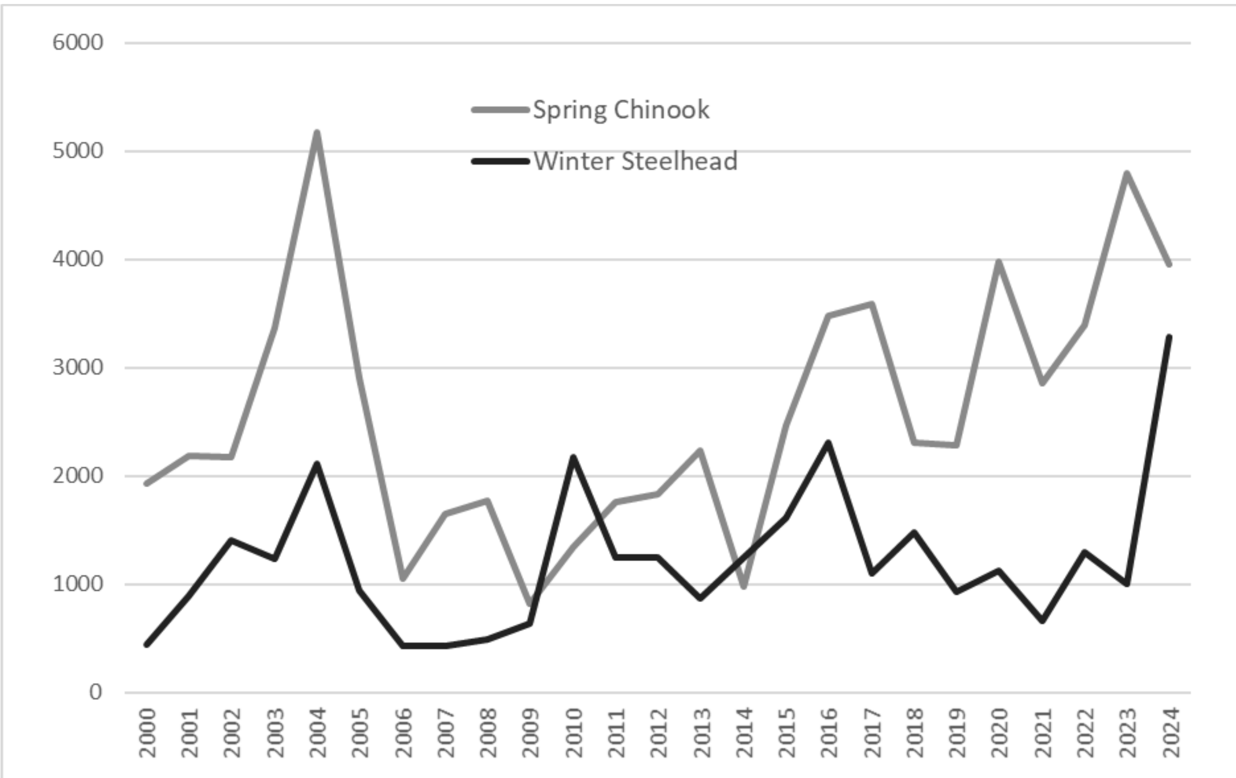


Figure 4.8-1. Annual adult passage counts for spring Chinook (UWR), and winter steelhead (LCR) at the North Fork Clackamas River Dam adult ladder and sorter. Improvements to the juvenile passage system through the Clackamas projects were made in 2015. Improvements to the adult sorter at North Fork were completed in 2013. Beginning in 2014 only natural-origin adults were passed above the North Fork Dam. Prior to 2014, adult Chinook counts include some hatchery-origin fish. Some natural production for these species also occurs in areas of the Clackamas River below the North Fork Dam.

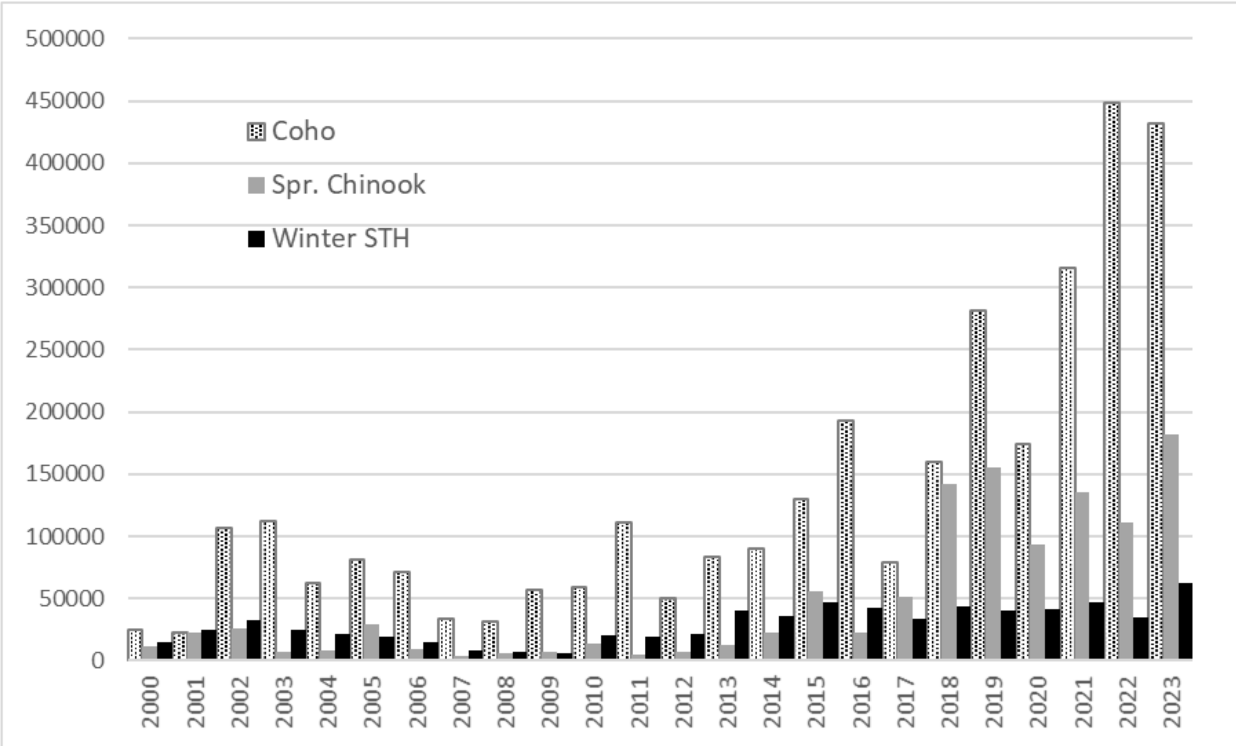


Figure 4.8-2. Annual juvenile passage estimates for coho salmon (LCR), spring Chinook salmon (UWR), and winter steelhead (LCR) through the North Fork Clackamas Dam bypass system. Improvements to the juvenile passage system through the Clackamas projects were made in 2015. Improvements to the adult sorter at North Fork were completed in 2013. Beginning in 2014, only natural-origin adults were passed above the North Fork Dam. Natural production for these species also occurs in areas below the North Fork Dam.

4.8.3 Environmental Conditions

4.8.3.1 Habitat Access and Fish Passage Conditions

Most of the historical spring Chinook salmon run is believed to have spawned in the Clackamas River and its larger tributaries upstream of the current site of River Mill Dam, including the Collawash River (Willis et al. 1960; Figure 4.8-3), though Eagle Creek was also an important spawning stream (McIntosh et al. 1995).

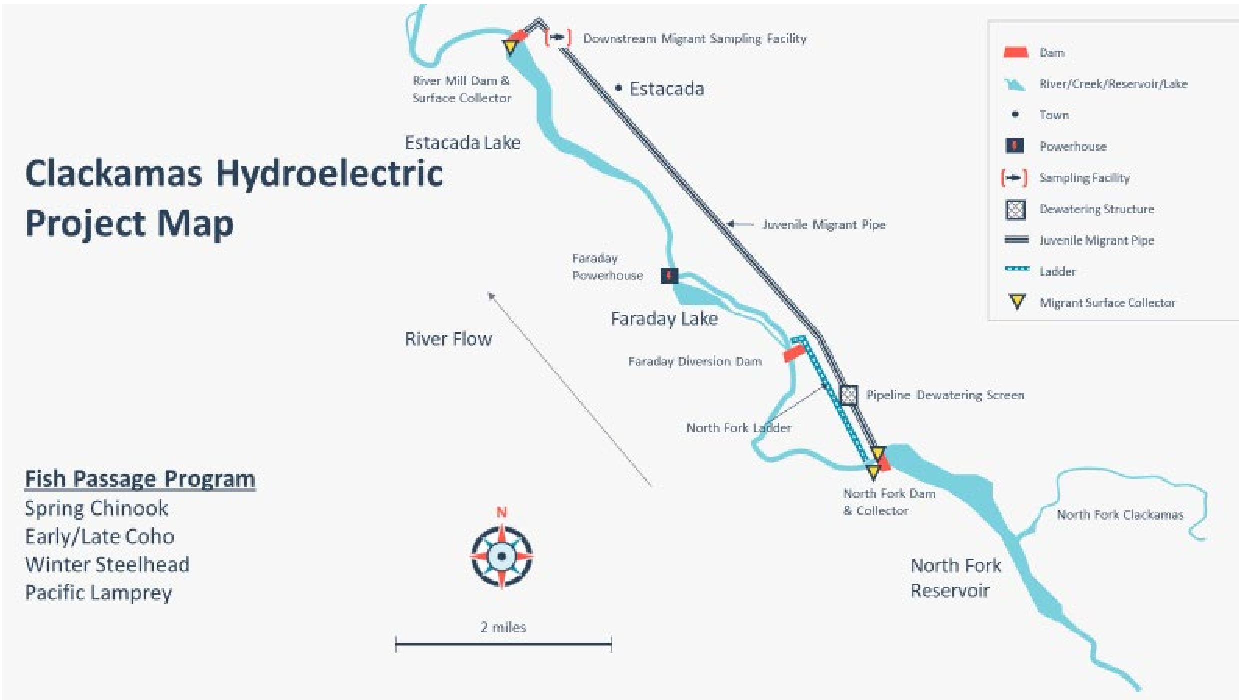


Figure 4.8-3. Map of Portland General Electric's Clackamas "Project" including all hydroelectric facilities and upstream and downstream fish passage systems.

As of 2015, new, state-of-the-art, fish-passage facilities at the Clackamas PGE dams (or Hydroelectric Project) have provided incredibly safe and effective upstream and downstream passage to all historically occupied streams above River Mill Dam (and North Fork Dam) for their (UWR ESU) Chinook salmon and (LCR DPS) steelhead populations (Figure 4.8-2). The River Mill Dam adult ladder was built in 1911 and replaced in 2006. Adult fish pass the ladder in 2–3 hours. Some returning adults do stop and spawn in the reach between River Mill Dam and the North Fork Dam, so there is natural production in this reach.

The North Fork adult ladder was completed in 1958. It is 1.9 miles long, 190 feet high, and has multiple exits to accommodate variable forebay elevations in the North Fork Dam reservoir. Adult fish pass the ladder in 1–1.2 days and it has a 95 percent adult passage efficiency (for salmonids). The adult sorting facility at the top of the adult ladder at North Fork Dam was completed in 2013. It is a hands-free sorting facility and allows wild, natural-origin fish, including UWR Chinook salmon, to return to the main ladder to pass above the dam volitionally, while diverting hatchery-origin fish to tanks for hauling back to the hatchery facilities or fishing areas. In a 2015–17 spawning survey, the prespawn mortality rate in the upper Clackamas River was low (3.6 percent) but can be quite high below the PGE dams (mean of 46.1 percent based on data from 2003 to 2016 spawning seasons) (Whitman et al. 2017).

The North Fork Dam juvenile collection system has 85–95 percent fish-guidance efficiency and 99 percent survival (including for UWR Chinook salmon in the Clackamas). The system includes a floating surface fish collector and a 7-mile-long pipeline covering 360 feet of head (elevation drop) that delivers the fish to an area below the lowest dam project, River Mill Dam, within 2 to

15 hours. The bypass pipeline upgrade was completed in 2012, and the floating surface collector became fully installed and operational in 2015. The North Fork spillway exclusion net reduces spillway entrainment by 54–75 percent. Also, during times of high winter flow and spillway use at the North Fork Dam, some juveniles end up passing over the spillway and must pass through River Mill Dam. The new River Mill Dam juvenile collector, completed in 2013, has a 97 percent fish guidance efficiency and a 99 percent survival rate.

4.8.3.2 Water Quantity/Hydrograph

Below River Mill Dam, flows in the Clackamas River generally follow a natural seasonal pattern and cause localized flooding during many winters (NMFS 2008a).

Additionally, the quantity of water in the Clackamas River Basin is influenced by three primary factors:

- Direct Withdrawals (e.g., dams, diversions, etc.): the exercise of water rights which reduce the amount of available instream water and have the greatest impacts on aquatic species and water quality during the summer and early fall.
- Indirect Land Use Effects: including increased runoff efficiency and decreased water retention associated with vegetation removal and the consequent reduction in evapotranspiration, roads and road drainage systems, and urbanization resulting in increased amounts of impervious surface area.
- Changes in Flow Timing: associated with the operation of hydroelectric facilities, and to a lesser degree, maintaining and operating irrigation storage facilities (WPN 2005).

Currently, water providers, including the City of Lake Oswego, Clackamas River Water, the South Fork Water Board, and the North Clackamas County Commission, have Clackamas River water rights, some of which are being exercised using existing diversion facilities. Expansions of diversion and treatment facilities by the water providers have been in conflict with salmon conservation objectives.

4.8.3.3 Water Quality

Starting in 1997, the USGS began routinely studying water resources in the Clackamas River basin. Whether it be assessing harmful algal blooms, runoff issues, streamflow, or watershed health, the USGS works with its partners to maintain water quality. Urban development and human activities, particularly in the lower river, have effects on water quality parameters despite it being better than many other rivers in the state of Oregon.

The USGS water temperature gage at the Carter Bridge (14209710), in the lower Clackamas River, measured maximum temperatures close to 18 degrees C in the months of July and August in 2024, though temperatures did cool down at night to around 13-14 degrees C. Dissolved oxygen levels at this location reached their lowest in these same summer months in 2024, but never lower than 9.0 mg/L.

The 2004/2006 ODEQ Integrated Report database (ODEQ 2006a) identified a combined 52 miles of eight streams in the lower subbasin as water quality impaired by intermittently high concentrations of *E. coli* bacteria. These include the lower 15 miles of the mainstem Clackamas River. as well as Deep Cr., N. Fk. Deep Cr., Tickle Cr., Cow Cr., Barfield Cr., Rock Cr., and Sieben Cr. (ODEQ 2006a). There are a number of potential sources of the bacterial contamination, including livestock and poorly functioning septic systems in rural-residential areas. The Clackamas River itself receives effluent from Estacada and Clackamas waste treatment plants and likely picks up contaminants from tributaries and non-point sources along its route.

4.8.3.4 Physical Habitat Characteristics

Land ownership within most of the lower subbasin is in private ownership and the upper subbasin is more publicly owned. Most of the upper subbasin is managed by the Mount Hood National Forest, which emphasizes aquatic conservation in its habitat management policies (NMFS 2008a). Specific to the action area being considered in this opinion, physical habitat quality is generally poorer in the lower subbasin because of reduced habitat diversity and increased levels of fine sediment (WRI 2004). The reductions in habitat diversity in the lower subbasin have been a function of a decline in large woody debris (LWD) and channel simplifications that have resulted from active manipulation and changes in riparian conditions.

Revetments

The USACE maintains 1.6 miles of revetments it has constructed along the lower Clackamas river between RM 1.5 and RM 20.1. In combination with aggregate mining and isolation of the floodplain by bank-protection structures, elimination of sediment delivery from the upper subbasin has helped create a less dynamic lower river with fewer active side channels and less salmon spawning habitat. Flow modifications and channel confinement and in-stream barriers have reduced access to off-channel habitats essential for juvenile salmonid rearing and winter refuge, decreased connectivity between habitats throughout the subbasin, and curtailed the dynamic processes needed to form and maintain habitat diversity (WRI 2004). Reduced floodplain connectivity can also reduce nutrient and prey exports from the floodplain to the river (Reid et al. 2012). Two types of USACE constructed revetments or bank protection structures are in the entire baseline action area, those which they maintain (83 total) and those which non-federal sponsors own and maintain (105); generally, those not owned by USACE were built after 1950. The effect of the revetments, in conjunction with other WVS flood risk reduction operations, is to simplify the prior complex meandering, braided mainstem rivers with extensive floodplain forests on both banks particularly “in the southern reaches of the Willamette River and lower reaches of its major tributaries, all of which were historically more complex and dynamic” (Hulse et al 2013). Stream-channel complexity, off-channel habitats, and floodplain connectivity are important elements of high-quality salmonid habitat that have been reduced in the Clackamas River subbasin, frequently as a result of low large woody debris abundance or direct channel manipulations.

Modification or removal of these revetments requires permits under the Clean Water Act and the Rivers and Harbors Act. USACE administers these permits but considers them outside the scope of this action. The extensive revetments that were built as part of the WVS were intended to respond to floods that could cause bank erosion. In the previous supplemental BA (Usace 2007), USACE proposed to identify and prioritize revetments where removal or modification may be feasible to improve habitat for ESA-listed salmonids, and the 2008 RPA measure 7.4 required a report to assess and prioritize USACE-maintained revetments. This document was intended to provide specific sites where modifying or removing revetments would restore natural river function (Hulse et al 2013). The authors worked to geographically distribute ecological benefits of revetment removal or modification. From the final list of 12 high priority zones, only four individual revetments were recommended for detailed consideration.

The continued maintenance and presence of this system of revetments has degraded rearing and migration habitat in the lower tributary reaches via reduced floodplain connectivity and channel complexity. In addition to reducing floodplain connectivity, other effects of revetments on the ecosystem include (Fischenich 2003):

1. Reduced morphological evolution of a river. Stream lateral migration and riparian succession are necessary processes in maintaining appropriate energy levels in a system. The ability of a stream to convert energy between its potential and kinetic forms through changes in physical features, hydraulic characteristics, and sediment transport processes is important in creating complex habitats generating heat for biochemical reactions, and reoxygenating flows.
2. Impacts on hydrologic balance.
3. Impacts on sediments, or reduction of sediment yields and thus the generation of scour / erosion at sites immediately downstream.
4. Impacts on habitat. Riprap provides a substrate that usually differs from local material of the channel, and offers a different habitat condition.
5. Impacts on chemical and biological processes including important nutrient cycles. They can also create barriers to natural plant and animal migration.

Lacking any modifications to offset major adverse impacts of the WVS revetments on important elements of critical habitat, the continued maintenance of the revetments has continued to degrade rearing and migration habitat in the mainstem Willamette and lower reaches of its tributaries via reduced floodplain connectivity and channel complexity.

Habitat Restoration Efforts

The Clackamas Focused Investment Partnership (FIP) Strategic Restoration Action Plan was developed by more than fifteen Portland metropolitan region organizations committed to working collaboratively to improve watershed health, including four watershed councils, local municipalities and utilities, and state and federal natural resource management agencies (Clackamas Partnership, 2018). The Partnership's plan was developed to guide restoration actions designed to improve river and stream habitat and the environment that sustains native fish populations through 2025. The Clackamas Partnership's mission will also be sustained for the long-term, addressing emerging threats to watershed health, water quality, and fish and wildlife populations. The Partnership will revise the Strategic Plan in 2026 to incorporate lessons learned over the previous implementation period and to address new priorities identified.

Since the last Clackamas dam project relicense in 2010, Portland General Electric has been awarding funds to habitat restoration efforts in the sub-basin through their "Clackamas Habitat Fund", including large-wood additions, and side-channel restoration projects (conducted by local non-profits and the watershed councils), invasive species removal (by the Clackamas Soil and Water Conservation District's Invasive Species Partnership), and a long-term planting program supported by the Clackamas River Basin Watershed Council called "Shade Our Streams." Similar funding was received for the Clackamas Watershed Council's applications to the NOAA Restoration Center funding opportunity in 2023-24.

4.8.4 Hatchery Programs

Hatchery-produced spring Chinook salmon (and early-run coho salmon) smolts are released into the lower Clackamas River subbasin each year. These programs have in the past focused almost exclusively on fishery augmentation but have been modified so as to improve their consistency with ESA mandates for the conservation of natural-origin fish runs. All hatchery-origin salmon released into the subbasin are fin-clipped, allowing managers to screen any strays, other than a fraction with imperfect or regenerated fin clips, out of the upper basin run.

Past spawning surveys have indicated that the pHOS for spring UWR Chinook salmon is relatively high—57.1 percent in 2017 compared to a mean of 54.0 percent (median 57.3 percent) from 2008–2016 (Whitman et al. 2017).

There are also two hatchery stocks of steelhead that are currently released into the Clackamas River, consisting of a winter run (native), to meet mitigation agreement goals for dam projects, and to provide sport fishing opportunities, and a summer run (introduced) which provides more fishing opportunities for sport anglers. Since 1999, only unmarked steelhead (those presumed to be of natural-origin) have been allowed to pass above North Fork Dam. There still remains the potential for stray hatchery summer steelhead as well as hatchery winter steelhead to spawn and compete in streams with natural-origin late-winter steelhead in the lower subbasin.

4.8.5 Fisheries

The Clackamas River is a very popular sport fishing destination in Oregon given its proximity to the Portland-metro area. The history of fisheries management in the Clackamas Basin can be found in Taylor (1999).

Currently, fishing opportunities in the action area below River Mill Dam include year-round fisheries for hatchery salmon (including UWR Chinook and LCR coho) and hatchery steelhead (LCR winter steelhead and hatchery summer steelhead). These fishery opportunities and their popularity are certain to impact natural-origin, ESA-listed UWR Chinook salmon when hooked and released by anglers targeting hatchery fish on their migration to upper basin spawning grounds (Lindsay et al. 2004; Vander Haegen et al. 2004; Lennox et al. 2015), particularly when temperatures in the lower Columbia and lower Willamette River are above average in the late spring and early summer season (Keefer et al. 2010; Schreck et al. 1994).

4.8.6 Research and Monitoring Evaluations

The PGE Company regularly employs a well-rounded staff of fish biologists who regularly conduct fish-passage studies and assessments at their facilities to ensure that they are meeting the requirements of their FERC license and that high fish passage performance levels remain consistent among seasons and water years. The installation of PIT tag detectors throughout all sections of their adult and juvenile fish passage facilities allows for frequent, reliable, and consistent fish-passage-criteria assessments through the entire project. Some of the results of their studies are mentioned in the Habitat Access section above (4.8.3.1).

4.9 Coast Fork and Long Tom Sub-Basin

The action area in these sub-basins includes the Row River from Dorena Reservoir to the confluence with the Coast Fork Willamette River and the mainstem Coast Fork Willamette from Cottage Grove Reservoir to its confluence with the Willamette mainstem, and also the Long Tom River from Fern Ridge Reservoir to the confluence with the Willamette mainstem. The following section presents an assessment of whether UWR ESA-listed Chinook salmon and steelhead are present in this part of the action area, and the condition of the associated habitat.

The Coast Fork Willamette River and the Long Tom River are part of the seven west-side Willamette Basin tributaries. The other five are the Marys, Luckiamute, Rickreal, Yamhill, and Tualatin Rivers. All three USACE projects (Cottage Grove, Dorena and Fern Ridge Dam) in these two subbasins are authorized for flood control, irrigation, navigation, fish and wildlife, water quality, recreation and water supply.

Coast Fork Projects - Cottage Grove and Dorena Dams

Cottage Grove Dam and Reservoir (COT) sits on the Coast Fork of the Willamette River approximately 5 miles south of Cottage Grove, Oregon. The dam is an earth-fill structure with a concrete spillway that controls runoff from 104 square miles of land in the Coast Fork Willamette River watershed. Construction of this project was completed in 1942. The reservoir provides 31,800 acre-feet of storage.

Dorena Dam and Reservoir (DOR) is located on the Row River, a tributary of the Coast Fork Willamette River, approximately 6 miles east of Cottage Grove, Oregon. The dam is an earth-fill structure with a concrete spillway that controls runoff from 265 square miles of drainage area. The reservoir provides 72,100 acre-feet of storage. This project was completed in 1949 and has a privately-operated hydropower unit that began operation in 2014 and is licensed by the Federal Energy Regulation Commission. The unit consists of two turbines consisting of one high flow and one low flow. Only one of the units is in operation at any given time, meaning that roughly half of the generating capacity is utilized depending on flow conditions. The hydropower unit is a run-of-the-river system, meaning that the plant does not control flows but rather uses the flows dictated by USACE. Any hydropower production at Dorena Dam is incidental to how USACE operates the dam and does not affect USACE's mission.

Long Tom Project - Fern Ridge Dam

Fern Ridge Dam and Reservoir (FRN) is on the Long Tom River, a tributary of the Willamette River, approximately 12 miles west of Eugene, Oregon. It is the only dam in the WVS west of Interstate 5. Fern Ridge Dam is an earth-fill structure that includes a gated-concrete spillway and outlet works for regulating reservoir levels. The reservoir provides 97,300 acre-feet of storage and controls runoff from a 275-square-mile drainage area. The Long Tom River below Fern Ridge Dam meanders before joining the mainstem Willamette River north of Monroe, Oregon. The river was shortened from 36.5 miles to 23.6 miles and was channelized with embankments. A series of seven drop structures were built with the intent to reduce channel velocity and decrease erosion, while still moving water downstream efficiently. Three of the seven drop structures, one at Monroe (RM 6.7), one at the Stroda property (RM 10.2), and one just upstream of Ferguson Road (RM 12.7), are constructed of concrete and range in height from 7.5 feet to 11.5 feet. The remaining four drop structures are smaller rock riffle weirs that are located in the uppermost 4 miles of the constructed channel. Operation and maintenance of all seven structures is minimal.

4.9.1 Historical Populations of ESA-Listed Anadromous Fish in the Coast Fork and Long Tom Sub-basins

Historical accounts indicate that small numbers of Chinook salmon were once observed spawning in the Coast Fork Willamette River (Dimick and Merryfield 1945), but these stocks had become depleted by the time their presence was documented by biologists. A 1938 survey by the Bureau of Commercial Fisheries attributed a lack of anadromous salmonids in the mainstem Coast Fork Willamette River at that time to artificial passage obstructions and water pollution (McIntosh et al. 1995). Meyers et al. (2003) did not identify historical populations of UWR Chinook salmon as occurring in either the Long Tom or Coast Fork Willamette rivers.

The WLCTRT (2003) identified four historically independent steelhead populations above Willamette Falls, each within a subbasin draining the Cascade Range but none native to the Willamette's west-side subbasins. In terms of historical records, Parkhurst et al. (1950) did not report the presence of winter steelhead in west-side streams.

4.9.2 Current Status of Sub-basin Population and Importance to Recovery

No evidence currently exists that the Coast Fork Willamette River supports an independent, self-sustaining spring UWR Chinook salmon population. There may have been intermittent production in this subbasin, but Dorena and Cottage Grove dams blocked access to most spawning areas. Hatchery-produced juvenile salmon have been released into the Coast Fork Willamette River in an effort to maintain a harvestable hatchery return (and reduce hatchery / natural adult interaction on natural spawning grounds in eastside tributaries) (ODFW and USACE 2019b; Ziller 2022 Pers. Comm.). Some of the returning adults from these releases ended up returning to their hatchery of origin rather than the Coast Fork Willamette River release site (Ford ed. 2022). A small number of surplus adult hatchery salmon have been outplanted into

Mosby Creek, a Coast Fork tributary, since 1998. This effort became more formal in 2006, when ODFW began to record water quality in the area, survey spawning areas, estimate the habitat capacity of Mosby Creek, and trap juvenile Chinook salmon produced by the outplanting effort (Moberly 2008). In combination with strays, these outplants have been associated with some limited spring Chinook salmon production in recent years (Ziller 2022 Pers. Comm.). However, these efforts have produced very limited adult returns, and no self-sustaining populations have been found to exist (Keefer and Caudill 2010).

Recent ODFW surveys have identified some juvenile Chinook salmon in the lower reaches of the Long Tom River, though their origin is not known. It is plausible that the lower Long Tom River is used as rearing habitat by juvenile UWR Chinook salmon yearlings during the cooler months of the year (Schroeder et al. 2016), but water temperatures in this subbasin are too warm to support spring Chinook salmon habitat for multiple life stages or an actual self-sustaining population of spring Chinook salmon. For these reasons, NMFS considers the Long Tom subbasin a low priority for UWR Chinook salmon recovery, other than having the potential to support some Chinook salmon rearing habitat at the river's confluence with the mainstem Willamette River.

4.9.3 Environmental Conditions and Climate Change

4.9.3.1 Habitat Access and Fish Passage Conditions

The 2008 NMFS biological opinion provides a synopsis of habitat access for these subbasins (see section 4.9.3.1 in NMFS 2008a). In general, there are numerous partial or complete barriers to fish passage in the form of dams and road culverts. This includes six structures constructed and maintained by USACE—Dorena, Cottage Grove, and Fern Ridge dams and three concrete drop structures on the Long Tom River below Fern Ridge. The lowermost drop structure on the Long Tom River, known as the Monroe drop structure, does have an existing fish ladder that is nonfunctional. For more information on fish-passage obstructions in these subbasins, refer to Section 4.9.3.1 in the 2008 WVS Bi-Op (NMFS 2008a).

4.9.3.2 Water Quantity/Hydrograph and Climate Change

The Fern Ridge, Dorena, and Cottage Grove dams modify flows in the Long Tom, Row, and Coast Fork Willamette rivers, respectively. USACE dams have diminished flooding (December to May) and augmented late-summer to early fall flows in the lower Coast Fork Willamette and Long Tom rivers (Figures 4.9-1 and 4.9-2). The 2008 NMFS WVS Biological Opinion's environmental baseline section has a detailed description of how flows have been modified by the projects in this subbasin (NMFS 2008a, section 4.9.3.2). There have been no modifications to the operations since the 2008 opinion, including at Dorena Dam where there is now a privately-owned turbine for which section 7 ESA consultation was completed in 2008 (NMFS 2008a).

Coast Fork Willamette

In both the Coast Fork Willamette and Row Rivers, natural flows are lowest in the summer and early fall, but the USACE stores winter floods, redistributing and releasing water later in the year for the purpose of augmenting flows in the mainstem Willamette River. Consequently, summer streamflows below the USACE dams in the Coast Fork Willamette River subbasin are higher now than they were before dam construction (Figure 4.9-1).

Summer is a period of rapid growth for juvenile Chinook salmon, and this increase in flows likely offsets other water diversions and has a beneficial effect on juvenile Chinook salmon growth and survival. However, with very low use of the Coast Fork Willamette River watershed by anadromous fish, this beneficial effect would only apply to fish holding and rearing near the mouth of the Coast Fork Willamette River, and, possibly, in the mainstem Willamette River. If the offspring of adult UWR Chinook salmon out-planted into Mosby Creek were to return as adults and spawn below Dorena Dam on the Row River, flows that are greatly elevated by reservoir drafting operations during the September–October spawning period may encourage fish to use areas near the channel margins that could become dewatered during periodic flood-control operations during late fall and winter.

The Coast Fork Willamette River supplies water for domestic, industrial, and agricultural uses. Since the 2008 Biological Opinion, the Bureau of Reclamation has recorded a decrease in the number of contracts (11 in 2007 down to 9 in 2022) and acre feet (1,272 acre-feet in 2007 and only 660 acre-feet in 2022) of water for consumptive use in the Coast Fork Willamette Willamette River below Dorena and Cottage Grove Dams.

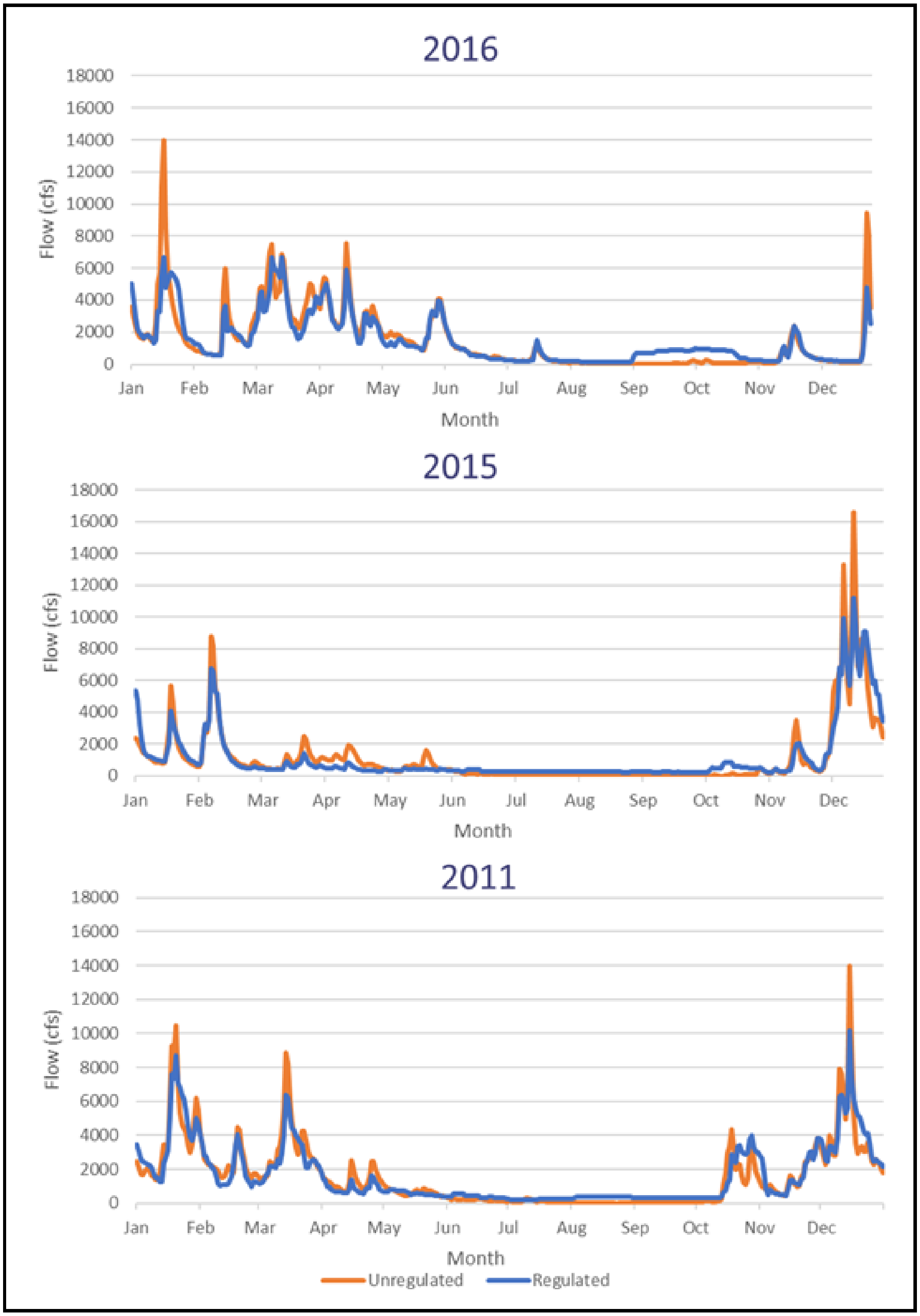


Figure 4.9-1. Coast Fork Willamette River at Goshen flows across three water years. The blue lines are for observed flows from 2011, 2015 and 2016. The orange lines are modeled flows for the unregulated hydrology for the same years.

Long Tom

Flood control operations at Fern Ridge Dam have decreased the magnitude and frequency of extreme flow events, although the overall reduction has been relatively small compared to that caused by other WVS dams (Figure 4.9-2). Summer flows below Fern Ridge Dam are slightly greater than they were historically because the USACE releases water as required to serve irrigation demand while meeting minimum-flow targets in the summer months at Monroe on the Long Tom River. However, the Fern Ridge Reservoir is not drafted to meet instream flow requirements on the mainstem Willamette River during the summer because of its high priority for reservoir recreation. Since the 2008 Biological Opinion, there was also a drop in consumptive use for the Long Tom River below Fern Ridge Dam (-5 contracts, -6,055-acre feet).

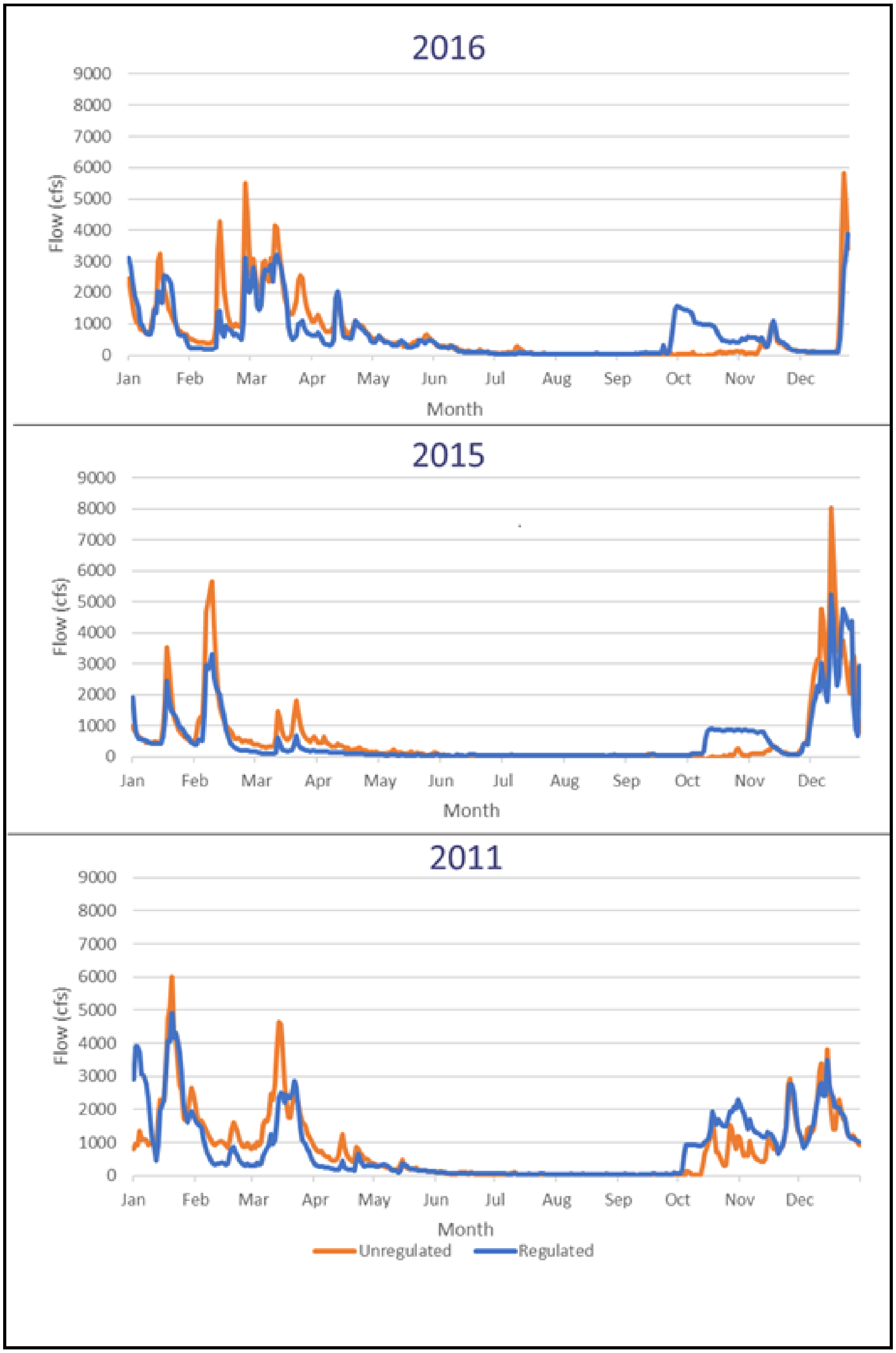


Figure 4.9-2. Long Tom River at Monroe, OR, Flows Across the Water Year. The blue lines are for observed flows from 2011, 2015 and 2016. The orange lines are modeled flows for the unregulated hydrology for the same years.

4.9.3.3 Water Quality

Water Temperature

Water quality is impaired in many streams within the Willamette River's westside subbasins, particularly in lowland areas affected by agricultural, rural-residential, and urban development. USACE-funded USGS gages monitor temperature at outflow points of Cottage Grove, Dorena, and Fern Ridge Reservoirs, but temperature-control operations are not conducted at Cottage Grove, Dorena, or Fern Ridge Reservoirs (USACE WQ Report 2024; USACE BA). There are no "fish agency" temperature targets implemented at these projects, although there are temperature TMDLs (total maximum daily loads) originally set by ODEQ in 2006 for waters downstream of the projects, and updated in 2024 (Michie et al. 2024).

TMDL temperature limits have often been exceeded below Cottage Grove Dam in the months of July or August through October and can exceed 68 in July through September (USACE 2024b). In 2021, temperatures measured in the Coast Fork below Cottage Grove Dam exceeded well above 70 °F. Below Dorena Dam in the Row River, temperature TMDLs have been exceeded in August through October. In 2021, temperatures at this location also exceeded 70°F (for a majority of days in August). Below Fern Ridge Dam in the Long Tom River, the TMDLs are nearly always being exceeded for all months they are set (April to November) and can now exceed 68°F June through September. Temperature data from the last 5 years (2019-2023) shows that temperatures in the Long Tom below Fern Ridge Dam have exceeded 70°F each and every year, for the majority of days in July and August, and sometimes in June (2021) (USACE WQ Report 2024). Temperatures at this level are not conducive to successful life history stage transitions, and ultimately, overall productivity, for either UWR Chinook salmon or steelhead (Hallock et al. 1970; Geist et al. 2006; Richter and Kolmes 2006).

Mercury mined or leached from rich deposits above both Coast Fork dams creates health risks in waterbodies downstream (ODEQ 2006b).

4.9.3.4 Physical Habitat Characteristics

<u>Coast Fork Willamette</u>
Above the two Coast Fork Willamette dams, the Umpqua National Forest and the Bureau of Land Management's Eugene District manage federally owned public lands for multiple uses, but the majority of forestland is privately owned and generally used for timber production and some agriculture.

Reductions in peak flows caused by flood-control operations at Cottage Grove and Dorena dams have contributed to a loss of habitat complexity in the lower Coast Fork Willamette River by substantially reducing the magnitude of the channel-forming dominant discharge (i.e., the 1.5- to 2-year flood) and greatly extending the return intervals of larger floods. Over time, flood control tends to reduce channel complexity (e.g., reduces the frequency of side channels and large-wood recruitment) and reduces the movement and recruitment of channel substrates. Side channels, backwaters, and instream-large-wood accumulations have been shown to be important habitat features for rearing juvenile salmonids.

Operation of USACE's Cottage Grove and Dorena dams is only partly responsible for the reduction in channel complexity noted in the lower Coast Fork Willamette River. Bank-stabilization measures and land-leveling and development in the basin have directly reduced channel complexity and associated juvenile salmon rearing habitat. In addition, sand and gravel are mined from the channels in the lower Coast Fork Willamette and Row rivers, and adjacent bottomlands have been developed for agriculture (NMFS 2008a).

Fern Ridge encompasses over 11,000 acres of marsh, wetland, and prairie habitat, with 5,000 acres dedicated to the Fern Ridge Wildlife Area managed by the Oregon Department of Fish and Wildlife (ODFW). Lowland portions of the subbasin are dominated by agriculture but include the urban landscape found in and around the city of Eugene (Thieman 2000). The river was severely degraded prior to dam construction, and the lower reaches have been extensively modified (channels straightened and diked for flood control) (NMFS 2008a). Reductions in peak flows have contributed to a loss of habitat complexity in the lower Long Tom River as well; however, virtually the entire reach of the Long Tom River has been channelized, straightened, leveed, or otherwise modified by projects related to drainage and irrigation (Thieman 2000).

4.9.4 Hatchery Programs

There are not any current or proposed hatchery programs in the Long Tom or Coast Fork subbasins for Chinook salmon, other than the releases and outplant efforts in the Coast Fork discussed above in section 4.9.2. ODFW does release hatchery rainbow trout in these subbasins for recreational fishing opportunities.

4.9.5 Fisheries

In addition to the information provided in the General Baseline and Willamette Mainstem Baseline Chapter 4.1 regarding fisheries, the Long Tom River and tributaries have year-round rainbow trout (and general trout) fishing opportunities, including allowable trout harvest between May 22 and October 31, and catch-and-release fishing only through the rest of the year. The Row River in the Coast Fork Willamette River subbasin is open all year for wild and hatchery trout, hatchery Chinook salmon, hatchery steelhead, and wild steelhead greater than 24 inches in length, though it is closed to salmon and steelhead angling in Mosby Creek and Mosby Creek tributaries. Since Chinook salmon and steelhead found in these subbasins are generally not considered to be part of the UWR Chinook salmon ESU or the UWR steelhead DPS, the effect of these fishing opportunities on the ESA-listed populations is likely to be negligible. However, it is possible that some ESA-listed fish could stray into these subbasins.

4.9.6 Predation

Wild and hatchery-origin rainbow trout are present in the Coast Fork Willamette and Long Tom subbasins and may compete with juvenile salmon. Many non-native predatory species are also present including: largemouth bass, smallmouth bass, white and black crappie, warmouth, bluegill, pumpkinseed sunfish, green sunfish, yellow perch, bullhead catfish, and, likely, some walleye. Northern pikeminnow can also be found in the Coast Fork Willamette and Long Tom river subbasins. For additional details, see information provided in the Willamette Mainstem and General Baseline Chapter and the associated Predation section, 4.1.6.

4.9.7 Research and Monitoring Evaluations

No current research and monitoring evaluations have been conducted in the Coast Fork Willamette or Long Tom river subbasins.

4.10 Lower Columbia River and Estuary

The action area includes the lower Columbia River from the confluence of the Willamette River to the mouth of the Columbia River. This section of the action area is all part of the Lower Columbia River Estuary, which is defined as the reach from the Bonneville Dam tailrace to the Pacific Ocean and the tidally influenced portions of tributaries to the Columbia River in that region (33 U.S. Code § 1275). The following section presents an assessment of the condition of the listed species and their designated critical habitat within the action area located in the Lower Columbia River.

Mean annual discharge from the Columbia River is estimated to be 265 kcfs (thousand cubic feet per second), but may range seasonally from lows of 71 to 106 kcfs to highs of 530 kcfs (Hamilton 1990, NMFS 1998, Prahl et al. 1998, USACE 1999). Comparatively, the mean annual discharge from the Willamette River is 37.4 kcfs, and contributes 12 to 15 percent of the total flow of the Columbia River. Columbia River System water management activities have reduced flows in the Columbia River, measured at Bonneville Dam, from April through July. On average, this reduction ranges from 7 kcfs in March to 171 kcfs in June (NMFS 2020a).

The effect of the Willamette Valley System (WVS) flood control (and other) operations on Columbia River flows is less significant. Willamette Valley System management can reduce Willamette River spring flows by 2 to 5 kcfs, summer flows by 0 to 1.7 kcfs, and then increase Willamette River flows by 2.5 to 3 kcfs in the month of October (USACE 2023a). These differences (due to management) equal 1-2% of total annual mean Columbia River flows in the estuary. Though the effect is a measurable effect, any impacts to Lower Columbia River flows are small and difficult to evaluate. Further, reduction of spring flows through the Willamette River and tributaries could also further reduce organic inputs to the Lower Columbia River, though again, the level of this effect is too low to be meaningfully evaluated.

4.10.1 ESA-Listed Species in the Lower Columbia River and Estuary

All of the ESA-listed Columbia River and Snake River anadromous salmon and steelhead species must pass through the Lower Columbia River and estuary, both as out-migrating juveniles and as returning adults. This includes the following 13 ESA-listed species (ESUs or DPSs):

Lower Columbia River Chinook salmon (includes a Clackamas River population, fall Chinook)
Lower Columbia River coho salmon (includes a Clackamas River population)
Lower Columbia River chum salmon (includes a Clackamas River population)
Lower Columbia River steelhead (includes a Clackamas River population)

Upper Willamette River Chinook salmon
Upper Willamette River steelhead

Mid-Columbia River steelhead

Snake River fall Chinook salmon
Snake River spring-summer Chinook salmon
Snake River sockeye salmon
Snake River steelhead

Upper Columbia River spring Chinook salmon
Upper Columbia River steelhead

Designated critical habitat for Southern Resident Killer Whales exists outside of the Lower Columbia River and estuary, though they are indirectly affected by any major effects to Chinook salmon in the action area. Other ESA-listed species present in this part of the action area, which are not likely to be adversely affected by the proposed action, include:

Southern DPS green sturgeon
Eulachon
Humpback whales

For more information about green sturgeon, eulachon, and humpback whales, please refer to Chapter 7.7 (Not Likely to Adversely Affect Determinations).

General Estuary Use by Species and by UWR Chinook Salmon and UWR Steelhead

Our understanding of the role of the estuary in the life history and ecology of salmonid populations has changed considerably over the past century. Initial perspectives about the estuary were that it was unimportant or irrelevant because the estuary (and ocean) was considered to be limitless in its ability to support salmon (Fresh et al. 2005). Eventually, scientists became aware that nonfreshwater factors had an important influence on numbers of returning adult salmon and began to consider the role that the estuary and ocean played in salmon population fluctuations. In more recent years, the estuary has come to be regarded as part of the continuum of ecosystems that salmon need to utilize in order to complete their life cycle. The estuary phase and the initial ocean stage are viewed as "critical periods" of the salmon life cycle because they are periods of high mortality as salmon transition from freshwater to marine habitats (Pearcy, 1992; Schreck et al., 2006; Welch et al., 2008). Although mortality may be high in the estuarine environment, estuaries provide juvenile salmon with productive foraging opportunities, and offer intermediate environments during the physiological transition to salt water (Simenstad et al., 1982; Thorpe, 1994; Bottom et al., 2005).

However, the degree of benefit likely varies by species and life history type, because some groups (e.g., subyearling Chinook salmon) make prolonged use of estuaries, whereas others (e.g., steelhead) largely pass through estuaries in a few days (Schreck et al., 2006; Campbell, 2010; Roegner et al. 2012). Extensive research efforts in the Columbia River estuary from the late 1960s (Johnsen and Sims, 1973) to the mid-1980 (McCabe et al., 1983; Bottom and Jones, 1990) established that most juvenile salmon migrating as yearlings (i.e., yearling Chinook and coho salmon and steelhead) passed rapidly through the estuary in the main, deep Columbia River channels, and most subyearling migrants (subyearling Chinook and chum salmon) occupied shallow waters close to shore (Bottom et al. 2005; Craig, 2010; Roegner et al., 2010, in press; Spilseth and Simenstad, 2010). Chinook salmon ESUs in the Columbia River basin display diverse life-history variation, including the timing of adults returning to freshwater indicated by season (spring, summer, or fall), in subgroup names (e.g., Snake River fall), and age of ocean entry for juveniles (fall runs have subyearling age 0.0 smolts, spring runs typically have yearling age 1.0 smolts) though UWR Chinook salmon juvenile migrate at several different stages (Myers et al., 1998; Schroeder et al. 2016).

Teel et al. (2014) collected genetic samples from juvenile salmonids found in the Lower Columbia River estuary (throughout the year from 2010 to 2012) in seven different reaches from the mouth to Bonneville Dam to better understand their presence in and use of the estuary habitat. They then matched the samples to areas of origin using available genetic baseline information. Genetic baseline information from three different UWR Chinook salmon populations (including hatchery and natural-origin samples) was included in their analysis: Clackamas, North Santiam and McKenzie. Out of 2,644 juvenile Chinook salmon sampled in the entire estuary (all seven reaches) over the course of these three years, 8% were matched to these UWR Chinook salmon populations, indicating the importance of estuary rearing habitat to this ESU, and their significant prevalence in the estuary rearing areas. In samples from the reaches which were most proximal to the mouth of the Willamette River (E,F,G), 13 to 17% of the juvenile Chinook sampled were identified as UWR Chinook salmon. Months and life stages in which their presence in the samples was highest (compared to a large number of Chinook from other ESUs) included January (as fry), March (as yearlings) and a few in the fall (as fingerlings) (Teel et al. 2014).

Juvenile UWR steelhead, like other steelhead, have not been found to use the estuary as rearing habitat for long, as they do most of their rearing and early freshwater growth in natal streams and sub-basins prior to their migration to the ocean. UWR steelhead use this part of the action area as an important migration corridor through which they are undergoing physiological changes to adapt to more saline ocean water (as juveniles) or less saline freshwater (as adults). Recent research indicates that steelhead also actively feed on prey (exported from productive estuarine habitats) during their relatively quick migration through the estuary (Weitkamp et al. 2022).

4.10.2 Environmental Conditions and Climate Change

The NMFS 2008 WVS biological opinion describes the historical environmental baseline for the Lower Columbia River Estuary (LCRE) and is hereby incorporated by reference. In summary, the current environmental baseline is significantly degraded over the historical condition with the development of the estuary, Federal Navigation Channel, and habitat effects from the Columbia River System, which, in combination, have led to large reductions in several key estuarine habitat ecotypes (Fresh et al. 2005; Sol et al. 2021; Weitkamp et al. 2022).

Since 2000, there have been ongoing efforts to restore estuarine habitat by federal, state, and local entities. One of the largest efforts has been the Lower Columbia River Estuary Partnership (LCEP), which is an interstate/federal group formed under the EPA's National Estuary Program (see 33 U.S. Code § 1330). Since the year 2000, LCEP has helped restore more than 28,387 acres of estuarine habitat in the LCRE. These efforts to improve the environmental baseline into the future through restoration actions are slated to continue as described in the 2019 NMFS biological opinion for the continued operation and maintenance of the Columbia River System (CRS) where 300 acres of habitat will be restored per year. These restoration efforts should improve the environmental baseline in the estuary.

It is likely that residency and migration times for Chinook salmon juveniles could increase into the future with anticipated changes to the hydrograph from climate change (see 4.17.1 and Crozier et al. 2021).

4.10.2.1 Habitat Access and Fish Passage

No obstructions to fish passage are present in this section of the Lower Columbia River.

4.10.2.2 Water Quantity/Hydrograph and Climate Change

On the mainstem of the Columbia River, water storage projects (including the Columbia River System and reservoirs in Canada operated under the Columbia River Treaty) and related flow regulation for flood control, hydropower, and consumptive (agricultural and municipal) uses have altered the quantity and timing of flows and have significantly degraded salmon and steelhead habitats (Bottom et al. 2005, Fresh et al. 2005, NMFS 2013b). Water management activities have reduced flows in the Columbia River, measured at Bonneville Dam, from April through July. On average, this reduction ranges from 7 kcfs in March to 171 kcfs in June (NMFS 2020a). The volume of water discharged by the Columbia River varies seasonally according to runoff, snowmelt, flood-control, and hydropower demands. Maximum flows on the river occur in May and June as a result of snowmelt in the headwater regions. Minimum flows occur from September to February. During the winter, periodic peaks in flow occur because of heavy-rain events (Holton 1984).

The flow versus survival relationships for some interior basin ESUs/DPSs remain nearly constant over a wide range of flows but decline markedly as flows drop below a threshold (NMFS 1995a, 1998). As a result, NMFS and action agencies have attempted to manage Columbia River water resources to more closely approximate the shape of the natural hydrograph to enhance flows and water quality and to improve juvenile and adult fish survival. The action agencies attempt to maintain seasonal flows above threshold objectives given the amount of runoff expected in a given year. This has been accomplished by avoiding excessive reservoir drafts going into spring to minimize the flow reductions needed for refill and by drafting the storage reservoirs during summer to augment flows. These seasonal flow objectives have guided preseason reservoir planning and in-season flow management. Despite management focused on meeting seasonal flow objectives, since the development of the hydrosystem, average monthly flows at Bonneville Dam have been lower during May to July (than pre-dam system flows) and higher in October to March. Even though several million acre-feet of stored water is released each summer to augment flows (and from Dworshak Dam, to reduce mainstem temperatures), these volumes do not fully offset the volume consumed in the basin in July and August (BPA, USBR, and USACE 2020).

4.10.2.3 Water Quality

Water quality in the action area is impaired. Common toxic contaminants include PCBs, PAHs, PBDEs, DDT, and other legacy pesticides; current use pesticides; pharmaceuticals and personal care products; and trace elements (LCREP 2007). The LCREP (2007) report noted widespread presence of PCBs and PAHs, both geographically and in the food web. Water quality and salmon samples from locations downstream of the lower river's major population and industrial centers showed higher concentrations of toxic contaminants than samples from upstream locations, suggesting that much of the contaminant load seen in juvenile salmon is coming from their time spent rearing and feeding in the lower Columbia River (LCREP 2007). Likewise, juvenile salmonids are accumulating DDT in their tissues and are exposed to estrogen-like compounds in the lower river, likely associated with pharmaceuticals and personal care products. Concentrations of copper are present at levels that could interfere with crucial salmon behaviors.

Growing population centers throughout the Columbia basin and numerous smaller communities contribute municipal and industrial waste discharges to the lower Columbia River. The most extensive urban development in the lower Columbia River basin has occurred in the Portland/Vancouver area. Outside of urban areas, the majority of residences and businesses rely on septic systems. Common water-quality issues with urban development and residential septic systems include warmer water temperatures, lowered dissolved oxygen, increased nutrient loading, increased fecal coliform bacteria, and increased chemicals associated with pesticides and urban runoff (LCREP 2007). Highly developed agricultural areas of the basin also deliver fertilizer, herbicide, and pesticide residues to the river.

Contaminants have been detected in aquatic insects, resident fish species, salmonids, river mammals, and osprey, and they are widespread throughout the estuarine food web (Furher et al. 1996, Tetra Tech 1996, LCREP 2007). Additionally, many toxic contaminants are specifically designed to kill insects and plants, reducing the availability of insect prey or modifying the surrounding vegetation and habitats. Changes in vegetative habitat can shift the composition of biological communities; create favorable conditions for invasive, pollution-tolerant plants and animals; and further shift the food web from macrodetrital to microdetrital sources. Overall, more work is needed on contaminant uptake and impacts on salmon of different populations and life-history types.

Under these environmental conditions, fish in the action area are stressed. While the magnitude of effects to juvenile or adult salmon and steelhead is unclear, stress is likely to lead to reductions in biological reserves, altered biological processes, increased disease susceptibility, and altered performance of individual fish (e.g., growth, osmoregulation, and survival). Our understanding of the effects on aquatic life of many contaminants is incomplete, especially when considering the exposure of rearing juveniles to multiple contaminants that may have synergistic or antagonistic effects, or when considering their interactions with other stressors or food-web mediated effects and effects in complex mixtures (NMFS 2017a). Together, these contaminants are likely affecting the productivity and abundance of ESA-listed salmon and steelhead groups, especially for Chinook salmon which spend more time rearing in the estuary. Effects can be direct or indirect and lethal or, more likely, sublethal. The interaction of co-occurring stressors may have a greater impact on salmon than if they occur in isolation (Dietrich et al. 2014).

The impact of water temperatures in the Columbia River on salmon and steelhead survival is a concern. Because of temperature standard exceedances, portions of the lower Columbia River are on the Clean Water Act §303(d) list of impaired waters established by Oregon and Washington. Temperature conditions in the Columbia River basin area are affected by many factors, including:

- Natural variation in weather and river flow.
- Construction of the dam and reservoir system (the large surface areas of reservoirs and resulting slower river velocities contribute to warmer late summer/fall water temperatures).
- Increased temperatures of tributaries caused by water withdrawn for irrigated agriculture and grazing and logging.
- Point-source discharges such as cities and industries.
- Climate change.

4.10.2.4 Physical Habitat Characteristics

The Columbia River estuary provides important migratory and rearing habitat for all Columbia basin salmon and steelhead populations, but particularly for early migrating juvenile Chinook salmon and chum salmon. Since the late 1800s, 68 to 74 percent of the vegetated tidal wetlands of the estuary have been lost to diking, filling, and bank hardening, combined with hydrosystem flow regulation and other modifications (Kukulka and Jay 2003, Bottom et al. 2005, Marcoe and Pilson 2017, Brophy et al. 2019). Disconnection of tidal wetlands and floodplains has eliminated much of the historical rearing habitat for subyearling Chinook salmon and reduced the production of wetland macrodetritus that supports salmonid food webs (Simenstad et al. 1990, Maier and Simenstad 2009), both in shallow water and for larger juveniles migrating in the mainstem (PNNL and NMFS 2020).

Restoration actions in the estuary, such as those highlighted in a recent 5-year review, have improved access and connectivity to floodplain habitat (NMFS 2016a). From 2007 through 2019, restoration sponsors implemented 64 projects, including dike and levee breaching or lowering, tide-gate removal, and tide-gate upgrades that reconnected over 6,100 acres of historical tidal floodplain habitat to the mainstem and another 2,000 acres of floodplain lakes (BPA et al. 2020). This represents a more than a 2.5 percent net increase in a connectivity index for habitats that are used extensively by subyearling Chinook salmon (Johnson et al. 2018, PNNL and NMFS 2018, 2020). Although yearling Chinook salmon and steelhead migrants are less likely to enter and rear in these areas, the large amounts of prey (particularly chironomid insects) exported from restored wetlands to the mainstem are actively consumed by both yearling and subyearling Chinook salmon smolts, as well as juvenile steelhead that have been found to actively feed as they move downstream (Weitkamp et al. 2022). The resulting growth by these fish likely contributes to survival at ocean entry (PNNL and NMFS 2020). In addition to recent and extensive reconnection efforts in the estuary, approximately 2,500 acres of currently functioning floodplain habitat have been acquired for conservation.

The series of dams and reservoirs in the Columbia River System (and in many Lower Columbia River tributaries, including the Willamette) has blocked natural sediment transport. Total sediment discharge into the estuary and Columbia River plume is only one-third of 19-century levels (Simenstad et al. 1982 and 1990; Sherwood et al. 1990, Weitkamp 1994, NRC 1996, NMFS 2008a). Bottom et al. (2005) estimated that, together, hydrosystem operations and reduced river flows caused by climate change have decreased the delivery of sediment to the lower river and estuary by more than 50 percent (as measured at Vancouver, Washington). The overall reduction in sediment, combined with bank armoring and in-water structures that focus flow in the navigation channel, has reduced the availability of shallow-water habitat along the margins of the river.

Industrial harbor and port development has a significant influence on the lower Columbia Rivers (Bottom et al. 2005, Fresh et al. 2005, NMFS 2013b). Since 1878, the Corps has dredged 100 miles of river channel within the mainstem Columbia River, its estuary, and the Willamette River as a navigation channel. Originally dredged to a 20-foot minimum depth, the federal navigation channel of the lower Columbia River is now maintained at a depth of 43 feet and a width of 600 feet. The dredging, along with diking, draining, and fill material placed in wetlands and shallow habitat, disconnects the river from its floodplain, resulting in the loss of shallow-water rearing habitat and the ecosystem functions that floodplains provide (e.g., supply of prey, refuge from high flows, temperature refugia) (Bottom et al. 2005).

4.10.3 Hatchery Programs

By 1908, more than 34 million juvenile salmon were being released from hatcheries in the Columbia basin every year, and still the number of adult fish returning from the ocean continued to decline[1]. In general, hatchery programs can provide short-term demographic benefits to salmon and steelhead, such as increases in abundance during periods of low natural abundance. They also can help preserve genetic resources until limiting factors can be addressed. However, the long-term use of artificial propagation may pose risks to natural productivity and diversity. The magnitude and type of the risk depends on the status of affected populations and on specific practices in the hatchery program. Hatchery programs can affect natural populations of salmon and steelhead in a variety of ways, including competition (for spawning sites and food) and predation effects, disease effects, genetic effects (e.g., outbreeding depression, hatchery-influenced selection), broodstock collection effects (e.g., to population diversity), and facility effects (e.g., water withdrawals, effluent discharge) (NMFS 2018a).

In 2017, NMFS completed an EIS and new biological opinion on its funding of the Mitchell Act program (NMFS 2017c). The Mitchell Act Record of Decision directs NMFS to apply strong performance goals to reduce the risks of hatchery programs on natural-origin populations. As a result, several additional hatchery reform measures have been or will be implemented.

Even with these improvements, hatchery production will continue to limit the diversity and productivity of natural-origin salmon and steelhead in the Columbia basin. Hatchery programs were designed to conserve vital genetic resources and to supplement harvest levels to compensate for losses throughout their life cycle. Up to 140 million hatchery salmon and steelhead juveniles are currently released into the Columbia basin each year. Though the majority are released from upriver hatcheries and a large proportion will not survive to the estuary, some scientists suspect that closely spaced releases of hatchery fish from all Columbia River basin hatcheries may lead to increased competition with natural-origin fish for food and habitat space in the estuary. NMFS (2006) and the Lower Columbia Fish Recovery Board (LCFRB 2010) identified competition for food and space among hatchery-origin and natural-origin juveniles in the estuary as a critical uncertainty.

4.10.4 Fisheries

Directed lower Columbia River commercial and sport fisheries for spring Chinook, summer steelhead, fall Chinook salmon and coho salmon are all mark-selected fisheries (only marked hatchery fish can be kept), though they do incidentally capture natural-origin fish which can cause hooking injuries and sometimes mortality. Management decisions for these fisheries are carried out on an annual and in-season basis and it is a responsibility shared by state, federal and tribal agencies. The overarching management objective is to meet conservation requirements while providing optimum sport and commercial fishing opportunities. For detailed information on how these fisheries are managed, and estimated impacts to species / runs, refer to the NMFS Biological Opinion for the U.S. v. Oregon Management Agreement (NMFS 2018a) and the seasonal Joint Staff Reports posted online at: dfw.state.or.us/fish/OSCRP/CRM/jsmreports.asp

The anticipated harvest rate for UWR spring Chinook salmon in the proposed mainstem Columbia River fisheries in 2018 to 2027 ranges from 5 to 11 percent and will not exceed an overall combined harvest rate of 15 percent from all freshwater fisheries combined. The 2018 Agreement proposes to continue adhering to these harvest limits for UWR Chinook salmon (NMFS 2018a). There is no directed fishery for winter steelhead in the lower Columbia River though they can be caught incidentally by spring Chinook fisheries (NPCC 2024). These Lower

Columbia River fisheries also have some impact on all other ESA-listed salmon and steelhead species in the Columbia River basin.

4.10.5 Predation

A variety of avian and piscine predators consume juvenile Chinook salmon and steelhead on their migration from tributary rearing areas to the ocean. Pinnipeds eat returning adults in the estuary. This section discusses predation rates and describes management measures to reduce the effects of the growth of predator populations within the action area.

Avian Predation

As noted above, dams and reservoirs around the Columbia River basin block sediment transport, and total sediment discharge into the river's estuary and plume is about one-third of 19th-century levels (Bottom et al. 2005). Reduced sediment discharge results in reduced turbidity in the lower river, especially during spring, which may make juvenile outmigrants more vulnerable to visual predators like piscivorous birds.

Piscivorous colonial waterbirds, especially terns, cormorants, and gulls, are having a significant impact on the survival of juvenile salmonids in the Columbia River. Caspian terns (*Hydroprogne caspia*) on Rice Island, an artificial dredged-material disposal island in the estuary, consumed about 5.4 to 14.2 million juvenile salmonids per year in 1997 and 1998, or 5 to 15 percent of all the smolts reaching the estuary (Roby et al. 2017). Efforts began in 1999 to relocate the tern colony 13 miles closer to the ocean at East Sand Island, where marine forage fish were available to diversify the terns' diet. Roby et al. (2017) estimated that terns on East Sand Island consumed an average of 5.1 million smolts per year, a 59 percent reduction from when the colony was on Rice Island.

More recently, Evans and Payton (2020) estimated Caspian tern predation rates for the LCR Chinook salmon ESU, specifically. Average annual tern predation rates for lower Columbia Chinook and steelhead ranged from 2.5 to 4.1 percent for Chinook and 10.4 to 15.2 for steelhead (Evans and Payton 2020). This improvement was offset to an unknown degree by approximately 1,000 terns trying to nest on Rice Island in 2017 (Evans et al. 2018) and smaller numbers roosting or trying to nest on Rice, Miller, and Pillar Islands in 2018 and 2019 (Harper and Collis 2018, USACE 2019f).

Before the management plan for double-crested cormorants (*Phalacrocorax auritus*) was first implemented, the vast majority of those in the Columbia River estuary nested on East Sand Island. The average annual predation rate by this colony on Chinook salmon in 2003 to 2014 was very high (27.5 percent) but less for steelhead (5.4 percent). Starting in 2016, however, cormorants did not establish a nesting colony throughout the entire peak of the smolt outmigration period (April to June). Instead, large numbers of birds dispersed from East Sand Island to other locations, especially the Astoria-Megler Bridge, where smolts are likely to constitute a larger proportion of the cormorants' diet.

Fish Predation

The native northern pikeminnow is a significant predator of juvenile salmonids in the Columbia River basin, followed by nonnative smallmouth bass and walleye (reviewed in Friesen and Ward 1999; ISAB 2011, 2015). Before the start of the Northern Pikeminnow Management Program (NPMP) in 1990, this species was estimated to eat approximately 8 percent of the 200 million juvenile salmonids that migrated downstream in the Columbia River basin each year. Williams et al. (2017) compared current estimates of northern pikeminnow predation rates on juvenile salmonids to before the start of the program and estimated a median reduction of 30 percent.

Juvenile salmonids are also consumed by nonnative fishes, including walleye, smallmouth bass, and channel catfish. Both the Oregon and Washington Departments of Fish and Wildlife have removed size and bag limits for these species in their sport fishing regulations in an effort to reduce predation pressure on juvenile salmonids. Removing these fish, both in the lower Columbia River may incrementally improve juvenile Chinook salmon survival.

The removal of the larger, piscivorous individuals from northern pikeminnow populations may result in a sustained survival improvement for migrating juvenile Chinook salmon, but only if it is not offset by a compensatory response from remaining northern pikeminnow or other piscivorous fishes (walleye, smallmouth bass, etc.). Signs of a compensatory response can include increased numbers of other predators, improved condition factors, or diet shifts (NMFS 2020a).

Pinniped Predation

Numbers of pinnipeds that are predators of adult salmonids have increased considerably in the Pacific Northwest since the MMPA was enacted in 1972 (Carretta et al. 2013). California sea lions, Steller sea lions, and harbor seals all consume salmonids from the mouth of the Columbia River and its tributaries up to the tailrace of Bonneville Dam. ODFW counted the number of individual California sea lions hauling out in the Columbia River mouth at the East Mooring Basin in Astoria, Oregon, from 1997 to 2017, which steadily increased during the life of that observation program (Wright 2018). Within the lower Columbia River, the abundance of pinnipeds peaks in the spring when the spring-run stocks of Chinook salmon adults are migrating through the estuary; though they have also been observed to predate on steelhead and other salmonids (Rub et al. 2018; NMFS 2020a).

4.10.6 Research and Monitoring Evaluations

In order to boost PIT tag detection rates in the Lower Columbia estuary for the very large and effective PIT tag monitoring program that has been built up within the USACE Columbia River System dam projects over the years, NMFS staff et al. have tested and developed new PIT tag antenna structures and technology. This includes the construction and evaluation of an autonomous PIT antenna barge, which is a platform supporting six vertical antennas, and PIT trawl array (Holcombe et al. 2019). Though neither the trawl array or the barge detect a large percentage of the 2 million juvenile fish that are PIT tagged and released into the Columbia

River basin, the detections and the data associated with each fish accumulates over time and provides a greater understanding of fish behavior and survival during the critical smolt transition period (Holcombe et al. 2019). Another promising development for PIT detection capabilities also includes new flexible pass-through antenna technology, which has been found to withstand high flows and debris (Ohms et al. 2023).

4.11 Southern Resident Killer Whales

Three major threats to SRKW include (1) quantity and quality of prey, (2) toxic chemicals that accumulate in top predators, and (3) impacts from sound and vessels. Other threats identified include oil spills, disease, inbreeding and the small population size, and other ecosystem-level effects (NMFS 2008c). It is likely that multiple threats act together to impact the whales, rather than any one threat being primarily responsible for the status of SRKWs. The 5-year review (NMFS 2021c) documents the latest progress made on understanding and addressing threats to SRKW. These threats affect the species' status throughout their geographic range, including the action area, as well as their critical habitat within the action area. As a result, most of the topics addressed in the Status of the Species and Critical Habitat Sections are also relevant to the environmental baseline and we refer to those descriptions or include only brief summaries in this section.

4.11.1 Prey Availability

Chinook salmon are the primary prey of SRKW throughout their geographic range, which includes the action area. A small portion of that prey base is UWR chinook salmon. The abundance, productivity, spatial structure, and diversity of UWR Chinook salmon are affected by a number of natural and human actions, and these actions also affect prey availability for SRKWs. As discussed in the Status of the Species, the abundance of UWR Chinook salmon now is significantly less than historic abundance due to a number of human activities. The most notable human activities that cause adverse effects on ESA-listed and non-ESA-listed salmon include land use activities that result in habitat loss and degradation, hatchery practices, harvest, and hydropower systems.

Here we provide an overview of previous ESA Section 7(a)(2) consultations covering effects to SRKWs from activities whose effects in the action area were sufficiently large in terms of reducing available prey that they were found likely to adversely affect or jeopardize the continued existence of the whales. We also consider ESA Section 7(a)(2) consultations on hatchery actions that are contributing prey to the whales. We then qualitatively assess the remaining prey available to SRKWs in the action area.

4.11.2 Harvest Actions

Salmon fisheries that intercept fish that would otherwise pass through the action area and become available prey for SRKWs occur all along the Pacific Coast, from Alaska to California. NMFS has characterized the short-term and long-term effects of Puget Sound, PFMC- area, Pacific Salmon Treaty (PST), and *U.S. v. Oregon* salmon fisheries on the SRKWs via prey reduction from fishery operations in past consultations (see NMFS 2024b for summary of Puget Sound fisheries, NMFS 2020b and NMFS 2021d for summary of PFMC fisheries, and Pacific Salmon Commission 2020 and NMFS 2024d for Pacific Salmon Treaty fisheries, and NMFS 2018a for *U.S. v. Oregon* fisheries). We considered the short-term direct effects to whales resulting from reductions in Chinook salmon abundance that occur during a specified year, and the long-term indirect effects to whales that could result if harvest affected viability of the salmon stock over time by decreasing the number of fish that escape to spawn. We first review individual fishery impacts and Biological Opinions, using evolving, best available methodologies, and then provide a comprehensive review of all fisheries to estimate baseline prey availability. The comprehensive fishery analysis uses updated methodology so that the assessments of multiple fisheries are comparable.

Salmon fisheries off Alaska, Canada, Washington, and Oregon are managed under the PST. The Treaty has annex agreements that provide detailed implementation provisions that are renegotiated periodically for multi-year periods ("PST Agreement"). The 2019-2028 PST Agreement currently in effect (Pacific Salmon Commission 2020) includes provisions limiting harvest impacts in all Chinook salmon fisheries and refining the management of coho, sockeye, chum, and pink salmon within its scope. This PST Agreement includes reductions in the allowable annual catch of Chinook salmon in the SEAK and Canadian West Coast of Vancouver Island and Northern British Columbia fisheries by up to 7.5 and 12.5 %, respectively, compared to the previous (2009-2018) PST Agreement. The level of reduction depends on the Chinook salmon abundance in a particular year. This comes on top of the reductions of 15 and 30 % for those same fisheries that occurred as a result of the 2009-2018 PST Agreement. These reductions should result in more salmon returning to the more southerly U.S. Pacific Coast portion of the EEZ than under prior PST Agreements. Therefore, under the new PST Agreement, the fisheries should have a smaller effect in terms of reducing SRKW prey than under the previous PST Agreement.

Some directed fishery actions affecting salmon abundance may be mitigated by hatchery production. For example, the *U.S. v. Oregon* action was determined not likely to adversely affect SRKWs because hatchery production included as part of that action offset the in-river harvest reductions (i.e., reductions occur after Chinook salmon are no longer available as prey). Columbia River salmon stocks are currently managed in line with their recovery plans, the status of several stocks and ESUs have improved under the fishing regime, and hatchery programs are managed in ways to minimize effects to listed species (NMFS 2018a). Similarly, the federal Columbia River System (CRS) action was determined not likely to adversely affect SRKWs because part of the action included production of hatchery Chinook salmon that more than offset Chinook salmon mortality (NMFS 2008c; 2020d).

4.11.3 Hatchery Actions

There are over 300 hatchery programs in Washington, Oregon, California, and Idaho that produce and release juvenile salmon that migrate through coastal and inland waters of the action area. Many of these fish contribute to both fisheries and the SRKW prey base in coastal and inland waters of the action area.

NMFS has completed Section 7(a)(2) consultations on more than two hundred hatchery programs (Doremus and Friedman 2021). Currently, hatchery production is a significant component of the salmon prey base within the range of SRKWs (Barnett-Johnson et al. 2007; NMFS 2008d). Prey availability has been identified as a threat to SRKW recovery, and we expect the existing hatchery programs to continue benefiting SRKWs by contributing to their prey base.

4.11.4 Habitat Actions

Habitat-altering activities such as agriculture, forestry, marine construction, levy maintenance, shoreline armoring, dredging, hydropower operations and new development continue to limit the ability of the habitat to produce and support salmon, and thus limit prey available to SRKWs in the action area. The environmental baseline is influenced by many actions that pre-date the salmonid listings and that have substantially degraded salmon habitat and lowered natural production of UWR Chinook salmon. Since the SRKWs were listed, federal agencies have consulted on impacts to the whales from actions affecting salmon by way of habitat modification. Some habitat improvements in the Willamette Basin have been implemented over time such the Willamette Confluence Project, the South Fork McKenzie stage zero habitat restoration project, and the Oaks Bottom floodplain reconnection project. Efforts such as these provide necessary uplift to improve critical habitat for UWR Chinook salmon and are supportive of recovery efforts for the species.

4.11.5 Prey Quality

Contaminants enter marine waters and sediments from numerous sources, but are typically concentrated near populated areas of high human activity and industrialization. Freshwater contamination is also a concern because it may contaminate salmon that are later consumed by the whales in marine habitats. Intermediate levels of PCBs were measured in California and Oregon populations, but Chinook salmon originating from California have been measured to have higher concentrations of DDTs (O'Neill et al. 2006; Mongillo et al. 2016). Therefore, SRKW prey is highly contaminated, causing contamination in the whales themselves. Build-up of pollutants can lead to adverse health effects in mammals. Nutritional stress, potentially due to periods of low prey availability or in combination with other factors, could cause SRKW to metabolize blubber, which can redistribute pollutants to other tissues and may cause toxicity. Pollutants are also released during gestation and lactation which can impact calves (Noren et al. 2024).

Size and age structure of Chinook salmon has substantially changed across the Northeast Pacific Ocean (Ohlberger et al. 2018). Since the late 1970s, adult Chinook salmon (ocean ages 4 and 5) along most of the eastern North Pacific Ocean are becoming smaller, whereas the size of age 2 fish are generally increasing (Ohlberger et al. 2018). Additionally, most of the Chinook salmon populations from Oregon to Alaska have shown declines in the proportions of age 4- and 5-year olds and an increase in the proportion of 2-year olds; the mean age of Chinook salmon in the majority of the populations has declined over time. Populations along the coast from western Alaska to northern Oregon had strong declining size trends of ocean-4 fish, including wild and hatchery fish. For Puget Sound Chinook salmon (primarily hatchery origin), there were little or weak trends in size-at-age of 4-year olds and the declining trend in the proportion of older ages in Washington stocks was also observed but slightly weaker than that in Alaska populations (Ohlberger et al. 2018). The authors suggest the reasons for this shift may be largely due to direct effects from size-selective removal by marine mammals and fisheries, followed by evolutionary changes toward these smaller sizes and early maturation (Ohlberger et al. 2019). Smaller fish have a lower total energy value than larger ones (O'Neill et al. 2014). Therefore, SRKWs need to consume more salmon in order to meet their caloric needs as a result of a decrease in average size of older Chinook salmon.

4.11.6 Vessel Activities and Sound

Commercial shipping, cruise ships, and military, recreational, and fishing vessels occur in the inland and coastal range of SRKWs. Additional whale watching, ferry operations, and recreational and fishing vessel traffic occur in their inland range. The overall density of traffic is lower in coastal waters compared to inland waters of the Salish Sea. Several studies in inland waters of Washington State and British Columbia have linked vessel interactions with short-term behavioral changes in NRKW and SRKW (see review in Ferrara et al. (2017)), whereas there have been no studies that have examined interactions of vessels and SRKWs with behavioral changes in coastal waters. These studies that occurred in inland waters concluded that vessel traffic may affect foraging efficiency, communication, and/or energy expenditure through the physical presence of the vessels, underwater sound created by the vessels, or both. Collisions of killer whales with vessels are rare, but remain a potential source of serious injury and mortality, although the true effect of vessel collisions on mortality is unknown.

It is currently unclear if SRKWs experience noise loud enough to have more than a short-term behavioral response. Reduced time spent feeding and the resulting potential reduction in prey consumption is likely the most important pathway of effects due to vessels (Ferrara et al. 2017; Holt et al. 2021b; Holt et al. 2021a). Although the impacts of short-term behavioral changes, including ephemeral feeding disruptions, on population dynamics are unknown, it is likely that because SRKWs are exposed to vessels during the majority of daylight hours they are in inland waters, and that the whales in general spend less time foraging in the presence of vessels, there may be biologically relevant effects at the individual or population-level (Ferrara et al. 2017). The extent of vessel impacts in coastal waters of SRKW critical habitat has not been studied and the density of vessels, particularly those targeting and following the whales for whale watching, is much less than inland waters.

4.11.7 Entrapment and Entanglement in Fishing Gear

Drowning from accidental entanglements in nets and longlines is a minor source of fishing related mortality in killer whales, although not all incidents may be reported. Two killer whales have been recorded entangled in Dungeness crab commercial trap fishery gear off California (a transient in 2015 and unknown ecotype in 2016) (NMFS 2016c). In 2018, DFO disentangled a transient killer whale entangled in commercial prawn gear near Salt Spring Island, British Columbia (NMFS strandings data, unpubl.). All incidental mortality and injury of marine mammals in fishing gear must be reported in accordance with the MMPA (16 U.S.C. 1387(e)). MMPA Section 118 established the Marine Mammal Authorization Program (MMAP) in 1994. Under MMAP all fishers are required to report any incidental taking (injuries or mortalities) of marine mammals during fishing operations. Any animal that ingests fishing gear or is released with fishing gear entangled, trailing, or perforating any part of the body is considered injured, and must be reported. No entanglements, injuries or mortalities of SRKW have been reported in recent years.

4.11.8 Scientific Research

Most of the scientific research conducted on SRKW occurs in inland and coastal waters of Washington State, and is outside of the action area for this consultation. In recognition of the potential for disturbance and takes, NMFS took steps to limit repeated harassment and avoid unnecessary duplication of effort through conditions included in the permits requiring coordination among permit holders, such as restricting the number of research vessels within 200 yards of a SRKW at any given time. The cumulative effects of research activities were considered in a batched Biological Opinion for four research permits in 2012 (NMFS 2012). The cumulative effects were also considered in the Biological Opinion on the renewal of the research permits (NMFS 2018b). The Biological Opinion concluded the cumulative impacts of the scientific research projects were likely to adversely affect but were not likely to jeopardize the continued existence of SRKWs.

4.11.9 Climate Change

As described in the Status of the Species, changing ocean conditions driven by climate change may influence ocean survival and distribution of Chinook salmon and other Pacific salmon further affecting the prey available to SRKWs. The effects of climate change described in the Status Section would be expected to occur in the action area. Extensive climate change caused by the continuing buildup of human-produced atmospheric carbon dioxide and other greenhouse gases is predicted to have major environmental impacts in the action area during the 21st century and beyond. Warming trends in water and air temperatures are ongoing and are projected to disrupt the region's annual cycles of rain and snow, alter prevailing patterns of winds and ocean currents, and result in higher sea levels (Snover et al. 2005). These changes, together with increased acidification of ocean waters, would likely have profound effects on marine productivity and food webs, including populations of salmon.

5 Effects of the Action

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

5.1 Basinwide Effects

NMFS' analysis of the effects of the Willamette Valley System (WVS) Proposed Action (PA) for each occupied tributary and the mainstem Willamette River, the lower Columbia River, and the Columbia River estuary and plume, is presented in Sections 5.2 through 5.9. This section, 5.1, describes the effects of specific parts of the Proposed Action that are generally applicable basinwide.

The upper Willamette River is divided from the lower river at Willamette Falls. Actions in the following sections primarily have effects on the tributaries and mainstem reaches above the falls, with a few exceptions below such as areas with USACE revetments and hatchery actions that modify returns to the lower Willamette River. Note that the two listed Upper Willamette River (UWR) species that mostly spawn and rear above the Willamette Falls are the UWR Chinook salmon and UWR steelhead. The one exception is the UWR Chinook Clackamas population, which is below Willamette Falls. Maps showing the respective populations and critical habitat are in Figure 3.1-1 and 3.2-1. The ESA listing of the UWR steelhead Distinct Population Segment (70 FR 37160) did not include mainstem reaches or tributaries upstream of the Calapooia River.

This section will cover the following actions that may have direct or indirect basinwide effects:

- Adaptive management plan and updates to Willamette Action Team for Ecosystem Restoration (WATER)
- Revetments maintenance and gravel augmentation
- Hatchery Program actions and proposed changes
- Bureau of Reclamation water contract program
- BPA Power Marketing Program and Habitat Program
- Maintenance of WVS dams and related facilities, and discharge of oil, grease, and contaminants
- Research, Monitoring and Evaluation (RM&E)
- Anticipated in- or near-water or other construction under the Proposed Action

5.1.1 Adaptive Management Plan and WATER Processes

USACE proposes to create an adaptive management plan (AM Plan) that updates the existing framework for decision-making, planning, and interagency coordination of the WVS described in the 2008 RPA. In addition, USACE proposes an Implementation Plan that is part of the AM Plan but extends beyond the annual AM Plan cycle:

> The Implementation Plan …identifies the prioritization of measures for implementation, a timeline for their implementation, and implementation performance criteria that must be met. It describes the sequencing of the measures in the proposed action and links immediate operations to improve fish passage and water quality (e.g., interim operations measure) to the longer-term structural measures, such as the downstream fish passage construction projects. The plan identifies check-ins or points along the implementation timeline where course correction (i.e., "on-ramps/off-ramps") may be necessary based on research, monitoring, and evaluation (RM&E).

The Implementation Plan and the Implementation Schedule (Figure 5.1-1) represents the USACE effort to include dates that reflect their "basin-wide priorities including costs, risk and uncertainty, and RM&E of data gaps" (USACE 2024a, PA). NMFS addresses some of the effects of the lengthy time horizons prior to substantive improvements in downstream passage in proceeding subbasin sections. These are summarized here:

- Adverse effects of existing passage routes will continue in the South Fork McKenzie, and South and Middle Santiam Rivers, to expose juvenile UWR Chinook salmon to passage delay, risk from predation and copepods. Additionally, there will be periods without viable passage during reservoir drawdowns or refills.
- Below the WVS dams, higher TDG levels, and warmer water will continue to affect holding and spawning Chinook salmon adults, incubating eggs, and rearing juveniles. In the South Santiam River, the ongoing operational passage will increase turbidity to levels that can harm downstream spawning areas, by reducing dissolved oxygen levels during initial drawdowns.
- Adverse effects on juvenile steelhead from South Santiam passage will continue for at minimum six years which leads to extended reservoir holding, and results in prolonged exposure to risk of predation and copepod infestation. UWR Steelhead will continue migrating through unsafe routes which decreases juvenile survival, thereby reducing abundance, productivity, and life-history diversity.
- After limited survival through Detroit Dam with the proposed operational interim juvenile passage, UWR Chinook salmon will continue to experience current high passage mortality, and similar high mortality passing through the Big Cliff to Detroit reach, and past the Big Cliff dam for at least 12 years.
- With proposed operational interim juvenile passage in the Middle Fork Willamette, UWR Chinook salmon from above Lookout Point reservoir will continue to experience current passage mortality through Lookout Point Dam, passing through Dexter Reservoir and past Dexter Dam for at least 20 years until structural passage at Lookout Point Dam is provided.

Where improvements in facilities to move adults upstream are proposed or under construction, there will be shorter delays, which will help reduce prespawn mortality. In some cases, the actions do not have sufficient certainty or RM&E proposed to ensure current harm levels will be reduced (Foster, Green Peter).

As noted in the UWR Recovery Plan (ODFW and NMFS 2011), all four VSP parameters: abundance, productivity, spatial structure, and diversity are expected to improve when safe downstream passage is provided. In the Biological Viability Assessment, Ford ed. (2022) note that substantial changes in accessibility to high-quality habitat are necessary for the UWR steelhead to move below "moderate-to-high" risk, while the current trend is declining viability; the same trend is noted for the UWR Chinook salmon. Downstream passage is the missing part of accessibility, as adult handling in updated facilities is not expected to cause high mortality. In the Clackamas River, PGE has provided safe downstream passage for juvenile UWR Chinook salmon and LCR steelhead since 2015, and the Clackamas River sub-basin sustains UWR Chinook salmon abundance and productivity above UWR Recovery Plan goals. Natural-origin adult UWR Chinook are 95 percent of the adults returning to North Fork Dam since 2017, and returns are between 129 and 173% of the ten-year average in the last 3 years. In contrast, returns to Willamette Falls, representing the other six of seven populations in the UWR Chinook salmon ESU, have been below the 10-year average in three of the last four years. When downstream passage with sufficiently high survival is provided where proposed, it will improve abundance, productivity, spatial structure, and diversity.

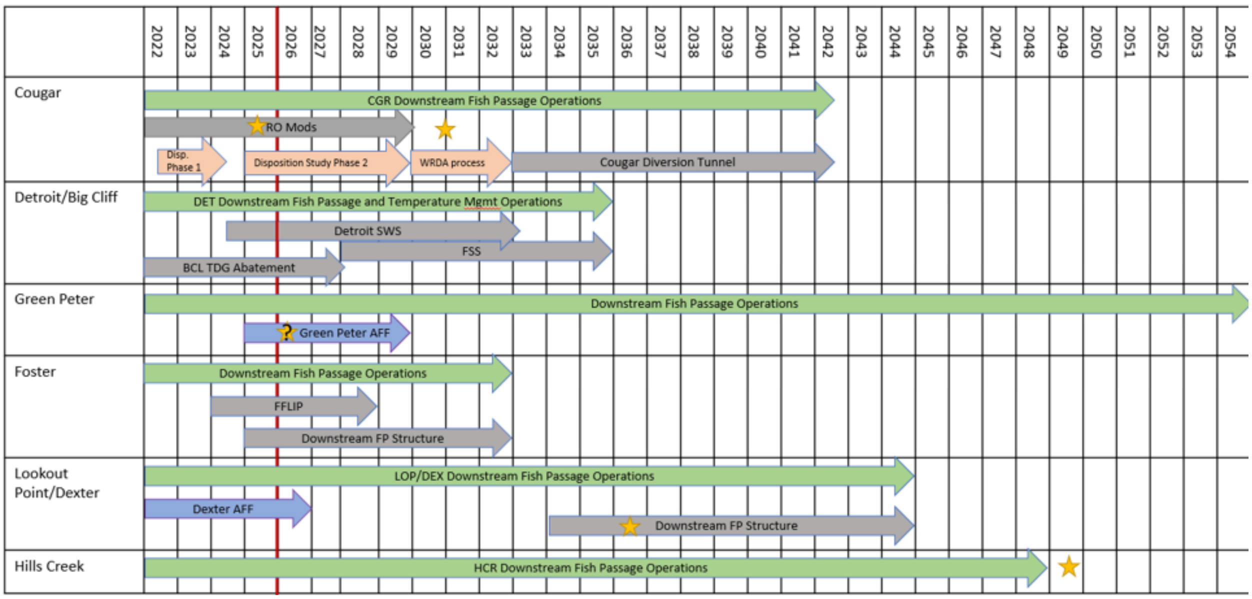


Figure 5.1-1 Most recent Implementation Timeline for the Proposed Actions. This covers some actions proposed for major changes in operations, and the actions that require design and construction of structural elements.

In addition to concerns with the timeline of actions, the AM Plan describes cyclical steps to Plan, Implement, Monitor, Evaluate, Continue/Adjust/Complete, and multiple targets for operational structural passage evaluation in USACE (August 2024 version of Appendix A, Figure 3-1). USACE proposed the below elements to inform this cycle for decisions to improve passage, temperature, and other habitat conditions.

Adaptive Management elements, also considered types of decision criteria:

a. **Performance metric** – A specific metric or quantitative indicator that is monitored and can be used to estimate and report consequences of management alternatives with respect to a particular objective.
b. **Target** – A specific value or range of performance metric that defines success. Targets can be quantitative values or overall trends (directional or trajectory).
c. **Decision Trigger** - A pre-defined commitment (population or habitat metric for a specific objective) that triggers a change in a management action.

While NMFS recognizes the value in adaptively managing the system over time, USACE proposes performance metrics that, if met, would still result in continued adverse effects and sustained low abundances. For example, USACE proposes an AM plan performance metric for evaluating the success of the proposed structural passage at Detroit Dam when the Floating Screen Structure is operational. The proposed dam passage survival (DPS) target uses cohort replacement rates (CRR) that indicate recruits replacing spawners above dams.[4] For current low abundances, this target for DPS would allow values that maintain low abundances. The modeled replacement rate target for structural passage survival will result in values that are much lower than the NMFS (2022h) Passage Criteria, and would undermine above-dam reintroduction efforts. At CRR = 1, the population is sustaining its abundance level and not growing. This is a problem for populations already at low levels of abundance, given the seven or more years specified in the AM Plan needed to estimate CRR and generate a geometric mean for three cohorts.

In contrast to a geometric mean CRR =1, the BA showed model results of the long-term passage proposed Floating Screen Structure. These provided both estimated NOR returns in the North Santiam for the baseline, which would be similar to a design where CRR =1, and for a Floating Screen Structure design that meets NMFS criteria for dam passage, with rapid population increases following structural passage (USACE 2023a, Figures 5.10-5a and b). If the AM performance metric were instead designed for a lower DPS driven by CRR =1, the higher population shown in Figure 5.10-5 would not result. The estimates from the modeling of the proposed Floating Screen Structure were not constrained by CRR = 1, and this demonstrates that it would be too low for the passage improvements needed.

In circumstances when CRR is at or near 1 for a low adult population abundance level, this can hold the population to the current limited spatial structure when few spawners return to tributaries for spawning. In Willamette sub-basins, adult return abundance fluctuations have had lower highs and lows, and a trend toward lower abundance. Rather than using CRR = 1 to limit the DPS values, instead it should be considered a long-term equilibrium goal of a self-sustaining population once increases from current low abundance are exceeded by long-term improved structural passage. . Furthermore, having a short-term view of CRR could miss other factors in some calculations of CRR, when it could be driven by estuary and ocean conditions which could mask (if they are bad, or favorable) effects of the proposed structural passage. This is because CRR includes all downstream and upstream effects, including several years UWR Chinook salmon and steelhead are in the ocean. Given the lack of sufficient tagging and detection in the UWR's populations it would be difficult to disentangle estuary and ocean effects of the effects of passage.

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[4] Dam passage survival (DPS) is a product of dam passage efficiency and 'at dam' passage survival. The targets were also described as the higher value of the following two estimates (although unclear how the first differs from the CRR for three cohorts if the CRR is used to 'support replacement.'
1.DPS rate needed to support replacement of spawners above dams
2. Estimate of annual DPS across water year types [prepared using the Fish Benefit Workbook (FBW) or other approaches] or Geometric mean of Above-dam Cohort Replacement Rate (CRR) for three cohorts ≥ 1.0

USACE also proposed targets to evaluate actions that would lead to modifications for interim measures or ongoing proposed operations. The proposed AM Plan Decision Triggers would include the following:

- Monitoring results that indicate the expected directional change is not being achieved
- New data that shows potential for improvement in one or more near-term metrics
- Negative consequences that occur, including those for environmental objectives or other mission areas

These are not reasonably certain to provide timely and sufficient responses as "directional change" or "potential for improvement" may only result in minor changes, for instance in temperature or TDG levels. The AM Plan has proposed physical values in lieu of biological targets for many interim operational actions. Therefore, under the proposed action, the AM plan is unclear whether there will be monitoring of UWR Chinook salmon and steelhead responses (e.g. mortality, injuries, lower abundance). This decreases certainty that actions will actually result in biological benefits to UWR Chinook salmon and steelhead.

Another example below shows the elements for the operational passage and uncertainties USACE listed in Table 5.1-1. This shows how passage operations would be studied at one dam and the results applied to others with similar uncertainties, although major differences between the subbasins would limit applicability. Without repeating the study in a basin with different temperature or bathymetry characteristics, to decide if changes in the operations are needed, it is unlikely there will be sufficient survival improvements and abundance would fall in the other basins.

The USACE's proposed action described a role for the WATER technical teams in the AM Plan, including efforts for improving downstream passage survival (DPS), as:

> *"to review the field study results and help develop hypotheses on how to further improve DPS, and alternative operational scenarios based on those hypotheses. Models of the existing near-term operation will then be run and compared with alternative operational scenarios. The Fish Benefit Workbook (FBW) is one such model that produces estimates of DPS and DPE, but other tools could be used in place of the FBW, or in addition, to support a robust assessment. Currently the FBW is being refined to address comments." (USACE 2024a, App A, Section 5.2.1, Multi-Dam Experimental Framework)*

Table 5.1-1 Example of near-term operational passage and key uncertainties (USACE 2023a Appendix A, Table 5-1).

General Operation Type	Location						Key Uncertainties
	DET	GPR	LOP	CGR	FCR	HCR	
Spring surface spill	X	**X**	X				Juvenile DPS (GPR)
Spring delayed refill at near RO				**X**	X		Fry and juvenile DPE
Prioritized use of the RO during fall drawdown	X	**X**	X			X	Juvenile DPE and DPS with/without turbines operating during draft

Notes: **X** indicates potential location for representative study to occur. Final list of key uncertainties to address, and study locations, to be determined with input from WATER.

Fish Benefit Workbook refinements have been recommended for some time, with concerns that the inputs are not representative of actual passage effects (Myers 2022). If the model chosen was FBW, NMFS would expect passage decisions to limit possible benefits in population abundance and productivity thereby continuing ongoing dam passage mortality and injury at levels more similar to those seen under the environmental baseline. For efforts to revise or replace FBW, it is unclear if the changes are sufficient to inform decisions to alter adverse effects related to dam passage that are currently occurring. If alternative models were used, it is unclear if the AM Plan would result in improvements sufficient to increase passage survival.

For Annual AM Cycle activities (Figure 5.1-2), steps one through four involve WATER technical teams exchanging information and reviewing draft documents. The final step, " IP Plan Update Final," does not state that there will be input from NMFS to coordinate priorities for UWR Chinook salmon and steelhead or species downstream of Willamette Falls. However, the draft Annual IP will be provided to WATER for review. Further, the Proposed Action for WATER removed the current central Research Monitoring and Evaluation (RM&E) team (Figure 5.1-3). The proposed action's lack of comprehensive studies on UWR Chinook and steelhead survival would lead to implementation decisions that provide inadequate progress toward reducing the adverse effects of the operation and maintenance of the WVS.

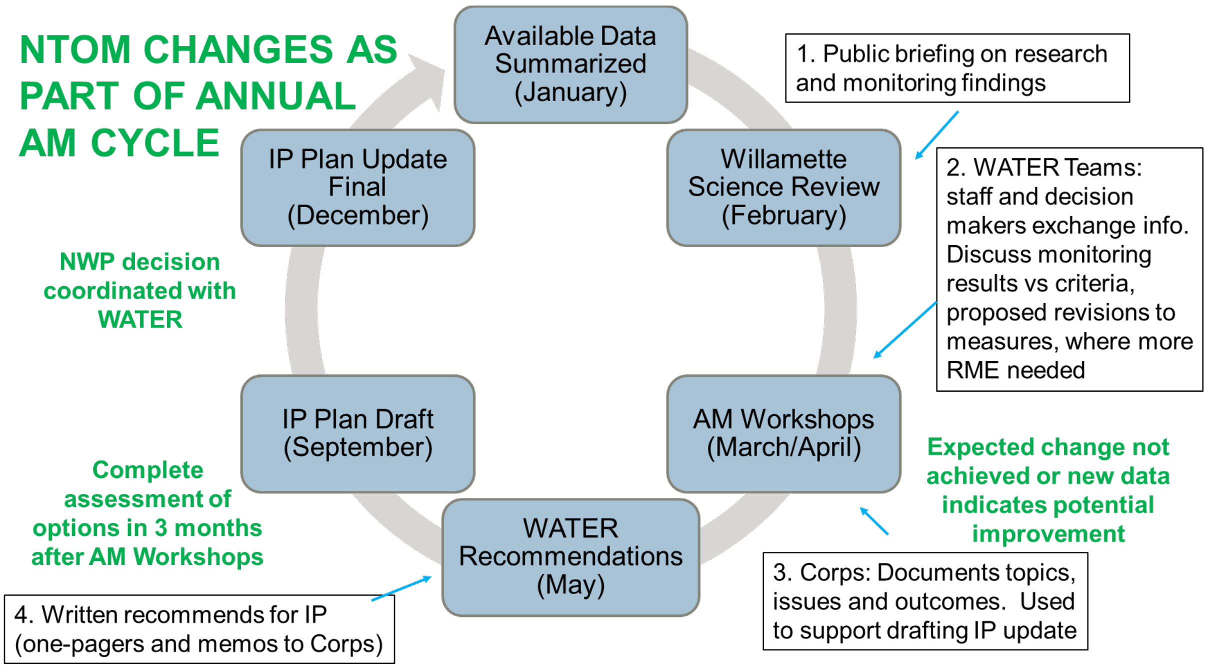

Figure 5.1-2 Annual cycle of Adaptive Management processes (USACE 2024a, Appendix A)

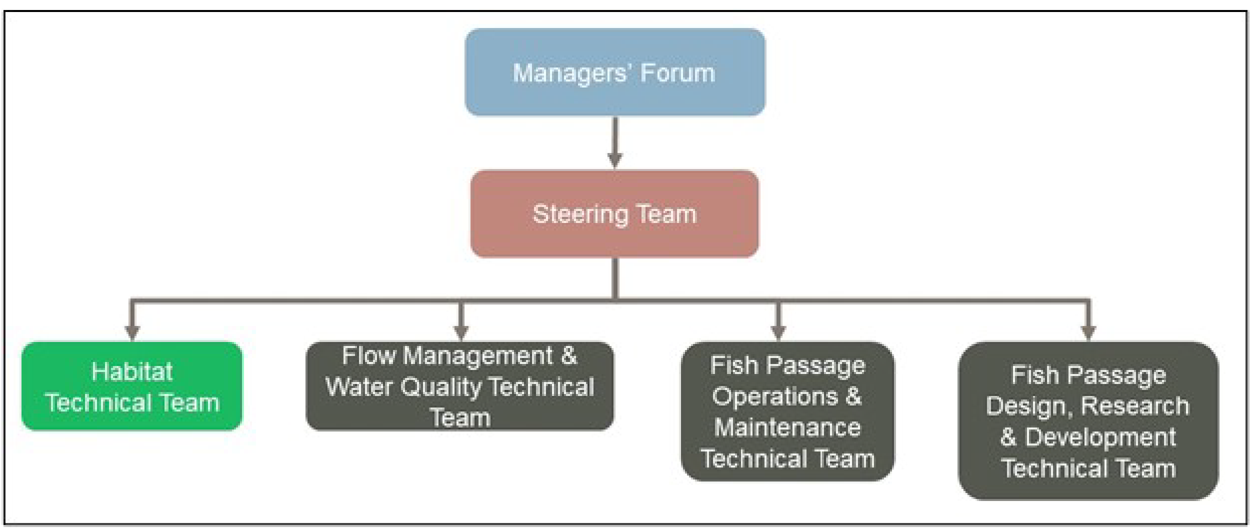

Figure 5.1-3 Proposed modified WATER structure in the AM Plan (USACE 2024a Appendix A).

The AM Plan process will be similar to current WATER team roles. Under the current process, USACE decisions do not always reflect concerns raised by WATER team members. Also, in the annual cycle (Figure 5.1-2), while the NWP Decision will be coordinated with WATER, updating the Implementation Plan will be USACE's responsibility; how NMFS will review the updated Implementation Plan and timeline is unclear. One possible outcome of this process would be priorities that are not aligned with UWR species recovery needs and the reduction of threats and limiting factors.

5.1.2 Revetments and Gravel Augmentation

Two types of USACE-constructed revetments or bank protection structures are in the action area, those that they maintain (83 total) and those that non-federal sponsors own and maintain (105). Generally, those not owned by USACE were built after 1950. For these revetments, modifying them requires permits under the Clean Water Act and the Rivers and Harbors Act. USACE administers these permits but considers them outside the scope of this action. Under the 2008 RPA measure 7.4, Restoration of Habitat at Revetments, the Action Agencies were asked to complete a comprehensive assessment of revetments placed or funded by the USACE Willamette River Bank Protection Program. The result was the Hulse et al (2013) report: “Assessment of potential for improving ESA-listed fish habitat associated with operations and maintenance of the U.S. Army Corps of Engineers Willamette Project: an approach to prioritizing revetments for removal or modification to restore natural river function,” which USACE can use to guide the proposed action for revement maintenance.

The proposed action is for USACE to maintain individual revetments when necessary and funded for bank protection. USACE proposes to maintain or repair revetments using more natural materials and nature-based engineering principles within the purpose of the project. While USACE has an active program called Engineering with Nature and demonstrates opportunities to engineer with nature across the Department of Defense properties (Bridges et al. 2021), it is unclear if the maintenance projects proposed will be consistent with this program. The extensive revetments that were built as part of the WVS cover approximately 42 miles of the mainstem Willamette River and tributary banks and were intended to respond to floods that could cause bank erosion. These congressionally authorized revetments are part of the environmental baseline. The effects of the repairs to the revetments are from short term construction impacts, are described in Section 5.1.9 General Effects of In- and Near-Water Construction. The effects of alterations to revetments that allow for increased access to off channel habitats would be improved rearing conditions with velocity, depth, and prey base suitable for smaller juvenile UWR Chinook salmon and steelhead.

USACE also proposes to augment reduced sediment in below-dam reaches by developing and implementing sediment-nourishment programs. This is proposed for reaches in the North and South Santiam rivers below Big Cliff and Foster dams and in the McKenzie River, below Cougar and Blue River dams. USACE would seek authorization for ecosystem restoration and then begin studies and designs to implement individual projects. These dams capture an estimated 94 percent and 91 percent of the total bed material flux in the North and South Santiam rivers, respectively (O’Connor et al. 2014); limit tributary habitat elements that would be used by UWR Chinook salmon and steelhead spawners for redds; and reduce prey base for juveniles from aquatic insects that use the gravel interstitial space (Suttle et al. 2004). The total peak bed-material flux reduction was estimated as 64 percent annually on the Willamette River just downstream of the Santiam River confluence, from 199,000 tonnes/yr without dams to 72,000 tonnes/yr with dams (O’Connor et al 2014).

For this proposed action, USACE would determine “an annual nourishment quantity at appropriate injection sites to achieve habitat improvements for spawning adult and rearing juvenile UWR Chinook and winter steelhead.” USACE would also determine if modifications to reservoir outflows would be necessary for sediment-nourishment program success. The flows component would be reviewed under the AM Plan to "ensure that expected habitat gains are realized and negative effects are minimized and provide the necessary flexibility to adjust the program to real-world site conditions observed" (USACE 2024a, Appendix A, Section 5.7). The lack of suitable substrate was considered a key limiting factor for UWR Chinook salmon parr and smolts in the UWR Recovery Plan (ODFW & NMFS 2011). Suggested recovery actions were:

> *Restore substrate recruitment to the mainstem Willamette River from tributary areas using a combination of peak flows and substrate supplementation. Subaction 1. Provide substrate supplementation downstream of dams and for the revetments blocking recruitment (Table 9-1. Summary of actions etc; p.9-57).*

The UWR Chinook salmon and steelhead populations inhabiting the rivers named above could benefit from this program through the restoration of habitat elements that would increase the availability and quality of spawning sites and improve rearing conditions, which may allow for increased growth. There would be limited downstream benefits in the mainstem Willamette River, as ongoing sediment transport processes may deliver a limited amount of the augmented gravel to the mainstem, if flows are sufficiently high to transport the augmented gravel. It is not reasonably certain that this program would be implemented because the Corps only proposed to seek authorization and conduct studies and designs; there was no commitment to implement the designs once completed, nor is there a proposed timeframe to implement, and so the benefits are not reasonably certain to occur.

5.1.3 Hatchery Program Effects

The USACE proposed to implement an Adapt Hatchery Program using "USACE discretion to determine how to implement the fish mitigation program, either through hatchery programs, passage improvements, or a combination of the two. Current levels of mitigation production are defined in HGMPs prepared by ODFW and USACE." The HGMP levels of mitigation production have not always been met in recent years (see example from McKenzie sub-basin below, and baseline sections). The overall goal of this proposed action is to adjust production of WVS hatcheries for mitigation obligations and conservation needs. The proposed steps to adjust production are:

- Before fish passage improvements at WVS dams in each sub-basin, hatchery juvenile spring Chinook salmon releases and outplanting of adult spring Chinook salmon hatchery fish above dams will occur according to the HGMPs and NMFS (2019a) Hatchery Biological Opinion.
- After passage improvements, hatchery spring Chinook salmon production will remain at production levels [and will] meet, but not exceed, abundance thresholds … in the HGMPs, and until decision criteria are achieved for the following metrics:
    - annual dam passage survival measured in two separate years within the first 5 years, and
    - cohort replacement rate (CRR) for three separate cohorts.

Two possible results for the CRR are:

- If the CRR for Chinook salmon is >=1 based on a geometric mean (of three cohorts, after 7 years), then the full credit for fish passage improvements will be applied, and changes applied over “five years to a Reduced Level of Production (WVS DPEIS Appendix A)
- If CRR < 1 after passage improvements for 3 cohorts and 7 years, then hatchery mitigation credit reductions will not occur, and instead be re-assessed again after year 14.

If CRR remains < 1 after year 14, further assessment of the major factors affecting populations will inform decisions.

This measure will intersect with the AM Plan (above) in defining adequate dam passage survival based on the replacement rate. This creates a metric for UWR Chinook to achieve the target of CRR =1, that if successful, will reduce future outplanting. If the dam passage survival modeled in this way is not able to achieve CRR >= 1, review of the pedigree analysis data for CRR would continue. These leave lengthy timeframes between reviews as the three cohorts require 7 years to have all 3, 4, and 5-year old adult UWR Chinook return for complete analysis. However, in the period between reviews, the hatchery program would continue to provide outplanting when possible. Recent years show this is not always possible, as hatchery productivity declined because of various issues (dam operations, water sources, fire, temperatures, disease). Other metrics to determine when abundance would lead to hatchery changes—for instance, prespawn mortality or pHOS—may be added (NMFS 2019a, HGMP 2019).

If changes in passage or related operations are not successful, passage mortalities that lead to low abundance will continue and the Adapt Hatchery steps would not take place. To complete testing of passage survival, increased hatchery production may be needed to allow for the testing of improved passage; this program does not address that need. With lower abundances in hatchery returns seen in some subbasins, study methods to provide sufficient passage testing are limited.

While the Adapt Hatchery program as proposed foresees the future when passage improvement is leading to improved CRR values, it does not provide reasonable certainty that passage would be monitored and evaluated to allow improvements that could increase survival. CRR values integrate many other life history stages, so may not alone show effects of passage. Past periods where CRR values in geometric means for three cohorts were >=1 were followed by much lower CRR values in the cohorts to follow. The earlier higher values may have had limited influence from the passage changes. This risk of conflating the non-passage inputs to CRR with passage would indicate that the values of three cohorts and CRR >=1 are not sufficient to capture passage changes, which USACE indicates would allow reduced mitigation releases. The overall subbasin populations may drop rapidly after a rising period because of population dynamics. The effect of focusing on a CRR level that holds abundance at a low level is likely to keep productivity from improving. If the CRR is responding to factors other than passage changes, then a false signal would lead to reduced hatchery production and would limit further reintroduction to improve productivity. Under the proposed action, there is no coordinated interagency input into the decisions to reduce production levels if the metric is met.

In the proposed action, hatchery juvenile spring Chinook releases and outplanting of adult spring Chinook hatchery fish above dams would be expected to occur according to the HGMP targets (USACE 2024a). However, due to problems with existing facilities, this will not be likely in all years. In addition to shortfalls of adult UWR Chinook hatchery salmon from fires and low returns, the facilities needed to maintain the broodstock with numbers to outplant above dams require ongoing maintenance and modified operations. In one case, the hatchery operations that would fulfill this proposed action have had and continue to need modifications in the McKenzie sub-basin following collection and water supply infrastructure loss. Changes were described as:

> *[Previously] McKenzie Hatchery would produce USACE's entire mitigation requirement for spring Chinook in the McKenzie sub-basin. In 2018, the water supply at McKenzie Hatchery was compromised due to structural integrity issues in Leaburg Canal that supplies the hatchery. . .The primary source of collection is a fish trap at Leaburg Hatchery. Fish are also being collected from a fish sorter located at the top of the [Leaburg] left bank ladder, though in lower numbers . . .Incubation of 2023-2024 juveniles occurred entirely at McKenzie Hatchery. (USACE 2024a, PA, Section 2.1.5 Willamette Hatchery Mitigation Program and Infrastructure).*

The PA describes how early stages of rearing would take place at McKenzie Hatchery, but after a point in summer, conditions degrade, and fish will be moved to Leaburg and reared until release. This hybrid operation would continue until USACE implemented a permanent solution. However due to water supply issues at McKenzie and Leaburg Hatcheries, in 2022-2024, McKenzie Spring Chinook were held at Minto Adult Fish Facilities (AFF) (on the North Santiam, owned and funded by USACE). This work-around led to high mortalities in 2024 due to faulty post-sort pond recirculation pumps that had not been repaired in prior years, which caused mortality rates in the pools holding McKenzie Stock UWR Chinook, in a 44.8% mortality rate for females, and 20.6% for males. This will limit future outplants at South Fork McKenzie, and will continue to be an issue if infrastructure maintenance is not timely. When hatchery UWR Chinook adult returns are not available, outplanting to meet HGMP targets will not occur, and the overall abundance that would increase from spawning above Cougar Dam will instead drop further. The targets for CRR to reduce outplanting are nowhere near the proposed replacement level of one, and the outplanting is not sufficient to improve abundance. This affects spatial structure and productivity in this sub-basin which was considered likely to reach a very low level of extinction risk in the UWR Recovery Plan (ODFW and NMFS 2011). Similar shortfalls from the abundance levels in the HGMPs are seen in North Santiam, South Santiam and Middle Fork Willamette hatchery programs.

5.1.4 Bureau of Reclamation Water Contract Program

Reclamation administers a water marketing program that sells water stored in USACE reservoirs to agricultural users. Reclamation will administer existing irrigation contracts and write new contracts for irrigation use of stored water up to 95,000 acre-feet provided. The Action Agencies will continue the 2008 RPA actions applied to the current contracts, and for additions or changes in these, up to a limit of 95,000 acre-feet. In 2023, Reclamation began working with the State of Oregon and USACE to better understand agencies' roles in implementing the NMFS (2019b)

Jeopardy Biological Opinion RPA elements, which allows for future consultation on the effects of increased allocations, once minimum instream flows have fully protected water rights.

Irrigated agriculture in the Willamette Basin is used primarily from July to October for late-maturing crops. In the 2024 PA, the total was described: "As of June 2024, Reclamation has issued water service contracts for 84,349 acre-feet of water from the WVS. The exact value varies from year to year as contracts are executed or expire." The water rights associated with the contracts differ from live flow water rights that Oregon Water Resources Department (OWRD) administers, as noted in the BA:

> *"The water service contract allows the irrigator to obtain a secondary water use permit from OWRD that authorizes the release of stored water for that purpose. Customers may divert water after the OWRD approves the secondary use application and issues the permit, and after meeting conditions of both the Reclamation contract and the OWRD permit. Contracts only provide a right to divert a certain amount of stored water and convey no rights in storage space of the reservoir nor any specific interest in Reclamation's storage water rights." (Section 4.6.1.12, USACE 2023a)*

The majority of contracted volumes are for water from the mainstem Willamette River, with the Long Tom River and North Santiam River having second and third largest contracted volumes. Continued water withdrawals for irrigation will reduce flows and may reduce flow-related habitat. In particular, with proposed low flows for both South and North Santiam rivers, and existing low flow conditions common during late summer in the North Santiam River reach downstream from Stayton, Oregon, the Reclamation contracted irrigation diversions could continue to exacerbate poor habitat and water quality conditions in the lower North Santiam and mainstem Santiam rivers. In the mainstem Willamette River, under proposed low minimum flows for dry years in spring, contracted diversions that overlap with the low minimum flows will further reduce habitat availability for rearing juveniles, and could add warm water from return flows into areas with high temperatures.

Reclamation's ongoing contract administration actions would not decrease the volume of water USACE releases from storage in streams below WVS projects. The Reclamation water marketing program is one step in a series that may lead to diversions under certain conditions; these reflect an effort to maintain UWR Chinook salmon and steelhead habitat conditions in the river reaches below USACE projects, and in the mainstem Willamette River. Contract releases are subject to the annual operating plan, laws governing the project, and other applicable State and Federal laws. Following the 2008 RPA measure 9.3 as proposed would disallow executing contracts fully in years that WVS storage releases are below the 2008 RPA minimum objectives.

Appendix B of the 2023 BA provides a sample of the current contract proposed by Reclamation for ongoing use. The 2023 BA also notes: "Reclamation intends to administer existing and future contracts at the current pricing rate shown on the sample contract. Reclamation anticipates that pricing may change in the future if USACE conducts an updated cost allocation triggering Reclamation to conduct an irrigation contract rate review. Reclamation contracts would include terms and conditions relative to water availability."

Contract conditions that require fish passage and screening at the point of diversion will minimize entrainment risk and assure fish passage. The effects of the protective restrictions will reduce the volume of stored water diverted to contract holders in low water years to allow minimum objectives to be met. These measures would also minimize adverse effects to critical habitat due to water diversions because they limit the total amount of water that can be diverted and require fish protection measures at the diversions.

5.1.5 BPA Power Marketing Program and Habitat Program

Power Marketing

The proposed action states that BPA will continue to market and sell hydropower produced by the WVS project. While the daily volume of water released from the WVS dams is not affected, for Detroit, Green Peter, and Lookout Point dams the magnitude and duration of the water released may change to optimize power production. Power generation is largely scheduled within USACE operating parameters for the dam. When turbines are one of or the only route available, the proposed action to generate hydropower will continue to kill and injure juvenile UWR Chinook salmon, and juvenile UWR steelhead where adults are released above reservoirs, as they migrate downstream through unscreened turbines. During the few months of deep drawdowns, at Green Peter, Lookout Point, and Cougar dams, these effects are eliminated as the reservoir elevation is below the power pool. At other dams, the turbine route is limited to daytime hours for part of the year to reduce the effects, but passage risk exists most of the year. In reaches below dams with peaking hydropower operations, the reservoir of the reregulation dam is used for tempering power peaking flow changes resulting from discharges from the upper dam (Detroit/Big Cliff, Lookout Point/Dexter). For other hydropower dams, such as Green Peter and Hills Creek, the reaches directly below are subject to the peaking flows.This can cause variable access to habitat and affect the habitat quality below these dams.

Planned or unplanned outages for transmission maintenance affects water quality below the dams when flow is routed to the spillway or regulating outlets, increasing TDG levels or changing temperatures below the dam. The effects are limited to the duration of the outage, unless deep drawdowns for repairs or maintenance change available volumes for downstream flow. Since 2023, drawdowns into and below power storage pools have occurred for fish passage and water quality operations as required by the injunction, as Green Peter and Lookout Point Dams.

In such cases, the effects would vary with the timing and duration, and depend on UWR Chinook salmon and steelhead life history stages present. In subbasin chapters, effects of TDG and low flow targets proposed by USACE are described. The Willamette Fish Operations Plan (WFOP) describes preferred timing for planned outages in each subbasin to limit water quality and quantity effects on UWR Chinook salmon and steelhead.

Habitat Program

BPA will also continue to fund and implement habitat restoration actions under its authority from the Northwest Power Act, as described in the 2008 NMFS RPA and section 1.8.2 of the Biological Assessment.

Proposed habitat actions will follow the 2008 RPA 7.1, within the framework developed for the Willamette Action Team for Ecosystem Restoration Habitat Technical Team (HTT). Individual projects reviewed by the HTT have site-specific project analyses, and environmental compliance for any effects to ESA species would be done at the time of implementation.

RPA 7.1.2 required that AAs:

1. Develop project selection criteria to address factors limiting recovery of ESA listed fish populations.
2. Identify proposals for habitat restoration projects.
3. Forward proposals to NMFS for review.
4. Fund priority projects
5. Report on how Projects were funded that proposed to meet these criteria:
    - Occur in the 2-year flood inundation zone of an anchor habitat.
    - Work at scale across contiguous acres.
    - Support native fish species identified in federal recovery plans.
    - Address one or more of the following objectives:
        - Increased channel complexity and length;
        - Improved connectivity between the river and its floodplain; and,
        - Expanded geographic extent and improved health of floodplain forests.

The effects of these ongoing actions will partially offset some impacts of the Willamette Valley System proposed operations including maintenance of existing revetments, such as degraded rearing and migration habitat in the mainstem Willamette and lower reaches of its tributaries caused by reduction in channel-forming flows. Many historical off- channels and side-channels continue to be blocked by proposed flood risk management and hydropower activities, or have ceased functioning due to other in-stream sediment imbalances. Restoration of off-channel, side-channel, and floodplain habitat includes removal of fill material to reconnect existing stream channels to historical off- channel habitat and side-channels. Funding under this measure will partially offset some effects of the losses by creating complex rearing and holding habitat, and by increasing access to off-channel habitat, and promote increased abundance and productivity of UWR Chinook salmon and UWR steelhead.

Between 2008 - 2021, BPA contributed 26% of overall funding to the Willamette Anchor Habitat Investments, Meyer 29%, and OWEB 45% of the total. Anchor habitats are located at major tributary confluences and river sections where there are opportunities to reconnect the river to its historic floodplain (Hoffert and Williams 2024). At present, from 2022-2025, BPA is the sole annual funder with primarily a mainstem focus providing $700,000/year. The restoration community has identified the HTT flexible approach can ensure partners continue to access available funds.

Based on funding pathways, the strengths of the past restoration projects were due to decades-long federal-state-private cooperative efforts on the mainstem Willamette River. This was initially led by the Meyer Memorial Trust.[5] With a cohesive 'anchor habitat approach' fitting the

[5] Meyer was also generously funding efforts to create model watershed programs in tributaries, to build capacity for necessary coordination by watershed councils.

requirements of the 2008 RPA, and support from the WATER Habitat Technical Team (HTT) on the federal side with BPA funds, state partners provided a foundation for these efforts by granting the 2016-2023 OWEB Willamette Focused Investment Partnership (WFIP) following an earlier Special Investment Partnership (2008-2015). This reserved State grant funds across multiple years, and was coordinated through the Nature Conservancy's efforts in applying for the FIP and assisting applicants to that fund, which added the resources of a non-profit partner. Other conservation non-profits were granted funds through this combination, with OWEB charged with using their already developed application review process. The HTT reviewed technical and cost-sharing aspects and through ranking and voting, selected projects when there were more requests than available funds. This funding source ended in 2023, with no long-term comparable funds replacing it.[6]

Going forward, with BPA providing the same level of HTT funding that has been offered annually, it is likely that overall habitat improvements will be drastically reduced by the limited or lack of partnerships. Meyer Memorial Trust moved their funding to other philanthropic goals. Another BPA fund, which is ending in 2025, was for the Willamette Wildlife Mitigation Program (WWMP). As noted in the environmental baseline, this included a 10% requirement of total funded projects would provide dual benefits to ESA-listed fish as well as wildlife. While this substantial fund benefitted widespread areas, and in particular purchased conservation lands, the overall results depend on other funding sources to manage the complex restoration needs for the lands protected by the program. In some cases, this included NOAA Restoration Center funding, which involves national competition, so are less predictable to Willamette River restoration practitioners. The current funding is dropping from all the 'sunsetting' actions, and a vacuum exists to some extent. As noted in the recent Status Review (NMFS 2024a), while restoration and protection actions have been implemented throughout the range of UWR salmon and steelhead, information that would reveal improvements in habitat quality, quantity, and function is lacking. Future status assessments would benefit from a systematic review and analysis of the amount of habitat addressed against those high priority upper Willamette River mainstem and tributary areas. Understanding effects requires status and trends monitoring, which was called for in 2021 (BEF et al 2021), including annual and decadal floodplain health indicators. Limited work on this front includes BPA funded studies on decadal trends of native fishes in the Willamette River basin (Penaluna et al 2024).

For critical habitat, some of the following PBFs in the locations where projects are carried out are likely to improve from these actions: free passage, substrate, water quantity, water quality, floodplain connectivity, cover/shelter, forage, and riparian vegetation.

5.1.6 Maintenance of WVS dams and related facilities

Routine maintenance of WVS dams and facilities is coordinated through the established forum, Willamette Fish Passage Operations & Maintenance (WFPOM), following procedures from the 2008 RPA. The proposed action describes routine and non-routine maintenance that is performed on turbine units, regulating outlets, spillway gates, hatcheries, and fish facilities at the WVS. These activities are described in the USACE Operations and Maintenance Manuals for each

[6] OWEB has granted smaller regional area FIPs, including below Willamette Falls in the Clackamas River Partnership.

facility. Facilities such as turbine units are placed out of service for 1-2 weeks annually which often requires the units to be completely dewatered to be inspected, cleaned, and lubricated. Each unit is also on a rotating schedule for a more rigorous inspection and non-routine repairs, which are proactively planned but not performed at regular intervals.

For other unscheduled maintenance that is reactive to address issues as they arise, the Action Agencies will continue procedures developed under the 2008 RPA. The Action Agencies will annually complete an updated Willamette Fish Operations Plan (WFOP) with input from WATER technical teams. Emergency operations will be managed in accordance with the WFOP and other appropriate Action Agency emergency procedures. The Action Agencies will take all reasonable steps to limit the duration of any emergency changes in system operations that may adversely affect ESA-listed species. Where emergency changes to system operations cause significant adverse effects on ESA-listed species, the Action Agencies will work with the established WATER teams such as the Willamette Fish Passage Operations and Maintenance, and Flow Management and Water Quality, to communicate issues and seek feedback on adverse effects and potential operational changes, when feasible. When not feasible to seek feedback prior to modified operations, USACE will continue to provide a description of the problem, type of outage required, potential impact on ESA-listed fish, estimated length of time for repairs or flood damage reduction operation, and proposed measures to minimize effects on fish or their habitat via email.

By carrying out the measures identified in the WFOP and in annual revisions to the WFOP, including timely notification and reporting, USACE will work with NMFS to initiate damage assessments; and work on a preferred course of action that will minimize adverse fish impacts. The effect of this measure will be to reduce stress, injury, and mortality to adult fish during outplanting, and to juveniles or spawners at or below dams, by ensuring field personnel have clear instructions for carrying out the procedures. The WFOP will also minimize fish injury and mortality caused by emergency operations by providing clear directions to field staff for dealing with emergencies in a manner that is protective for listed fish. However, some fish injury and mortality caused by maintenance activities are expected to continue under the proposed action.

Non-routine maintenance and major maintenance and rehabilitation may be considered major federal actions. Each action would be assessed for environmental compliance, including ESA compliance, prior to implementation

5.1.6.1 Discharge of oil/grease/contaminants from WVS dams

Leakage of oils, greases, or other lubricants into rivers has the potential to affect salmon and steelhead, and could result in exposure to toxic compounds, behavioral avoidance of contaminated water or sediments, or even, in some circumstances, death. The frequency of such events is anticipated to be low, and the spatial and temporal magnitude is expected to be small based on recent events[7]. Unless emergency conditions prevent USACE from providing clean up, they will have a rapid response and report the steps taken.

[7] As an example, in January 9,2020 email from Chris Walker, USACE, described a high-water alarm for the Detroit Dam transformer secondary containment, and residual oil from stormwater drained to the river, where a small sheen observed in the tailrace that had nearly dissipated 30 minutes later. The estimated quantity of oil released was less than 1 teaspoon.

5.1.7 RM&E

Research Monitoring and Evaluation (RM&E) under the Proposed Action would have direct effects on both UWR Chinook and UWR steelhead that are used in field studies. Fish may be trapped, examined, released, confined, re-located, marked, tagged, and subjected to related handling operations, subjected to the administration of pharmacological agents, including anesthetics, subjected to capture by electrofishing, propagated, transported between stream basins, killed or injured during test and control conditions, and affected in diverse other ways.

Under the Proposed Action, numerous fish protection measures will be carried out that depend on site-specific evaluations to identify feasible alternatives. These measures include restoration actions to address, in part, habitat factors limiting the viability of salmonid populations. The AM Plan notes that the Implementation Timeline will use RM&E to identify points where a course correction is part of decisions on 'on-ramp or off-ramps' for proposed actions. Some examples are the Engineering Design Report (EDR) and alternatives analysis for long-term structural downstream fish passage at Lookout Point in 2034, with decisions on completing the Design Document Report (DDR) phase of passage design, possibly delayed to review additional RM&E and/or the post-construction evaluation of the Detroit Dam downstream passage structure (PA, section 2.5.1).

Studies that USACE will contract for under the proposed AM plan RM&E to handle fish will continue to be reviewed when researchers submit plans under the Authorizations and Permits for Protected Species (APPS) program. Most studies have been focused on juvenile passage through reservoirs and past dams, migration to reaches downstream in the natal river, and into the mainstem Willamette River for a few studies. Others focus on rearing conditions affected by flow changes, temperatures, dissolved gas, or turbidity. Adult UWR Chinook salmon and steelhead are also monitored for effects during migration through the mainstem and into the tributaries below dams, and for effects of handling and outplanting into reaches above dams. Spawner surveys are also potentially part of proposed AM Plan RM&E to provide accurate counts of their survival or where pre-spawn mortality is found, to better understand why these losses occur. The majority of the studies in recent years have involved tagging and capture via rotary screwtrap; each type is useful for their specific objectives, and results will continue to be reviewed to determine whether alternative approaches are needed. As proposed passage routes or structures are provided or modified, bulk hatchery or surrogate tagging methods will be productive for study fish raised to useful sizes off site, while trapping allows more detailed information about natural origin juveniles emerging from redds and migrating downstream, and can be combined with some tagging. Returning tagged adult UWR Chinook salmon and steelhead can be identified back to their natal river and in some cases, approximate reach, while genetic pedigree studies will continue to provide detailed cohort information from the clips collected for DNA analyses.

5.1.7.1 RME Effect on Species

Part of the AM Plan will be to monitor and evaluate the effectiveness of various aquatic measures in the Proposed Action, including fish passage, water quality, habitat quality and quantity, and hatchery supplementation programs. The Action Agencies will prepare annual monitoring reports that describe the work conducted each year and the results of each study. Work will be conducted by the Action Agencies, or those hired by the Action Agencies to conduct the work (their contractors). This section is devoted to a discussion of the general effects known to be caused by the potential activities—regardless of where they occur or what species are involved.

Research and monitoring programs identified in the RPA will be funded or conducted by the Action Agencies. These programs are expected to take listed UWR Chinook salmon and steelhead. The activities include, but are not limited to, the following: (1) evaluating fish passage through reservoirs and various outlets at dams; (2) evaluating alternative fish passage facilities, screens, and other bypass systems; (3) evaluating effects of alternative flow scenarios, flow pulses, minimum and maximum flow levels, and of various ramping rates; (4) evaluating salmonid production (i.e., smolt-to-adult survival rates, for example); (5) determining stock composition, population trends, and life history patterns; (6) evaluating habitat restoration projects; (7) evaluating effects of artificial production and supplementation on natural-origin listed fish; (8) evaluating alternative methods for achieving temperature control on fish and fish habitat below WVS dams; (9) investigating migration timing and migratory patterns; (10) moving fish above artificial barriers to migration; (11) investigating fish behaviors in streams, reservoirs and off-channel areas; (12) evaluating fish spawning above or below dams; (13) monitoring and mitigating the effects of USACE dams; (14) evaluating effects of water diversions on fish; (14) conducting total dissolved gas experiments; (15) and investigating effects of alternative reservoir levels on fish passage and survival.

The following subsections describe the types of activities that NMFS anticipates the Action Agencies may use to carry out the AM Plan-related research and monitoring. The types of activities are organized into the following categories: observation, capture/handle/release, tagging/marking, biological sampling, and sacrifice. The activities would be carried out by trained professionals using established protocols and have widely recognized specific impacts. The Action Agencies are required to incorporate NMFS' uniform, pre-established set of minimization measures, including training, protocol standardization, data management, and reporting for these activities (e.g. electrofishing). These measures will be included in the specific monitoring plans subject to NMFS' concurrence.

5.1.7.2 Observation

For some studies, fish will be observed in-water (i.e., snorkel surveys). Direct observation is the least disruptive and simplest method for determining presence/absence of the species and estimating their relative abundance. Its effects are also generally the shortest-lived among any of the research activities discussed in this chapter. Typically, a cautious observer can obtain data without disrupting the normal behavior of a fish. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge behind rocks, vegetation, and deep-water areas. In extreme cases, some individuals may temporarily leave a particular pool or habitat type when observers are in their area. Researchers minimize the amount of disturbance by slowly moving through streams, thus allowing ample time for fish to reach escape cover; though it should be noted that the research may at times involve observing adult fish—which are more sensitive to disturbance. There is little a researcher can do to mitigate the effects associated with observation activities because those effects are so minimal. In general, they can choose the time of day to limit the exposure for feeding fish, move with care and attempt to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves.

Monitoring of population status and the effects of programs and actions will include conducting spawning and redd surveys to visually inspect and count the redds of spawning salmon and steelhead and to estimate prespawn mortality from carcasses. Harassment is the primary form of take associated with these observation activities, and few if any injuries or deaths are expected to occur—particularly in cases where the observation is to be conducted solely by researchers on the stream banks or from a raft rather than walking in the water. Fish may temporarily move off of a redd and seek cover nearby until the observer has past. In general, researchers can move with care and attempt to avoid disturbing sediments, gravels, and, to the extent possible, spawners near or on the redds.

5.1.7.3 Capture/Handle/Release

Capturing and handling fish causes them stress—though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and the point where fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18 degrees C or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps if the traps are not regularly emptied. Debris buildup at traps can also kill or injure fish if the traps are not monitored and regularly cleared of debris.

The use of capture/handling/release protocols, which are generally standardized throughout the Columbia basin and include maintaining high quality water (appropriate temperature, oxygen levels, anesthetic concentrations) and keeping fish in water to the maximum extent possible, serve to minimize potential adverse impacts on individual fish. Based on experience with the standard protocols that would be used to conduct the research and monitoring, no more than five percent and in most cases, less than two percent of the juvenile salmonids encountered are likely to be killed as an unintentional result of being captured and handled. In any case, researchers will employ the standard protocols and thereby keep adverse effects to a minimum. Finally, any fish unintentionally killed by the research activities in the proposed permit may be retained as reference specimens or used for other research purposes.

5.1.7.4 Smolt, rotary screw and other out-migration traps or nets

Smolt, rotary screw, and other out-migration traps, or nets, are generally operated to gain population specific information on natural population abundance and productivity. They can achieve sample efficiency averages up to 20% of the emigrating population from a river or stream, depending on the river size, although under some conditions, traps may achieve a lower or higher efficiency for a relatively short period of time. Recent trapping in the Willamette tributaries have found as low as 0.0-0.4% efficiencies under some conditions (EAS 2024b). Based on experience in Columbia River tributaries the mortality of fish captured /handled /released at rotary screw type juvenile fish traps would be expected to be two percent or less on target species. However, in traps below dams, the effect of passage through the dam can lead to higher mortality rates, and three percent is not uncommon.

The trapping, capturing, or collecting and handling of juvenile fish using traps is likely to cause some stress on listed fish. However, fish typically recover rapidly from handling procedures. The primary factors that contribute to stress and mortality from handling are excessive doses of anesthetic, differences in water temperature, dissolved oxygen conditions, the amount of time that fish are held out of water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 64.4°F (18°C) or if dissolved oxygen is below saturation. Additionally, stress can occur if there are more than a few degrees difference in water temperature between the stream/river and the holding tank. The potential for unexpected injuries or mortalities to ESA-listed fish will be reduced in a number of ways. Fish can also experience stress and injury from overcrowding in fish traps, if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis

Other traps used for sampling in reservoirs described by Monzyk et al. (2014) include nearshore methods using box minnow traps and “Oneida floating box traps consisting of a… frame wrapped with 0.42-cm delta mesh.” For offshore, suspended small mesh gill nets assess vertical distribution of juvenile Chinook salmon. The former are likely to have harm levels below 2%. The latter can be fatal, so permits to use those are limited to use if other forms of RM&E are not feasible in large water bodies, and when the environment has high mortality rates.

In general, traps would be checked and fish handled in the morning. This would ensure that the water temperature is at its daily minimum when fish are handled. Fish may not be handled if the water temperature exceeds 69.8 F (21 C). Sanctuary nets must be used when transferring fish to holding containers to avoid potential injuries. The investigator’s hands must be wet before and during fish handling. Appropriate anesthetics must be used to calm fish subjected to collection of biological data. Captured fish must be allowed to fully recover before being released back into the stream and will be released only in slow water areas.

5.1.7.5 Electrofishing

Electrofishing is a process by which an electrical current is passed through water containing fish in order to stun them—thus making them easy to capture. It can cause a suite of effects ranging from simple harassment to actually killing the fish. The amount of unintentional mortality attributed to electrofishing may vary widely depending on the equipment used, the settings on the equipment, and the expertise of the technician. Electrofishing can have severe effects on adult salmonids. Spinal injuries in adult salmonids from forced muscle contraction have been documented. Sharber and Carothers (1988) reported that electrofishing killed 50% of the adult rainbow trout in their study. The long-term effects electrofishing has on both juveniles and adult salmonids are not well understood, but long-term experience with electrofishing indicates that most impacts occur at the time of sampling and are of relatively short duration.

The effects electrofishing may have on the threatened species would be limited to the direct and indirect effects of exposure to an electric field, capture by netting, holding captured fish in aerated tanks, and the effects of handling associated with transferring the fish back to the river (see the previous subsection for more detail on capturing and handling effects). Most of the studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (Hollender and Carline 1994; Dalbey et al. 1996; Thompson et al. 1997). McMichael et al. (1998) found a 5.1% injury rate for juvenile Middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin. Continuous direct current (DC) or low-frequency (30 Hz) pulsed DC have been recommended for electrofishing (Snyder 1995; Dalbey et al. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (McMichael 1993). Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey et al. 1996; Ainslie et al. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey et al. 1996).

NMFS' electrofishing guidelines (2000) will be followed in all surveys using this procedure. The guidelines require that field crews be trained in observing animals for signs of stress and shown how to adjust electrofishing equipment to minimize that stress. Electrofishing is used only when all other survey methods are not feasible. All areas for stream and special needs surveys are visually searched for fish before electrofishing may begin. Electrofishing is not done in the vicinity of redds or spawning adults. All electrofishing equipment operators are trained by qualified personnel to be familiar with equipment handling, settings, maintenance, and safety. Operators work in pairs to increase both the number of fish that may be seen and the ability to identify individual fish without having to net them. Working in pairs also allows the operators to net fish before they are subjected to higher electrical fields. Only DC units will be used, and the equipment will be regularly maintained to ensure proper operating condition. Voltage, pulse width, and rate will be kept at minimal levels and water conductivity will be tested at the start of every electrofishing session so those minimal levels can be determined. Due to the low settings used, shocked fish normally revive instantaneously. Fish needing to be revived will receive immediate, adequate care.

A side effect of the electrofishing effort is that salmon and steelhead may be exposed to the electrofishing field, with the potential for injury, stress, fatigue, and even cardiac or respiratory failure (Snyder 2003). Operators shut off the electrical field immediately upon observation of any salmonids, but due to the sampling conditions mentioned above, and because most stunned fish quickly recover and swim away, the take cannot be accurately observed, and the affected fish that are observed cannot be identified to species (i.e., Chinook, coho, chum, or sockeye salmon, or steelhead).

The preceding discussion focused on the effects of using a backpack unit for electrofishing and the ways those effects will be mitigated. It should be noted, however, that in larger streams and rivers electrofishing units are sometimes mounted on boats. These units often use more current than backpack electrofishing equipment because they need to cover larger (and deeper) areas, and as a result, can have a greater impact on fish. In addition, the environmental conditions in larger, more turbid streams can limit the operators' ability to minimize impacts on fish. For example, in areas of lower visibility it is difficult for operators to detect the presence of adults and thereby take steps to avoid them. Because of its greater potential to harm fish, and because NMFS has not published appropriate guidelines, boat electrofishing has not been given a general authorization and all boat electrofishing projects will be evaluated on a case by case basis.

5.1.7.6 Angling

While valuable to examine mature fish in natal rivers or the mainstem Willamette, the use of angling is rare for the study purposes noted above (Section 5.1.8.1). Fish that are caught and released alive as part of an RM&E project may still die as a result of injuries or stress resulting from the capture method or handling. The likelihood of mortality varies widely, based on a number of factors including the gear type used, the species, the water conditions, and the care with which the fish is released. An overview of the catch-and-release effects for steelhead and Chinook salmon are discussed here.

Catch and Release mortality –The available information assessing hook and release mortality of adult steelhead suggests that hook and release mortality is low. Hooton (1987) found catch and release mortality of adult winter steelhead to average 3.4% (127 mortalities of 3,715 steelhead caught) when using barbed and barbless hooks, bait and artificial lures. Among 336 steelhead captured on various combinations of popular terminal gear in the Keogh River, the mortality of the combined sample was 5.1%. Natural bait had slightly higher mortality (5.6%) than did artificial lures (3.8%), and barbed hooks (7.3%) had higher mortality than barbless hooks (2.9%). Hooton (1987) concluded that catch and release of adult steelhead was an effective mechanism for maintaining angling opportunity without negatively impacting stock recruitment. The highest percentage (17.8%) of critical area hookings occurred when using bait and treble hooks in winter steelhead fisheries.

The referenced studies were conducted when water temperatures were relatively cool, and primarily involve winter-run steelhead. Data on summer-run steelhead and warmer water conditions are less abundant (Cramer et al. 1997). Catch and release mortality of steelhead is likely to be higher if the activity occurs during warm water conditions. In a study conducted on the catch and release mortality of steelhead in a California river, Taylor and Barnhart (1999) reported over 80% of the observed mortalities occurred at stream temperatures greater than 21°C. Catch and release mortality during periods of elevated water temperature are likely to result in post-release mortality rates greater than reported by Hooton (1987) because of warmer water and extended freshwater residence of summer fish which make them more likely to be caught. As a result, NMFS expects steelhead hook and release mortality to be in the lower range discussed above.

Juvenile steelhead occupy many waters that are also occupied by resident trout species and it is not possible to visually separate juvenile steelhead from similarly-sized stream-resident, rainbow trout. Because juvenile steelhead and stream-resident rainbow trout are the same species, are similar in size, and have the same food habits and habitat preferences, it is reasonable to assume that catch-and-release mortality studies on stream-resident trout are similar for juvenile steelhead. Where angling for trout is permitted, catch-and-release fishing with prohibition of use of natural or synthetic bait will reduce juvenile steelhead mortality more than any other angling regulatory change. In the compendium of studies reviewed by Mongillo (1984) mortality of trout caught and released using artificial lures and single barbless hooks was often reported at less than 2%. Some investigators believe that the use of barbless hooks reduces handling time and stress on hooked fish and adds to survival after release (Wydoski 1977). In summary, catch-and-release mortality of juvenile steelhead is expected to be less than 10% and approaches 0% when researchers are restricted to use of artificial flies and lures.

ODFW has conducted studies of hooking mortality incidental to the recreational fishery for Chinook salmon in the Willamette River. A study of the recreational fishery estimates a per-capture hook-and-release mortality for natural-origin spring Chinook in Willamette River fisheries of 8.6% (Schroeder et al. 2000. In the Lower Willamette River (below Willamette Falls) and UWR recreational (Rec) fisheries that reflect retention of clipped fish and encounter/hooking mortalities of unmarked fish; hooking mortality rates for the Willamette River are estimated at 12.2% (ODFW and WDFW 2020).

Based on the available data, the *U.S. v. Oregon* Technical Advisory Committee (TAC 2008) has adopted a 10% rate in order to make conservative estimates of incidental mortality in fisheries (NMFS 2005b). For similar reasons, NMFS currently applies the 10% rate to provide conservative estimates of the hook and release mortality when evaluating the impact of proposed RM&E activities using angling as a monitoring technique.

5.1.7.7 Tagging & Marking

Techniques such as passive integrated transponder tagging, coded wire tagging, fin-clipping, and the use of radio transmitters are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. This section discusses each of the marking processes and its associated risks.

Passive Integrated Transponder (PIT) tag

A passive integrated transponder (PIT) tag is an electronic device that relays signals to a radio receiver; it allows salmonids to be identified whenever they pass a location containing such a receiver (e.g., any of several dam outlets, or downstream antenna in passage routes) without researchers having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled; therefore, any researchers engaged in such activities will follow the conditions listed previously in this Opinion (as well as any permit-specific conditions) to ensure that the operations take place in the safest possible manner. In general, the tagging operations will take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a carefully regulated holding environment where the fish can be allowed to recover from the operation.

PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice et al. 1987; Jenkins and Smith 1990; Prentice et al. 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 km), Hockersmith et al. (2000) concluded that the performance of yearling Chinook salmon was not adversely affected by gastrically-or surgically implanted sham radio tags or PIT-tags. Additional studies have shown that growth rates among PIT-tagged Snake River juvenile fall Chinook salmon in 1992 (Rondorf and Miller 1994) were similar to growth rates for salmon that were not tagged (Connor et al. 2001). Prentice and Park (1984) also found that PIT-tagging did not substantially affect survival in juvenile salmonids.

Coded wire tags

Coded wire tags (CWTs) are made of magnetized, stainless-steel wire. They bear distinctive notches that can be coded for such data as species, brood year, hatchery of origin, and so forth (Nielsen 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for long-term, population-level assessments of Pacific Northwest salmon. The tag is injected into the nasal cartilage of a salmon and therefore causes little direct tissue damage (Bergman et al. 1968; Bordner et al. 1990). The conditions under which CWTs may be inserted are similar to those required for applying PIT-tags.

A major advantage to using CWTs is the fact that they have a negligible effect on the biological condition or response of tagged salmon. However, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987; Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

In order for researchers to be able to determine later (after the initial tagging) which fish possess CWTs, it is necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed in order for the tag to be removed. However, this is not a significant problem because researchers generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest (and are therefore already dead).

Radio or acoustic tagging

Radio and acoustic tagging are referred to as active tagging methods. Often these methods involve double tagging, where the fish is surgically tagged with an acoustic or radiofrequncy transmitter and a PIT tag. This enables greater recapture probability as the PIT tag will last through all life stages, while the active tags will provide more information during limited periods when the receivers overlap with (usually) juvenile rearing and migration. These double tagged fish are raised for study purposes, either in the surrogate program at Oregon Hatchery Research Center or at hatcheries in the basin under study.

The two tagging insertion methods differ in effects. The method of stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways. Another common method for implanting tags is to surgicplace them within the body cavities of (usually juvenile) salmonids. The frequent use of this method led to standard operating procedure for the surgical implantation published by USGS (Liedtke et al 2012), "developed from a broad base of published information, laboratory experiments, and practical experience in tagging thousands of fish for numerous studies of juvenile salmon movements" past hydroelectric dams.

These tags do not interfere with feeding or movement. Infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985; Mellas and Haynes 1985).

Fish with internal radio tags often die at higher rates than fish tagged by other means because radio tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance. And as noted by Liedtke et al. (2012), the handling and surgical stress can be cumulative and lethal, so providing "best possible fish care at every step in order to manage the overall effect on study fish" is the standard expected. Following the recommended minimum length of fish for surgical implantation of tags in Chinook salmon to minimize tag burden will reduce the tag presence adversely affecting survival in fish smaller than 95 mm FL (Geist et al. 2018). Recent work with double-tagged fish had body burdens, defined as the total weight of the transmitter and PIT tag divided by fish weight, that remained low, of only 1.4 percent (Hance et al 2024).

Fin clipping

Fin clipping is the process of removing part or all of one or more fins to alter a fish's appearance and thus make it identifiable. When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made when only a part of the fin is removed or the end of a fin or a few fin rays are clipped. Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins. Marks can also be made by punching holes or cutting notches in fins, or severing individual fin rays (Kohlhorst 1979; Welch and Mills 1981). Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied; however, it can be said that fin clips do not generally alter fish growth. Studies comparing the growth of clipped and unclipped fish generally have shown no differences between them (Brynildson and Brynildson 1967). Moreover, wounds caused by fin clipping usually heal quickly—especially those caused by partial clips.

Mortality among fin-clipped fish is also variable. Some immediate mortality may occur during the marking process, especially if fish have been handled extensively for other purposes (e.g., stomach sampling). Delayed mortality depends, at least in part, on fish size; small fishes have often been found to be susceptible to it. Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Studies show that adipose- and pelvic-fin-clipped coho salmon fingerlings have a 100 % recovery rate (Stolte 1973). Recovery rates are generally recognized as being higher for adipose- and pelvic-fin-clipped fish in comparison to those that are clipped on the pectoral, dorsal, and anal fins (Nicola and Cordone 1973). Clipping the adipose and pelvic fins probably kills fewer fish because these fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). Mortality is generally higher when the major median and pectoral fins are removed. Mears and Hatch (1976) showed that clipping more than one fin may increase delayed mortality but other studies have been less conclusive. Regardless, any time researchers clip or remove fins, it is necessary that the fish be handled. Therefore, the same safe and sanitary conditions required for tagging operations also apply to clipping activities.

Stomach Flushing

Stomach flushing is a technique to induce fish to regurgitate the contents of their stomachs without killing the fish. Knowledge of the food and feeding habits of fish are important in the study of aquatic ecosystems. However, in the past, food habit studies required researchers to kill fish for stomach removal and examination. Consequently, several methods have been developed to remove stomach contents without injuring the fish. Most techniques use a rigid or semi-rigid tube to inject water into the stomach to flush out the contents.

Few assessments have been conducted regarding the mortality rates associated with nonlethal methods of examining fish stomach contents (Kamler and Pope 2001). However, Strange and Kennedy (1981) assessed the survival of salmonids subjected to stomach flushing and found no difference between stomach-flushed fish and control fish that were held for three to five days. In addition, when Light et al. (1983) flushed the stomachs of electrofished and anesthetized brook trout, survival was 100% for the entire observation period. In contrast, Meehan and Miller (1978) determined the survival rate of electrofished, anesthetized, and stomach flushed natural-origin and hatchery coho salmon over a 30-day period to be 87% and 84% respectively.

5.1.7.8 Biological Sampling

Genetic Samples (fin clips)

Genetic sampling uses non-lethal methods to obtain material that is used to assess parentage and develop population structure

Sacrifice

In some instances, it is necessary to kill a captured fish in order to gather whatever data a study is designed to produce. In such cases, determining effect is a very straightforward process: the sacrificed fish, if juveniles are forever removed from the listed species' gene pool; if the fish are adults, the effect depends upon whether they are killed before or after they have a chance to spawn. If they are killed after they spawn, there is very little overall effect. Essentially, it amounts to removing the nutrients their bodies would have provided to the spawning grounds. If they are killed before they spawn, not only are they removed, but so are all their potential progeny. Thus, killing pre-spawning adults has the greatest potential to affect the listed species.

Due to this, NMFS rarely issues permits for this. In almost every instance where it is allowed, the adults are stripped of sperm and eggs so their progeny can be raised in a controlled environment such as a hatchery—thereby greatly decreasing the potential harm posed by sacrificing the adults.

5.1.7.9 Habitat surveys & installation of monitoring devices

The following potential effects to listed species and their habitats associated with the proposed actions for stream channel, floodplain, and upland surveys and installation of stream monitoring devices - erosion and sedimentation, compaction and disturbance of streambed sediments - are negligible and would have little impact on compaction or instream turbidity. The effect of stream channel, floodplain, and upland surveys and installation of stream monitoring devices activity is described in the HIP Biological Opinion (2.2.1.2.1 Stream Channel, Floodplain, and Uplands Surveys and Installation Stream Monitoring Devices such as Streamflow and Temperature Monitors) (NMFS 2008e) as applicable. These actions will incorporate the conservation measures for general construction identified in the next section.

Excavated material from cultural resource testing conducted near streams may contribute sediment to streams and increase turbidity. The amount of soil disturbed would be negligible and would have a minimal effect on instream turbidity.

5.1.7.10 Benefits of Research, Monitoring & Evaluation (RM&E)

NMFS supports research and monitoring plans despite adverse effects, as the information is crucial to reducing harm, and so provides benefits to the listed species, which accrue from the acquisition of scientific information. Information and data gained from RM&E is critical to help inform the conservation and recovery of ESA-listed populations.

For more than a decade, research and monitoring activities conducted with anadromous salmonids in the Pacific Northwest have provided resource managers with important and useful information on anadromous fish populations. For example, juvenile fish trapping efforts have enabled the production of population inventories, PIT tagging efforts have increased the knowledge of anadromous fish migration timing and survival, and fish passage studies have provided an enhanced understanding of fish behavior and survival when moving past dams and through reservoirs. By approving plans, NMFS will enable information to be acquired that will enhance resource manager’s ability to make more effective and responsible decisions to sustain anadromous salmonid populations that are at risk of extinction, to mitigate impacts to endangered and threatened salmon and steelhead, and to implement recovery efforts. The resulting data continue to improve the knowledge of the respective species’ life history, specific biological requirements, genetic make-up, migration timing, responses to anthropogenic impacts, and survival in the river system.

RME studies comprise an essential part of the Proposed Action for the AM Plan. In multiple instances, detailed information on geographically-specific environmental conditions (e.g., quantity and distribution of functional spawning and rearing habitat) and the extent to which ongoing WVSoperations are continuing to affect those conditions (e.g., flow variation and duration in relation to sediment transport dynamics, channel and habitat complexity, and related juvenile fish behavior and survival) is lacking. In other cases, known problems attributable to Willamette Valley System dams and operations (e.g., migration barriers and water temperature alteration) cannot be addressed by the Action Agencies until they have narrowed uncertainties about the most prudent and effective remedies. Consequently, the ability of the Action Agencies to carry out meaningful conservation measures within the period covered by this Biological Opinion will often depend upon their ability to complete studies and make timely, informed decisions on how best to achieve protection and restoration objectives associated with each of the listed species.

5.1.8 General Effects of In- and Near-Water Construction

The USACE's proposed action includes activities that would require in- or near-water construction. Here, we present an analysis of this type of construction on listed species and their critical habitat. Future projects that exceed the scope of effects considered here would be subject to an individual consultation.

Construction activities would include: 1) work area isolation, 2) surveying, mapping, and the placement of stakes; 3) installation of erosion and pollution control measures; 4) creation of temporary access roads and staging areas; 5) drilling operations; 6) use of heavy equipment; and 7) temporary water withdrawal. Project footprints that extend far into the active channel may require activities like work area isolation, fish capture, and relocation. Pre-construction activities are likely to have short-term adverse effects due to vegetation removal and the compaction of soil reducing permeability and infiltration due to site preparation for construction activities to occur in aquatic or riparian habitats.

Construction activities cause a number of direct and indirect effects on anadromous fish and their habitat. A summary of the effects of these pathways on anadromous fish and their habitat is presented in Table 5.1-2. The effects occur through pathways including:

- Elevated suspended sediment
- Fish exclusion from preferred habitat and stress from capture and handling
- Riparian and streambank disturbance
- Reduction of water quantity
- Small spills or leaks of fuel, lubricants, hydraulic fluid, coolants, and other contaminants
- Physical injury or death of fish through contact with heavy equipment
- Fish displacement
- Temporary reduction in aquatic invertebrate prey in the dewatered work isolation area
- Water quality impacts from construction discharge water
- Drilling and boring impacts

Table 5.1-2 Summary of effect pathways from near- and in-water construction on anadromous fish and their habitat

Effect pathway	Summary of effects on anadromous fish and their habitat
Elevated suspended sediment	During and after wet weather, increased runoff resulting from soil and vegetation disturbance at a construction site during both preconstruction and construction phases is likely to suspend and transport more sediment to receiving waters as long as construction continues so that multi-year projects are likely to cause more sedimentation. This increases total suspended solids and, in some cases, stream fertility. Increased runoff also increases the frequency and duration of high stream flows and wetland inundation in construction areas. Higher stream flow increases stream energy that scours stream bottoms and transports greater sediment loads farther downstream than would otherwise occur. Sediments in the water column reduce light penetration, increase water temperature, and modify water chemistry. Redeposited sediments partly or completely fill pools, increase the width-to-depth ratio of streams, and change the distribution of pools, riffles, and glides. Increased fine sediments in substrate also reduce survival of eggs and fry, reducing spawning success of salmon and steelhead. These effects are expected to be temporary and of small scale as construction sites are typically small relative to the amount of stream and riparian area in a given watershed. During dry weather, the physical effects of increased runoff appear as reduced groundwater storage, lowered stream flows, and lowered wetland water levels. The combination of erosion and mineral loss reduce soil quality and site fertility in upland and riparian areas. Concurrent in-water work compacts or dislodges channel sediments, thus increasing total suspended solids and allowing currents to transport sediment downstream where it is eventually re-deposited. Turbidity may have beneficial or detrimental effects on fish, depending on the intensity, duration, and frequency of exposure (Newcombe and MacDonald 1991). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such high pulse exposures. Adult and larger juvenile salmonids may be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjorn and Reiser 1991), although these events may produce behavioral effects, such as gill flaring and feeding changes (Berg and Northcote 1985). Deposition of fine sediments reduces incubation success (Bell 1991), interferes with primary and secondary productivity (Spence et al. 1996), and degrades cover for juvenile salmonids (Bjornn and Reiser 1991). Chronic, moderate turbidity can harm newly emerged salmonid fry, juveniles, and even adults by causing physiological stress that reduces feeding and growth and increases basal metabolic requirements (Redding et al. 1987, Lloyd 1987, Bjornn and Reiser 1991, Servizi and Martens 1991, Spence et al. 1996). Juveniles avoid chronically turbid streams, such as glacial streams or those disturbed by human activities, unless those streams must be traversed along a migration route (Lloyd et al. 1987). Older salmonids typically move laterally and downstream to avoid turbid plumes (McLeay et al. 1984, 1987, Sigler et al. 1984, Lloyd 1987, Scannell 1988, Servizi and Martens 1991). On the other hand, predation on salmonids may be reduced in waters with turbidity equivalent to 23 Nephalometric Turbidity Units (NTU) (Gregory 1993, Gregory and Levings 1998), an effect that may improve overall survival.

Effect pathway	Summary of effects on anadromous fish and their habitat
Work area isolation and fish relocation	Capturing and handling fish causes them stress, though they typically recover fairly rapidly from the process, and therefore, the overall effects of the procedure are generally short-lived. The primary contributing factors to stress and death from handling are differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18°C (64°F) or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in fish traps, if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis. The total number of fish relocated from a construction site is typically in the dozens to hundreds. Most fish will survive the process although a small percentage of fish will be injured or die during relocation.
Riparian Disturbance	Near-water construction causes disturbance of vegetation and soils that support floodplain and riparian function, such as delivery of large wood and particulate organic matter, shade, development of root strength for slope and bank stability, and sediment filtering and nutrient absorption from runoff (Darnell 1976; Spence et al. 1996). Although the size of areas likely to be adversely affected by in- or near-water is small, and those effects are likely to be short-term (weeks or months), even small denuded areas will lose organic matter and dissolved minerals, such as nitrates and phosphates. The microclimate at each action site where vegetation is removed is likely to become drier and warmer, with a corresponding increase in wind speed and soil and water temperature. Water tables and spring flow in the immediate area may be temporarily reduced. Loose soil will temporarily accumulate in the construction area. In dry weather, part of this soil is dispersed as dust, and in wet weather; part is transported to streams by erosion and runoff, particularly in steep areas. Erosion and runoff increase the supply of sediment to lowland drainage areas and eventually to aquatic habitats, where they increase total suspended solids and sedimentation. This generally leads to degradation of riparian and stream habitat lasting for a few years. Complete recovery of most of these impacts is expected within 5 years.
Reduction of water quantity	The temporary withdrawal of water for construction activities decreases the amount of water in streams and rivers. This can reduce the depth of wetted width of streams, decreasing the amount of habitat available for listed fish. Withdrawal without an adequate fish screen can entrain juvenile fish, which typically injures or kills them. These impacts are typically short duration, lasting a few hours at a time during active construction. Other than temporary reduction in aquatic invertebrate prey (as further described below), impacts from reduction of water quantity are not long lasting.
Spills or leaks of fuel or lubricants	The use of heavy equipment creates a risk that accidental spills of fuel, lubricants, hydraulic fluid, coolants, and other contaminants will occur. Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons (PAHs), which can be acutely toxic to salmonid fish and other aquatic organisms at high levels of exposure and can cause sublethal adverse effects to aquatic organisms at lower concentrations (Heintz et al. 1999; Incardona et al. 2005; Incardona et al. 2004; Incardona et al. 2006).
Physical injury or death of fish through contact with heavy equipment	Work involving the presence of equipment or vehicles in the active channel when ESA-listed fish are present is likely to result in injury or death of some individuals as they come in contact with the equipment. The number of salmon or steelhead

Effect pathway	Summary of effects on anadromous fish and their habitat
	affected at any individual project site is expected to be small, nowhere near the number that would cause population-level effects.
Fish displacement	Work involving the presence of equipment or vehicles in the active channel when ESA-listed fish are present is likely to cause some fish to experience elevated stress or leave the area. Essential behavior behaviors such as feeding and sheltering are also interrupted during in-water work. Fish relocating to an undisturbed area may become more vulnerable to avian or piscine predation. These fish are typically injured or killed during predation attempts. The number of fish expected to be affected at any given project site would be small.
Temporary reduction in aquatic invertebrate prey in the dewatered work isolation area	In-water construction often kills or injures aquatic invertebrates in the construction area. Invertebrates can be killed during dewatering associated with work area isolation. They can also be killed by elevated suspended sediment, which may interfere with respiration or other essential behaviors such as feeding. Minor spills of fuel or lubricants can kill aquatic invertebrates, as many species are highly sensitive to these substances. The reduction in invertebrates typically persists for one to two seasons, resulting in a temporary loss of forage for salmonids. Invertebrates from upstream and downstream of the project site will recolonize the affected area.
Water quality impacts from construction discharge water.	Water discharges from construction sites into streams or rivers can contain chemicals such as green concrete, drilling fluids, and petroleum products. These chemicals can be toxic to fish, invertebrates, and other aquatic life.
Impacts from drilling and boring	Drilling operations as a means of soil testing may themselves cause erosion, sedimentation from drilling mud, or other temporary site disturbances. Similarly, untreated drilling fluids sometimes travel along a subsurface soil layer and exit in a stream or wetland and degrade water quality. Air-rotary drilling produces dust, flying sand-sized rock particles, foaming additives, and fine-water spray. The distances that cuttings and liquids (e.g., water, foaming additives) are ejected out of the boring depend on the size of the drilling equipment. Unrestrained, larger equipment will disperse particles up to 6 meters, while smaller equipment will typically expel particles up to 3 meters. As with any heavy equipment, drilling rigs are subject to accidental spills of fuel, bentonite, lubricants, hydraulic fluid, and other contaminants that, if unconfined, may harm the riparian zone or aquatic habitats.

5.1.9 Effects Basinwide Activities on Critical Habitat

1. Freshwater spawning sites
    a. Water quantity – Reduced habitat from low flow during irrigation diversions in spring to summer months, affecting both UWR Chinook salmon and steelhead. Brief reduction in flow from short-term construction needs.
    b. Water quality – Short-term increase in total suspended solids and dissolved oxygen demand along with increased contaminants and temperature when operational passage via deep drawdowns overlaps with any riparian disturbance due to near and

in-water construction. Runoff from irrigation return flows can increase temperatures, as can reduced flow due to irrigation diversions.

   c. Substrate – Short-term reduction in substrate quality from increased compaction and sedimentation. Ongoing substrate reduction from dam operations that reduce flow during refill for irrigation storage and hydropower production.

2. Freshwater rearing sites
   a. Water quantity – same as above.
   b. Floodplain connectivity – Short-term decrease from increased compaction and riparian disturbance at sites where revetment maintenance is provided. Some long-term improvements from improvements in stormwater management, riparian, streambank and channel conditions, and ecological connectivity due to habitat restoration.
   c. Water quality – Short-term increase in total suspended solids and dissolved oxygen demand along with increased contaminants and temperature from riparian disturbance due to short term construction. Reduced flows and runoff downstream from irrigation diversion affecting temperatures and contaminant levels.
   d. Forage – Short-term decrease from riparian and channel disturbance, and water-quality impairments.
   e. Natural cover – Short-term decrease from riparian and channel disturbance.

3. Freshwater migration corridors
   a. Free passage – Short-term decrease from decreased water quality and in-water work isolation.
   b. Water quantity – same as above.
   c. Water quality – Temperature increases from lower flows during spring refill for hydropower and irrigation purposes.
   d. Natural cover – Short-term decrease from riparian and channel disturbance.

5.2 Middle Fork Willamette Sub-basins: Effects of the Willamette Valley System Proposed Action on UWR Chinook Salmon and Critical Habitat

Historically, the Middle Fork Willamette population may have been the largest of all populations in the UWR Chinook salmon ESU and once likely produced tens of thousands of adult spring Chinook (McElhany et al 2007). The primary cause of declining populations are the four dams that block access to 90% of the historical spawning habitat, and are lower in the subbasin than any other Willamette River tributary. The mainstem Middle Fork Willamette has three dams, the lowest of which is Dexter Dam, which is three miles downstream of Lookout Point Dam (Figure 5.2-1). This dam regulates the peak discharges from Lookout Point Dam power production, reducing downstream fluctuations. Lookout Point Dam, operating with Dexter since 1955, has gated spillways. A key difference between these two dams is that Lookout Point is a peak power generating dam, while Dexter is run-of-river with water constantly passing through the turbine, the spillways, or a combination of both.

Farther upstream in the subbasin Hills Creek Dam, part of the environmental baseline, and blocks access to the highest elevation Middle Fork Willamette River and Hills Creek habitat (Figure 5.2-1). This dam also generates power, and the reservoir can support refilling and flood risk management at Lookout Point Dam. It was completed in 1962, and has a gated concrete spillway. The regulating outlets (ROs) provide an alternative passage route from the turbines. Fall Creek Dam, a smaller structure on the lower Fall Creek tributary (Figure 5.2-1) to the Middle Fork Willamette River, also has a gated concrete spillway and was completed in 1965. It has operational passage through the ROs when drawndown to near the river bed elevation. Unlike the Middle Fork River mainstem dams, this is not operated for hydropower, and has much smaller storage capacity. The Proposed Action includes USACE doing the following:

- USACE will initially maintain the current configuration, and will continue operations and maintenance of Lookout Point, Dexter, and Hills Creek dams in the Middle Fork.
- USACE will maintain the current configuration, and will continue operations and maintenance of Fall Creek Dam. In addition, they will operate and maintain the Fall Creek Adult Fish Facility, following the Middle Fork Willamette Sub-Basin Fish Operations Plan (FOP, see PA Appendix F).
- USACE will complete the construction for Dexter adult fish facility (AFF) upgrades in 2026 as part of the environmental baseline, and will test functionality. Following a pre-commissioning walk-through, they will update the Middle Fork Willamette Sub-Basin FOP with modified Dexter AFF actions, and provide for NMFS review.
- USACE will continue to limit down ramping below Dexter dam to a maximum nighttime 0.1 feet per hour (ft/hr) and maximum daytime ramping rates to 0.2 ft/hr when not operating for flood risk management as decribed in the Middle Fork Willamette Sub-Basin Fish Operations Plan (FOP).
- For approximately 20 years, USACE proposes to continue interim passage operations at Lookout Point and Dexter dams. For spring passage, they will use ungated spill at Lookout Point Dam for 30 days, then transition to gated spill at night with turbine operations during the day, and night spill at Dexter, through 1st July. For fall passage, they propose to continue deep drawdowns of the Lookout Point reservoir to allow UWR Chinook salmon access to ROs from mid- November to mid-December, unless flood risk management limits discharge to hold lower elevations.
- For long term passage at Lookout Point Dam, USACE proposed to construct a Floating Surface Collector (FSC), following a review of the structural passage proposed for Detroit Dam. The Lookout Point Dam FSC design, if pursued, is expected to begin in 2034, with completion allowing operations in 2045.
- USACE will continue Hills Creek operational passage that began under 2021 Injunction measures. In fall and winter, they will prioritize operations of the RO only outflows for four hours nightly when the reservoir elevation is less than 1460 feet.
- USACE also proposed a review of "the feasibility and likelihood that a safe and effective upstream fish trap for bull trout can be operated in the tailrace of Hills Creek Dam" and if found feasible, this trap would be built by 2033.
- For structural downstream passage at Hills Creek Dam, USACE proposes to consider options in an evaluation of other WVS passage projects that could inform potential future designs. The evaluation is scheduled for 2047.
- USACE proposed minimum flow objectives for Lookout Point/Dexter releases based on reservoir elevation in the spring, relative to the water control diagram, with some

decreased from NMFS (2008a) Willamette Valley Project Biological Opinion RPA (hereafter 2008 RPA), and others increasing.
- USACE proposes operational passage at Fall Creek Dam that will continue the fall deep drawdown to use the ROs, with similar timing and duration from 2011-2022; they will discontinue a second drawdown in December that was part of Injunction operations.

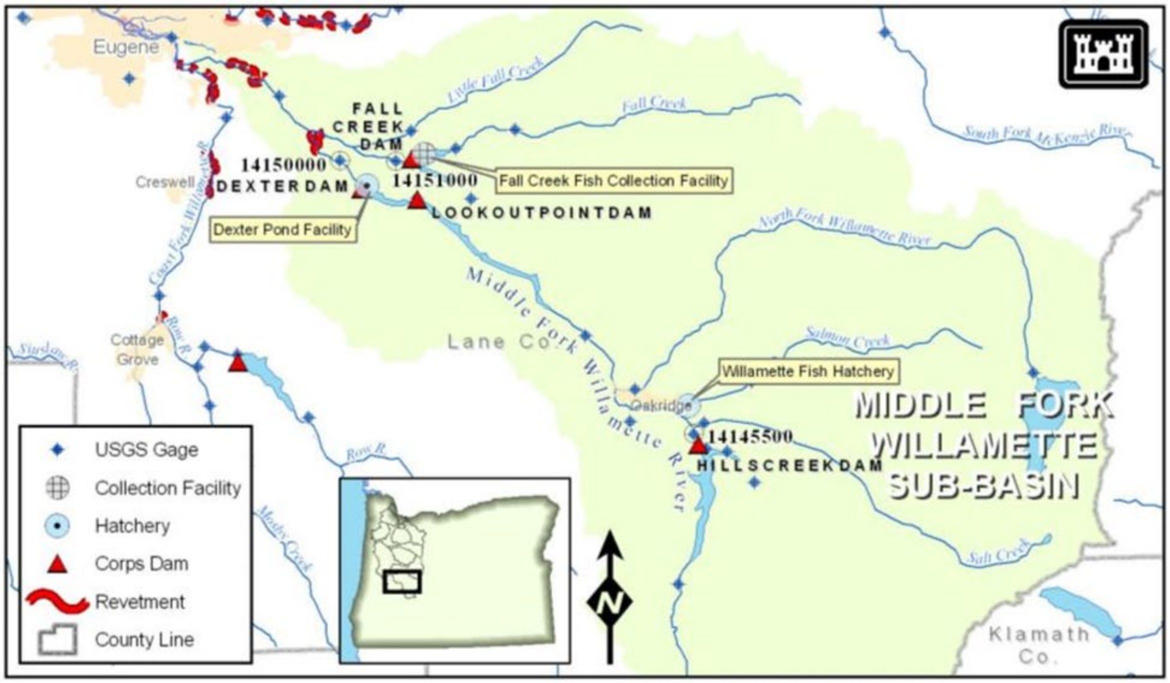

Figure 5.2-1 Map from the Middle Fork Willamette Sub-Basin FOP (USACE 2024a, Ch 5).

5.2.1 Habitat Access and Fish Passage

5.2.1.1 Effects of actions to provide adult upstream passage for UWR Chinook salmon

USACE proposed to continue operations for adult upstream passage at the current Dexter AFF, with upgrades under construction. They also propose to continue Fall Creek adult facility operations, and to outplant only natural-origin UWR Chinook salmon above Fall Creek reservoir, as they have since 2009[8]. The new Fall Creek ladder and adult trapping facility, built in 2018, have improved handling of Fall Creek adult UWR Chinook spawners (Carey et al 2024). The two facilities and outplanting actions are very different. For the Dexter facility, mostly hatchery origin fish return, with a small number that are offspring from hatchery outplants. Fall Creek has a small total number of returns, primarily natural-origin. The shift from hatchery origin to natural origin has followed Fall Creek downstream passage through deep drawdowns. The following

[8] In 1998, hatchery-origin UWR Chinook salmon releases above Fall Creek Dam began to re-establish natural production on historical spawning and rearing grounds.

shows that current operations result in few adult UWR Chinook salmon returning to the subbasin.

UWR Chinook salmon move into the Dexter Dam ladder, where they are trapped and moved into the adult facility. Dexter AFF upgrades were part of the September 2021 Court Injunction Order, stating: "(18) As required by [2008] RPA 4.6, the Corps SHALL make improvements to and begin operating the Dexter adult fish facility within two years of this Interim Injunction" (US DOJ 2021a). USACE began construction of the Dexter adult facility upgrade in 2023, and the upgraded facility is expected to be operating in May 2026, with additional screening work to be completed by 2027. USACE described expected benefits as more frequent operations, daily rather than two days/week during spawner returns. This will change numbers from a maximum of 1500 to 1000 adult UWR Chinook salmon handled per day, and from an average of 200 to 150 per day. The maximum annual targets for Hatchery/Wild UWR Chinook changed from 12,000/0 presently to 6,000/10,000 UWR Chinook moving through the facility (USACE 2022b). The new facility will return to juvenile rearing mid-May to mid-April. The UWR Chinook collected onsite are used in broodstock, sales, tribal allocation, transport above Lookout Point Dam, and transport above Hills Creek Dam. The proposed action describes how adults at Dexter are currently transported to the adult Chinook salmon holding facility at the Willamette Hatchery until spawning. The holding facility was constructed in a former earthen rearing pond from the original hatchery. It is inadequate for current adult holding needs at the Willamette Hatchery; consequently, the adults are overcrowded in the pond, not easily captured, and overly stressed which contributes to high pre-spawn mortality of collected broodstock (USACE 2024a).

In the PA, USACE (2024a) described the integrated conservation-oriented genetic protocols for UWR Chinook, with the Willamette Hatchery producing USACE's entire mitigation requirement for spring Chinook in the Middle Fork Willamette sub-basin. Tables 5.2-1 and 5.2-2 show target numbers of outplanted fish and release sites described in the Middle Fork Willamette Sub-Basin FOP (USACE 2024a, Appendix F WFOP). In addition, the Middle Fork Willamette Sub-Basin FOP describes changes that may occur:

> *In-season variances to either outplant site use, fish disposition, or other outplanting protocols can be completed with agreement from the WFPOM Team with notification provided to the WATER Steering Team. NMFS must agree to any in-season variances proposed by the WFPOM Team before the action is taken. (Section 5.2.2.12)*

However, the numbers of UWR Chinook returning has severely limited the outplanting, and in many recent years, none have been placed above Hills Creek Reservoir.

The Middle Fork Willamette River UWR Chinook adult counts declined from over 6000 in 2015 to under 1700 in 2024, nearly a four-fold decrease, and most of the returning adults are hatchery origin (HOR). Due to actions intended to boost natural origin influences in the hatchery population, there are no natural origin (NOR) outplanted above the Middle Fork Willamette River mainstem dams. In recent years, returning NORs were only 0.4% to 9% of the UWR Chinook adults, and while NOR numbers increased somewhat they remain quite low (Figure 5.2-2). The goal for successful restoration of production is less than 10 percent hatchery origin spawners (pHOS). This is far from being met, as average pHOS is 96% for UWR Chinook returning to Dexter Dam 2015-2024 (USACE Willamette Valley Fish Counts), with an estimated 81% pHOS for the few UWR Chinook adults that spawn downstream of Dexter Dam (NMFS 2019a, table 6). These few NOR returning UWR Chinook are mostly first generation hatchery offspring since few to no NOR adults are outplanted above the dams. Their extremely low abundance indicates limited productivity for UWR Chinook in the Middle Fork Willamette River, as does the high pHOS values. This may be due in part to the challenges of upstream transport, but is even more likely due to lack of safe downstream passage options (more details in later sections).

Table 5.2-1 Number of Adult Spring Chinook to be Outplanted, by location and origin. X indicates fish are outplanted, and 0 indicates if none are outplanted. From Middle Fork Willamette Sub-Basin FOP, Table MFW-5.

Location	Target Number of Fish	Origin	
		Hatchery	Natural
Middle Fork Willamette, upstream of Hills Creek Reservoir	1,100	X	0
North Fork Middle Fork Willamette, upstream of Lookout Point Reservoir	1,350	X	0
Fall Creek, upstream of Fall Creek Reservoir	All	0	X

Table 5.2-2. Release sites approximate locations. From Middle Fork Willamette Sub-Basin FOP, Table MFW-6.

Release Site
Middle Fork Willamette (upstream of Hills Creek reservoir)
North Fork Middle Fork (15 river miles upstream of Lookout Point Reservoir)
Fall Creek, Site C (8 river miles upstream of Fall Creek Reservoir)

In contrast, 71-96% of the adult UWR Chinook returning to Fall Creek Dam are NOR, with pHOS since 2011 ranging from 4 to 29% (average 12%). This relative success, allowing outplanting above the reservoir without hatchery supplementation means hatchery genetic effects have been reduced, and natural selection can drive adaptation. However, total returns have also been declining with a high count of 873 in 2020 dropping to a low of 136 in 2021 (Figure 5.2-2). High levels of prespawn mortality (PSM), ranging from 0.37 to 0.94, are likely causes. Return timing is early as more than 70% UWR Chinook arrive at the dam by the end of June (O'Malley 2024a). Similar to Dexter Dam, there is little spawning in the reaches below the dam to the confluence with the Middle Fork. Those outplanted above Fall Creek Dam have very high prespawn mortality, with a recent study noting possible causes as elevated temperature exposure on the spawning grounds, elevated temperature exposure below the trap, total number of outplanted fish, and human disturbance of outplanted fish (Carey et al 2024). While there are more NOR than HOR adult UWR Chinook returning, the abundance is dropping (Figure 5.2-2). The high PSM levels will continue to limit productivity in this subbasin.

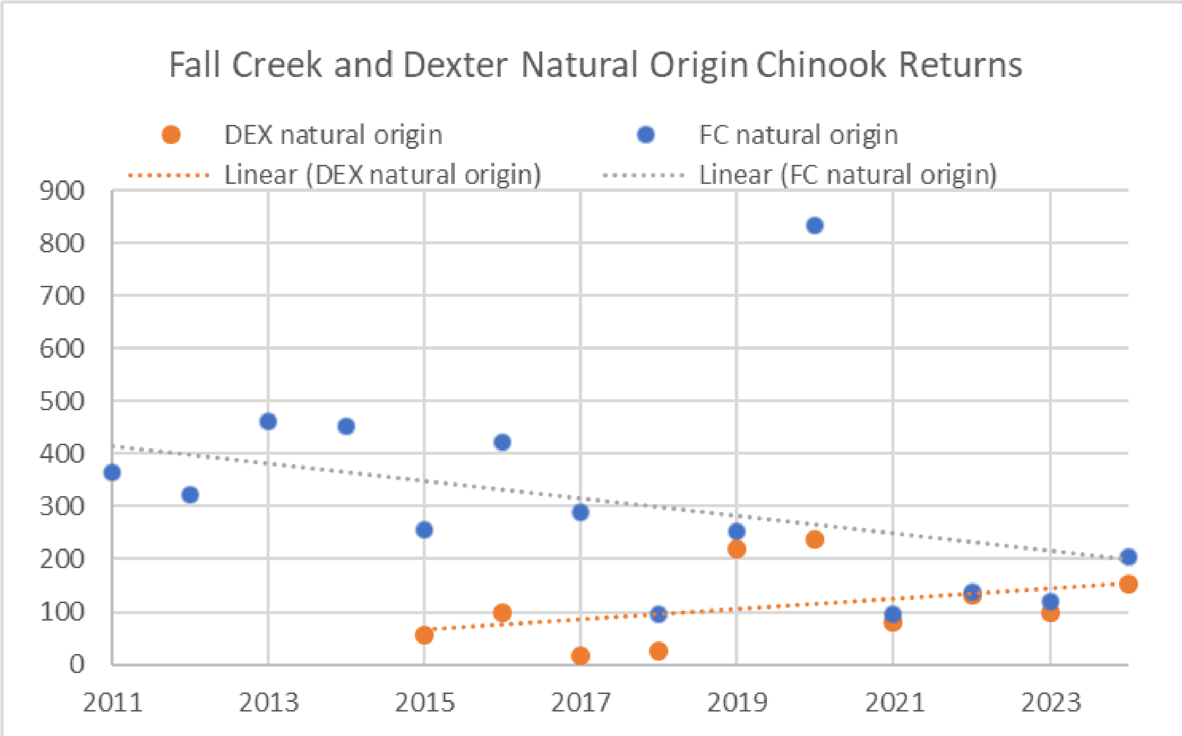

Figure 5.2-2 The natural origin returns to the two lower dams. The Fall Creek tributary has had mostly natural origin returns in recent years, while Dexter Dam has almost entirely hatchery returns. Source data from ODFW (Dexter Dam) and USACE (Fall Creek Dam), at https://pweb.crohms.org/tmt/documents/FPOM/2010/Willamette_Coordination/Willamette%20HMT/Fish%20counts

Although the NORs at Fall Creek outnumbered those returning to Dexter Dam for the entire upper Middle Fork basin from 2015-2020, they have faced obstacles of ongoing high-water temperatures, particularly in July. This may affect the later returns, although in most years 70% or more have moved upstream by the end of June. In addition, there have been numerous late summer and fall wildfires in the upper basin since 2021, which can interfere with spawning habitat conditions (USDA 2024). Carey et al.'s (2024) study of spawning problems suggested dam operations may reduce downstream temperatures in the spring when UWR Chinook spawners return to the Fall Creek adult facility, but also note fishing and swimming activities in the outplanting area are disturbing UWR Chinook. With the natural origin UWR Chinook productivity declining in this smaller basin, further viability loss for the Middle Fork Willamette population is likely.

The 2022 Biological Viability assessment noted, that under the environmental baseline: "Accessible habitat in the Middle Fork Willamette River is very limited and, until effective upstream and downstream passage past the dams is developed, it is unlikely that abundance will improve markedly" (Ford ed. 2022). This lack of abundance is also seen in the cohort replacement rates reported by O'Malley et al (2024a) on Fall Creek Genetic Parentage Analysis. They reported on the total lifetime fitness and cohort replacement rate (CRR) for adults outplanted from 2011 to 2015, with most years below one, indicating that the reintroduced population above Fall Creek Dam is not replacing itself. The initial runs for total lifetime fitness (TLF) was extended to include 2016 and 2017 parents, with the TLF rising in part due to the 2020 strong returns, although lacking 5 yr old returns for 2016 and both 4 and 5 yr old returns for 2017 (Figure 5.2-2). However, Figure 5.2-2 shows sharp declines after the 2020 peak of 850 to returns of only 100 -200 UWR Chinook, limiting abundance in Fall Creek. This smaller population is important to the overall subbasin, but cannot replace the need to increase productivity in the mainstem Middle Fork Willamette.

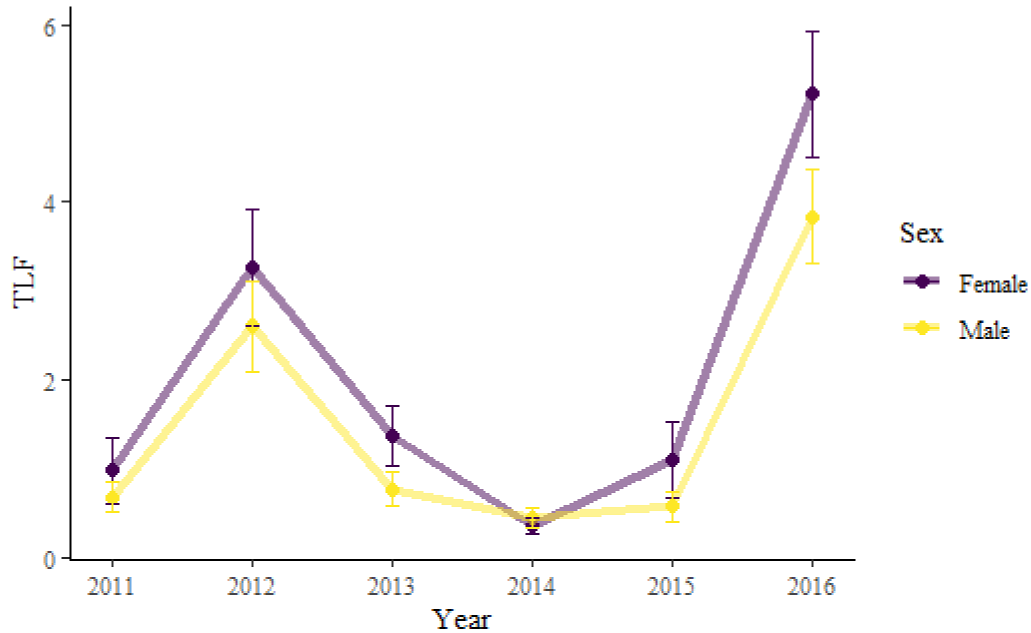

Figure 5.2-3 Mean TLF and standard error for Chinook salmon reintroduced above Fall Creek Dam from 2011 – 2015 by sex. While 2016 estimates do not include potential age-5 offspring, these usually few with none returning in 2020, and only 8 and 11, in the two years prior. Total Lifetime Fitness is the number of adult offspring identified returning in years three through five.

5.2.1.2 Outplanting effects from Spawner surveys

USACE has partnered with ODFW to survey for redds during observed spawn timing above Fall Creek and in some past years, above Lookout Point reservoir. The timing has not always been optimal due to wildfires in 2017, and again in 2020-2023 (USDA 2024). However past surveys provide estimates of successful spawning, from the total number of redds.

Previous surveys followed outplanting either to test a particular practice, such as how early UWR Chinook salmon outplants fared relative to those held on site at the Dexter adult facility, or in the river below the ladder when it was not open. Other survey efforts included hatchery adults from both the Dexter trap and Willamette Hatchery outplanted into the North Fork Middle Fork Willamette River above Lookout Point Reservoir in various locations to support research into causes of prespawning mortality. In the case of Fall Creek, with only natural origin “unclipped” outplanted, the transport of UWR Chinook timing began and ended “with the capture of the first and last unclipped adult fish" (Sharpe et al 2017b). UWR Chinook spawner abundance estimates used the count of spawning females and males at the peak redd count. The estimates for pHOS include fin-clipped spawners and unclipped thermally-marked fish, from an analysis of otoliths collected.

These data were used to improve estimates of cohort replacement rates (CRRs) which USACE has proposed to use for downstream passage effectiveness. The CRR is also propoped as a measure of the success of outplanting, when the data CRR would inform future outplanting decisions (described in 5.1.3 above). However, spawner surveys are not consistently performed, above or below the Middle Fork mainstem dams. Genetic samples are not analyzed for the outplanted UWR Chinook spawners in this basin, as the default strategy is to outplant only HOR adult UWR Chinook. This outplanting strategy will continue, and will limit benefits for diversity and productivity of UWR Chinook salmon. As noted above the Middle Fork River FOP will be updated, with changes to fish disposition or other outplanting protocols to be completed with agreement from the WFPOM Team, with notification provided to the WATER Steering Team. USACE noted effects on temperature from Dexter Dam on the Dexter AFF adult attraction, collection, and health as part of the "Risks and Uncertainties" for this facility (USACE 2024a, Appendix A, Section 5.6.1.5). If these effects are not assessed quickly, decisions on when to release warm water will not reduce harm from ongoing higher risk of disease and prespawn mortality (PSM) for UWR Chinook spawners holding below Dexter Dam.

The PSM values reported in 2015 (when outplanting numbers were closer to the targets in Table 5.2-1) ranged from 30% in the North Fork Middle Fork, to 89% above Hills Creek Reservoir, and for the few spawners downstream from Dexter, 99% (Sharpe et al 2017c). The very warm conditions in 2015 would have affected the UWR Chinook moving from the ocean up the mainstem Willamette River to the Dexter AFF, although they migrated earlier than usual. In Fall Creek, the PSM above the reservoir was 60% in 2015, and 30% in 2016. Middle Fork Willamette PSM values are anticipated to change in the near future with better handling from the upgraded Dexter AFF. Declining adult returns shows this UWR Chinook population has the highest risk from low abundance of natural-origin salmon due to poor survival of the outplanted adults and as is covered below, the juveniles migrating past the dams. Given proposed operations will continue limited outplanting, modifications to passage (below) will not increase UWR Chinook until outplanting is increased to upstream tributaries with higher quality habitat. In addition, temperature conditions in Lookout Point reservoir, which pass through Dexter Dam increase risk of prespawn mortality for adult UWR Chinook that are collected at Dexter adult facility for outplanting. The new Dexter AFF, following initial monitoring and evaluation should ensure optimal handling to allow future increases in outplanting.

5.2.1.3 Effects of Interim Juvenile Passage Operations

In the mainstem Middle Fork Willamette River, USACE will continue the current ungated spill passage when Lookout Point reservoir elevation is 2.5 feet over spillway crest in the spring. This will proceed for at least 30 days or longer if reservoir elevation allows, then transition to gated spill at night when the reservoir level remains above the spillway elevation. Hydropower generation continues during the day. Downstream of Lookout Point Dam, operational passage through Dexter Dam will have dusk to dawn spill, with daytime turbine operations. These passage operations provide alternatives to the turbines, which are available most of the year but are considered much less safe. In fall, Lookout Point reservoir is proposed to continue the deep drawdown to elevations that provide juvenile UWR Chinook access within 30 feet of the ROs. Review of passage routes shows few juveniles surviving in the reservoirs, and fewer still will find routes, with limited survival for outmigrating juvenile UWR Chinook salmon. This has been shown in several studies, and the most recent estimates of cumulative survival probability for April-June staggered releases recaptured up to October in Lookout Point reservoir was 0.52 (Kock et al. 2019a, 2019b). They noted most of the mortality occurred in the first four months, and that these subyearling UWR Chinook were vulnerable to predation, and estimated only 19% of the mid-April outplanted UWR Chinook survived to October (Kock et al 2019a, 2019b). For later entries that are able to grow to larger size, they estimated higher survival. The limited reservoir survival, and proposed limited passage that does not attract juveniles, would cause reduced abundance when UWR Chinook are unable to migrate past Lookout Point dam after entering the reservoir in the spring.

Fischer et al (2019b) followed outplanted UWR Chinook salmon as they passed through Lookout Point reservoir, past the dam, and then downstream in Dexter reservoir and past Dexter Dam during fall 2017 (October–February) and spring 2018 (March–July). UWR Chinook salmon[9] were double tagged with small acoustic tags, and PIT tags to track both in the reservoir and with observations of passage at arrays of hydrophones that detect UWR Chinook approaching the dam, and in the forebay at the spillway, between the spillway and powerhouse, and at the center of the powerhouse. Below Dexter Dam, a "last detection" hydrophone captured UWR Chinook detections. For subyearling UWR Chinook in fall/winter 2017, they estimated survival through Lookout Point turbines and to Dexter Dam downstream ranged from 0.724 to 0.727. While these survivals were moderate for turbines, they are only for a subset of UWR Chinook subyearling from the head of reservoir that would have passed Lookout Point Dam. The proposed action would continue similar turbine mortalities during months each year when this is the only passage route available.

For UWR Chinook released in October, some detected in the forebay throughout the first 2 weeks did pass Lookout Point but the authors noted that "36.0% of fish. . .never migrated to the lower end of the reservoir near Lookout Point. . .and 71.9% were classified as 'disappearing' by day 55 post-release" (Fischer et al 2019b). More of the UWR Chinook released in December approached the dam. Overall passage efficiencies calculated for those detected in the forebay in October and December were 0.306, and 0.578 showing "just over half of the fish that encountered the Lookout Point forebay eventually passed the dam" (Fischer et al 2019b). The combined effect of low passage efficiency and low survival leaves few UWR Chinook juvenile surviving passage. The lack of safe passage through the reservoir and past the dam under the proposed action reduces the abundance of UWR Chinook migrating and rearing in the lower river and the mainstem Willamette River. This will reduce overall diversity and productivity when UWR Chinook salmon cannot 'spread the risk' by different migration timing and age classes. While recent fall deep drawdown operations provided a route through ROs in the late fall/winter, it lasts just over a month and is unclear if they are able to pass safely (Hance 2024).

[9] These UWR Chinook were reared and tagged at the OSU Wild Fish Surrogate Program described in Cogliati et al (2019).

Fischer et al (2019b) also released UWR Chinook yearlings with 50.2% ultimately disappearing for the February releases while others approached the forebay, then disappeared, with only 3.5% passing Lookout Point (in the 55 days after April release). Passage efficiencies for those detected in the forebay were much lower than fall, 0.267 for February and 0.052 for April releases. Survival to Dexter Dam from Lookout Point Dam forebay ranged from a low of 0.441 through the Lookout Point turbines, to a high of 0.884 for the spillway routes combined for February and April (see Table 5.2 in Fischer et al 2019b).

Other conclusions related to high mortality in Lookout Point tailwaters through the Dexter reservoir to Dexter Dam; most passing Lookout Point turbines passed at night, as did study fish passing Dexter through turbines during nighttime hours; and travel rates in the Middle Fork Willamette was slow through the two reservoirs, extremely slow through Lookout Point forebay, and quick from Dexter tailwaters down to Wilsonville, Oregon (Fischer et al 2019b).

During the Injunction operations, the deep drawdown to provide fall RO passage resulted in temperatures changing in the Lookout Point reservoir. The main study tagged UWR Chinook outplanted from August to October. While noting they would continue modeling the data, Hance et al. (2024) conclusions noted that passage and survival through Lookout Point Dam peaked at minimum reservoir elevation and higher RO outflows, and provided these summaries:

- Apparent survival was poor in Lookout Point Reservoir *and* in Dexter Reservoir in September due to the elevated water temperatures, which were stressful for juvenile salmon, but optimal for non-native predators (e.g. smallmouth bass).
- Proportion of fish detected at Dexter forebay from Lookout Point head of reservoir releases ranged from 0.00 (August-September releases) to 0.34 (October releases).
- In contrast, tailrace releases had proportions of fish detected at Dexter forebay ranging from 0.11 (September releases) to 0.89 (October releases).
- Rearing Chinook salmon preferentially inhabit cool water at depth.
- Drawdown operations began in June, with regulating outlets in use by mid-July.
- Lookout Point temperature operations began in June, with regulating outlets in use by mid-July.The reservoir mixed fully by mid-August with evenly warm temperatures.

They also noted, similar to the earlier study above, additional “mortality and delay in and through Dexter reservoir and dam” (Hance et al 2024). One area suggested for future operations was to consider a “return of the thermocline” -- which may require modified timing and duration of the deep drawdown passage operation. From this initial year, the results were not positive as high juvenile UWR Chinook losses in the reservoir continued, attributed to the warmer water. A similar concern was noted at the Dexter fish facility in 2023 as illness increased with rising temperatures, with a report from Dr. Aimee Reed, ODFW’s Fish Health Program Manager and Veterinarian: “Dexter Ponds [ ] fish have been experiencing very high temperatures, between 72-74°F, which is contributing to significant losses due to infectious disease” (Couture 2023).

Hills Creek Dam downstream passage, prior to the Injunction changes in timing had an estimated survival of UWR Chinook through the turbines and regulating outlets at about 41% and 68%, respectively (Ziller 2002). USACE proposed to continue following the Injunction actions that specify for November to March, if below target elevation of 1460 feet (following rule curve), prioritizing RO use from 6PM to 10PM, and a mix of turbines and RO run at other times. This

RO has a very high drop route, with juveniles landing in a stilling basin with high risk of injury, and into water with high TDG below.

In addition, for natural juvenile UWR Chinook migrants, RST data reported injuries were prevalent in juvenile UWR Chinook caught below Lookout Point Dam, either in the powerhouse tailrace screwtrap, or in the RO tailrace screwtrap (combining passage of Chinook from both RO and Powerhouse routes). The most common injuries observed at this site include descaling (both < 20% and > 20%), bleeding from vent or eyes, fin damage, operculum damage, and the presence of copepods. These differ slightly in magnitude between the powerhouse and the RO tailrace trap data, but generally follow the same pattern (EAS 2024c). In order from highest to lowest of these injuries: fin damage (94-100%), descaling (96-97%), copepod presence (75-89%), vent bleeding (22-33%), bloody eye (21-28%) and operculum damage (8-21%) (EAS Tables 76 and 77). All of these consequences caused by the proposed action would lead to lower survival during downstream migration. Increased copepod presence for higher fork length juvenile UWR Chinook salmon would harm fish that survived the reservoir rearing and passage, as generally larger fish would expect to have higher survival, but are compromised by copepod infestation (Monzyk et al. 2015b). Compounding the survival difficulties, these UWR Chinook migrants have to pass through the Lookout Point reservoir, past Lookout Point dam, and through Dexter reservoir and the Dexter Dam.

To estimate the number of juvenile UWR Chinook that passed the Hills Creek head of reservoir sampling site February to June EAS (2024c) utilized pooled averages from trap efficiency trials and reported 2,016 juvenile Chinook passed the sampling site. In contrast, the estimates using trap efficiency trials to expand counts reported 316 in the powerhouse (PH) tailrace and 864 in the RO trap. The authors provided this 2024 Summary:

> *Similar to previous observations from monitoring in 2022 and 2023, peak passage of [UWR Chinook below Hills Creek Dam] occurred from November through January with the RO spill operations. However, many of the fish captured in each period were in the PH trap, suggesting that most fish passed through the PH instead of the RO. This implies that other factors such as pool elevation, depth to reservoir outlets or time of year may be influencing Chinook salmon movement out of Hills Creek Reservoir and that fish may pass through the RO channel at lower relative percentages, when compared directly to the PH. (EAS 2024c)*

Fall Creek passage operations are proposed to change from recent years, as USACE will discontinue a second drawdown in December that was part of Injunction operations. This will return the timing and duration of passage to earlier in the fall and shorter length, with many UWR Chinook moving out in the early part of the operation. The second later drawdown under the Injunction actions was intended to allow another life history stage, fry, to migrate, without affecting refill of the reservoir, and adult facility operations. UWR Chinook returns for these 2011-2021 actions are in part covered by the CRR results reported above, with the later years as yet not covered (full cohort samples were not available). It remains to be seen if the obstacles from spawning habitat conditions above the Fall Creek reservoir can be overcome through operational measures.

In the Middle Fork Willamette River, the passage routes are few and inadequate for safe passage for multiple age classes. This will continue under the proposed action with current routes, although it may improve over time in the Lookout Point combined spill and deep drawdown. Ongoing data collection will be needed, and if expanded will help sort out under which conditions at each of the routes there would be highest survival. Given available information, increased adult returns to improve productivity at both of the lower dams will be challenging under the proposed action.

5.2.1.4 Effects of Long-Term Passage Operations

In 2034, USACE "anticipates starting the Engineering Design Report (EDR) and alternatives analysis for long-term structural downstream fish passage at Lookout Point" (USACE 2024a). After review of existing fish passage data and the identification of further RM&E needs, USACE proposes a major check-in at the conclusion of the EDR (usually 1.5 to 2 years), when they would decide whether to move forward with the Design Document Report (DDR) phase of Lookout Point juvenile UWR Chinook salmon downstream structural passage. Time that would be spent working on structural design options will elapse while USACE potentially chooses to wait for additional evaluation of the Detroit Dam downstream passage structure, which is proposed to be completed and begin operating in 2036. This substantial delay in moving past the Lookout Point passage EDR to the DDR would cause more than a decade of continued adverse effects caused by operational passage measures and reduce the abundance and productivity further in the Middle Fork Willamette River Chinook salmon population, beyond the lower levels seen in recent years.

In selecting their preferred alternative for the Draft EIS (2022), USACE contracted for two modeling approaches to evaluate the benefits of the structural passage routes at Lookout Point and Hills Creek dams. One was from the NOAA NWFSC and compared the Draft EIS alternatives, with relationship to VSP scores. The alternative that achieved the highest combined abundance and productivity in the Middle Fork Willamette included structural passage at both Hills Creek and Lookout Point dams (Myers et al 2022). The second comparison effort by University of British Columbia modelers found the same higher abundance for this combination of structural passage at Lookout Point and Hills Creek dams (McAllister et al. 2023). Both models also reviewed results compared to probabilities that the natural origin UWR Chinook population would be lower than a Quasi-Extinction Threshold (QET); in the first model this had the lowest risk probability while in the second, it showed a lower range than all but one other option.

With no clear timeline for improvements with structures that would pass juvenile UWR Chinook salmon during all periods of peak outmigration at Hills Creek, increased productivity remains in hatchery outplants. This means the pHOS goals agreed on with USACE, NMFS, and ODFW are unlikely to be met, which reduces the potential for the recovery of natural origin UWR Chinook in this basin. The higher pHOS is linked to higher PSM in this subbasin, and this lowers abundance and increases risk of extinction.

5.2.2 Flow Effects

Flood risk reduction is the priority authorized purpose for the four dams in the Middle Fork Willamette River, and hydropower production is also part of the proposed action at all but Fall Creek dam. Flood prevention would decrease the magnitude and frequency of instantaneous peak flow events. Continuing these operations will contribute to the ongoing loss of habitat complexity in the Middle Fork Willamette River and the mainstem Willamette by substantially reducing the magnitude of channel-forming dominant discharge (generally 1.5- to 2-year) events and increasing the return intervals of larger floods. The result would be fewer side channels and alcoves, less large wood recruitment, and coinciding changes in movement of the full range of channel substrates.

Drawing down the Lookout Point and Fall Creek reservoirs as proposed for fall passage through ROs will modify the sediment transport as has been seen in the past decade at Fall Creek (Keith et al, 2024). Lookout Point had high turbidity due to suspended sediment movement in the first deep drawdown in 2023, and turbidity increases during 2024 early storms. Normally, the lower peak flows limit flushing of fine sediments, which have been seen building up for decades in the upper reaches of the Fall Creek and Lookout Point reservoirs, where the channel is forming through deposits when drawn down for passage. As noted in 2008 BiOp, one risk of the fines depositing would be reduction in interstitial spaces that can affect aquatic invertebrate prey species and may also affect juvenile salmonids, which are known to use interstitial spaces for cover during winter periods (Bjornn and Reiser 1991, Suttle et al. 2004).

There are limited numbers of spawners below both Fall Creek and Lookout Point/Dexter dams, with high prespawn mortality. The drawdown actions would affect these areas by changing the ramping rates when spawners are present, or after eggs are in redds. At times, flows are reduced abruptly to prevent downstream flooding causing rapid water level fluctuations. Discharges can also fluctuate over the course of the day to meet peak demand for power generation, although this will mostly affect the reaches below Hills Creek dam and the Chinook in Dexter Reservoir, which have shown low survival rates (see above sections). In the 2008 RPA measure 2.6, ramping rates for Hills Creek and Lookout Point/Dexter dams were specified to minimize stranding of juvenile UWR Chinook and aquatic invertebrates, as well as avoiding dessication of redds. The 2008 RPA also noted that structural modifications would improve USACE's ability to meet ramping rates, and that Action Agencies will conduct RM&E when rates could not be met above the listed outflow limit (NMFS 2008, Table 9.2-3, RPA measures 2.63 and 2.64). These ramping rate restrictions were not presented in the proposed action.

USACE also proposes minimum flows modified from those in the 2008 RPA (NMFS 2008a, Table 9.2-2). These are shown in Table 5.2.2, with the primary life history stage present during dates shown, but this does not preclude other life history stages from overlapping (e.g. rearing juveniles are present with adult spawners). While higher minimum flows are useful as a target, the proposed reflect current discharges as result of the order of drawdown to meet Willamette River mainstem targets with Lookout Point reservoir as first to be used (USACE 2000, Table 2-9). Fall Creek minimum flows are the same as those in 2008 RPA: 80 cfs April 1- August 31, 200 cfs Sept 1- Oct 15, and 50 cfs Oct 16- to March 31.

Table 5.2-2. Proposed Tributary Minimum Flow Objectives for Lookout Point Dam releases. Highlighted proposed minima in orange are reduced from the 2008 RPA Minimum Flow Objectives, and increases are shown in green when on higher refill trajectory. Hills Creek Dam fixed minimum flows are shown, unchanged from those in the 2008 RPA.

Start Date	Primary Use	2008 RPA Minimum Flow Objectives	Proposed Lookout Point >90% rule curve	Proposed Lookout Point >90% rule curve	Hills Creek (same as 2008 RPA)
1-Feb	Rearing/ migration	1200	1200	1000	400
16-Mar	Rearing/ migration	1200	1200	1000	400
1-Apr	Rearing/ migration	1200	1440	1000	400
16-Apr	Rearing/ migration	1200	1800	1000	400
1-May	Rearing/ migration	1200	1860	1100	400
16-May	Rearing/ migration	1200	1920	1200	400
1-Jun	Rearing/ migration	1200	1860	1300	400
16-Jun	Rearing/ migration	1200	1800	1400	400
1-Jul	Rearing/ migration	1200	1680	1500	400
16-Jul	Rearing/ migration	1200	1500	1600	400
1-Aug	Rearing/ migration	1200	1500	1300	400
16-Aug	Rearing/ adult migration	1200	1500	1200	400
1-Sep	Chinook spawning	1200	1500	1200	400
16-Sep	Chinook spawning	1200	1440	1200	400
16-Oct to 31-Jan	Chinook incubation	1200	1440	1200	400

5.2.3 Water Quality Effects

The proposed action for interim temperature management would continue working with discharges mixed from different elevations to achieve current temperature targets (USACE 2024a, Appendix F WFOP, Chapter 5). For Lookout Point, the proposed action is prioritizing use of the ROs in the late summer/fall for downstream temperature management when elevation is less than 887.5 feet. This generally is possible with the drawdown in June or July. Earlier, USACE discharges from the spillway for passage in the spring, and these are mixed with turbine discharge to meet spring and summer temperature targets. Once the reservoir elevation is below the spillway level, they can use turbines alone or mixed with cooler water from the RO depths in summer and early fall. When the turbines are initially the sole outlet, there is a brief drop to cooler temperatures, then rising summer temperatures continue (figure 5.2-4 shows summer temperature dip in 2021, 2023, 2024, and 2011).

However, as the drawdown for the fall operational passage continues, the reservoir ‘turns over’ the stratified layers, fully mixing until only a narrow range of temperatures remain, with little to no difference between the turbine outlets and the RO elevations. Prior to this, the ROs mixed with turbines can reduce the extreme levels. When turbines are no longer accessible, the ROs alone are used but once the reservoir layers are fully mixed, discharges from this level are warm as well. Target temperatures are rarely achieved outside of November, which leaves any eggs in redds likely to emerge very early, with lower survival. This would be reflected in low return rates of the few natural origin spawners below Dexter Dam.

Rising temperatures as the proposed drawdown continues can increase risk of PSM when adults are returning to the Dexter AFF. Late timing for migration over Willamette Falls will increase exposure at unsafe temperatures. If the holding area temperatures are higher, there is increased risk of PSM, especially when crowding conditions are present as was seen in past extremely high PSM levels. Figure 5.2-5 shows the limited spawner abundance in reaches below the Dexter Dam, and high pHOS values indicates the dominance of returning HOR adult UWR Chinook. However, it doesn’t capture the larger numbers of returning UWR Chinook holding below Dexter dam that would be crowded before and during ladder operations, in what is many times too warm water (Figure 5.2-4). Cutoff temperatures for spawners during holding are passed early and with little relief.

USACE has funded USGS to monitor turbidity, dissolved oxygen and suspended sediment concentration data for Lookout Point Dam, Dexter Dam, and Fall Creek Dam where deep drawdowns will be repeated (USACE 2024c; August Biannual Status Report, Table 17 gages). Suspended sediment increases rapidly after reaching the lowest elevation in the deep drawdown operational passage (Figure 5.2-6).

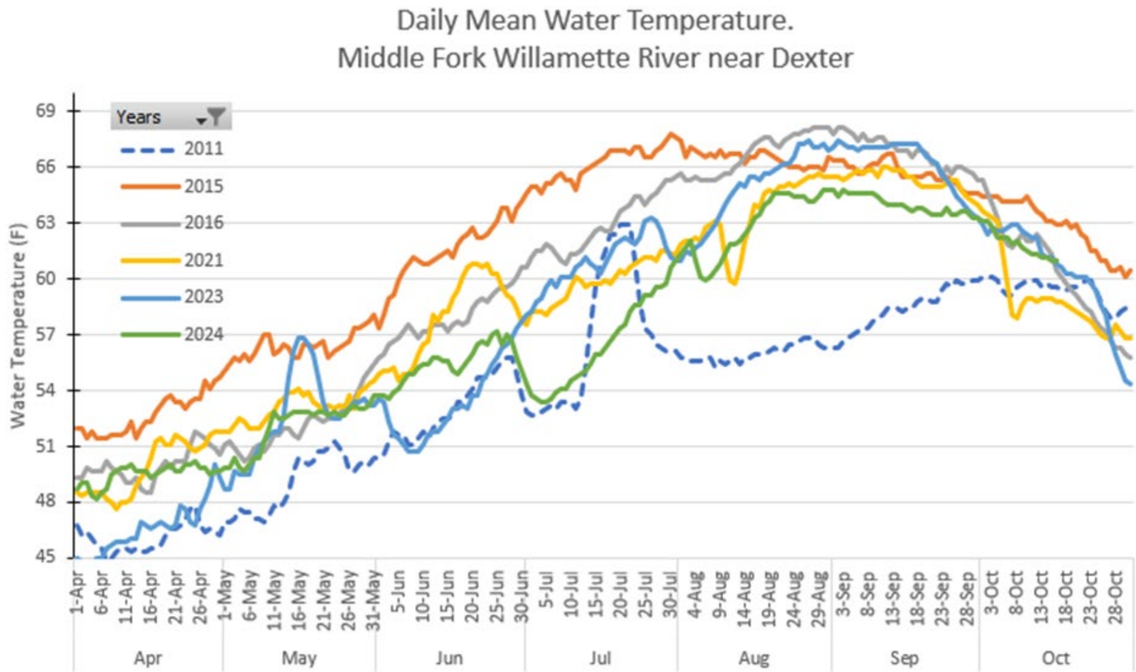

Figure 5.2-4 Mean daily temperatures during drier, low flow years are shown (2015, 2016, and 2021) along with recent years showing changes from drawdowns (2023, 2024), and one contrasting high flow, cooler year (2011). High late summer and fall temperatures were seen in 2016 and 2023; the latter due to drawdown conditions influencing reaches below Dexter Dam.

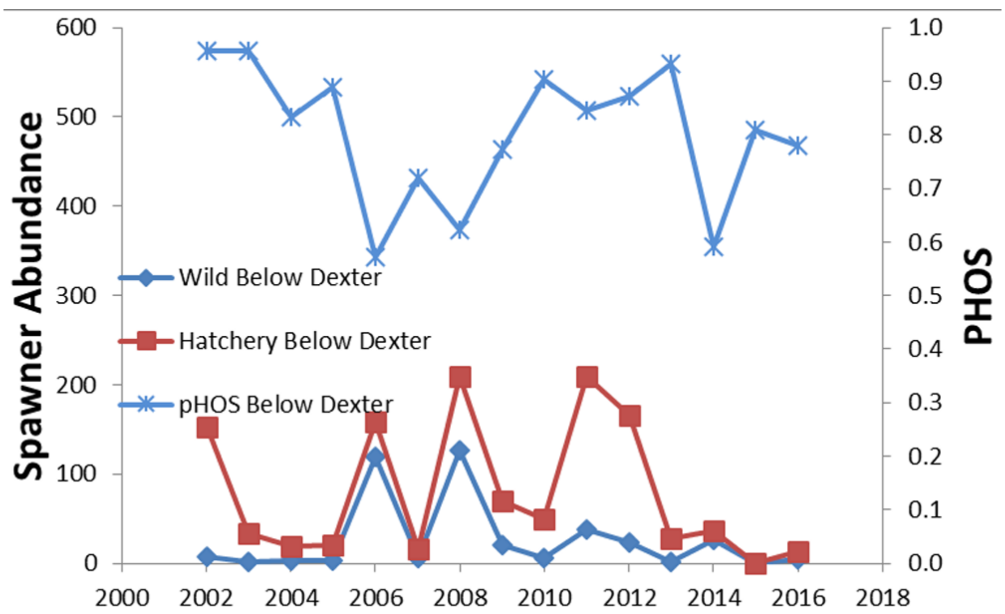

Figure 5.2-5 Below Dexter, the UWR Chinook spawners split by natural origin (wild) and hatchery, with the resulting pHOS, percent hatchery origin spawners. Source: Sharpe (2017b)

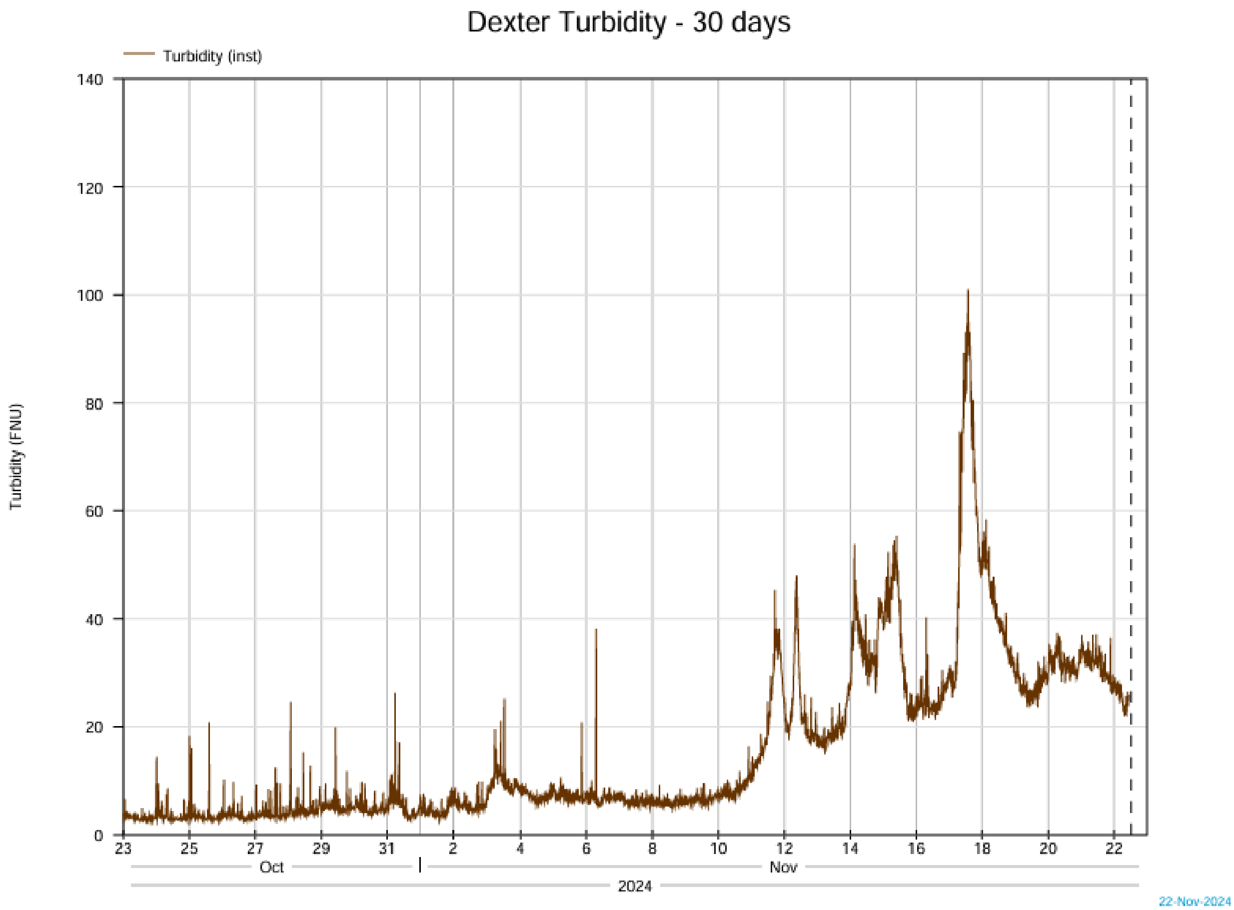

Figure 5.2-6. Gage data at Dexter Dam shows rising turbidity in fall 2024. Note these turbidity values are 50 to 80 percent lower than those at Lookout Point, 2 miles upstream, suggesting some of the suspended sediment drops out in Dexter reservoir. Source: https://www.nwd-wc.usace.army.mil/nwp/teacup/willamette/dex.pdf, accessed 11/22/2024.

The proposed operational passage produces much higher turbidity than normal fall and winter levels. During precipitation events sediment exposed while drawn down combined with high stream flow that increases stream energy, is scoured from the open stream bottom and sediment loads are transported farther downstream than would otherwise occur. Sediments in the water column reduce light penetration, increase water temperature, and modify water chemistry. Redeposited sediments can partly or completely fill pools, increase the width-to-depth ratio of streams, and change the distribution of pools, riffles, and glides. Increased fine sediments deposited in spawning substrate also reduce survival of eggs and fry, reducing spawning success of salmon and steelhead. These effects are expected to be repeated seasonally, ending as Lookout Point reservoir refills after the deep drawdown ends in December, although they can continue while the sediment transport continues. Downstream measurements show the turbidity is high below Dexter Dam, yet lower than below Lookout Point Dam. This may indicate partial deposition in Dexter reservoir, while a subset of the sediment remains suspended to move out of the Middle Fork Willamette River and on to the mainstem Willamette River. More information will be available as the ongoing USGS studies are completed.

In summary, the proposed actions in the Middle Fork Willamette River will cause:

- Continued high prespawner mortality for UWR Chinook salmon from higher temperature releases below dams
- Decreased survival for migrating and rearing juvenile UWR Chinook salmon, and high injury rates; slow travel rates in and past Lookout Point and Dexter reservoirs, and downstream through the mainstem Willamette River
- Reduced Middle Fork Willamette River off-channel habitat quality, connectivity and availability during refill and flood risk management
- Lower flow targets during dry years affecting temperatures and mainstem Willamette River targets, which can increase PSM of adult UWR Chinook during migration
- Hills Creek injuries to juveniles from turbines and operational RO passage will continue without changes to this dam

5.2.4 Effects on Critical Habitat

Designated critical habitat within the action area for the ESA-listed UWR Chinook salmon in the Middle Fork Willamette River consists of freshwater spawning, freshwater rearing sites and freshwater migration corridors and their essential physical and biological features (PBFs), described in the Rangewide Status of the Species and Critical Habitat.

PBF 1. Freshwater spawning sites

a) Water quantity. Lower peak flows in winter and spring caused by the proposed action limits creation and maintenance of channel complexity. Proposed Lookout Point lower flows in dry years, February to May, reduces access to in- and off-channel higher quality adult holding and spawning habitat.
b) Water quality. Continued interim passage can cause higher temperatures in areas where UWR Chinook hold below Dexter Dam during the fall drawdown of the stratified pool. Long term passage, if provided via a proposed structural route such as the floating screen structure in 2045, will increase the numbers of spawners outplanted to higher water quality reaches above the dams, resulting in higher productivity.
c) Substrate. Continued operation of the Middle Fork dams to reduce high flows for flood risk reduction, and to refill in spring and again in the early winter after the fall drawdown operation, will block sediment transport of suitable sized substrate for spawning. This will not change with proposed long-term structural passage, other than winter refill after deep drawdown. In contrast, Fall Creek reservoir continues to drawdown to near streambed which could mobilize spawning gravels, at higher flows. During operational passage of Lookout Point Dam, the suspended sediment will cause possible deposition of fines on redds below Dexter Dam, with turbidity gage readings indicating some deposition upstream in Dexter reservoir. Studies are underway to better understand the effects of this operation.

PBF 2. Freshwater rearing sites

a) Water quantity. Flow-related habitat availability and connections will be reduced when proposed lower minimum flows are released in February to May. In addition, continued operations to drawdown reservoir elevations, then refill, can reduce the high flows in winter and spring, which limits the creation of complex channels, and the connectivity to the floodplain features used by juveniles prior to migrating;

b) Water quality. Proposed lower flows in February to May, may lead to limited habitat when subyearlings and yearlings migrate. Late summer and fall flows that are very warm when drawing down the Lookout Point stratified reservoir will also harm UWR Chinook subyearlings.
c) Floodplain connectivity. Lower minimum flows proposed in spring, or lower flows in spring and winter for post drawdown refill, will reduce the floodplain connectivity by increasing the likelihood of 'single channel' habitat. Significant work to restore connectivity with the floodplain habitat in the lower Middle Fork Willamette confluence can limit the effects of this in those project reaches, but will leave other reaches with lower complexity.
d) Natural cover. Continued operations of Fall Creek, Dexter, Lookout Point and Hills Creek dams to refill and operations that restrict movement of large wood from above each dam, leads to reaches below where simplified single channel habitat dominates, diminishing riparian vegetation benefits (shade, refuge, prey habitat, and cover from predators). After 2020 fires this movement of large wood was removed from Fall Creek, with diminished amount in above and below dam areas will not be offset by below dam unburned areas due to lack of habitat enrichment.

PBF 3. Freshwater migration corridors

a) Free passage. Lack of clear, safe passage routes due to USACE operations of Middle Fork Willamette River Dams impedes juveniles from moving downstream, although adults are moved upstream to some of the higher quality spawning and rearing habitat. The proposed long-term passage solution of a floating screen structure at Lookout Point Dam will improve this PBF, for a subset of the UWR Chinook in this subbasin, however under the proposed action a long-term structural solution is not anticipated until 2045 at Lookout Point. At Hills Creek Dam, no long-term structural solution is proposed only a check-in after 2049.
b) Water quantity. Subyearling UWR Chinook migrants need flows to provide assistance to their volitional migration. There are fewer areas to find refuge due to reduced complexity from lower flows.
c) Water quality. Similar to above, with juveniles exposed to higher temperatures during migration in summer and fall under continued operational passage.
d) Forage. When juveniles are moving out from above the Detroit and Big Cliff dams, the USACE operations can affect the availability of complex habitat elements. Dam operations during post-drawdown reservoir refill, flood risk reduction, and low minimum spring flows also reduce transport of large wood and coarse sediment, habitat elements that increase prey from macroinvertebrate diversity and abundance.
e) Natural cover. Similar to above, migrating adults and juveniles need refuge from low flows (for temperature) and high flows (for velocity), and from predators.

5.3 McKenzie River Subbasin Effects

The McKenzie UWR Chinook salmon population is a stronghold population for the ESU. It had sustained the highest production of natural-origin spring Chinook salmon in the Willamette Basin until 2010, when Clackamas River natural-origin spawner counts exceeded those in the

McKenzie[10] (Ford ed. 2022). Nevertheless, the current abundance is greatly reduced compared to historical levels, and the population is at a "moderate" risk of extinction (McElhany et al. 2007, Ford ed. 2022). The primary causes for the decline of this population include loss of access to historical spawning and rearing habitat, altered physical and biological conditions downstream of the dams (hydrograph, temperature, flow, recruitment of gravel and woody debris), and interbreeding between hatchery and natural-origin Chinook salmon. As described in the Environmental Baseline section, Cougar Dam blocked 56 km of spawning habitat historically available to the McKenzie population of UWR Chinook salmon (Myers et al 2006), while the Blue River Dam blocked 4.3 km on the Blue River. There are no Chinook salmon spawning in the Blue River, nor any outplants above the Blue River Dam. Construction of power-generating facilities at the Cougar project was authorized in the Flood Control Act of 1954. Blue River also had hydropower authorized, but no facilities were built. While Cougar Dam was constructed with a fish-passage system in place, this was abandoned in the late 1960s because of poor passage and high mortality of juvenile Chinook salmon (USACE 2024a). Congress authorized the construction of a water-temperature-control tower at Cougar Dam in the Water Resources Development Act of 1996, and this began operations in 2010. The effects of the Proposed Action on UWR Chinook salmon in the McKenzie River subbasin are described below.

The Proposed Action includes USACE doing the following (USACE 2024a):

- Continued operation and maintenance of Cougar Dam on the South Fork McKenzie River and Blue River Dam on Blue River, as stated in the Willamette Fish Operations Plan (WFOP), McKenzie chapter 4 (USACE 2024a, Appendix F). USACE will continue to limit down ramping below Cougar and Blue River dams to no greater than 0.1 ft. per hour during nighttime hours and 0.2 ft. per hour rate during daytime hours. When possible, flow will be capped during peak migration to minimize TDG levels during regulating outlet operations.
- Trap-and-haul of UWR Chinook salmon from below Cougar Dam to release locations above Cougar Reservoir in the South Fork McKenzie and from Leaburg and on the McKenzie to hatcheries for artificial spawning. Fish collection and handling will be as described in the WFOP, Chapter 4, Section 5. Figure 5.3-1 shows all facilities in the basin.
- Cougar adult fish collection facilities - operate and maintain the fish ladder at the base of Cougar Dam and maintain or update facilities at Leaburg and McKenzie hatcheries.
- Continued priority use of the regulating outlet (RO) through 2042 during a fall drawdown to 1505 ft elevation and spring delayed refill with a drawdown to 1520 ft elevation. This operation is intended to improve downstream passage for juvenile UWR Chinook salmon produced from spawners above Cougar Reservoir. In other seasons, a mix of RO and turbine operations provide passage.
- Complete final design, plans and specifications, fund, and construct the proposed RO modifications to improve passage in the current chute and reduce mortality in the stilling pool.
- For long-term passage, the Corps proposes to complete a Deauthorization Disposition Study, finish the proposed RO channel modifications (Figure 5.3-2), and with the post-construction evaluation data, inform the next steps for downstream fish passage. If

[10]Geometric means for 2010–14 and 2015–19 natural origin spawners in the Clackamas River exceeded the McKenzie River.

Congress agrees to deauthorizing affected project purposes, then the Corps would have sufficient authority by 2033 to move forward with the Cougar long-term downstream passage measure design. The design would provide volitional passage through the diversion tunnel from a minimum proposed reservoir elevation 30 feet over the top of the tunnel (at or above 1330 feet), for periods during spring and fall, refilling as much as possible between these periods. The design, contracting, and construction steps would be completed in 2042.

- Flow Management - For biweekly timing of changes in flows released from Cougar Dam, meet or exceed proposed lower flow minimum objectives. For refill, use the water control diagram to guide the level of lower flows, unless dam operations require higher flows. In other periods, and for Blue River Dam, flows released are proposed to meet the minimum objectives in the 2008 RPA (NMFS 2008a); all are shown in Table 5.3-1
- Continued production of hatchery Chinook salmon at Leaburg and McKenzie Hatchery, or alternative sites as needed, for fishery augmentation and conservation purposes.

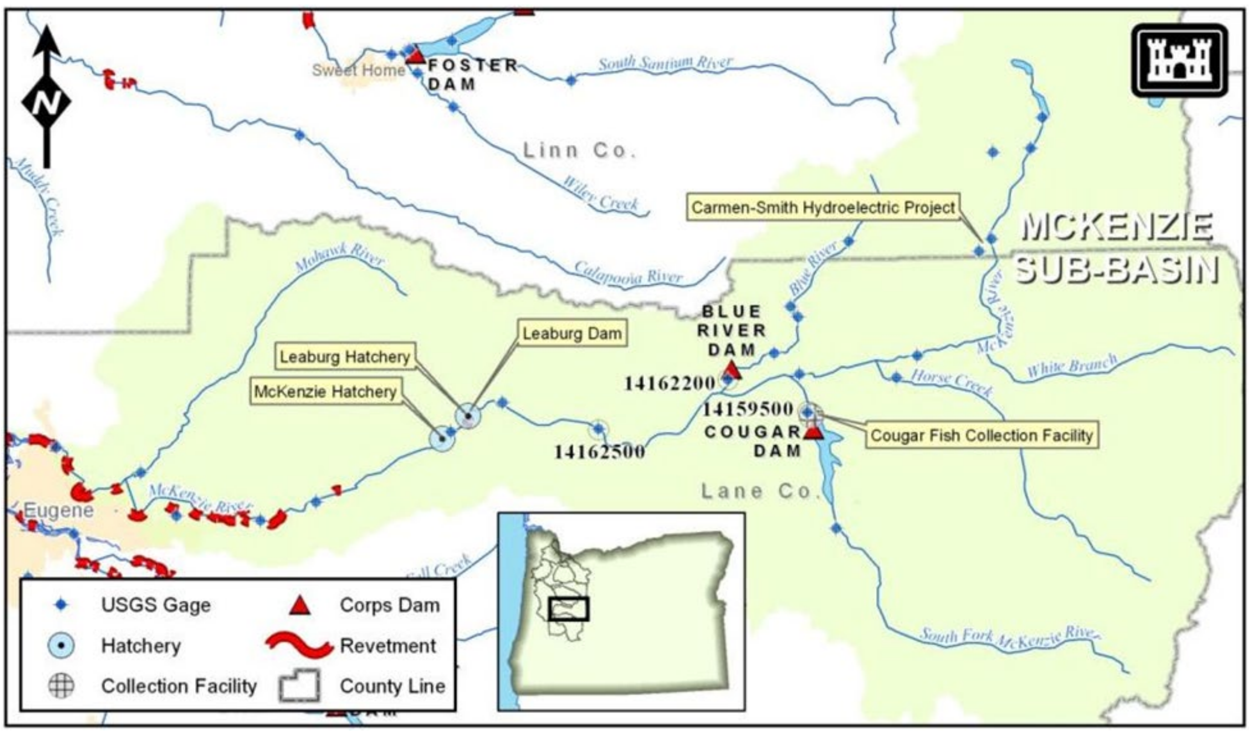

Figure 5.3-1. Overview of the McKenzie Subbasin and the Corps Dams and associated hatcheries used for collection and supplementation. Source: USACE, 2024b, WFOP Ch 4, Figure MCK-1.

Table 5.3-1 Minimum flow thresholds for releases (cubic feet per sec, cfs) from Cougar and Blue River Dams. Proposed Cougar minimum flow thresholds would vary based on elevations ≥90% or < 90% of the water control diagram. 2008 RPA minimum flow objectives are 300 cfs, except 400 cfs in June. BlueRiver minimum flows are the same as the 2008 RPA.

Dates	Blue River all levels	Cougar >90%*	Cougar <90%*	NMFS 2008 RPA
1-Feb to 30-Apr	50	300	250	300
1-May	50	465	275	300
16-May	50	480	300	300
1-Jun	50	465	325	400
16-Jun	50	450	350	400
1-Jul	50	420	375	300
16-Jul	50	375	400	300
1-Aug	50	375	325	300
16-Aug – 15-Sept	50	375	300	300
16-Sep-30 Nov	50	360	300	300
Remaining dates are based on flood risk reduction or power operations				

5.3.1 Habitat Access and Fish Passage

5.3.1.1 Actions to address upstream passage

USACE proposes to continue collecting UWR Chinook salmon adults from the mainstem McKenzie River and the South Fork McKenzie River, and move natural-origin and hatchery-origin Chinook salmon above Cougar Dam and Reservoir. The proposed action causes harm and mortality from fish collection and handling processes. However, continued outplanting also has the potential to improve productivity and spatial structure, provided UWR Chinook salmon are handled appropriately. USACE plans to work on solutions to manage the loss of facilities that allow them to remove hatchery-origin adult Chinook salmon from areas with natural-origin adult Chinook salmon. To do so, they will continue to work with ODFW to distribute adult fish using an appropriate mix of hatchery- and natural-origin fish. Despite ongoing efforts to reintroduce returning spawners and outplant hatchery-origin Chinook salmon, this has not resulted in recruits returning close to numbers of spawners outplanted, so overall productivity is declining in the South Fork McKenzie River population.

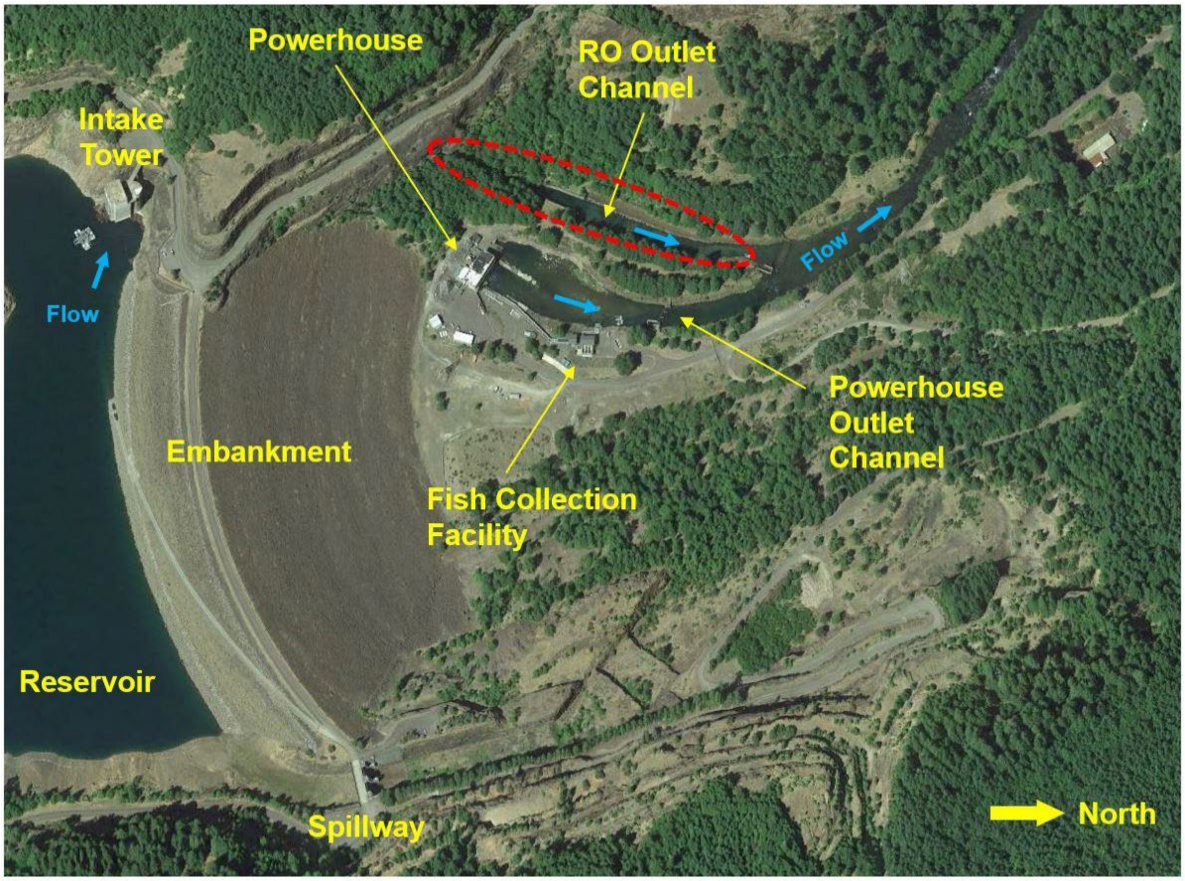

Figure 5.3-2 Overview of Cougar Dam project and passage outlet channels. Source: USACE 2024d, Figure 1-3.

Two sources are currently used to collect adult Chinook salmon for the upper basin (Figure 5.3-1). A fish trap at Leaburg Hatchery and a fish sorter located at the top of the left-bank Leaburg Dam ladder allow Chinook salmon adults to be collected and placed above or below Leaburg Dam based on the percent hatchery fish, or moved to the McKenzie broodstock for hatchery mitigation. Previously, most hatchery Chinook salmon were collected at the McKenzie Hatchery, but because of current water conditions, collection the last several seasons has been ineffective (USACE 2024a). In recent years, the collection has moved to Leaburg Dam while some spawners were moved out of the McKenzie to be reared in other facilities, with mixed results, including high adult Chinook salmon male and female mortalities in 2024 (Walker 2024).

Adult hatchery-origin Chinook salmon have been outplanted above Cougar Dam since 1996. Starting in 2010, the newly constructed Cougar fish ladder has been used to collect adult Chinook salmon that arrive at Cougar Dam. In 2015, the initial returns of natural origin Chinook salmon spawners were floy-tagged and returned to a point below the South Fork McKenzie confluence. Only when returning a second time where they released above Cougar Reservoir. In 2023, the practice was changed to only tag and 'recycle' the adult Chinook arriving in September. To better understand the fate of the offspring from these transported fish, whether they are of natural origin (NOR) or hatchery origin (HOR), samples taken before transport were used to complete genetic pedigree analysis.

O'Malley et al (2023) described how USACE reports have "assigned potential offspring to candidate parents released or otherwise sampled above the dam and used the resulting pedigrees to evaluate release strategies and infer demographic parameters that describe the productivity of the above dam population." From these studies, the cohort replacement rates (CRR) were calculated for the number of 'future spawners produced by a spawner' (Botsford and Brittnacher 1998, cited in O'Malley et al 2023). From 2007–2010, CRR values were less than one, showing the above-dam population was not replacing itself. Further, the increased likelihood that adult Chinook salmon collected at the Cougar ladder were offspring of adults not previously released above the dam ('immigrants') meant spawners transported above were more likely from parents that had spawned downstream of Cougar Dam, especially if arriving later in the spawning season. The 2010–2015 returns[11] were part of an updated pedigree analysis results for the South Fork McKenzie River that found CRR values much less than one, with a maximum in 2007 for total CRR= 0.44 and a minimum for total CRR = 0.08 in 2009. While these represent some years when only HOR adult Chinook salmon were outplanted above the dam, the total CRR over all years from 2007–2015 ranged from 0.09 to 0.39 (O'Malley et al 2023). This means that the productivity of adults outplanted above Cougar Dam are far below replacement levels, and the abundance of the UWR Chinook salmon McKenzie population continues to decline rapidly. The proposed adaptive management plan is insufficiently detailed in how the outplanting processes will be changed to address the declining productivity. The USACE proposes to review future CRR analyses to decide if more HOR outplanting should occur, and ongoing causes for UWR Chinook salmon McKenzie River population abundance decline will continue to limit productivity until the future review is completed.

O'Malley et al (2023) noted: "While NOR salmon produce approximately twice as many adult offspring as their HOR counterparts above the dam, this increased productivity is not sufficient to reach replacement. Therefore, any potential benefits of releasing NOR salmon above the dam must be weighed against the costs of releasing NOR salmon into a demographic sink, which may reduce NOR productivity basinwide." However, it is possible to adaptively manage and control the disposition of both Chinook salmon immigrants and returning spawners produced above Cougar Dam. Recent research showed the importance of careful management of mixing HOR and NOR McKenzie River adult Chinook salmon and their offspring, with the finding that the first-generation, wild-born descendants of McKenzie HOR Chinook salmon parents had increased fitness over the HOR Chinook salmon released as juveniles. In fact, these HOR wild-born descendants produced nearly as many adult offspring as NORs and 1.8-fold more adult offspring than HORs (Dayan et al 2024).

Until adaptive management actions shift the proposed action to continue limited outplanting, McKenzie River Chinook salmon spawners decline shown in the baseline is likely to continue. The overall McKenzie River 5-year geometric mean for Chinook salmon natural spawners, once considered a stronghold, dropped between 2005–2009 and 2010–2014 by 19 percent and from

[11] Data did not include 6-year old returns from parents outplanted in 2015. These are usually less than 2% of total returns, so results would change very little as authors noted for total lifetime fitness, the number of offspring attributed to any one parent (O'Malley et al 2023).

2005–2009 to 2015–2019 by 7 percent (Ford ed. 2022). Recent counts of McKenzie River Chinook salmon natural spawners steeply declined, with a 23 percent drop for the 4-year geomean from 2015–2019 to 2020–2023 for returning spawners counted at Leaburg Dam sorter. The proposed action to continue outplanting without clear changes in McKenzie River Chinook salmon spawner handling will cause a further drop in returning adults to the South Fork McKenzie and possibly mainstem McKenzie River. Lowered UWR Chinook salmon adult survival will lead to further decreases in abundance, productivity, and spatial structure.

Despite the problems identified above, the diversity parameter benefits from current and proposed efforts to avoid increases in HOR Chinook salmon in the upper McKenzie River basin. However, above Cougar Dam, more HOR adults were outplanted because of low NOR returns (ODFW and USACE 2019a, NMFS 2019a, Ford ed. 2022). These HOR Chinook salmon spawners could increase the total population if offspring return to spawn (Dayan 2024), but that has not generally been the case as the CRR values show. The McKenzie River Chinook salmon population in the mainstem and above Cougar Dam will not provide the diversity needed for recovery without improvements to the proposed handling processes to increase CRR.

5.3.1.2 Interim Reservoir and Dam Passage Operation Effects

The Blue River Dam is used for flood-risk management, reservoir recreation, and potential irrigation contracts. No passage is proposed for adults above or juveniles below this dam, and no UWR Chinook are spawning in this smaller subbasin. The remainder of this McKenzie River passage section will be about Cougar Dam on the South Fork McKenzie River. To manage passage at Cougar Dam, the Cougar Reservoir elevations are lowered from the higher levels (generally summer range of 1570–1685 feet to 1505–1520 feet in fall or spring), with lower elevations used for limited duration fish-passage operations. Current preferred dam-passage routes are the two ROs with 6.5 feet wide by 12.5 feet tall gates, and, when turbines operate, possibly the powerhouse intakes. The powerhouse has two turbines operating over a range of station service (or minimal flows) to full hydropower operations up to maximum capacity 1,380 cfs per turbine at minimum conservation pool elevation (1,532 feet). Each of the two RO gates operate at a range from less than 300 cfs each up to 5,280 cfs if both are 80 percent open at minimum conservation pool elevation (USACE 2024b, WFOP Appendix B, Willamette Basin Projects Reservoir and Outlet Works Stats). These operations have been modified in response to the Injunction (US DOJ 2021b) and research previously published (Beeman et al 2014a) but have yet to see results with respect to sufficient survival or reduced injuries. There is potentially decreased mortality during drawdowns when only the the RO route is available, but when both turbine and the RO routes are available, the relative mortality from screwtrap data is varying; more analysis is needed to determine sources of injury such as the temperature control tower and RO gates.

USACE proposed interim measures are to continue the Injunction operational passage with lower reservoir elevations that increase juvenile Chinook salmon access to the RO route. Fall drawdown would target an elevation range of 1,505 ft +/- 5 ft, by early November and then begin refill to 1,532 ft (normal flood season minimum) on or close to December 15. USACE also proposes to continue the delayed spring refill, and lowered elevation by February 1, "to reach fish passage target elevation of 1,520 ft by mid-March." They would begin to refill as early as

May 1, or in wetter years, wait up to June 1. During these interim operations, flow from the RO is set to maintain the target elevation and moderated by flood-risk management based on downstream checkpoints. No modifications are proposed to increase passage efficiency, although past research has shown that higher flows result in higher proportion of fish passing through the RO (Figure 5.3-3). Following the refill to Water Control Diagram elevations (see Baseline Section), USACE returns to daytime turbines with nighttime RO operations. This combination of spring and fall operational passage using the ROs does not provide safe and efficient passage for UWR juvenile Chinook salmon.

Juvenile Chinook salmon passing through Cougar Reservoir and past Cougar Dam are adversely affected by ongoing operations at all life stages, including fry entering the reservoir at the upstream end and later stages that seek available routes to pass the dam. The risk of freshwater copepod parasites (*Salmincola californiensis*) infesting juvenile Chinook salmon while they inhabit the reservoir increases with longer reservoir stays. Monzyk et al (2015b) documented that Chinook salmon in reservoirs were more vulnerable than other species, and age-0 Chinook salmon showed increasing infection prevalence (percentage of individuals infected) throughout the year—up to 84 percent by fall in reservoirs compared to 11 percent in streams. Even higher levels, 81 percent to 99 percent, were seen in multiple seasons for age-1 Chinook salmon (Monzyk et al. 2015b, Table 1).

Monzyk et al (2015b) also showed intensity (number of parasites per infected fish) was two to three times greater for reservoir-rearing than stream-rearing Chinook salmon. Differences in *S. californiensis* attachment locations were also noted, as the brachial cavity was more common for reservoir fish (79 percent) and fins more common on stream fish (71 percent). While at the time of their paper, intensity shown to cause mortality during salinity tolerance tests was high (at levels of 23 copepods/fish results from salinity tolerance tests showed 90 percent mortality compared with 10 percent mortality for noninfected control fish), they noted effects of infection at different intensities during saltwater transition were not known. Rearing in the reservoir lentic environment may offer growth opportunities when juveniles are prevented from migrating, but that potential is offset by predation and parasite infestation. Throughout most of the year, USACE maintains reservoir elevations in the McKenzie subbasin that delay juvenile outmigration and increase parasitic load, which adversely affects juvenile Chinook salmon survival.

Mortality and injury risks to juvenile fish are also high through current passage routes, with higher injuries from turbine operations generally. While the RO route is nominally better, juveniles experience a steep drop after passing the RO gates, through the shallow chute into a stilling basin. Reservoir elevation and gate openings are important variables for survival as shown in the Beeman et al. (2014a) comparison of three studies, which found that different dam-operating conditions changed passage survival. The study conditions that were more conducive to fish passage included changes in reservoir elevation, dam discharge, location of the entrance to the temperature control tower, and height of the RO gate openings. In particular, when reservoir elevations were below the power-pool elevation and all discharge passed through the RO bypass gate in the later study period, they saw higher survival. Increased discharge and low-pool elevation resulted in much larger RO gate openings. They found that Chinook salmon juveniles' relative survival[12] passing through the ROs was much greater for the later passage conditions (0.7389 vs. 0.4594 relative survival), measured from the point just upstream of the dam to Marshall Island, downstream of the McKenzie confluence with the mainstem Willamette River. As the authors noted, the reach-specific estimates of survival suggested the treatment effect was not expressed until several miles downstream from the Cougar Dam, in the Leaburg Dam-to-Marshall Island reach, for paired releases. They showed a functional relationship between proportion of flow and fish passing the RO using data from three studies (Figure 5.3-3).

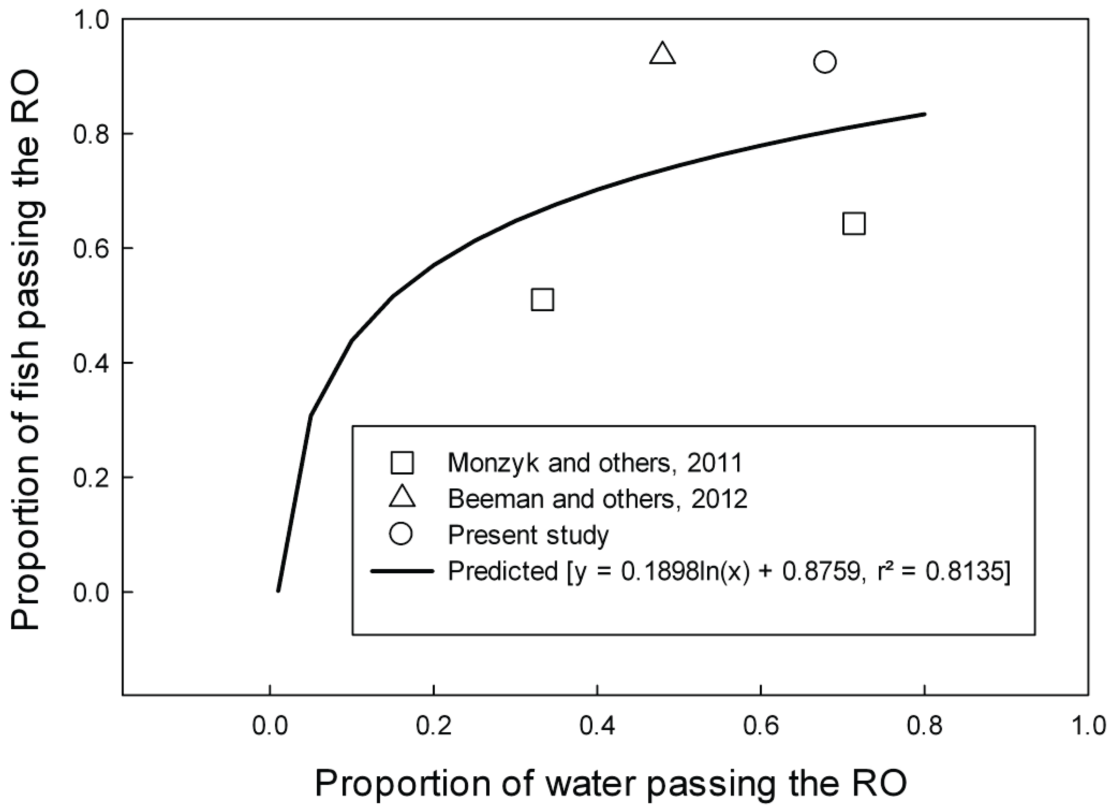

Figure 5.3-3. Graph showing regulating outlet (RO) fish passage efficiency curve for juvenile Chinook salmon at Cougar Dam, Oregon, based on the available data. Source: Beeman et al (2014a), Figure 15.

USACE has not proposed to optimize the RO operational passage during the current interim measures to reduce the risk of injury and mortality. In particular, RO gate openings vary considerably during current interim passage operations (Tackley 2024), and screwtrap data show varying counts, injuries, and mortality rates (EAS 2024B). Contractors operating rotary screwtraps downstream of Cougar Dam report a wide range of injuries including: fin damage, copepods, descaling, gas bubble disease, opercle damage, bloody eye, fungus, bruising, tearing or scrapes, and head injury. Most of these injuries were seen in both powerhouse passage and RO

12 In the Beeman et al (2014a) study, they estimated relative survival levels greater than 1.0 and note that estimates greater than 1.0 can arise normally due to variation in estimated survivals of treatment and control groups. More information was provided in their report's Appendix G. Single-Release Estimates of Reach-Specific Survival of Treatment and Control Groups Used to Estimate Relative Survival of Fish Passing Cougar Dam, Oregon, November and December 2012.

passage routes (EAS 2024B Tables D-3 and D-4, injury codes defined in Table 2). The percent injured in 2023 for any of the above ranged from 4.3 percent to 94.5 percent for the RO passage route and 2.4 percent to 77.3 percent for the powerhouse passage route (EAS 2024B Tables D-3 and D-4). Generally, larger fish were more likely to be injured in the RO, and smaller fish had higher injury rates through the powerhouse, except there was a higher percent of copepods for larger fish in both routes. Injury rates varied between years for fall operations when operations were changing (EAS 2024B Table D-5).

The PA notes, "The ROs at Cougar Dam are known to produce elevated downstream TDG [total dissolved gas] when releases are in excess of 800 cfs." Balancing higher outflow with desired passage elevations is a challenge; however, it is vital to reduce harm to multiple life history stages. The highest risk is during active migration through the RO when the juveniles have been subject to existing passage conditions, with the highest TDG occurring in the stilling basin.

Chinook salmon mortalities varied over the period of October 2021 to the present. Rotary screwtrap operators noted in the 2023 annual report that "[m]ortality rates from this study reflect the combined effects of previous fish health conditions at the time of passage, passage effects, handling, and holding at the trap site" (EAS 2024B). At each trap, the first 60 natural-origin juvenile Chinook salmon were held for 24 hours to assess post-capture or delayed mortality from dam passage. Of the 993 fish held in 2023, 92 fish died during the holding period (9.3 percent). The mortality rate for fish held for observation ranged from zero (43 percent of RO biweekly reporting periods; 19 percent of powerhouse biweekly periods) to a high of 66.7 percent, with most other periods having rates between 5 and 30 percent mortality (Calculated from data in EAS 2024B, Table 38).

To expand the counted fish to an estimate of total fish passing the dam, the screwtrap operators plant marked hatchery-origin juvenile Chinook salmon upstream of the trap, and from recaptures, they calculate the trap efficiency. Dividing the 'raw' trap counts by the trap efficiency provides an estimate of total juvenile Chinook salmon passing through available routes. Trapping efficiency trials showed a range of efficiency values from 2021 to 2023 in both powerhouse and the RO tailrace traps (1.0–27.7 percent and 0.4–12.8 percent, respectively [EAS 2024B]). From counts, survival under different operations can be compared, although fewer fish can increase the total estimated count at lower efficiencies.

Over time, screwtrap raw and expanded counts show how different conditions affect passage (2023 expanded counts, and confidence intervals are shown in Figures 5.3.3 and 5.3.4). When continued operations are not responding to these data, dam passage efficiency is likely lower than possible, and fish remain in the reservoir for longer periods. In the contractors annual 2023 report (EAS 2024b), these differences in passage timing are evident, showing juveniles are passing through both routes when daytime powerhouse and nighttime RO operations overlap (Figures 5.3.3 and 5.3.4). At other times, only RO or powerhouse routes were available. Juvenile counts are much higher through the ROs when elevations were dropping and flow was higher, based on expanded counts from trap efficiency estimates. The 2023 seasonal and operational changes are shown for regulating outlet and powerhouse counts in Figures 5.3-4 and 5.3-5; note that scales differ for y-axis flows and passage estimates, and high/low values differ for the y-axis forebay elevation.

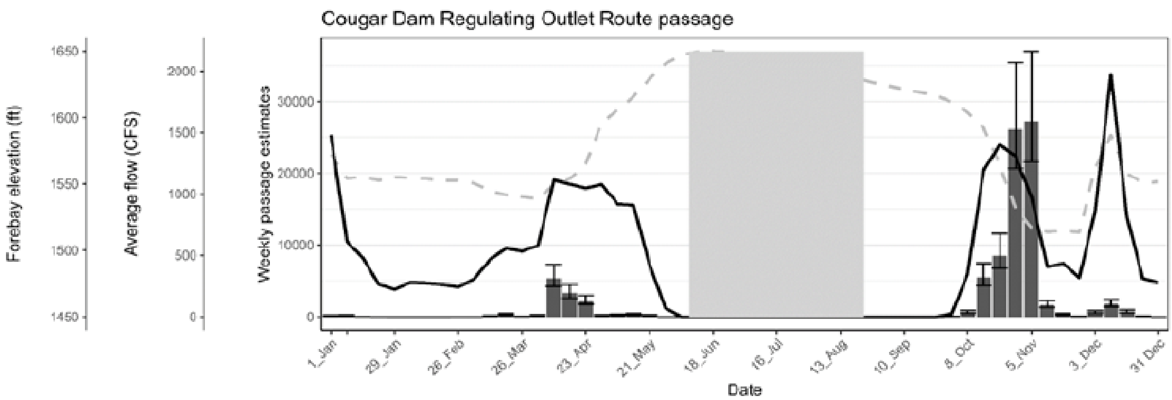

Figure 5.3-4. Weekly passage estimates in 2023 from the Cougar Dam RO tailrace screwtrap (gray bars), overlaid with regulating outlet outflow (black line), reservoir elevation (gray dashed line). Lower elevations and higher flows in April, and more noticeably in October through early November coincide with higher weekly counts. The weeks with no RO sampling are shaded out (gray). Source: EAS (2024b) Figure 35, bottom panel.

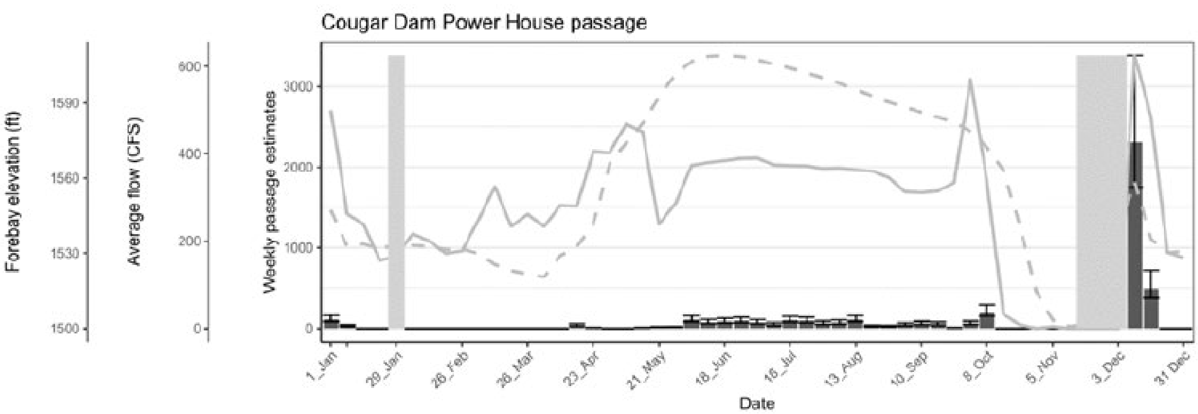

Figure 5.3-5. Weekly passage estimates in 2023 from the Cougar Dam powerhouse tailrace screwtraps (gray bars), overlaid with powerhouse outflow (gray line), forebay elevation (gray dashed line). The weeks with no powerhouse sampling are shaded out (gray). Source: EAS (2024b) Figure 34, bottom panel.

USACE contractors collected injury, mortality, or survival estimates related to varying conditions over the 2021–2024 operations. The range of conditions affected survival and injuries during passage. The USACE-proposed adaptive management plan has no analyses of how the effects of the RO gate opening, relative flows, and reservoir elevation correlate with existing or future screwtrap counts, injuries, and mortalities. Therefore, the proposed action is likely to continue lower dam passage efficiency and survival. The adaptive management plan fails to include a description of how the information will be developed to analyze the discharge and gate openings and reduce juvenile Chinook salmon injuries and mortalities.

USACE proposes to continue the Regulating Outlet Modification project, directed by the Willamette Valley Injunction (DOJ 2022). These structural changes were expected to provide interim passage improvements prior to a long-term passage solution. The Cougar RO modifications include construction of an extended chute, a low-flow channel within the existing chute, and a new stilling basin at the terminus. As noted in the court documents describing potential modifications, the expert panel recommended:

> *[T]he Corps have a technical Product Delivery Team (PDT) conduct a full review of available data on potential sources of injury and mortality through the RO passage route to 1) identify the known sources of injury and mortality from the RO system components (RO gates, chute, and stilling basin) and operations (e.g. head, gate openings), and 2) identify critical information gaps and identify studies to address gaps. The Expert Panel recommends that the PDT based on this information, identify measures to improve/ modify the Cougar Dam RO passage route to provide safer fish passage and to increase the allowable rate of discharge without generating excess TDG.* (US DOJ 2022)

One specific design goal was to provide 95 percent juvenile passage survival through the RO system, with an allowable RO discharge rate of 1,500 cfs, yet avoid exceeding 110 percent TDG downstream from the RO. This statement was joined by a footnote: “Achieving these numerical goals may prove infeasible and may be modified as needed to provide feasibility with the goal of improving RO passage survival and TDG performance to the extent possible.”

As part of this project, the PDT has produced engineering and design documents, most recently the Cougar Dam Regulating Outlet Modification Design Documentation Report (DDR 60% report, USACE 2024d). In the design process, the PDT reviewed and summarized multiple studies, some of which used sensor fish[13] to test how shear forces or collisions could harm actual fish. In a brief concluding summary of this work, they noted: “Based on information provided from Cougar RO studies, alternatives should focus design considerations to reduce collisions and strikes on the chute, address the diminishing depth of flow at lower gate openings, and consider ways to reduce shear forces observed at the transition of flow at the RO Chute and stilling basin. (USACE 2024d). While gate-opening data was available in the referenced studies, in some cases study conditions did not have sensor or live study fish pass through the RO gates. Instead, researchers introduced fish through a release pipe parallel to the RO above the water surface and downstream of the head gate (Deng et al 2018). However, the reviewers did note the RO chute depth was related to lower gate openings.

This design process for the regulating outlet modification will continue with the review of the current DDR, then the 90 percent DDR (anticipated to be completed in March 2025), followed by plans and specifications to be completed in March 2026. Construction is expected to begin in 2027 and be completed 3 years later, with operations expected to begin in 2030. This timeline is incorporated into the USACE proposed action implementation plan. While developed to accommodate complex construction at a challenging site, this timeline leaves passage conditions unchanged for several years prior to the start of another proposed alternative design shown in Figure 5.3-6. As a result, juvenile Chinook salmon will be subject to harm and mortality in the reservoir and passing the dam for at least five additional years, limiting the benefits of

[13] Sensor fish are devices developed to understand physical conditions to which fish are exposed when they pass through complex hydraulic environments, and are used to identify the locations and operations where conditions are severe enough to injure or kill fish. (Deng et al 2007).

outplanting Chinook salmon above Cougar Reservoir that will in turn reduce productivity, abundance, and spatial structure for the McKenzie UWR Chinook salmon population.

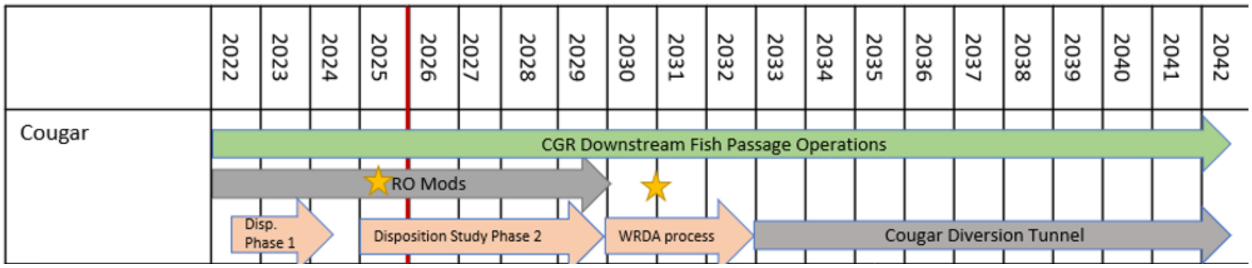

Figure 5.3-6. Timeline for actions at Cougar, including the Regulating Outlet Modification. Stars indicate check-in Source: Proposed Action, Figure 2-3-1 Structural Improvement Implementation Schedule, Excerpt for Cougar Dam (USACE 2024a).

5.3.1.3 Effects of Long -Term Passage Operations

USACE proposed passage operations that would allow fish access through the existing diversion tunnel. The operations would draw the reservoir elevation down to 1,330 feet, 50 feet above the midline in the diversion tunnel, for spring and fall passage. After each season, the tunnel would be partially or fully blocked to attempt a partial refill. This will not consistently provide volitional passage, nor will it change reservoir to riverine conditions. During the proposed spring refill, cooler inflows will be held back to partially fill the reservoir, with the effect of trapping juvenile Chinook salmon by preventing downstream passage until another outlet is accessible. This refill will also lead to stratification resulting in warmer water layers similar to those under current conditions, albeit at smaller volumes (see section 5.3.3). USACE ResSim modeling of inflows and elevations showed that the refill would only achieve higher target elevations two times in the period of record, making the purpose of the refills almost moot. A second drawdown in the fall and subsequent refill will provide initial passage to fish trapped over the summer and exposed to predation and copepods, and, following the limited period of lower elevations, fish will again be trapped during and after the refill. This will lead to warmer temperature releases affecting downstream Chinook salmon spawning success. This means that passage will not be optimal and may even reduce productivity if the overall purpose of the tunnel passage is subverted. Juvenile Chinook salmon survival will not sufficiently increase adult returns to replacement levels, productivity would remain limited, and abundance would remain at current low adult Chinook salmon levels.

Prior to diversion tunnel operations, from 2025 to 2032 USACE proposes to initiate disposition and dam safety studies, and seek statutory authority to operate the dam in a substantially different manner to allow routine use of the diversion tunnel outlet (Figure 5.3-6). Part of these studies would include the technical feasibility of operations and “continued federal interest in the project.” (USACE 2024a). Similar recent studies included the Disposition Phase 1 study (2024, as yet not released) and an earlier Cougar Dam Downstream Fish Passage Engineering Documentation Report (USACE 2017). The purpose of the latter was to evaluate the feasibility of structural and operational alternatives for downstream passage at Cougar Dam, and ultimately, identify a preferred alternative for implementation. At that time, the downstream passage option that was designated preferred was Alternative 28, Floating Screen Structure with Truck Transport, and significant work was done to design and test a model of this structure, with the near final plans and specifications set of documents released for comments in August 2020 (USACE 2020b). However, the work on this was later eclipsed by ongoing work shared first in October 2019 when fish-passage options at Cougar Dam in the absence of hydropower were presented at a fish managers' meeting held by USACE, including the configuration diagram shown in Figure 5.3-7 (Tetra Tech 2021).

This was followed by a review in 2020–2021 and a Re-evaluation Technical Fact-Finding Report that developed non-hydropower alternatives for downstream fish passage at Cougar, stating these were considered for downstream passage "as hydropower may be deauthorized at Cougar in the future" (TetraTech 2021). In this report, two baseline elevations for tunnel operations were explored at 1,290 feet and 1,340 feet. The report described the lower elevation in the second alternative:

> This alternative will lower Cougar Reservoir to the historic bed of South Fork McKenzie River (El. 1,290) at the entrance to the diversion tunnel. Cougar would then operate with inflow equaling outflow except when water is retained for flood control. Flood risk management will not be impacted, and the RO outlets and penstock will remain available to pass flood flows, although without modifications those additional water passages would not be safe for fish passage. (Tetra Tech 2021, Section 4-3).

The report noted the elevations would be affected by flood control and drawdown rates would be limited for erosion prevention. In 50 percent of the period of record, the reservoir could be above 1,340 feet for most of December, January, February, and March. (Note, however, ResSim model runs constrained the drawdown to 1,300 feet.) The authors also noted that this alternative will eliminate stratified temperature layers. In their conclusion, the lower-elevation alternative was described as preferred from a biological perspective: "This conclusion was driven largely by the fact that this alternative had higher attraction potential related to the greatest number of years when fish would access the passage tunnel by descending less than 50 feet, as the reservoir was receding and with an order of magnitude more flow moving toward and through the tunnel as compared to the other alternatives" (Tetra Tech 2021, Section 6.1).

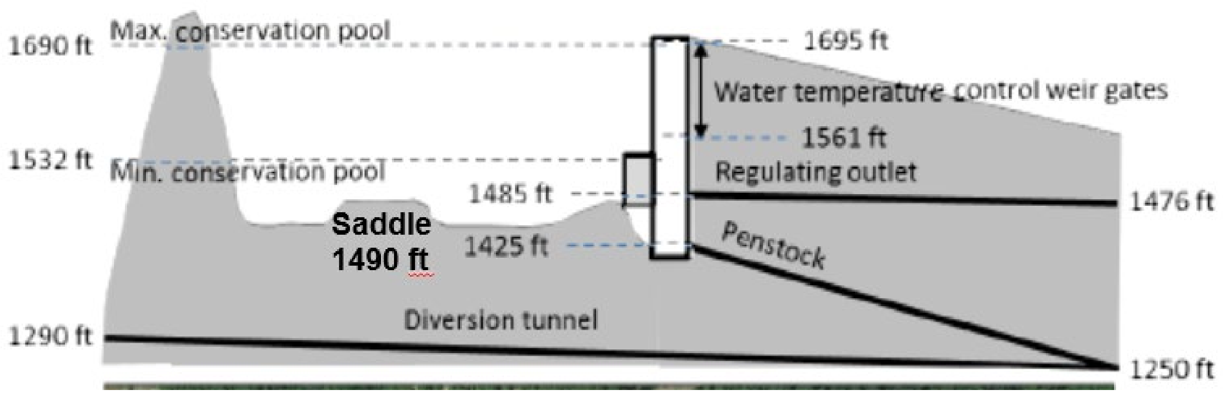

Figure 5.3-7. Cougar Dam configuration, with various outlets for flows and potential fish passage shown. Flow is from left to right, with the reservoir on the left. Note the tunnel begins upstream of a rock formation that defines a cul de sac area, which can be cutoff when elevations are lower than the saddle dam. Source: Tetra Tech (2021).

Following further analysis in the Draft EIS, USACE described the selection of the Preferred Alternative as Operational Downstream Passage at Cougar – Drawdown to Diversion Tunnel (USACE 2022c, Appendix A, Section 3.7). This alternative proposes Cougar Dam operations to drawdown the reservoir so that juvenile Chinook salmon can pass through the tunnel in the fall and spring, with a refill attempt after each drawdown period. USACE added details in the PA, proposing an elevation of 1,330 ft +/- 5 ft or 30 feet over the top of the tunnel entrance (USACE 2024a, Table 2.2-14). While the lower tunnel elevation would provide optimal passage and modify the reservoir conditions to benefit juvenile Chinook salmon passage efficiency (Tetra Tech 2021), USACE proposed action is for a higher elevation drawdown and two refill periods. The proposed action to limit the passage options will reduce efficiency and survival, lowering productivity gains otherwise possible.

In the proposed action, USACE described structural modifications to the dam and diversion tunnel to allow for safe, routine operations (USACE 2024a). Dam safety concerns included fluctuating pool levels at lower elevations. The proposed structural modifications require the design and construction of redundant gate structures to allow for routine inspections and a tower with a bridge connecting to the reservoir shoreline. The timeline for design and construction steps are shown in Figure 5.3-6, with operations expected to begin in 2043, 18 years after the Opinion is finalized. As noted in the DEIS and proposed action (USACE 2022c, USACE 2024a), the modifications would require site-specific construction and environmental compliance.

In addition to the lengthy timeline required to complete these steps, the proposed action limited the baseline elevation for access to the tunnel to 1,330 feet, although the Tetra Tech (2021) report contrasted the tunnel option at 1,340 feet and 1,290 feet elevations, noting these concerns:

- Requires frequent gate adjustments to maintain pool elevation and flows that may reduce the service life of the flow control gates
- Requires fish to sound to greater depths more often
- Requires downstream migrants to sound up to 80 feet under some reservoir conditions, which could result in passage delay

The USACE's proposal to design and operate the diversion tunnel in this manner will continue the adverse effects of lower dam-passage efficiency, by providing fewer, shorter volitional passage periods. McKenzie River juvenile Chinook salmon will be exposed to increased risk of copepod infestation, resulting from the proposed reservoir elevations.

NMFS recognizes benefits of the proposed long-term passage route through the diversion tunnel, compared to the operational RO passage, even with RO modifications. The modified reservoir conditions from drawing down to the proposed elevations, while reducing the passage timing, efficiency, and improved reservoir conditions, will provide limited access to the diversion tunnel gates and lower mortality for juvenile Chinook salmon, relative to the much higher injury and mortality rates from passing the RO and turbines. Adverse effects will continue to expose juvenile Chinook salmon to passage delay, risk from predation and copepods, more time before viable passage during refills, downstream effects of higher TDG levels, and stratified reservoir layers that send warmer water to areas where holding and spawning Chinook salmon adults, incubating eggs, and rearing juveniles will be harmed. These ongoing adverse effects will lower overall productivity, abundance, and spatial structure in the McKenzie River UWR Chinook salmon population.

5.3.1.4 Adaptive Management Plan Effects

USACE proposes using adaptive management as a tool to adjust operations and actions as new information is learned. However, USACE is not proposing any specific metrics for the ongoing operational passage, to determine if mortality and injury rates can be reduced. The result is that under the proposed AM plan, ongoing operations are likely to continue having adverse effects to UWR Chinook until metrics are defined that will include decision triggers for this action.

Currently there are few robust data on fish survival through the reservoir, past the dam passage routes, and downstream of the RO and powerhouse tailraces to any points downstream of the South Fork McKenzie confluence with the McKenzie River. The studies described above (Beeman et al. 2014a) provide a starting point for evaluating RO use under different operations, as guided by the Injunction Cougar Delayed Refill Implementation Plan (Injunction Measure 15) and Cougar Reservoir Fall Drawdown Implementation Plan (Injunction Measure 14) (US DOJ 2021b, 2021c).

These interim operations have created a set of data that have yet to be used to modify the operation dates, range of discharge, low pool elevations, and RO gate openings. In the proposed action (and subsequent documents), USACE has proposed annual reviews of data [e.g. 2025 contractor screwtrapping] in the adaptive management process. However, a key aspect of the adaptive management plan is to have defined the following:

> "Decision Trigger - A pre-defined commitment (population or habitat metric for a specific objective) that triggers a change in a management action. Decision triggers are addressed in the Evaluate step … and specify the metrics and actions that will be taken if monitoring indicates performance metrics are or are not reaching target values."

The missing piece of this is identifying which subset of the metrics (Table 5.3.2) will be used to decide when to implement Cougar Dam passage changes to optimize survival by reducing injuries and mortality both in the near term and during the lengthy interim period before long-term action is taken.

Table 5.3-2. USACE "Near-term adaptive management metrics and targets" (Source: USACE 2024a).

Activity	Near-term metrics		Near-term Targets
Downstream passage	Dam passage survival Dam passage injury Dam passage efficiency Dam passage timing Passage age/size composition	Metric(s) monitored depends on operation	Expected directional change in metric achieved compared to previous operation
Temperatures	7-day Average of the Daily Max (7dADM) at Salem		
Total dissolved gas	Total dissolved gas(TDG) levels below dam		

Until the adaptive management plan cycles described in the proposed action (USACE 2024a, Section 2.5.12, 2.5.12 RM&E and the Near-term Implementation Plan) lead to a decision coordinated with WATER, and a new implementation plan (IP) update is completed, actions are likely to continue that result in high mortality post-passage, high injury rates, and lengthy exposure to predation and copepods. Below is the timeline outlined by USACE for completing the annual adaptive management cycle:

1. January: Available data summarized
2. February: Public briefing on research and monitoring findings at WFSR.
3. March/April: Workshops for WATER Teams staff, and decision makers exchange info. Discuss monitoring results vs criteria, proposed revisions to measures, where more RME needed.and Corps: Documents topics, issues and outcomes. Used to support drafting IP update
4. May: Written recommends for IP
5. September: Draft IP
6. December: IP Plan Final

The steps outlined in the adaptive management cycle do not include consideration for potential impacts on flow or temperature in the South Fork McKenzie River or the mainstem McKenzie River. Proposed passage and flow actions at Cougar Dam will affect ongoing habitat restoration in the South Fork McKenzie and mainstem McKenzie as described in the Baseline Section.

5.3.2 Flow Effects

Flood risk reduction is the priority authorized purpose for the Cougar Dam on the South Fork Willamette River, and hydropower production is also part of the proposed action for 10 to 15 years following completion of this Opinion. Flood risk management would decrease the magnitude and frequency of instantaneous peak flow events. Continuing these operations will contribute to the ongoing loss of habitat complexity in the South Fork McKenzie River by substantially reducing the magnitude of channel-forming dominant discharge (generally 1.5- to 2-year) events and increasing the return intervals of larger floods. The result would be fewer side channels and alcoves, less large wood recruitment, and coinciding changes in movement of the full range of channel substrates.

USACE proposes to release lower flows from Cougar Dam during drier years (Table 5.3-1). This will cause habitat to be diminished in area and quality. When early-spring flows are reduced to 250-275 cfs in dry years, downstream juvenile salmonid rearing habitats will more often be confined to a single channel in reaches that would otherwise be connected to off-channel areas with more abundant cover and, often, lower flow velocities, both of which are important habitat components for newly emerged alevin fry. Interim actions to drawdown the reservoir during spring months indicate this set of lower minimum flows are unlikely to occur. Other operations may also increase flows when the refill is higher than 90 percent of the water-control diagram, although the interim operation of spring-delayed refill makes higher refill very unlikely.

The proposed lower releases from Cougar Dam are likely to decrease the quantity and quality of juvenile Chinook salmon rearing habitat downstream where off-channel and edgewater areas become disconnected or dewatered as water levels recede and channel widths decrease. The simplified or single channels that are likely to occur downstream of Cougar Dam as a result of lower flow releases will exhibit warmer water during higher air temperatures and likely lack sufficient depth to provide temperature refugia for Chinook salmon inhabiting such areas. This will lead to lower survival and reduced abundance and productivity when spawners are exposed to higher temperature while holding below Cougar Dam. The ResSim modeling program showed that target flows (Table 5.3-1) would be missed after September 1 for 34–45 percent of the years in the period of record (USACE 2023a, Appendix K). During these years, USACE releasing lower flows will harm Chinook salmon spawners by reducing overall habitat quantity downstream of the Cougar Dam and reducing cover for incubating eggs in the redds during dry years. Juvenile Chinook salmon rearing in flow-limited areas may be induced to move downstream before they reach sizes conducive to survival in higher flow mainstem reaches or the estuary. Individuals that remain in reaches subject to decreased flow as a result of lower releases from Cougar Dam may become stranded in areas that are of lower quality and do not meet their needs for feeding or cover. Where juvenile Chinook salmon survival is decreased due to suboptimal rearing conditions associated with simplified, warmer habitats resulting from lower flow releases, it is likely that life-history diversity will be reduced and spatial structure will be lost in affected populations.

5.3.3 Effects on Water Quality Action

Blue River Dam, on the Blue River lower in the McKenzie River basin, will continue to operate as it has under the 2008 RPA, with the current configuration, continued operations and maintenance, and the same seasonal timing of water released. Some flows released from Blue River Dam will replace the Cougar Dam flows no longer available to augment downstream reaches of the McKenzie River and the mainstem Willamette River when the long term passage through the diversion tunnel results in passing inflow during lower flow periods. Given this is a smaller reservoir, the supply will be limited and unlikely to fully make up for the lower Cougar Dam releases. Warmer temperatures from lower flows will harm spawners and juveniles in some reaches downstream. The Cougar Dam releases during earlier delayed refill months (March through May) could increase overall habitat for fry and subyearlings to neutralize changes from Blue River.

USACE constructed Cougar Dam's WTC tower adjoining the original intake tower and began operating it in May 2005 to release water at temperatures that partially mimic temperatures from above the dam. Once the reservoir elevation is above 1,570 feet, the WTC tower can selectively withdraw water from gates at varying reservoir elevations with different temperatures to meet target outflow water temperatures and provide conditions that benefit salmonids in the South Fork McKenzie and mainstem McKenzie rivers. USACE proposes to continue operating the Cougar Dam WTC tower when the reservoir elevation is above the operating limits. This provides more appropriate water temperatures for spawning and egg incubation that can lead to increased juvenile production with more natural emergence timing, relative to years prior to WTC tower operations. In addition, adult migration is not slowed by much cooler releases at turbine elevations when a more normative temperature regime is provided. Improved egg survival and emergence timing for juvenile Chinook salmon downstream of the dam, relative to conditions without the WTC tower, will continue while it is operating. However, each fall when the reservoir elevation drops below the WTC tower operating range, as shown in Figure 5.3-8, the October–November temperatures exceed the upper target during incubation. At this point, the remaining volume of warm water above the thermocline is released, affecting egg incubation by causing earlier emergence—up to two months earlier during the winter—and reducing fry survival (NMFS 2008a, Chapter 5). During the proposed interim passage operations, USACE will continue to lower the reservoir levels in the spring, decreasing reservoir elevations in the WTC tower operating range (to an extent depending on late spring meteorology). This limits the survival and abundance of juvenile Chinook salmon in spawning reaches downstream, as the warmer releases later in the year will cause earlier fry emergence from redds in reaches below Cougar Dam.

The proposed long-term downstream fish passage operation utilizing the diversion tunnel will also prevent use of the WTC tower in most years. There will be small volumes of warm water that stratify and are released in the fall. Improved floodplain connectivity from the more normative flows through the tunnel will also limit the effects of the smaller volumes of warm water. Further, a large area of restored 'stage zero' habitat reconnected the floodplain in the South Fork McKenzie River, which can ameliorate warm water releases because this restoration increased groundwater connections during more months of the year (Flitcroft 2022). The mix of temperatures through interim reservoir releases and restored habitat complexity has yet to be fully studied for effects on spawning, incubation, and rearing. Long-term downstream passage via the tunnel could provide for better water quality and habitat connectivity, although the proposed refills during summer and late fall could add some potential stratification without the WTC tower to selectively release normative temperature flows.

For long-term passage via the diversion tunnel, one of the benefits of the drawdown to near tunnel elevations would be cooler outflow, as reservoir storage and thermal stratification of the reservoir would be less likely to occur. The temperatures in the river downstream of the dam would more closely match above-reservoir river temperatures, in contrast to the gap seen under current WTC tower operations (Figure 5.3-8). Yet, the proposed refill noted above would reduce this benefit by increasing the reservoir volume, stratification period, and warm water releases, and the effects would include earlier emergence from downstream redds, lower fry survival, and overall reduced abundance from the South Fork McKenzie UWR Chinook salmon sub-population. This reduces the abundance, diversity, and overall productivity of McKenzie River Chinook UWR Chinook salmon.

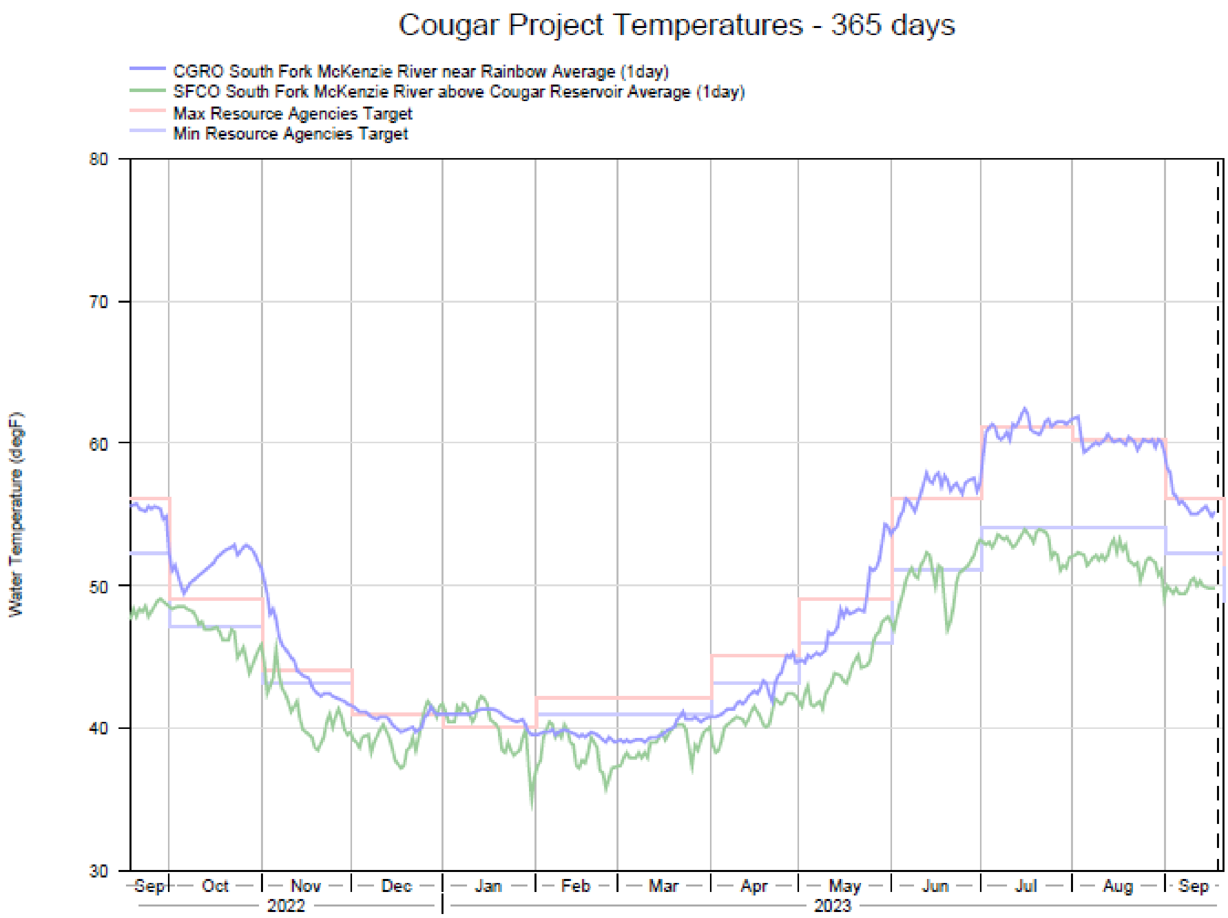

Figure 5.3-8. The range of daily average temperatures in the South Fork McKenzie River above Cougar Reservoir (green line) and below Cougar Dam (blue line) in 2022-2023. The maximum (light red) and minimum (light blue) targets were set to protect downstream salmonids. Source, accessed Sept 18, 2023: www.nwd-wc.usace.army.mil/nwp/teacup/willamette/cgr.pdf.

Total dissolved gas (TDG) can have harmful effects on emergent fry and rearing juveniles in reaches downstream of Cougar Dam. Existing operational passage has been adjusted for downstream effects on rearing and spawning habitats to reduce some of the excessive flows that lead to high TDG levels during the drawdown. USACE proposes to limit flows to 880 cfs through the ROs to manage for downstream TDG when possible and add turbine flow as needed. The limit was exceeded in October–November 2022–2023, with flows from 1,200 to 1,600 cfs, and November 2021, with flows up to 1,400 cfs. In some cases, TDG exceeded 115 percent. However, RO operations can also cause high TDG levels under current conditions because of the configuration of the chute and shallow stilling basin. This will continue for at least 5 years while the RO modifications are completed and tested. USACE does not currently measure TDG in the stilling basin when operating the RO for passage, but TDG levels are likely higher than those measured at the nearest downstream gage. The adaptive management plan to modify current operational passage based on TDG is limited. Specifically, USACE-proposed decision triggers for considering operational changes will be based on monitoring results that indicate whether the expected directional change was achieved. However, the lack of TDG measurement in the stilling basin, and the higher flows seen in fall months, ensures that there are limited directional changes. The harm from TDG to juvenile fish migrating through Cougar Dam via the RO will continue until either the RO modifications are completed, tested, and demonstrate improved TDG levels or steps for the long-term diversion tunnel passage are completed.

Other water-quality effects from long-term passage via the diversion tunnel include those related to sediment transport. For over six decades, sediments have been deposited within Cougar Reservoir, particularly at the upstream end, from water slowing as it reaches the reservoir pool. As noted in the Tetra Tech (2021) report:

> *Lowering the reservoir to the historic riverbed will subject the sediment deposits to re-mobilization and downstream transport. Erosion will be especially high during the first few years after draining and during large flood events and will increase water turbidity and sediment deposition in the downstream reaches of the river. . . .The amount of sediment that may be released as a result of lowering the reservoir to the historic riverbed has not been studied and will need to be investigated and quantified if this alternative is carried forward. Sediment mitigation measures, such as mechanical removal or stabilization are expected to be necessary if this alternative is carried forward.*

However, during drawdowns from 2002–2004, USACE provided studies and mitigation for these effects in the WTC tower construction NEPA documentation (USACE 2003). Data was collected as part of the studies to follow past estimates:

> *During 2002, Cougar Reservoir released approximately 17,000 tons of suspended sediment into the South Fork McKenzie River, or more than twice the incoming load from the South Fork upstream of the reservoir. In 2003 and 2004, the release of sediment from Cougar Reservoir decreased to 10,900 and 4,100 tons, respectively. (Anderson 2007).*

Data has not been collected recently on the sediment volumes exposed, suspended and transported downstream during interim passage operations when elevations are at 1,505 feet. This reduced the upstream extent of the reservoir (by approximately 2 miles) during November and December 2021–2024. If data is collected to evaluate the effects of reservoir drawdown on sediment transport, deeper drawdowns to lower elevations may be explored and implemented with managed turbidity levels that would allow sediment to mobilize. As in other reservoirs, the effects of deeper drawdowns are uncertain, although analysis of existing data, and collecting more for proposed adaptive management actions, there is potential for the reservoir drawdown to improve.

5.3.4 Effects on Critical Habitat

Designated critical habitat within the action area for the ESA-listed McKenzie River UWR Chinook salmon considered in this chapter consists of freshwater spawning, freshwater rearing sites, and freshwater migration corridors and their essential physical and biological features (PBFs), as described in the Rangewide Status of the Species and Critical Habitat.

PBF 1. Freshwater spawning sites

a) Water quantity. Flow-related increases from reservoir drawdowns would result in discharges greater than the proposed maximum of 880 cfs that may dewater Chinook salmon redds in later fall and winter in the South Fork McKenzie when inflows are passed. This risk will persist in wet years when higher inflows occur before or during drawdowns. In the recent operations (2021–2023), spawning outflows have been lower than 880 cfs, as higher inflows to Cougar Reservoir did not occur until after October 15. Lower flows later in the winter can limit the creation and maintenance of channel complexity.
b) Water quality. Proposed lower flows in February–June may lead to higher temperatures when eggs are still in redds. Continued interim passage and temperature management can cause higher temperatures in areas where spawners are holding below the dam. The use of the WTC tower reduces some but not all of this risk and, as proposed to continue operating, reduces any risk of cold water impeding upstream Chinook salmon migrants in the South Fork McKenzie River. Long-term passage through the diversion tunnel will provide more periods of normative flow and temperatures.
c) Substrate. Continued operation of the dam to reduce high flows for flood-risk reduction, for refill in the spring, and again in the early winter after the fall drawdown passage operation will block sediment transport of suitable-sized substrate for spawning. When proposed long-term passage is provided, the possible movement of appropriate sediment can reduce the coarsening of downstream reaches in the South Fork McKenzie River. The deeper drawdown to the diversion tunnel will also, for an unknown shorter period, increase water turbidity and possible finer sediment deposition in the downstream reaches.

PBF 2. Freshwater rearing sites

a) Water quantity. Flow-related habitat availability and connections will be reduced when proposed lower minimum flows are released in February–June. Continued operations to drawdown reservoirs and then refill them can reduce the high flows in winter and spring, which limits the creation of complex channels and the connectivity to the floodplain features used by juveniles prior to migrating. In the McKenzie basin, a significant percentage of juvenile Chinook salmon are 'stayers' rather than 'movers', which leave in the first year after emergence.
b) Water quality. Similar to above, juvenile Chinook salmon will be exposed to higher temperatures during rearing in spring under proposed minimum flows and will have fewer areas to find refuge from high temperatures because of reduced channel complexity caused by lower flows.
c) Floodplain connectivity. Lower minimum flows proposed in spring, or lower flows in spring and winter for post-drawdown refill, will reduce floodplain connectivity by increasing the likelihood of 'single channel' habitats forming. Recent work to restore lower South Fork McKenzie River to 'stage zero' habitat enabled by funding and expertise of other federal agencies can limit this in those project reaches but will leave other reaches vulnerable to lower complexity.
d) Natural cover. Continued operations of Cougar Dam to refill will restrict movement of large wood from above the dam and in reaches below where simplified single-channel habitat dominates, thereby diminishing beneficial habitat functions provided by large wood (refuge, prey habitat, and cover from predators). After the 2020 fires, this loss was notable due to land

management, with restoration efforts by USFS improving a significant South Fork McKenzie area where the downed wood was provided for natural cover and used for refuge by the juvenile and adult Chinook salmon during and after the fires (USDA 2022).

PBF 3. Freshwater migration corridors

a) Free passage. Lack of clear, safe passage routes because of USACE operations of Cougar Dam and Reservoir impedes juveniles from moving downstream, although adults are generally safely moved upstream to higher quality spawning and rearing habitat. The long-term passage solution via the diversion tunnel will improve this PBF, other than when the proposed tunnel shutdown to refill occurs in late spring and late fall, leading to extended periods when the refilling elevation may allow no passage route.
b) Water quantity. Subyearling 'movers' migrate throughout the late winter and spring, and they need flows to signal and provide assistance to their volitional migration, which will be lower when proposed minimum flows are released in February–June.
c) Water quality. Similar to above, with juveniles exposed to higher temperatures during migration in spring under new minimum flows and fewer areas to find refuge because of reduced habitat complexity from lower flows. Juveniles were found to move primarily as yearling smolts from the McKenzie River (below the dam) during spring, and they need higher water quality for their slower migration, including natural temperature regimes.
d) Forage. When juveniles are moving out of the South Fork McKenzie River from above Cougar Dam and into the maintem McKenzie, USACE dam operations can reduce the availability of complex habitat elements. Dam operations during post-drawdown reservoir refill, flood risk reduction, and low minimum spring flows also reduce transport of large wood and coarse sediment, which are habitat elements that increase the diversity and abundance of macroinvertebrate prey.
e) Natural cover. Similar to above, migrating adults and juveniles need refuge from low flows (for temperature), high flows (for velocity), and from predators.

Figure 5.3-9. Habitat downstream from Cougar Dam, where USFS project restored 'stage 0' floodplain reconnection. USDA 2022.

5.4 Coast Fork Willamette & Long tom Subbasin Effects

In the Proposed Action, USACE stated that they are not proposing significant changes to the current operations and maintenance for these sub-basins. The proposed action is unchanged from those described in the 2007 Supplemental BA and 2008 NMFS Biological Opinion (Usace 2007; NMFS 2008a). The only minor potential change is in flow releases resulting from the proposed flow management measures.

The effects as described in NMFS 2008 would continue to apply to the current proposed action:

- Coast Fork Willamette Subbasin: The Proposed Action would result in continued degradation of juvenile rearing and refugia habitat in lower reaches of the Coast Fork Willamette River, causing relatively minor decline in abundance and productivity of Middle Fork Willamette and McKenzie populations of UWR Chinook salmon.
- Long Tom Subbasin: The Proposed Action would result in continued degradation of juvenile rearing and refugia habitat in lower reaches of the Long Tom River, causing relatively minor decline in abundance and productivity of Middle Fork Willamette, McKenzie, and Calapooia populations of UWR Chinook.

USACE proposed minimum flow thresholds (PA, Table 2.2-5), and while other sub-basins had lower thresholds, here there were no changes from those proposed in the USACE (2007) Supplemental BA. Flows from Coast Fork reservoirs, Cottage Grove and Dorena, contribute to the mainstem flows, and could have minor changes from current flows. These changes would occur predominantly in the summer when there is a very low likelihood of UWR Chinook and UWR steelhead presence.

5.4.1 Habitat access and fish passage

Coast Fork Willamette River Subbasin

Under the environmental baseline, Cottage Grove and Dorena dams prevent access to 80 miles of historic habitat (USACE 2000, 5-72). However, because Chinook salmon and steelhead were virtually extirpated from this basin prior to Project construction, neither dam was constructed with fish passage facilities. Given the existing problems with mercury contamination in the reservoirs and habitat further upstream, and NMFS' determination that the Coast Fork does not support a demographically independent population of Chinook salmon, fish passage and access to historic habitat in this subbasin is a low priority for actions to increase the viability of UWR Chinook salmon.

In summary, the effect of the Proposed Action on habitat access in the Coast Fork for UWR Chinook salmon is negligible.

Long Tom River Subbasin

Under the environmental baseline, there are no passage facilities at Fern Ridge Dam on the Long Tom River, but the project does not block access to historic habitat for UWR Chinook salmon, as they are known to use only the lower reaches of the Long Tom River for juvenile rearing and possibly overwintering. UWR Chinook salmon have not used this river due to high summer water temperatures, other than the confluence. Thus, the Proposed Action on the Long Tom River would have little effect on UWR Chinook that would differ from a continuation of the effects of past operations.

5.4.2 Water Quantity/Hydrology and Quality

Coast Fork Willamette River Subbasin

Under the Proposed Action, the Dorena and Cottage Grove projects would continue to be used for flood control and to meet mainstem Willamette flow objectives at Albany and Salem. These operations would reduce the magnitude and frequency of peak flows in the Row and Coast Fork Willamette rivers, simplifying the channel and restricting connectivity to the floodplain, which in turn would reduce refugia and complex habitat for juvenile UWR Chinook salmon that use lower reaches of the Coast Fork Willamette River near its mouth. However, because this habitat is used for only a short duration by individuals of the Middle Fork Willamette and McKenzie populations, NMFS expects the effect of this habitat degradation and loss to be relatively small compared to adverse effects of similar elements of the Proposed Action in eastside subbasins.

Long Tom River Subbasin

Under the Proposed Action, Fern Ridge Dam would continue to be used for flood control and to meet mainstem flow objectives. These operations would reduce the magnitude and frequency of peak flows in the Long Tom River, simplifying the channel and restricting connectivity to the floodplain, which in turn, would reduce refugia and complex habitat for juvenile UWR Chinook salmon rearing in lower reaches of the Long Tom River. However, because this habitat tends to be used seasonally by individual fish (possibly from Middle Fork Willamette, Calapooia, and McKenzie UWR Chinook salmon populations), NMFS expects the effect of this habitat degradation and loss to be relatively small compared to effects of similar elements of the Proposed Action in eastside subbasins

Water Temperature

Coast Fork Willamette River Subbasin

Under the Proposed Action, minor changes would be made to the structure or operation of Dorena or Cottage Grove dams. These Coast Fork subbasin reservoirs would store more water in the spring and release it later during dry years, which may increase water temperatures downstream in summer, fall, and winter depending on whether the spillway or regulating outlets are used. Thus, the effect of the proposed action would be to maintain the current degraded water temperature condition, limiting the value of the Coast Fork Willamette and Row rivers as potential spawning habitat for UWR Chinook salmon.

Long Tom River Subbasin

Under the Proposed Action, no changes would be made to the operation of Fern Ridge Dam to restore normative water temperatures downstream. Thus, the effect of the proposed action would be to maintain the current degraded water temperature condition, with temperatures below Fern Ridge Dam higher than above during fall and winter. Some juvenile UWR Chinook overwinter in the lower Long Tom before emigrating from the system the following spring

5.4.3 Physical Habitat Quality

5.4.3.1 Large Wood, Sediment Transport, & Channel Complexity

Continued operations of Cottage Grove and Dorena dams will trap gravel and large wood from 50% of the subbasin and reduce the magnitude of peak flows in the Coast Fork Willamette subbasin. These operations will deprive downstream reaches of bed material and transport mechanisms needed to create new gravel bars, islands, side channels, and pools, which provide habitat for rearing and migrating anadromous salmonids. Andrus and Walsh (2002) reported a 69% decrease in gravel bars in the lower 4 miles of the Coast Fork Willamette River.

Under the Proposed Action, operation of Dorena and Cottage Grove dams would continue to store sediment and large wood in the reservoirs, prevent recruitment of large wood and sediment from streambanks, stabilize formerly active bar surfaces, and prevent flows capable of creating new bars, side channels, and pools. This would result in the continued reduced amount and quality of habitat for juvenile UWR Chinook salmon that rear in lower reaches of the Coast Fork Willamette River near its mouth. However, because this habitat appears to be used only seasonally during winter (most likely by individuals from Middle Fork Willamette and McKenzie UWR Chinook salmon populations), NMFS expects the effects of this habitat degradation and loss to be relatively small compared to effects of similar elements of the Proposed Action in eastside subbasins.

Continued operations of Fern Ridge Dam in the Long Tom will trap gravel and large wood from 60% of the subbasin and will continue to reduce the magnitude of peak flows in the subbasin. These operations deprive downstream reaches of bed material and transport mechanisms needed to create new gravel bars, islands, side channels, and pools, which provide habitat for rearing salmonids.

Under the Proposed Action, operation of Fern Ridge Dam would continue to store sediment and large wood in the reservoir, prevent recruitment of large wood and sediment from streambanks, stabilize formerly active bar surfaces due to lower peak flows, and diminish high flows that might otherwise be capable of creating new bars, side channels, and pools. This would result in reduced amount and quality habitat for juvenile UWR Chinook salmon that rear in lower reaches of the Long Tom River. However, because this habitat is used seasonally (most likely by individuals from Middle Fork Willamette, Calapooia and McKenzie UWR Chinook salmon populations), NMFS would expect the effects of this habitat degradation and loss to be relatively small compared to effects of similar elements of the Proposed Action in eastside subbasins. Aside from unspecified habitat restoration actions that are expected to result from the Willamette Floodplain Restoration Study, the Action Agencies do not propose any measures that would restore large wood, sediment, and channel complexity in the Long Tom subbasin. (Gravel augmentation is proposed only below Big Cliff, Foster, Cougar, and Blue River dams.)

5.4.3.2 Riparian Vegetation & Floodplain Function

Coast Fork Willamette Subbasin

As described above, continued operations of Cottage Grove and Dorena dams will trap gravel and large wood and reduce peak flows in the Coast Fork and Row rivers, which will restrict new gravel bar formation and floodplain surfaces, on which riparian vegetation can become established, and reduce inundation of forested floodplains, limiting the availability of high-water refugia for juveniles.

Under the Proposed Action, operation of Cottage Grove and Dorena dams and maintenance of revetments would continue to store sediment and large wood in the reservoirs, prevent recruitment of large wood and sediment from streambanks, allow stabilization of formerly active bar surfaces, and prevent flows capable of inundating floodplains and creating new bars and islands on which vegetation can establish. This would result in reduced amount and quality of habitat for juvenile UWR Chinook salmon that rear in lower reaches of the Coast Fork Willamette. However, because this habitat is used only seasonally (most likely by individual fish from Middle Fork Willamette and McKenzie UWR Chinook salmon populations), NMFS would expect the effects of this habitat degradation and loss to be relatively small compared to effects of similar elements of the Proposed Action in eastside subbasins. Aside from unspecified habitat restoration actions that are expected to result from the Willamette Floodplain Restoration Study, the Action Agencies do not propose any measures that would riparian vegetation and floodplain function in the Coast Fork Willamette subbasin.

Long Tom Subbasin

As described above, continued operations of Fern Ridge Dam will trap gravel and large wood and reduce peak flows in the Long Tom River subbasins. This limits formation of new gravel bars and floodplain surfaces on which riparian vegetation can become established and reduces inundation of forested floodplains, limiting the availability of high-water refugia for juveniles.

Under the Proposed Action, operation of Fern Ridge Dam would continue to store sediment and large wood in the reservoirs, prevent recruitment of large wood and sediment from streambanks, allow stabilization of formerly active bar surfaces, and prevent flows capable of inundating floodplains and creating new bars and islands on which vegetation can establish. This would result in reduced amount and quality of habitat for juvenile UWR Chinook salmon that rear in lower reaches of the Long Tom River. However, because this habitat is used only seasonally (most likely by individual fish from Middle Fork Willamette, Calapooia and McKenzie UWR Chinook salmon populations), NMFS would expect the effects of this habitat degradation and loss to be relatively small compared to effects of similar elements of the Proposed Action in eastside subbasins.

In summary, the Proposed Action would have small adverse effects within the lower Coast Fork and Long Tom subbasins on fish from the Middle Fork Willamette, McKenzie, and Calapooia populations of UWR Chinook. These effects would result from continued reductions in the amount and quality of habitat for rearing/overwintering of UWR Chinook below dams in the lower reaches of each system. The result would be a continuation of minor, unquantifiable reductions in abundance, productivity, diversity, and spatial structure for the identified populations.

5.4.4 Effects on Designated Critical Habitat

NMFS did not designate critical habitat in the Coast Fork Willamette or Long Tom subbasins.

5.5 South and Middle Santiam Subbasin Effects

This section analyzes the effects of the proposed action on UWR spring Chinook salmon, UWR steelhead, and designated critical habitat in the South Santiam sub-basin. WVS operated Foster and Green Peter dams are located on the South and Middle Santiam rivers, respectively, and under the environmental baseline block 70 percent of historical spawning habitat (Figure 5.5-1).

The Corps proposes to operate and maintain these dams as they have in the past for flood-risk reduction as the primary authorized purpose, as well as for hydropower, recreation, irrigation, and fish and wildlife purposes.

In addition, the Corps proposes to continue operating the Foster Adult Fish Facility to collect and outplant UWR Chinook salmon and steelhead above Foster Dam. They will also continue to outplant adult UWR Chinook salmon above Green Peter Reservoir, which began in 2022 as part of Injunction actions. As described in more detail below, the effects of the proposed action include altered physical and biological conditions downstream of the dams (e.g., hydrograph, temperatures, recruitment of gravel and large wood) and mortality and injury of UWR Chinook and steelhead adults and juveniles.

Recent UWR Chinook salmon abundance numbers are shown in Figure 5.5-2, and spawner surveys conducted below Foster Dam show the same trend. The hatchery-origin (HOR) adult UWR Chinook salmon trend at Foster Dam ladder appears flat, in contrast to falling numbers for the natural-origin (NOR) adult UWR Chinook salmon, leaving this important population at 'very high risk' of extinction (Ford ed. 2022). Similarly, UWR steelhead, with hatchery outplants stopping in 1998, have had falling numbers, with a modest increase in 2024. UWR steelhead adults mostly return at 4 years old because of limited life-history diversity under dam operations. The higher 2024 counts at Willamette Falls and in the South Santiam may be related to the 2004 cohort, yet were only 75 percent of the Willamette Falls counts and only 41 percent of the 2004 Foster Dam ladder counts. This shows the UWR steelhead that return to Foster Dam from Willamette Falls are less likely to have offspring returning to spawn.

The Proposed Action includes the following actions in the South and Middle Santiam rivers:

- USACE will initially maintain the current configuration and continue operation and maintenance of Foster and Green Peter dams in the South Santiam River watershed. USACE will continue to limit down-ramping below Foster Dam to no greater than 0.1 ft. per hour during nighttime hours and 0.2 ft. per hour rate during daytime hours. When possible, flow will be capped during peak migration to minimize TDG levels during regulating outlet operations. These actions are described in the Willamette Fish Operations Plan, which is proposed for continued use as guidance for facility operations (USACE 2024a, Appendix F WFOP, Ch. 2).
- USACE will continue the Outplanting Program to trap-and-haul natural-origin UWR Chinook salmon and UWR steelhead from the Foster Adult Fish Facility to release locations above and below Foster Dam. In addition, they will continue outplanting hatchery origin UWR Chinook salmon above Green Peter Reservoir. Spawning surveys in Quartzville Creek will continue as well as those that began in the upper Middle Santiam River in October 2024.

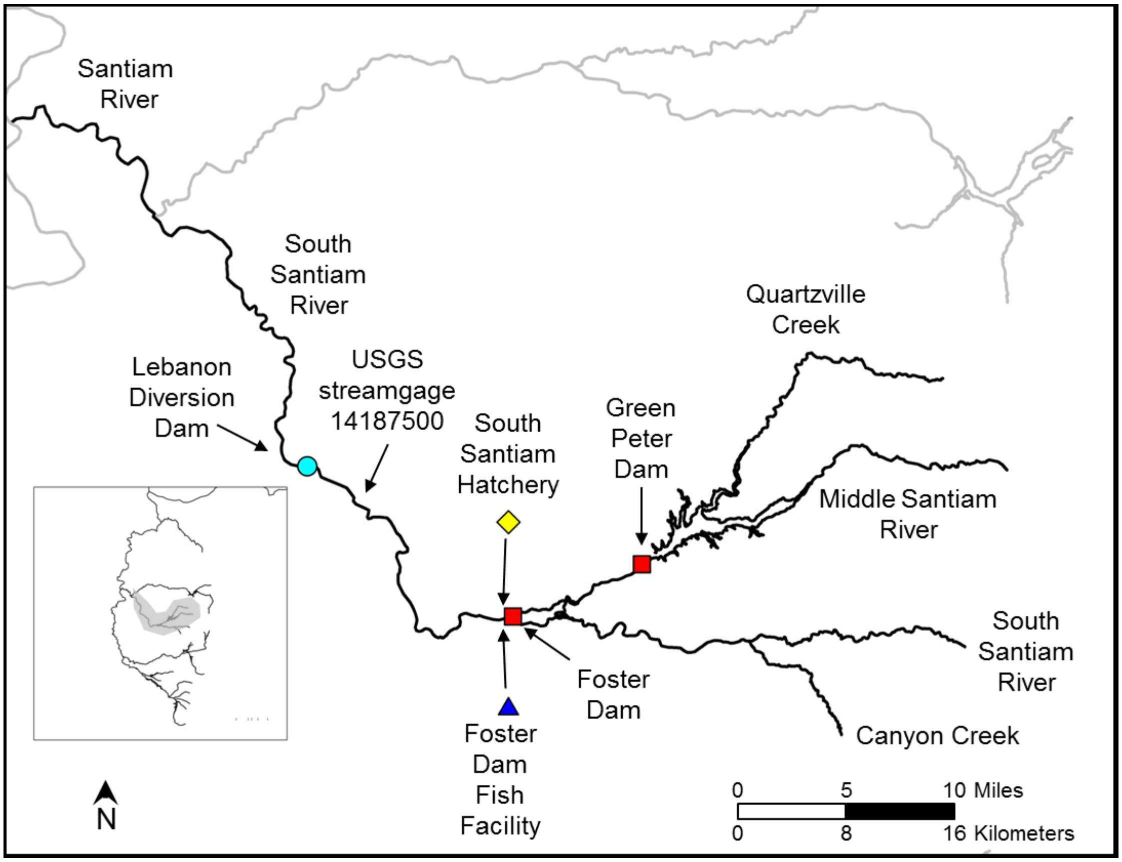

Figure 5.5-1. Locations of the South Santiam River, Middle Santiam River, Dams, Hatchery, and Foster Fish Facility discussed in this chapter. Source: Hansen et al 2017, Figure 16.

- USACE will oversee the operation and maintenance of the Foster Adult Fish Facility. The upgraded facility began operating in 2014, with rebuilt structures to reduce direct handling of adult fish. Pipes through the dam supply water to the pools, fish lock, crowding channel, truck fill station, upper fish ladder, and other facilities (WFOP Appendix for Foster Adult Fish Facility O&M Manual, in USACE 2024a).
- Continuing interim temperature actions, USACE will place a weir in the Foster Dam spill bay nearest to the adult ladder. The weir releases flows from upper reservoir elevations, and modifies temperatures to help attract UWR Chinook salmon to the facility ladder entrance.
- USACE proposes to construct and operate the Foster Fish Ladder Improvement Project for a new intake and pipe network. This will mix warmer surface water with cooler water from existing intakes in the Foster forebay to reduce differences in temperature between the fish ladder entrance and the tailrace. It is expected to be completed and operational by 2029.
- USACE proposes to design and construct a new adult fish facility at the base of Green Peter Dam to trap adult UWR Chinook salmon previously collected at the Foster adult facility and released into the upper Foster Reservoir. UWR Chinook salmon that migrate to the Middle Santiam River would be collected a second time and placed upstream of Green Peter Reservoir, in Quartzville Creek and the Middle Santiam River. USACE

facility design would be determined during the construction design phase and will be similar in scope and design to those constructed and operated at Cougar Dam and Fall Creek Dam. They propose to begin operations in 2033.

- USACE proposes long-term passage at Foster Dam, with the first phase of a structural downstream fish passage solution to begin in 2025. The design and timeline are based on a modification to a weir internal to the spillway. They propose to be operating the new passage route by 2033.
- USACE proposed new minimum-flow targets with seasonal timing of flows released from Green Peter and Foster dams. These flows will be based on changes in Green Peter Reservoir elevation and efforts to meet or exceed proposed flow minimum objectives. USACE will base releases on the Green Peter Reservoir elevation in the spring, relative to the water-control diagram.
- USACE proposed new minimum-flow targets with seasonal timing of flows released from Green Peter and Foster dams. These flows will be based on changes in Green Peter Reservoir elevation and efforts to meet or exceed proposed flow minimum objectives. USACE will base releases on the Green Peter Reservoir elevation in the spring, relative to the water control diagram.

5.5.1 Habitat Access and Fish Passage

5.5.1.1 Effects of actions to provide adult upstream passage for UWR Chinook salmon and steelhead

The proposed operation of the Foster Dam Adult Fish Facility allows for adult UWR Chinook salmon and steelhead to be collected and moved above Foster and Green Peter dams, which otherwise block fish passage. However, collecting and handling UWR Chinook salmon and steelhead also results in adverse effects under proposed actions, including delays in passage and increased prespawn mortality.

Adult UWR Chinook salmon and steelhead will continue to be captured at Foster Dam Adult Fish Facility (AFF) after ascending the ladder. All UWR steelhead from the ladder are transported above Foster Reservoir. Most of the UWR natural-origin (NOR) Chinook salmon are also moved upstream of Foster Dam into the South Santiam River. UWR hatchery-origin (HOR) Chinook salmon are moved upstream of Green Peter Reservoir into Quartzville Creek and the Middle Santiam River, reintroducing UWR Chinook salmon to historical habitat, which was initiated under the Injunction (US DOJ 2021). Other HOR adult UWR Chinook salmon are sorted to be used as broodstock for hatchery production or returned downstream to spawn below Foster Dam. When sufficient numbers of NOR adult UWR Chinook salmon return to the Foster Dam, hatchery managers can request to use some of them for broodstock, with NMFS concurrence as part of the conservation hatchery actions (NMFS 2019a).

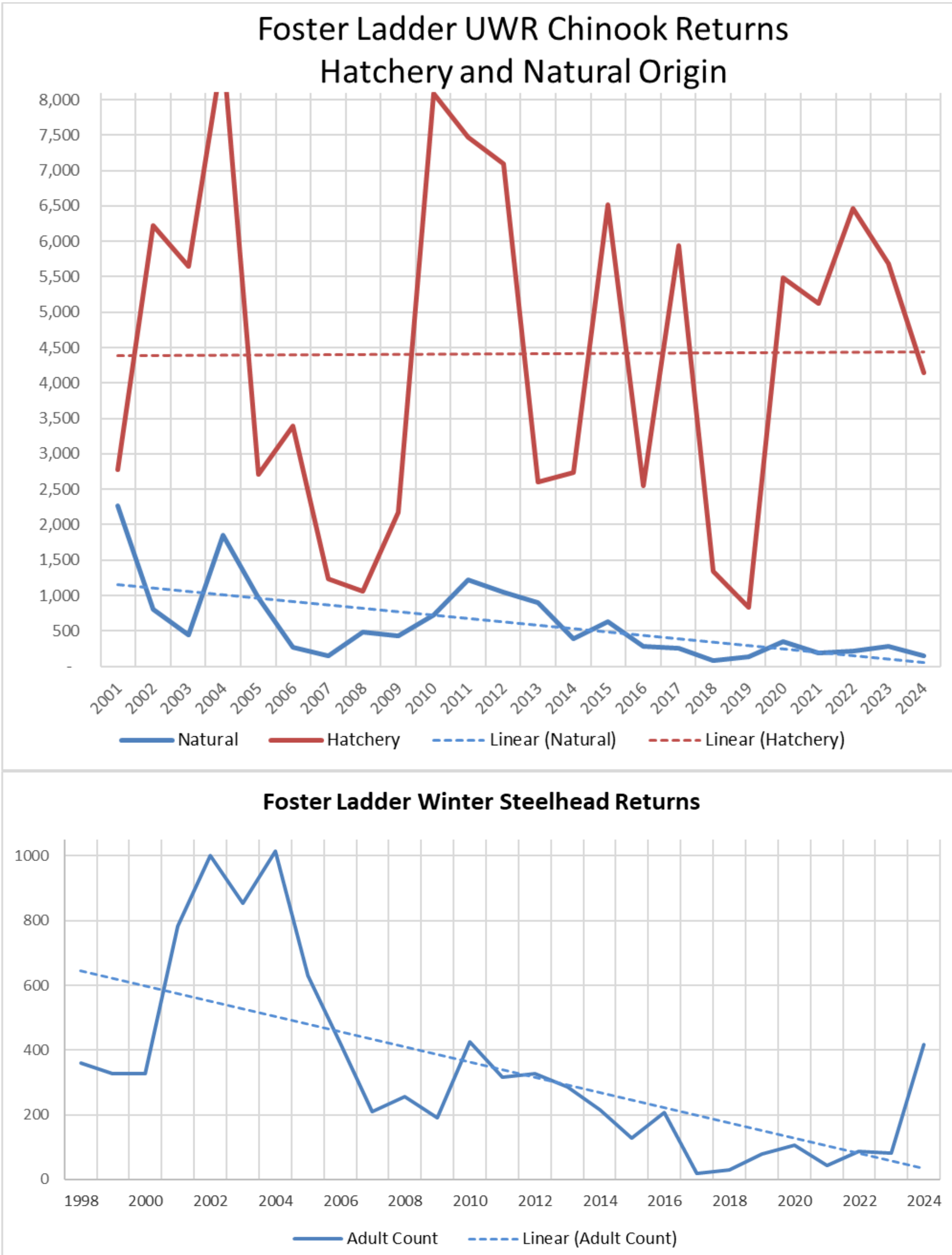

Figure 5.5-2. Counts and trends for Foster Fish Facility adult UWR Chinook salmon (upper) and steelhead (lower). Hatchery-origin flat trend contrasts with falling natural-origin UWR Chinook salmon. Data from ODFW Foster Ladder counts.

Since Foster AFF was rebuilt and began operating in 2014, there have been issues with UWR Chinook salmon attraction to the ladder. Because of this limitation, the number of adults collected after returning to the ladder has declined for UWR Chinook salmon and steelhead, with the lowest returns after the new facility was completed. Both before and after the facility was rebuilt, genetic pedigree studies indicated overall very low cohort replacement rates (CRR) for the adult UWR Chinook salmon outplanted into the South Santiam River above Foster Reservoir, showing this population is not replacing itself (O'Malley et al 2017, 2024b). While similar studies are limited for adult UWR steelhead outplanted upstream of Foster Reservoir, the counts at Foster AFF were extremely low from 2014 to 2023, ranging from only 18 to 214, with a rebound in 2024 to 416 that is still below 20-year-average values (Figure 5.5-2). The combined effects on UWR Chinook salmon and steelhead from mortalities during upstream and downstream passage will continue to cause low basinwide productivity.

The Foster AFF has had limited success in collecting adult UWR Chinook salmon because of the input flow temperatures, which are particularly problematic for the adult UWR Chinook salmon returning in summer. The temperatures near the AFF ladder are influenced by the inflow into Foster Reservoir from the South Santiam River but with larger impacts from the Middle Santiam River (Figure 5.5-1). This much colder water acts as a deterrent to upstream migration, and the Green Peter powerhouse discharge that flows into Foster Reservoir and into the ladder can deter adults from entering the ladder. The pipes through Foster Dam penstocks lead to the AFF water supply system and ladder, while other pipes distribute water to pre-sort, holding, and post-sort pools; and transfer or return pipes. Below Foster Dam, the water temperature mismatch occurs when the cooler water discharges into the warmer water where adult fish congregate before entering the ladder. The delay can lead to crowding when both HOR and NOR adult UWR Chinook salmon meet cold water and stop at the base of the ladder. As the density of holding adult fish rises, so too does of risk of harm from disease. Poor water conditions and disease outbreaks from overcrowding below the dams have contributed to the excessive mortality rates of adult UWR spring Chinook salmon (Bowerman et al. 2018). Moreover, the same study found PSM increased as the percentage of hatchery-origin spawners (pHOS) increased, and annual releases of salmon above Foster Dam may include up to 30 percent HOR adult UWR Chinook salmon, although there have been efforts to reduce inadvertent HOR outplanting (Bowerman et al. 2018).

Under the proposed action during summer weeks, flow will be passed through a weir placed in the spill bay closest to the ladder. The weir will skim warmer water from above the reservoir thermocline, so adult UWR Chinook salmon will more readily enter and ascend the ladder when the temperatures are closer to those they have migrated through. Unknown numbers of returning spawners may remain downstream of the dam as many spawners in reaches directly below Foster Dam are likely offspring of adult UWR Chinook previously outplanted above Foster Reservoir. These UWR Chinook salmon spawners are then subject to late summer and fall higher temperatures that may cause higher PSM and limit spawning success.

Water temperatures in the Foster pools, truck refill, and return pipes are also based on water piped from below the thermocline so can be significantly colder than the tailrace area when adult UWR Chinook salmon are held on-site. Proposed weir operations are helping equalize the temperatures near the ladder entrance, but not throughout the rest of the facility. This leads to handling challenges, as they risk temperature shock when moved upstream to warmer release sites. As these fish are handled in sorting and hauling, stress can increase the risk of prespawn mortality and lower their overall spawning success. Bowerman et al (2018) noted that "migration and handling stress, as well as pathogen transmission and other density-dependent effects associated with fish aggregations and trap-and-haul, all likely contribute to relatively high PSM in some upper Willamette River populations." The delays and temperature impacts of holding below the dam will reduce the abundance and productivity of the South Santiam River UWR Chinook salmon population, until proposed changes in piping are provided.

USACE proposes to continue moving the natural-origin spawners that return to Foster AFF above the reservoir, although studies of outplanted UWR Chinook salmon show that the population above the dam is not replacing itself (O'Malley et al. 2017, 2024b). Despite the efforts to transport the NORs above the dams, temperatures and unsafe downstream passage together limit their success. Fin-clip samples are taken during handling of UWR Chinook salmon at Foster Dam to provide genetic material for pedigree analysis, as required by the NMFS (2019a) Hatchery Biological Opinion. This analysis informs decision-making about NOR and HOR adult UWR Chinook salmon outplanting and future hatchery production. The results from the first pedigree analysis showed average replacement rates greater than one for adult UWR Chinook salmon outplanted from 2007–2009 (O'Malley 2017 et al.). Based on the UWR Chinook salmon offspring returning to the Foster Dam ladder, and samples from spawning surveys conducted above and below Foster Dam, the cohort replacement rate (CRR) ranged from 0.96 to 1.55 (O'Malley 2017). However, beginning with adults outplanted in 2010, these replacement rates plummeted to much lower than one, indicating that the above dam population is far from replacing itself. Initially, in 2010 the drop in CRR values to 0.06–0.07 (male, female, respectively) was thought to be related to scouring flood-level flows above Foster Reservoir that could have damaged or eliminated redds (O'Malley 2017 et al.). Another analysis for adults outplanted during 2011 to 2015 was completed in 2023, and was equally grim, with CRR values ranging from 0.04 to 0.16 (O'Malley 2024b). These low values, are due in part to low collection rates attributed to cooler attraction flow temperatures at the Foster AFF ladder since the facility upgrade in 2014. However, low CRR values for outplanted adults from 2011–2015 precede and follow the start of the new facility's operations. Results of analysis for UWR Chinook salmon adults outplanted since 2016 are expected in 2026. The overall downward trend in NOR adult UWR Chinook salmon counts at the dam continues the low replacement rates, with only a slight improvement after the lowest returns recorded, of only 87 adults at Foster ladder in 2018 (Figure 5.5-2). The variable returns have downward trends dominating, with outplanted NOR adult UWR Chinook salmon numbers diminishing. Combined with water-quality concerns during spawning and incubation periods, the overall productivity of the UWR Chinook salmon South Santiam population will likely continue to trend downward in abundance and productivity.

UWR Chinook salmon outplanted above Green Peter Reservoir from 2022–24 cannot have pedigree analyses completed until the full cohort's age 3- to 5-year old adult returns are available to calculate replacement rate beginning in 2027. There are no detailed data from NOR juvenile migration other than timing at rotary screwtraps below Green Peter Dam. Proposed plans to capture, tag, and recapture juvenile UWR Chinook migrants above the reservoir in 2025 are underway. The UWR Chinook salmon reintroduced above Green Peter Dam have to traverse two reservoirs and pass two dams with limited passage options, which have only been partially evaluated with study fish outplanted after the reservoir was fully drawn down (Larson et al 2024). The lack of data for these passage options will increase the time for full evaluations of the program. Earlier studies are discussed below for passage route survival differences.

Steelhead Pedigree Analysis

UWR steelhead also had limited results from a single pedigree analysis study for 2012–2016 parental outplants (Weigel et al 2019a). The specific goals were to review whether natural-origin spawners returning to Foster Dam were offspring of the adult UWR steelhead outplanted above Foster Dam, which began in 2006. They also wanted to see if the summer steelhead mitigation fish in the subbasin were interbreeding with the natural-origin winter steelhead. Results provided partial answers to both of these questions:

> *Parentage analyses demonstrated that 51% of outplanted steelhead successfully produced either juvenile or adult offspring. More than 68% of the natural-origin adults outplanted during the study were homozygous for mature migration alleles that are typical of native, winter-run steelhead, however, potential introgression from non-native, summer-run steelhead was detected in 26% of the outplanted adults (Weigel et al, 2019a).*

Since this study was conducted on UWR steelhead outplanted only for the 4 years noted, they did not have data to analyze multiple years of adult-to-adult returns. They did calculate from 2012 outplants that only 20 percent of the 2016 returning adults were progeny of previous UWR steelhead spawning upstream of Foster Reservoir. Similar to the UWR Chinook salmon results, this low fitness for the adult UWR steelhead transported upstream is concerning. In a related presentation (Weigel et al 2018), authors recommended:

- Additional years of adult UWR steelhead sampling to improve fitness estimates and program effectiveness;
- Genetic sampling below Foster Dam to identify proportion of missed offspring; and
- Additional analyses of existing data.

They noted for the majority of outplanted adult UWR steelhead, genotypes indicated that they were native, winter-run steelhead but also that a quarter to a third of these outplants had alleles associated with premature migration similar to non-native summer steelhead (25 percent hatchery introgression, and 6 percent F1 hybrids). While the outplanting program removes most HOR steelhead, some have introgressed due to outplanting with the non-native summer steelhead, when a fin-clip is not visible. Weigel et al (2019b) note that these "presumably native winter steelhead returning to the basin [are outplanted] into inaccessible spawning areas upstream from dams, thereby introducing the hatchery-origin summer steelhead genes into these areas", which could reduce the fitness of the UWR steelhead populations. Further data would be helpful, although the trend of mostly downward counts suggests a lack of spawning success and low survival migrating past Foster Dam reducing the productivity of these UWR steelhead.

Effects found in spawner surveys

Sharpe et al (multiyear) used spawner surveys above and below Foster Reservoir to provide estimates of the prespawn mortality (PSM) and percent hatchery origin spawners (pHOS) rates (from 2011–2018). They also estimated total spawners, in contrast to total adults counted at the Foster AFF, and provided similar estimates for below-dam spawners.

These included surveys in lower tributaries, close to the confluence of the North and South Santiam rivers, and also ejust below Foster Dam in Wiley Creek. The spawner surveys also capture the differences between adult UWR Chinook salmon outplanted above the dam and those that spawned successfully below the dam. For instance, at Foster Dam two years showd very different proportions of adult UWR Chinook salmon outplants that spawned, and the authors noted:

> *With fewer natural-origin fish captured and transported above Foster and fewer hatchery-origin fish removed, spawning in the river below Foster might be expected to increase with a commensurate increase in pHOS. Essentially, some of the productivity advantages gained through selection among natural-origin spawners above Foster Dam might be lost in their offspring because relatively more spawning with hatchery-origin fish would occur. . . In particular, it is necessary to have sufficient confidence that outplanting NORs is a benefit to the populations, not a reproductive sink. The single most important criteria will be confidence that outplanted fish exceed replacement, an outcome that will probably wait until downstream passage issues are resolved.*

USACE proposed continuing to calculate CRRs for recent and future cohorts to evaluate the benefits of passage actions. This step would help ensure the downstream reaches are not losing spawners to the outplanting of NOR adult UWR Chinook salmon, in effect ‘mining’ the lower reaches. A reported 5-year estimate of PSM of 29 percent below and 15 percent above Foster Dam shows that outplanting above Foster Dam could be expected to increase UWR Chinook salmon survival over the long term, with better downstream passage (Sharpe et al. 2017c). However, the PSM trend will be affected by pHOS when there are issues sorting the hatchery from natural-origin adult UWR Chinook salmon. Improved estimates of the HOR inputs to spawning above Foster Dam will provide a better understanding of how survival would change with passage improvements, given pHOS increases reported following the new Foster facility upgrades.[14] USACE will continue to fund pedigree analysis for evaluation of the UWR Chinook salmon outplanting. O’Malley et al. (2024b) noted that, based on carcass data, HOR adults had much lower fitness than NOR adult UWR Chinook salmon spawners. They also reported on a comprehensive and efficient approach to identify and exclude unmarked HOR salmon with parentage-based tagging of overlapping hatchery broodstock (O’Malley et al. 2024b). Given this recommendation to improve data, the proposed AM Plan could decide to improve Foster Dam UWR Chinook outplanting. Without clear pedigree analysis results, the decisions for outplanting that could improve returns are unlikely to increase abundance of the natural origin UWR Chinook salmon.

[14] Sharpe et al. (2017) reported pHOS values above Foster in 2 years after the new Foster AFF of 23.6 percent in 2015 and 35.2 percent in 2016, in contrast to 19 percent average over 5 previous years. The HGMP target pHOS to achieve recovery is <30 percent for the entire South Santiam, 0% above and 80% below Foster Dam (ODFW and USACE, 2019d).

UWR Chinook Green Peter outplanting

UWR Chinook were recently reintroduced in response to the 2021 Injunction, and USACE proposed to continue this program. In contrast to the sites where UWR Chinook salmon are outplanted above Foster Dam, the Middle Santiam outplanting location would be cooler, and by migrating to the upper Middle Santiam River, UWR Chinook salmon will have access to habitat with lower temperatures during the warm summer months (Figure 5.5-1). At an upper location in fall 2023, USGS staff observed that spawners had moved upstream, for the first time in the Middle Santiam River, although no formal spawner surveys were conducted (Tackley 2023). Spawning surveys planned for 2024 were delayed because of fires and were expected to begin in October. That initial outplanted UWR Chinook salmon moved to higher, cooler reaches in the Middle Santiam River far above the outplanting location was a sign of success. Without counts for spawners on redds relative to numbers outplanted (Table 5.5-1), how successful this operation has been is difficult to discern. Lacking data on the success of these spawners limits the ability to manage outplanting timing and location for improved spawning; similarly, limited data on offspring from this effort impedes understanding of problems or overall benefits. The data collection at the head of the two reservoir arms with outplanting is proposed for the first time to begin in 2025 during winter and spring. This will inform proposed adaptive management decision-making based on the results.

Lower temperature reaches can reduce the risk of prespawn mortality. Timing of the outplanting from Foster AFF to the Middle Fork River could reduce exposure to temperatures above 18°C, with dates from recent years shown in Table 5.5-1 and temperatures in Figure 5.5-3. The first two years of spawner surveys were in the smaller Quartzville Creek area. Researchers reported low PSM in 2022–2023, ranging from approximately 8 percent to 11 percent (Romas 2024). In 2024, Quartzville Creek UWR Chinook had a sharp increase in PSM with an estimate of 21.7 percent (Flaherty 2024). The limited spatial extent of the surveys due to the Pyramid Fire made it impossible to calculate PSM for the Middle Santiam (Flaherty 2024). The results from first two years of outplanting suggest that there were overall strong spawning results. The juvenile UWR Chinook salmon offspring must migrate through Green Peter Reservoir, past Green Peter Dam, down the Middle Santiam River, through Foster Reservoir, and past Foster Dam. Low survival in several reaches will lead to lower abundance, as has been seen in returns to Foster AFF.

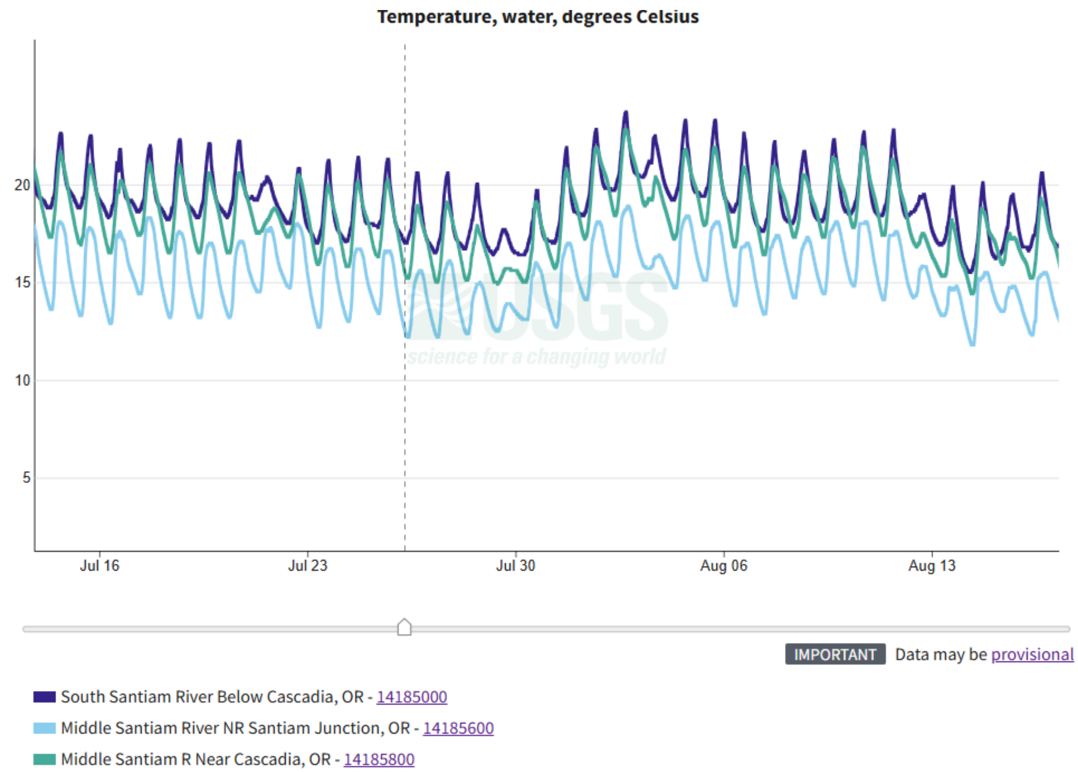

Figure 5.5-3 Temperatures vary during the warmest periods July–August 2024, at sites used for UWR Chinook salmon outplanting. The coolest temperatures (light blue) are at the upstream site where spawners were found in 2023, and the warmest are in the South Santiam above Foster Dam. Data from USGS gage numbers shown.

Table 5.5-1. Timing of 2022-2023 releases above Green Peter Reservoir. (Source Sachs 2024)

Green Peter Adult Chinook Outplanting Dates			
Year	Release Site	Date	Spawners
2022	Middle Santiam	11-Jul	240
	Middle Santiam	14-Jul	120
	Middle Santiam	19-Jul	120
	Middle Santiam	26-Jul	120
	Quartzville	8-Sep	180
2023	Middle Santiam	30-Jun	120
	Middle Santiam	12-Jul	240
	Middle Santiam	14-Jul	120
	Middle Santiam	20-Jul	120
	Quartzville	26-Sep	200
2024	Middle Santiam	10-Jul	360
	Middle Santiam	23-Jul	240
	Quartzville	24-Sep	200

5.5.1.2 Effects of Interim Reservoir and Downstream Dam Passage Operations

USACE proposed to continue actions at Foster and Green Peter dams to provide operational downstream passage (Table 5.5-2). At Foster Dam, these continued actions provide improved passage relative to previous attempts involving weirs in the dam spillways for the UWR Chinook salmon and steelhead.

Table 5.5-2. Proposed Downstream Passage Options for UWR Chinook and UWR steelhead at the Foster and Green Peter dams.

Actions and Location	Season	Priority outlet or method	Start/End Timeline	Considerations
		Continuing and Interim Actions		
Foster Dam	Fall	Night spillway with station service turbine flow. Day turbines only.	Oct 1 to Dec 15	Drop pool elevation to 620-625 ft by Oct 1. Follow rule curve dropping to 613 ft by Nov 15
Foster Dam	Spring	Spillway with station service turbine flow 4pm – 8am (dusk to dawn). Daytime turbines only.	Delay spring refill until 16 May. Spill Feb 1 to Jun 15.	Hold elevation at 613-615 ft until refill to 637 begins.
Green Peter	Spring	Spillway 24 hours, for 3 weeks;	March to July 1 latest; Dusk to dawn for 30 days min	Begin at 971 ft elevation; timing depends on refill rate
Green Peter	Fall	Deep drawdown to 780 ft elevation, 25 ft over RO	Begin drawdown Jul 1 or soon after, targeted for Nov 15, refill after Dec 15	Maintain target elevation for 3 weeks; refill to minimum conservation pool as feasible.
		Long-Term Actions		
Foster Dam	Spring	Spillway with overnight and daytime turbines	No turbines 6-10am, 6-10pm April 15 to July 1.	
Foster Dam	Year round	Develop conceptual design for structure using surface route	Design starting in 2025, completed by 2031.	
Green Peter	Spring, Fall	Same as near term	Changes under review to reduce temperature effects	Fall deep drawdown initial run in fall 2023

The recent actions have included prioritized night spill at Foster Dam, with some tests of lower pool elevations. For Green Peter Dam, new volitional passage operations began under the spring spill and fall deep drawdowns in the 2021 Injunction Court-ordered Actions. These are currently also proposed for long-term passage.

- The expected benefits of these actions are that more UWR Chinook salmon and steelhead would successfully pass Foster Dam.

- There are challenges to manage outflow timing, temperatures, and the increases in TDG with spill.
- Green Peter Dam operations also prioritize the spillway passage in spring.
- To provide volitional passage in the fall, Green Peter Dam is operated under deep drawdown releases. The reservoir elevation target of 780 feet had not been attempted since the Green Peter Dam became operational in 1967 (USACE 2024e Fifth Biannual Status Report). This allows juvenile UWR Chinook salmon to sound no more than 30 feet to pass through the ROs.

To monitor the effects of operational passage in Foster Reservoir, juvenile UWR steelhead tagged after capture in an RST while migrating into Foster Reservoir were used to evaluate passage routes (Monzyk et al. 2017). Many more juvenile UWR steelhead entered at the head of Foster Reservoir than those migrating past the dam (Monzyk et al 2017). In this multi-year study of tagged NOR juvenile steelhead, the majority that passed did so in March to June, peaking in May, and were mostly age-2 (overall age structure of: 13 percent age-1, 84 percent age-2, and 2 percent age-3) (Monzyk et al. 2017). Untagged smaller (age-0) UWR steelhead could also pass with high discharge levels in the fall, possibly through turbines. However, the authors note that "better understanding of their distribution in the forebay and route selection at Foster Dam are needed given their abundance in the reservoir and potential survival disadvantage from a turbine passage route." A subset of those not passing may rear in the reservoir, as was seen for age-1 tagged fish where only 26 percent were detected leaving at age-1, but 72 percent then left at age-2, and 2 percent at age-3. The diminished life history diversity shown by this restriction to primarily age-2 migrants affects the resilience of the South Santiam UWR steelhead population, most of which also return as age-4 spawners. In the reservoir, rearing juvenile UWR steelhead would also be exposed to predation and risk of copepod infestation (Monzyk et al 2015a, citing 25–36 percent reported by Barndt and Stone (2003) for juvenile steelhead). While the UWR steelhead that are able to find a route are passing with unknown survival, significant numbers do not pass the proposed operational routes. These losses will continue to affect productivity, confirmed by extreme low returns and falling abundance for UWR steelhead.

Later releases of surrogate[15] UWR steelhead study-fish informed passage rates under different conditions. Surrogate juvenile UWR Chinook salmon releases also informed both Foster and Green Peter dam passage studies. For the study fish, releases were surgically implanted with both an RT tag and a PIT tag (Larson et al 2024). To reduce the tag burden, these fish had to be larger than 95 mm fork length so do not represent all juvenile Chinook. For overall passage under proposed actions, 2023 studies with surrogate UWR Chinook salmon and steelhead show limited survival in the reservoir (from release to passage), varied survival during passage, and low survival downstream to the confluence of South and North Santiam rivers (Table 5.5-1 and 2). For UWR steelhead passing Foster Dam in the spring, 1-yr age showed few to none passing (23, of 671 released). For fall 1+ yr UWR steelhead, while more passed (223 of 1527 released), they were still very few and the proposed spill passage had lower survival than even that of UWR Chinook salmon subyearlings passing by turbine. Few UWR Chinook salmon yearlings in the spring were seen to pass (34 of 149 released) because of low survival from release to passage, but those that passed had moderate survival. In the fall during low-pool conditions, UWR

[15] Obtained from the program at the Oregon Hatchery Research Center (details in Larson 2024).

Chinook salmon subyearlings passed at higher rates and with higher survival, except for those that passed through the turbine route. These proposed action operational passage routes have high mortality for fish in the reservoir prior to making their way to the dam face, and then limited dam passage survival. This leads to lower abundance of juveniles and further decline in productivity, as was shown by low cohort replacement rates.

Similar studies on the Green Peter Dam spill passage route were not possible in spring 2023 because of the lack of surrogate UWR Chinook salmon (Larson et al 2024). In the fall, researchers were able to release UWR Chinook salmon following the drawdown to the target elevation for passage and found that less than half (319 of 738) moved to the dam face, where those that passed had moderate survival. These UWR Chinook salmon also had to move through the turbid water from the drawdown into Foster Reservoir and past Foster Dam. The survival past those barriers to near the North and South Santiam river confluence was quite low, suggesting improvements will be needed to increase productivity.

In earlier studies at Foster Dam of an alternative weir placed in one spillbay, tagged UWR Chinook salmon more often passed through other spillways than through the weir when both routes were available at both low- and high-pool elevations (Hughes et al. 2016). UWR Chinook salmon also passed through turbines at survival rates of 0.018 to 0.326 depending on the year and low- and high-pool levels (Hughes et al. 2017). Juvenile UWR steelhead were more likely to use the weir at high pool, which may be due to their tendency to pass at shallower depths. When weir and turbine routes were available in 2015 and 2016, more UWR Chinook salmon passed turbines, while for the weir and spill routes, more chose spill. This study showed the weir had higher survival than spillways, but since fewer UWR Chinook salmon chose this route, it was not maintained as operational passage (Hughes et al 2017).

In 2018 tests of a new weir showed that UWR steelhead preferred it at high pool and had improved survival, but at low pool UWR steelhead were almost evenly split between the weir and spillway, with better survival in the spillway. While the researchers showed in a post-construction evaluation that upstream of Foster Dam, the weir successfully attracted UWR Chinook salmon and steelhead, they also found higher rates of severe events in chute and sensor-fish injuries compared to similar structures (Liss et al. 2019, Deng et al. 2019). Most recently, the studies of low and high pools contrasting UWR steelhead and Chinook salmon showed very low steelhead survival following the interim actions to evaluate low pool attraction and passage survival and low survival for Green Peter passage via the deep drawdowns in 2023 (Table 5.5-3). The results verified that most UWR Chinook salmon and steelhead pass at night and generally chose the spillway, with a subset using the turbine route (Larson et al 2024). From RST data in fall 2024, the numbers of migrating juvenile UWR Chinook increased considerably, but the mortality rate was very high (56-61%) during early November prior to the halt of the drawdown operation (Cramer 2024).

Collecting fish passage data below Foster Dam for naturally migrating offspring of adult UWR Chinook salmon and steelhead has proved difficult because of the lack of functional rotary screwtrap locations in the wide area downstream, given shallow depths that prevent the trap from spinning. In addition, South Santiam Hatchery is on the South Santiam River, just downstream of Foster Dam, with intakes that provide river water to the hatchery egg trays and holding pools.

Adults are collected, eggs incubated, and UWR Chinook salmon are reared briefly at this location then moved to the Willamette Hatchery for further rearing, returning for acclimation later. Alternative evaluation methods include PIT-tagging naturally migrating UWR Chinook salmon and steelhead captured above the dams, with data from observations at downstream PIT antennae[16] (see earlier examples in Monzyk et al. 2017).

USACE installed replacement PIT antennae and infrastructure on Lebanon Diversion Dam, 17 miles downstream of Foster Dam, as part of the 2021 Injunction actions[17]. Limited returns of large numbers of PIT-tagged hatchery UWR Chinook salmon 'bulk' that were released into Green Peter and Foster reservoirs showed that very few were recaptured at downstream antennas, compared to UWR Chinook salmon released in the tailrace below Green Peter Dam. Less than 7 tags were recaptured from the reservoir releases vs 49 from the tailrace releases with varying travel times (Figure 5.5-4). These study fish could also be informative as adult returns if the Willamette Falls ladder replacement antennas are provided prior to their return from estuary and ocean life stages. Other sites that record passage are the towed arrays of pile dike antennas in the Columbia River Estuary where six tagged fish released from the tailrace and eight tagged fish released above Green Peter Reservoir were observed, with travel time to the estuary antenna averaging 124 and 195 days, respectively. A single tag from the PNNL study was also observed in the estuary, with a travel time of 149 days. Passage timing of the hatchery bulk releases and dual-tagged surrogate (PNNL study) UWR Chinook salmon is continuing to be recorded in 2024 using the limited Lebanon antennae. Better tracking under different conditions and operations would inform options to improve passage and, potentially, provide higher returns. Because of the lack of PIT-tag-detection infrastructure, there are little to no data available to characterize the movements of naturally outmigrating UWR Chinook salmon and steelhead that are tagged at the head of Foster reservoir and those that will soon be PIT-tagged above Green Peter Reservoir.

[16] Many Columbia River PIT tagging programs facilitate analyses of juvenile and adult migration and survival, habitat use, and fishery management practices as described recently by Bosch et al (2023) for the Cle Elum dam studies.

[17] In the 2 years following the installation, antennas sustained damage but because of contracting issues, no repairs were completed for many months, resulting in limited data (Jan to Sept 2023, January-Oct 2024). In fall 2024, repairs to the power cables may allow some data from bypass and ladder antennas, but larger damaged plate antennas on the dam were not replaced.

Table 5.5-3. Passage from Green Peter and Foster dam in 2023 results with study fish. Notably few UWR steelhead passed in the spring, as 1-yr age compared to fall as 1+ yr age, more UWR steelhead passed with lower survival than even those UWR Chinook salmon subyearlings passing by turbine. Note that the fall counts at Foster Dam include Green Peter subyearling Chinook salmon that passed Foster Dam so total passing are not equal to Foster outplants. (Estimates in Larson et al 2024; note no yearling Chinook salmon were available for Green Peter 2023 spring spill evaluations due to disease problems at the surrogate fish facility).

Dam	Season, Pool level	Species	Passage Treatment	Released alive (n)	Head-of-Reservoir release (n)	Survival Release to passage	Mid-of-Reservoir release (n)	Survival Release to passage	Passing dam (n) Passage Survival probabilities	Reach survival to near North Santiam confluence
Green Peter	Fall Deep Drawdown*	subyearling Chinook	RO 24/7 Operation	738	371	0.396	367	0.485	(319), 0.727	0.227
Foster	Spring Low Feb 1– May 15	yearling Chinook**	Nighttime Spill	149	75	0.200	74	0.257	(34), 0.800	0.312
	Spring Low Feb 1– May 15	Steelhead 1 yr	Spill (near sunset, post sunrise)	671	335	0.027	336	0.057	(23), 0.244	insufficient detections
	Spring High May 21– June 16	Steelhead 1 yr	Nighttime Spill	832	419	unknown	413		(3), insufficient to estimate	none detected
Foster	Fall Low Oct 1– Dec 16	subyearling Chinook	Nighttime Spill	120	60	0.517	60	0.683	(145) 0.952 spillway (33) 0.654 turbine	(64) 0.609
	Fall Low Oct 1– Dec 16	Steelhead 1+ yr	Nighttime Spill	1527	763	0.120	764	0.173	(223), 0.301	none detected

* released at reservoir lowest elevation, after r drawdown
**limited study fish available due to fish health issues; none were provided for Green Peter spring spill

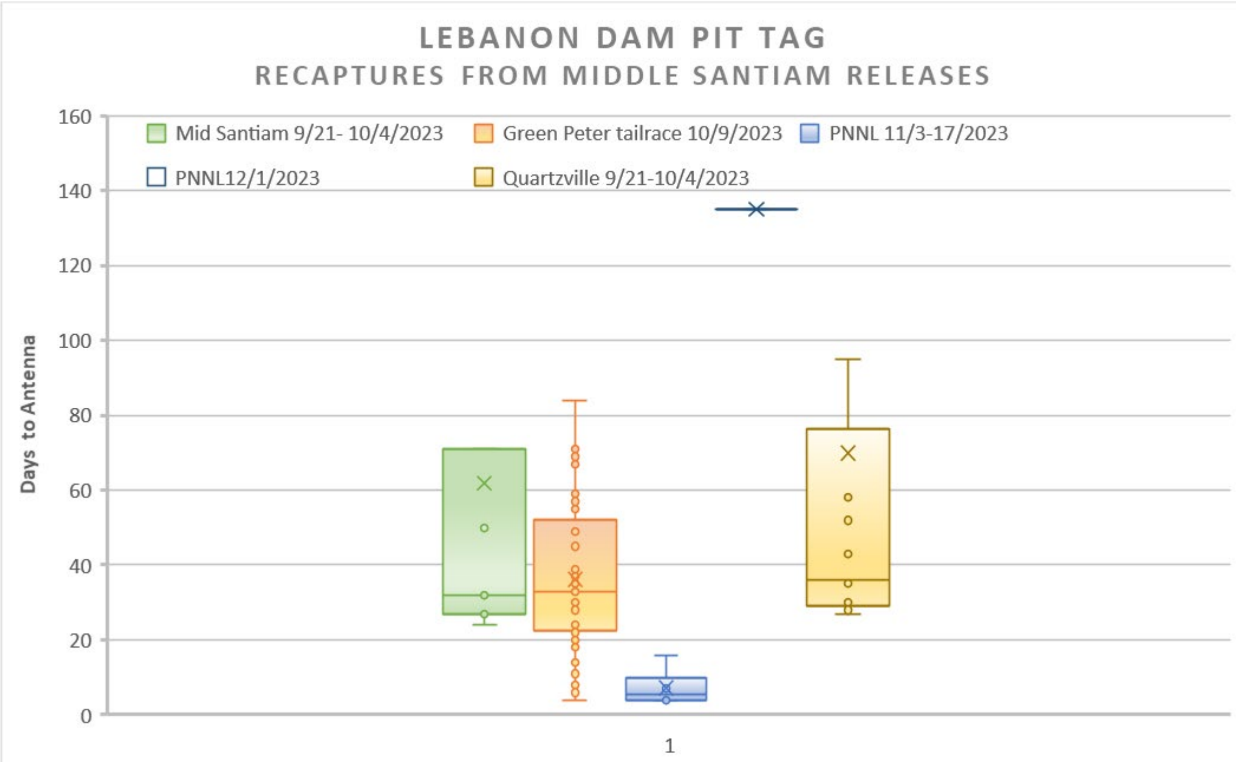

Figure 5.5-4 PTAGIS observations of tagged UWR Chinook salmon released in 2023. Fewer downstream counts were seen from the above dam and in the reservoir than from the releases in the Green Peter tailrace. The median days to the Lebanon antenna were 32 days or the Middle Santiam releases (without an outlier of 197 days, and 62 days with it), 36 days for those released into Quartzville Creek, 36 days for Green Peter tailrace releases, and 7 days for the study fish placed in reservoir after the drawdown. (Source: www.ptagis.org downloaded observation data June 27, 2024).

To better understand current operations, USACE explored other ideas and locations for PIT antennas at or below Foster Dam, working with contractors who design and construct antennas, to find out timing and numbers of tagged fish that pass during an operation. Three possibilities and constraints were described (USACE 2024e, Fifth BiAnnual Status Report, Appendix A):

1) Floating barges with PIT antennas located in the forebay of the spillway. Costs were not estimated for this option because of USACE's view of the infeasibility of this option.
2) Flat-plate PIT antennas in the riverbed in the Foster tailrace downstream of the spillway stilling basin. This type of flat-plate PIT antenna could be installed at the bottom of the river and anchored directly into the bed of the river or encased in concrete to protect it from high river flows and debris. Because of the location at the bottom of the river, the read-range (i.e., distance the antenna can detect PIT tagged fish) will be limited, especially during high river flows when the water is deeper. A timeline to design and install the in-river flat plate antenna, if feasible, is estimated to take 26 months from contract award.

3) Floating Hydrofoil PIT antennas. Floating Hydrofoil PIT antennas could be challenging at Foster Dam and in the South Santiam River because floating antennas are generally designed for small, shallow streams and rivers and small outlets. If feasible, the design, construction, and installation of a floating hydrofoil antenna system in the river downstream of Foster Dam may take approximately 12 months after contract award (Table 2). The floating hydrofoil antenna system has high risks associated with it, specifically high river flows typical in the South Santiam River, large debris, including large logs and trees floating downriver, which could damage the floating antenna system. For reference, the flat-plate antennas installed at Lebanon Dam spillway, downstream of Foster Dam, were damaged during the first year after installation by large debris and floating trees from high-flow conditions. The Lebanon Dam antennas are much more robust and attached to the dam compared to floating antennas in the river that will be subject to high flows and debris.

In the AM Plan, the above review will help with decisions on how to track UWR Chinook salmon and steelhead below Foster Dam, where the South Santiam water depth and width have precluded use of RSTs. While still at an early stage to review a future plan for one of the above options or completing redesign at Lebanon Dam, USACE is continuing the bulk release of PIT-tagged fish upstream and in the Green Peter and Foster reservoirs. If the formerly operational antennae in the Willamette Falls fish ladder are replaced, these tagged UWR steelhead and UWR Chinook salmon would be tracked when returning as adults entering the upper Willamette River. This would help with estimates of how many tagged fish enter the Willamette River from this subbasin prior to their arrival at the Foster ladders with PIT antennas.

5.5.1.3 Effects of Long-Term Downstream Dam Passage Operations

USACE proposed a structural passage solution at Foster Dam, which will be designed and built with anticipated completion and initial operation occurring in 2031. This could recreate the weir with improvements that were used in 2018 but without sufficient attraction if other outlets were available (UWR steelhead in particular). There is limited information to analyze the effects of this, but improvements would be anticipated to boost the abundance of migrating juveniles, and, ultimately, adult returns.

For Green Peter Dam, no structural downstream passage is proposed. Instead, operational passage with some adaptive management is proposed, as was done for temperature effects (Section 5.5.3). Also, USACE proposed to evaluate passage by CRR values, while data will be available for a single cohort in 2028 at the soonest. Until there is improved data analysis to inform the operations for UWR Chinook juvenile passage timing and success, low survival and passage efficiency will likely reduce the abundance from early outplanting efforts. Similarly, Foster Dam may impede passage for different life stages of juvenile UWR steelhead, which would continue to limit possible increases in abundance or productivity. Proposed adult fish passage at Green Peter Dam would require that adult UWR Chinook are handled first at Foster AFF, then once more after swimming through part of the Foster Reservoir and up the Middle Fork River, which may have fluctuating stages during power production. It may also be considerably warmer during spill operations. Rather than continue with outplanting from Foster

Dam to above Green Peter reservoir, this creates added stress and temperature exposures that would lead to higher PSM. The limited benefits are for homing to natal reaches, but these are outweighed by the harm to spawners.

5.5.2 Flow Effects

USACE proposed new minimum flow thresholds for the South Santiam River, which in comparison to the 2008 RPA minimum flow objectives, are lower during UWR steelhead and Chinook salmon spawning periods (Table 5.5-4). When refilling the reservoir elevations at or above 90 percent of the rule curve, they propose values that are 76–80 percent of the 2008 RPA minimum flow objectives. The proposed low minimum flows when refill levels are less than 90 percent of the rule curve range from 46 percent of current minimum flow objectives in March through May, when UWR steelhead are spawning, to 76–89 percent during the UWR steelhead incubation period in late spring. When UWR Chinook salmon are spawning, they drop to 76 percent for September and part of October, although overlappint with the proposed Green Peter deep drawdown. During rearing periods in July and August, minimum flows are higher than 2008 RPA minimum flow objectives, as well as part of May and June when at or above 90 percent of the refill curve. This tradeoff of lower spawning and incubation flows during dry years for increased rearing minimums during wet years does not provide sufficient protection for crucial spawning life-history stages. If reduced spawning success results in lower productivity, benefits from rearing flows are unlikely to be realized. The proposed changes in flow will contribute to a continued drop in overall abundance and productivity for both the UWR steelhead and Chinook salmon (Figure 5.5-1, and details in Baseline section).

Other proposed operations with flow effects include flood-risk reduction. Flood prevention decreases the magnitude and frequency of instantaneous peak flow events. Continuing these operations will contribute to the ongoing loss of habitat complexity in the South Santiam River by substantially reducing the magnitude of channel-forming dominant discharge (generally 1.5- to 2-year events) and increasing the return intervals of larger floods. The proposed action will cause lower channel complexity, fewer side channels and alcoves, less large wood recruitment, and coinciding changes in movement of the full range of channel substrates. This sub-basin has more revetments than others, part of the environmental baseline.

In 2015, 2016, 2021, and 2023, USACE fall discharges from Green Peter and Foster dams were lower than 2008 RPA spawner minimum flows, and 2015 spring and summer flows were also lower (Figure 5.5-5). The short period of lower flows in fall of 2023 were to enable repairs to the PIT antenna on Lebanon Dam, downstream of Foster Dam. These observations show that while there have been a few years per decade where low flows are below minimum objectives, the reductions proposed are considerably lower (Table 5.5-4, and Figure 5.5-5) and would leave more habitat disconnected. Lower flows during holding and spawning reduce spawning success if habitat is inaccessible, warm, or has insufficient water depth to cover the redds. USACE's proposed modified minimum flow objectives would lead to lower flows during spawning, reducing spawning success, particularly for UWR Chinook salmon. During dry winters, there is a chance of refill following drawdown, which would lower flows and affect UWR steelhead spawning flows.

Table 5.5-4 Proposed minimum flows proposed for Foster Dam and Green Peter releases. during different seasons, and affecting different life history stages. Highlighted proposed minima in orange are reduced from the 2008 RPA Minimum Flow Objectives, and increases are shown in green when on or above the refill rule curve. October minimum flows apply for months not shown, unless flood risk reduction requires lower flows.

Start Date	Primary Use	Proposed Green Peter & Foster >90% rule curve	Proposed Green Peter & Foster <90% rule curve	2008 RPA Minimum Flow Objectives
1-Feb	Rearing	1140	700	800
16-Mar	Steelhead spawning	1140	700	1500
1-Apr	Steelhead spawning	1200	700	1500
16-Apr	Steelhead spawning	1500	700	1500
1-May	Steelhead spawning	1550	770	1500
16-May	Steelhead incubation	1600	840	1100
1-Jun	Steelhead incubation	1550	910	1100
16-Jun	Steelhead incubation	1500	980	1100
1-Jul	Rearing	1400	1140	800
16-Jul	Rearing	1250	1140	800
1-Aug	Rearing	1140	1140	800
16-Aug	Rearing	1140	1140	800
1-Sep	Chinook spawning	1140	1140	1500
16-Sep	Chinook spawning	1140	1140	1500
1-Oct	Chinook spawning	1140	1140	1500
16-Oct	Chinook incubation	1140	1140	1100
1-Nov to 31-Jan	Chinook incubation	1140	1140	1100

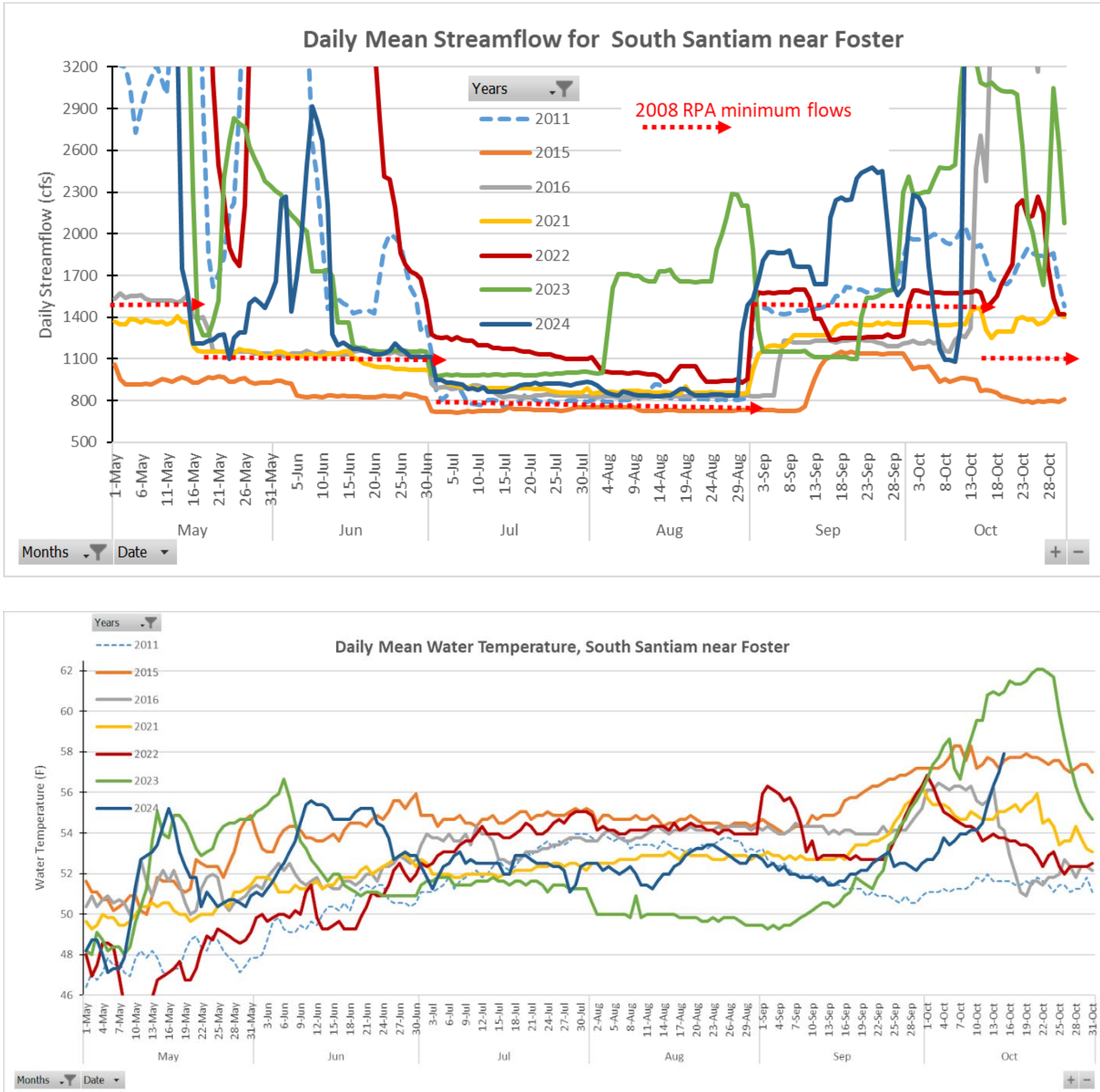

Figure 5.5-5 Flows (upper graph) and temperatures (lower graph) during 2011, 2015, and 2016, representing years that were cool, hot, and moderately warm respectively, along with 2021–2024 to show recent temperatures. In 2023, the first deep drawdown was managed at Green Peter Reservoir. Summer 2023 had lower temperatures from Green Peter flows, only to be followed by much warmer fall temperatures due to reservoir levels mixing. For 2024, USACE started the drawdown later to reduce downstream temperatures, which rose later. USGS 14187200 data.

Higher flows below Foster Dam in fall will result from drawdown operations and can affect UWR Chinook salmon spawners in the reaches below Foster Dam. They may use areas that are on the river margins when available, but later flows could be reduced, leaving those redds stranded. Higher PSM has been documented in this lower reach of Fall Creek. Proposed drawdown operations create conditions where flows can be challenging to balance. When the drawdown is occurring, higher flows will be released to get to the lower target elevation. The risk is noted in the BA justification for setting maximum flows:

> *Because high flows encourage spawning in areas of the river which could become dewatered after reservoirs have been drafted for flood risk management, reducing egg and fry survival, maximum flows were developed based on spawning WUA estimates. . . The 75% WUA spawning flow level was chosen to help balance the need to encourage spawning in areas that will remain wetted after reservoir drafting and the need to increase flows to draft reservoirs for flood management." (USACE 2024a)*

The proposed action stated "total discharge from the dam will be maintained at or below the maximum flows for spawning," which will require much higher flows to attain the lower elevation once restricted maximum flows end on October 15, as was seen in 2023 and 2024 (Figure 5.5-5, and 5.5-6). These higher flows can scour redds and will also deliver higher suspended sediment.

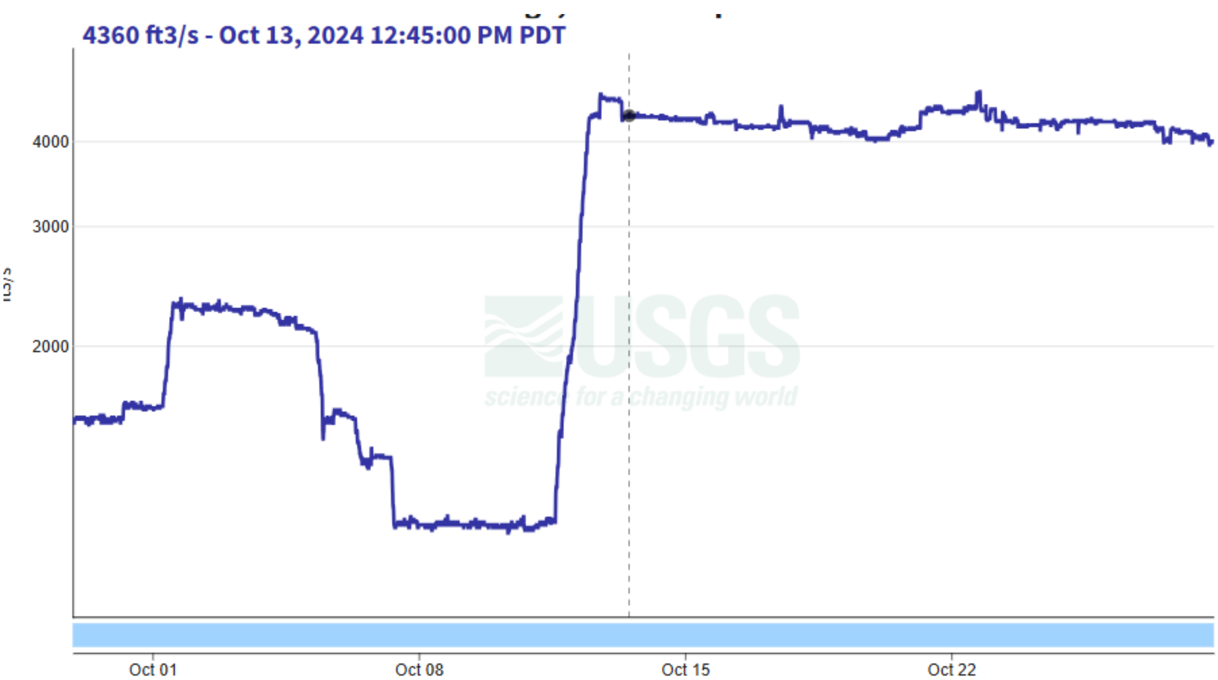

Figure 5.5-6 Large changes in discharge below Foster Dam, with low flows during 2024 because of work on PIT antenna downstream. Higher discharges to get to lower elevations in Green Peter are passed though at Foster Dam. Source USGS 14187200.

Maximum flows proposed for the South Santiam below Foster Dam are 2,825 cfs, in contrast to 2008 RPA maximum flow of 3,000 cfs through September 30. Under the 2008 RPA, if sufficient incubation flows were unlikely following high releases during spawning, the Flow Water Quality Team would consider monitoring where redds were placed in relation to flow rates, and given reservoir storage, would make recommendations for sustainable incubation flow rates (NMFS 2008a, Table 9.2-2 footnotes). Monitoring and evaluation of effects for the AM Plan will show tradeoffs for juvenile migration and adult spawning; this would lead to reduced productivity below Foster Dam until the AM Plan provides better information.

5.5.3 Water Quality Effects

Table 5.5-5 Proposed Actions Affecting Temperature below South and Middle Santiam Dams.

Actions and Location	Season	Priority outlet or method	Start/End Timeline	Considerations
Near-Term Actions				
Foster Dam Ladder	Summer Temperature management	Weir in spillway nearest to adult ladder to access warmer water	June 16 to approx. late July	Timing will also be based on inflow temperatures
Green Peter	Fall	Deep drawdown to 780 ft elevation, 25 ft over top of RO	Begin drawdown Oct 15 to avoid higher temps below Foster	Continue to monitor temperature, TDG, and turbidity
Long-Term Actions				
Foster Dam	Summer Temperature management	Flow through new Forebay Warm Water Supply (FWWS) pipe	Near complete design, Construction to begin 2025, completed 2027	May need less flow to FWWS when spilling from Green Peter
Green Peter	Fall	Same as near term: meet minimum flows, drawdown to 780 feet	Changes in timing of drawdown to reduce temperatures below Foster	Deep drawdown initial run in fall 2023, followed by later start in 2024

Total Dissolved Gas levels

Levels of total dissolved gas (TDG) are a concern for the UWR Chinook salmon and steelhead, and TDG levels are affected by proposed passage and temperature operations. USACE operational passage at Green Peter Dam with deep drawdown in the fall affects the Middle Santiam River below the Green Peter Dam and extends to below the South Santiam River below Foster Dam, albeit at reduced levels (Figure 5.5-7). When the elevation drops below the turbines, that passage route is no longer available, and flows are passed through the RO for fish passage. The TDG levels rise above the Oregon DEQ maximum of 110 percent, as high as 132 percent in 2024 (Figure 5.5-7). These higher values will cause gas bubble disease for UWR Chinook salmon below Green Peter Dam, although few would be anticipated to be there as the elevations in October are 100 feet above the ROs. Juvenile UWR Chinook salmon migrating through the only passage outlet, the ROs, were not expected to use them until the reservoir elevation was within 50 feet of the RO invert. At this point, lower discharge would lead to lower TDG.

In past operations that led to high TDG, NMFS has supplied comments on the problems this causes (NMFS 2017d e.g.), noting risks of higher mortality to juvenile salmonids:

> *Juvenile rainbow trout held in surface waters at 122% TDG saturation showed 53% mortality at 49 hours of exposure, and studies of juvenile Chinook resulted in 43% mortality after 58 hours of exposure to 120% TDG saturation, while at 116% TDG mortality was 42% after a 9-day exposure. Higher levels, 130% TDG led to fish showing*

significant increased vulnerability to predation (Antcliffe et al 2002, and Mesa et al 1997, both as cited in Weitkamp 2008).

For the current year and past years, we note the increased risk of mortality from higher TDG levels during operational passage caused by outlets that ca not balance with turbine operations. In Figure 5.5-7, the Foster Dam mix of day-night operations for turbines and spill, respectively, appears to reduce TDG peak values, while the Middle Santiam River below Green Peter has levels beyond safe limits. While currently there are unknown numbers of juvenile UWR Chinook salmon migrating in this reach, the numbers would be expected to grow over time with ongoing spawning above Green Peter Reservoir and ongoing passage operations.

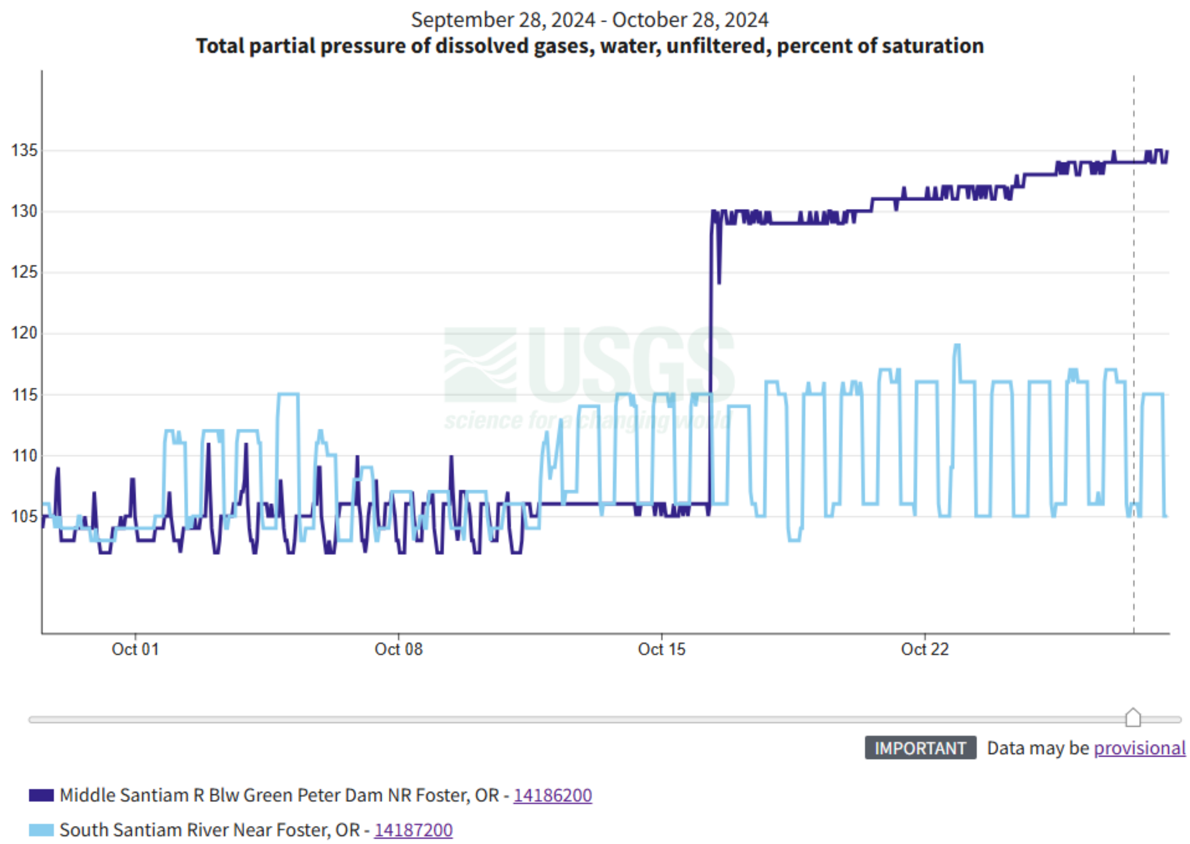

Figure 5.5-7 Total dissolved gas levels below Green Peter Dam and Foster Dam during October 2024 deep drawdown for operational passage from Green Peter Reservoir and Dam. Source: USGS gage data from 14187200 (Middle Santiam) and 14186200 (South Santiam).

Work described in 2018 (Colotelo et al 2018) demonstrated that dissolved gas levels lowered when smaller amounts of turbine operations coincided with spill for passage. Turbines will be used to provide 'station service' for the powerhouse during spring spill passage operations (USACE 2024g). These overlapping operations were shown to bring higher TDG levels with spill down by 2 percent (Colotelo et al 2018), which could alleviate the gas bubble disease risk. Better data for changing effects on UWR Chinook salmon and steelhead rearing and spawning below Foster Dam persists will be part of the AM Plan.

Temperature

Below both Green Peter and Foster Dam, the proposed drawdown operations in the late summer and fall would lead to temperatures high enough to risk lethal harm to the spawners and the eggs in redds below Foster Dam. In the past, these were noted as a significant problem during the first drawdown in 2023, when reaching the lower elevations required sending significant volumes of warm water from above the thermocline in Green Peter Reservoir downstream from the Middle Santiam River into Foster reservoir and below Foster Dam into the South Santiam. Following these temperature exceedances, USACE had USGS model alternatives with to evaluate potential later start dates (Stratton Garvin et al. 2023). Given shorter late fall days and atmospheric interactions with the warmer surface layers, possible natural cooling before the reservoir fully mixed would improve downstream water temperatures. This hypothesis was tested in 2024, and the results show nearly 3 weeks of lower temperatures (Figure 5.5-8). However, temperatures rose later in 2024 until they were equal to the extreme levels of 63°F seen in 2023, near the end of October. This delay, however, limited harm to UWR Chinook salmon spawners, with temperatures below 60°F (16°C) up to middle of October, but continued to risk mortality for eggs in redds as mean temperatures rose near 62°F (17°C) in late October 2024 below Foster. Ongoing higher temperatures will continue due to the proposed deep drawdown operational passage that passes fall-migrant UWR Chinook, yet could lead to reduced spawning success below Foster Dam.

Increased temperatures would cause mortality for UWR Chinook salmon eggs in redds below Foster Dam, or early emergence. These, together, demonstrate adverse water quality effects of proposed operational passage at Green Peter Dam. In this subbasin, with no other passage options proposed, these effects will cause a continuing downward trend in UWR Chinook salmon abundance and reduce productivity in the subbasin. Current counts are already low for natural-origin spawners (Figure 5.5-2), and will likely drop with warmer water at crucial periods during the proposed Green Peter deep drawdown passage.

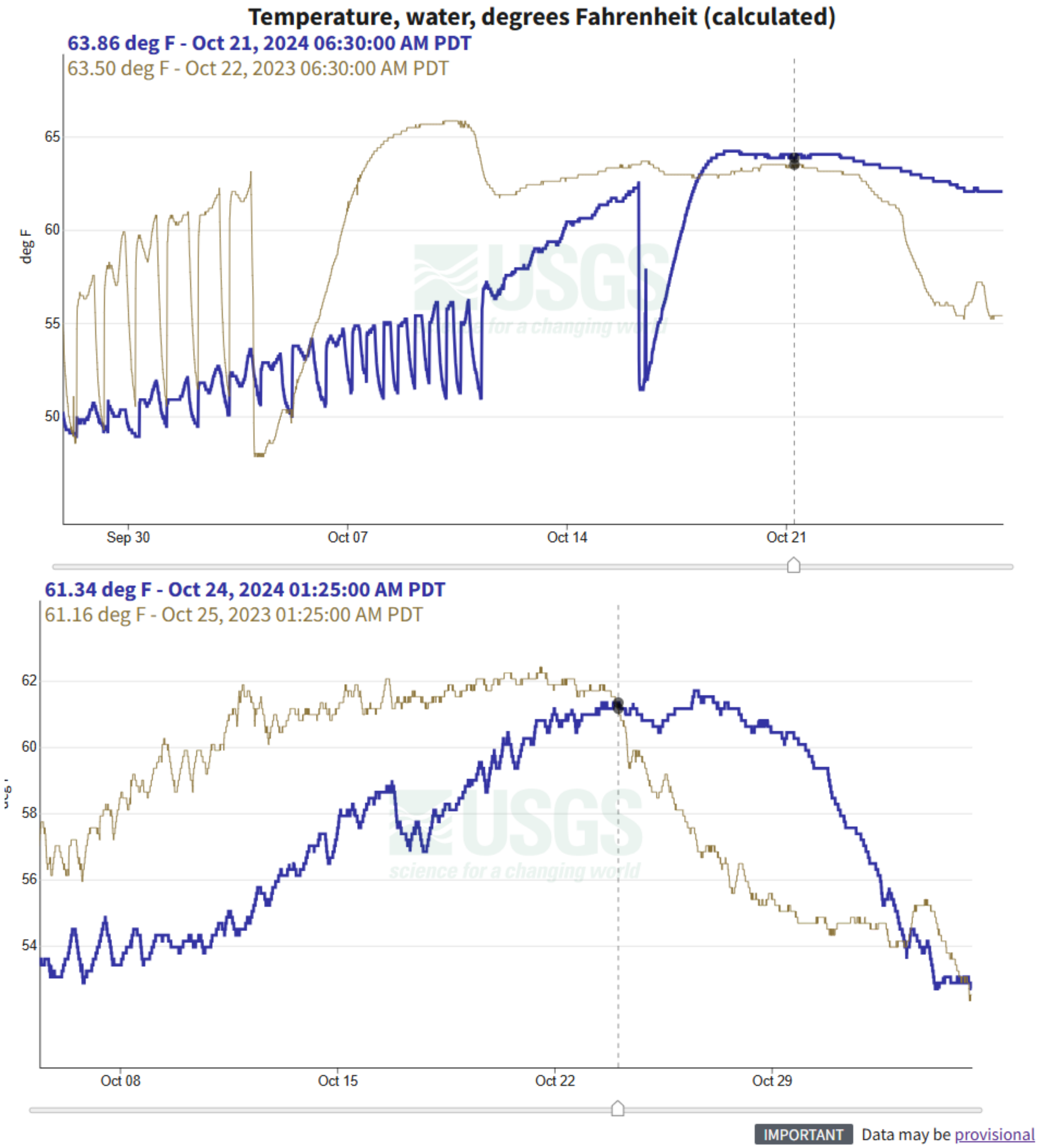

Figure 5.5-8 Temperatures below Green Peter (upper) and Foster (lower) dams during drawdown in both 2023 (brown) and 2024 (dark blue). Sources: USGS gage. Temperatures were lower at Foster Dam until October 23, 2024. Higher temperatures track the elevations in Green Peter Dam, with the 2024 drawdown starting several weeks later than 2023. USGS gage data 14187200 (Foster) and 14186200 (Green Peter).

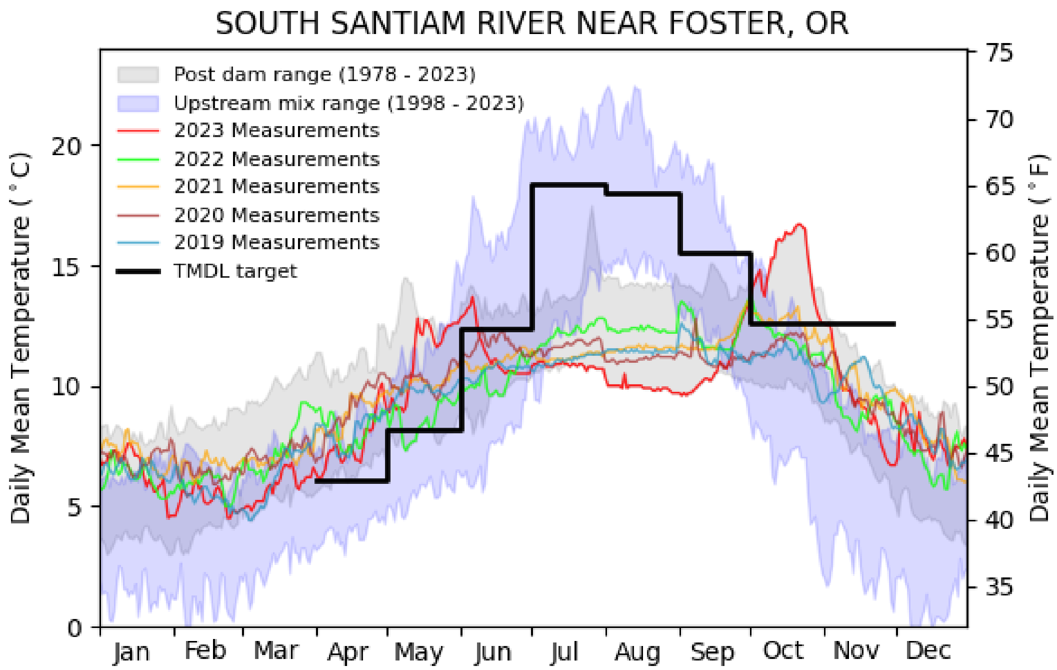

Figure 5.5-9 Specific recent years (2019–2023) and range from 1998–2023 shows how much higher temperatures were in fall 2024 during the deep drawdown. In summer, cooler flow would have come from Green Peter Dam turbines, and in the fall, from the ROs, with the reservoir mixing warm and cool pools, after elevations dropped below the turbine intake. In 2024, similar high temperatures were seen below Foster Dam in March through May. Source: USACE 2024b.

Turbidity

Because of high precipitation from October to December 2023, the exposed sediment during the deep drawdown was suspended in outflows from both Green Peter and Foster dams. As USACE noted in the February 2024 Bi-Annual Status Report:

> *"Turbidity levels indicate that sediment from the drawdown at Green Peter Dam is being transported below Foster Dam to the confluence of the South and North Santiam Rivers (Figure 15). At this time, it is uncertain if this sediment is impacting Chinook eggs in gravels ("redds") below Foster Dam" (USACE Document 292-1 Filed 02/28/24).*

Figure 5.5-10 shows the changes from 2023 and 2024, with considerably lower turbidity during the early drawdown in 2024. Given the later start to the drawdown, elevations were not as low, so sediments were exposed over a smaller area in 2024. Additionally, early fall storms were not as intense as those in 2023. One further possible explanation of the lower turbidity readings over time is a reduction in fine sediment volume following the first year of 2023, over ongoing years. This pattern was seen in 3 years of very low elevations in the South Fork McKenzie below Cougar Dam (Anderson 2007) during the construction of the Cougar Temperature Control Tower. Fall Creek has also had repeated drawdowns to the river bed, and over years the turbidity and sediment loads diminished but did not disappear entirely (Keith et al 2023, Keith et al 2024, Schenk and Bragg 2021). Proposed ongoing drawdowns will cause higher risks to downstream spawners and incubating eggs that persist from the resulting higher temperatures, high turbidity with related reductions in dissolved oxygen (Schenk and Bragg 2021), and increased TDG. Currently any effects from sediment levels over time are not predictable as the sediment deposition and mobilization have not been measured. USACE noted new fall 2024 actions include: monitoring turbidity, dissolved oxygen, suspended sediment sampling, and satellite imagery. They anticipate the data will be used to develop a sediment transport model to predict sediment transport within and downstream of Green Peter for future deep drawdown passage operations (USACE 2024e). These follow USACE-funded USGS studies with turbidity sampling upstream and downstream of Green Peter in summer 2023, and new turbidity monitoring sites and suspended sediment concentration data collected in summer 2024. As the drawdown is creating potential issues for downstream water users via increased turbidity, USACE coordinated with Oregon state agencies and local authorities to plan for modifications in an effort to reduce turbidity spikes (Tackley 2024b). During late November 2024, USACE made the decision to halt the drawdown at Green Peter Dam and begin to refill after a request from local water providers (Tackley 2024c).

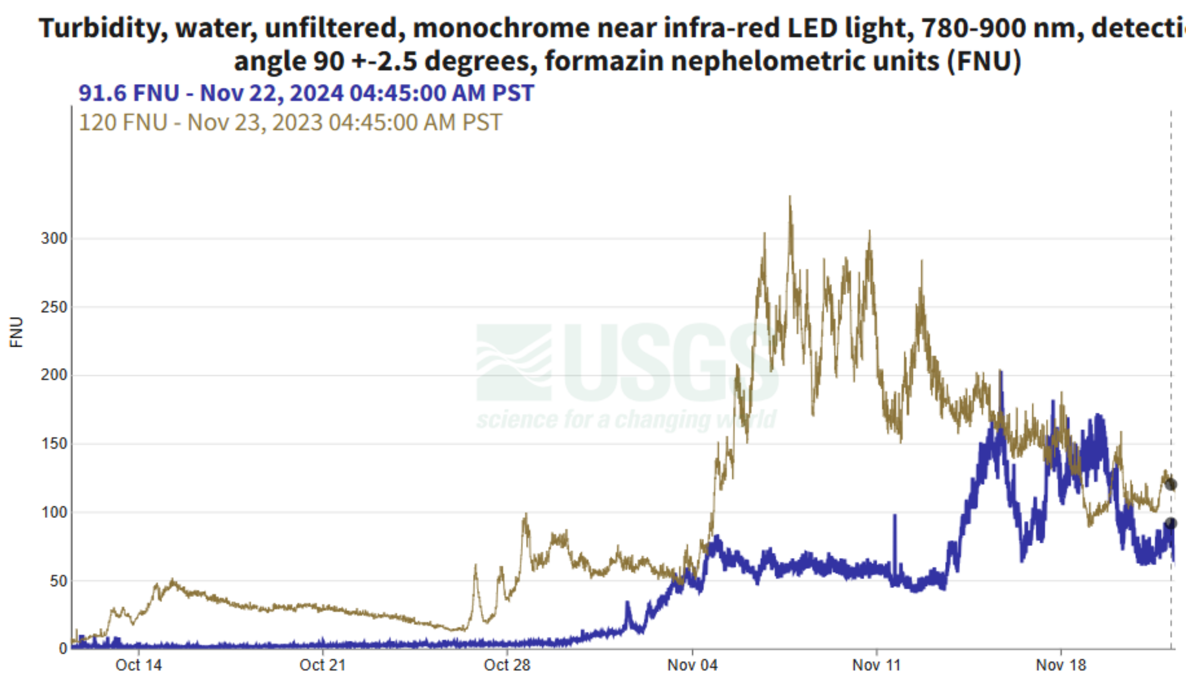

Figure 5.5-10 Moderate turbidity levels in October 2023 (brown) compared to considerably lower in October 2024 (dark blue). Much higher levels were seen in November and December 2023. Source USGS 14187200 South Santiam near Foster.

The proposed operational passage produces much higher turbidity than normal fall and winter levels. During precipitation events sediment exposed while drawn down combined with high stream flow that increases stream energy, is scoured from the open stream bottom and sediment loads are transported farther downstream than would otherwise occur. Sediments in the water column reduce light penetration, increase water temperature, and modify water chemistry.

Redeposited sediments can partly or completely fill pools, increase the width-to-depth ratio of streams, and change the distribution of pools, riffles, and glides. Increased fine sediments deposited in spawning substrate also reduce survival of eggs and fry, reducing spawning success of salmon and steelhead. These effects are expected to be repeated seasonally, with lowered levels as Green Peter reservoir refills when the deep drawdown ends, which continue while the suspended sediment moves downstream. Much of the UWR Chinook spawning takes place in the first half mile directly below Foster Dam. Downstream measurements show the turbidity is high below Foster Dam, and yet gage data on the South Santiam at Waterloo downstream approximately 20 miles shows higher turbidity (Figure 5.5-11). This may indicate sediment remains suspended and continues moving out of the South Santiam River, possibly into the lower North Santiam, and on to the mainstem Willamette River. It is also possible that the instruments' location affects the relative values. More information will be available from the ongoing USGS studies.

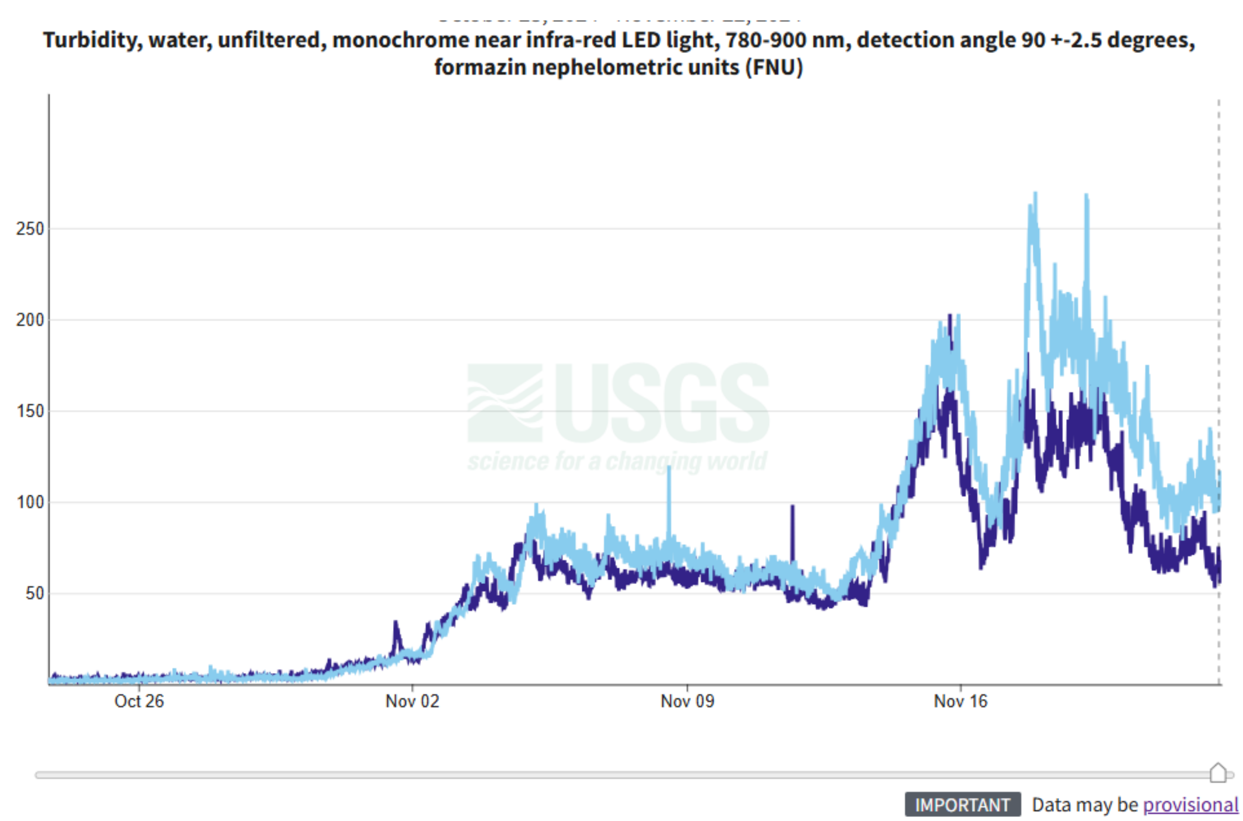

Figure 5.5-11 2024 Turbidity measurements (2024) in South Santiam at Foster Dam (USGS gage 14187200) (dark blue) and downstream at Waterloo gage (light blue) (USGS gage 14187500).

Total fine sediment carried downstream may diminish in ensuing years as the sediment load above the reservoir shifts to coarser material, less likely to be suspended or transported. The results of USGS studies will help to better understand the sediment size distribution, and the transport in response to changing flow. The effect on eggs and fry downstream of Foster Dam will require monitoring, which could occur as part of the Adaptive Management Plan (Section

5.1.2), although this remains to be decided when the AM Plan is underway. The deep drawdown proposed to continue at Green Peter Dam also causes high TDG below this dam, possibly Foster Dam, and would harm rearing or migrating UWR Chinook salmon juveniles (Weitkamp 2008).

Ongoing work to evaluate the changes in the temperature effects downstream of Foster Dam; the TDG, particularly for the reach below Green Peter Dam; and the turbidity throughout the Middle and South Santiam will continue. The results of this early work on focal water quality parameters will inform assessments of how UWR Chinook salmon and steelhead spawning adults and migrating juveniles are responding to operational passage. Due to the harm currently occurring to UWR Chinook salmon and steelhead from degraded water quality associated with dam operations, the spawning success to produce viable offspring will decline below Foster Dam, and possibly for life history stages moving in Foster reservoir. If this harm continues unabated, the corresponding risk of reduced abundance and productivity remains, leading to higher risk of extinction.

In summary, the proposed actions in the South Santiam and Middle Santiam rivers will cause:

- Increased risk of prespawner mortality for UWR Chinook salmon in reaches above Foster and harm or higher mortality for eggs in redds below Foster Dam
- Decreased survival for migrating and rearing juvenile UWR Chinook salmon below Foster Dam resulting from water quality effects of operational passage
- Because of the prolonged timeline for improved passage at Foster Dam, the abundance will decline, affecting the productivity of both South and Middle Santiam UWR Chinook salmon and South Santiam UWR steelhead outplanted above Foster Dam
- Reduced connectivity and suitability of some spawning and rearing off-channel habitat from lower flows and water quality effects
- Faster incubation for UWR steelhead during interim and long-term temperature management and for UWR Chinook salmon during interim temperature management.
- The proposed additional adult facility below Green Peter is uncertain to improve UWR Chinook salmon survival because it requires repeated handling of adult fish.
- Limited productivity from outplanted hatchery origin UWR Chinook salmon due to low passage efficiency and high mortality for juveniles migrating past Green Peter Dam via operational deep drawdown to allow use of the RO in the fall.

Over the longer term:

- Proposed piping improvements to the Foster AFF will increase attraction of adults to the facility ladder causing fewer delays, and reduce crowding and prespawing mortality risk.
- Improved downstream passage proposed for Foster Dam could decrease the juvenile mortality rate and increase abundance, improve productivity, with outplanting data collection informing actions to increase spawning success. Design has not begun for this option, so the extent of possible improvements remains uncertain.

5.5.4 Effects on Critical Habitat

Designated critical habitat within the action area for ESA-listed UWR Chinook salmon and steelhead in the South and Middle Santiam consists of freshwater spawning, freshwater rearing sites, and freshwater migration corridors and their essential physical and biological features (PBFs), as described in the Rangewide Status of the Species and Critical Habitat.

PBF 1. Freshwater spawning sites

a) Water quantity. Flows during UWR steelhead spawning in spring proposed to drop from 2008 RPA targets by more than 50% in dry years during spring refill and again in fall by ~25% would cause reduced habitat availability. Lower peak flows in winter would limit the creation and maintenance of channel complexity as well as transport of spawning gravel.
b) Water quality. Proposed lower flows in February–June cause limited access to higher quality in and off-channel areas for holding and spawning. Continued interim passage would cause higher temperatures in areas where UWR Chinook salmon redds are present below the dam. This will lead to earlier emergence of fry from the redds, into winter conditions with reduced prey.
c) Substrate. Continued operation of the dam to reduce high flows for flood-risk reduction and for refill in the spring and again in the early winter after the fall drawdown passage operation will block transport of suitably sized substrate for spawning. During operational passage of Green Peter Dam, the suspended sediment will cause possible deposition of fines on redds below Foster Dam, as the total turbidity indicates lack of deposition upstream of the dam. Studies are underway to better understand the effects of this operation.

PBF 2. Freshwater rearing sites

a) Water quantity. Flow-related habitat availability and connections will be reduced when proposed minimum flows are released in February–June. Additionally, continued operations to draw down reservoirs, and then refill them, can reduce the high flows in winter and spring, which limits the creation of complex channels and the connectivity to the floodplain features used by juveniles prior to migrating. The operations also limit transport of spawning gravel and large wood.
b) Water quality. Proposed lower flows in February–June may lead to higher temperatures when UWR steelhead eggs are still in redds. Proposed fall drawdowns increase temperatures during UWR Chinook spawning and incubation which will reduce spawning success. The suspended sediment increases shown by high turbidity levels below Foster Dam may settle into redds reducing egg survival.
c) Floodplain connectivity. Lower minimum flows proposed in spring, or lower flows in spring and winter for post drawdown refill, will reduce floodplain connectivity by increasing the likelihood of 'single channel' habitats forming.
d) Natural cover. Continued operations of Foster and Green Peter dams to refill and provide flood-risk-reduction operations will restrict movement of large wood from above the dam and from reaches below the dam where simplified single-channel habitat dominates, diminishing riparian forest benefits (shade, refuge, prey habitat, and cover from predators).

PBF 3. Freshwater migration corridors

a) Free passage. The lack of clear, safe passage routes as a result of USACE's operation of Foster and Green Peter reservoirs and dams impedes the downstream migration of juveniles. As Green Peter refill occurs in late fall and early winter, the ROs will require sounding at over 100 feet, and turbines will not provide safe passage, leading to extended periods when the refilling operations will allow no safe passage route. Adults are moved upstream to higher quality spawning and rearing habitat. The long-term passage solution via modified weir structures will improve this PBF at Foster Dam. The long-term adult passage proposed may decrease survival for UWR Chinook spawners when handled and hauled twice as well as due to exposure to high temperatures in the lower Middle Santiam.
b) Water quantity. Proposed changes to lower flows in dry winter/spring periods will reduce connections to habitat that provide refuge and prey. Migrating juveniles' volitional migration will be lengthened. Subyearling 'movers' migrate throughout the late winter and spring, and they will be exposed to conditions in and below Green Peter Dam, and Foster reservoir when it is most difficult to survive, in part due to fluctuating flows in response to efforts to hold target elevations and during refill.
c) Water quality. Similar to above, with juveniles exposed to higher temperatures during migration in spring under new minimum flows and fewer areas to find refuge because of reduced complexity from lower flows. Water quality. Similar to above, with juveniles exposed to higher temperatures during migration in spring, summer, and fall under new operational passage.
d) Forage. When juveniles are moving out from above Foster and Green Peter dams, the USACE operations can affect the availability of complex habitat elements. Dam operations during post-drawdown reservoir refill, flood risk reduction, and low minimum spring flows also reduce transport of large wood and coarse sediment, habitat elements that increase prey from macroinvertebrate diversity and abundance.
e) Natural cover. Similar to above, migrating adults and juveniles will have less refuge from low flows (for temperature), high flows, (for velocity), and predators. The dam refill and flood risk reduction operations restrict movement of large wood from above each dam, leading to reaches below where simplified single channel habitat dominates, diminishing riparian vegetation benefits (shade, refuge, prey habitat, and cover from predators).

5.6 North Santiam Subbasin Effects

The North Santiam River was historically a significant producer of UWR steelhead and Chinook salmon, but under the environmental baseline these species are presently denied access to the majority of their historical spawning habitat because of USACE facilities at Big Cliff Dam and Detroit Dam that completely block volitional passage. The ongoing trap-and haul-program collects adult UWR steelhead and Chinook salmon from the Minto Fish Facility for outplanting above Minto Dam and above Detroit Dam. Below these dams, spawning currently takes place in the mainstem North Santiam River and in the Little North Santiam River, which together comprise abundance that is a small fraction of historical levels (Ford 2022, Sharpe 2017, Table 3). UWR steelhead spawning has also been observed in the mainstem North Santiam River and in smaller tributaries, but because steelhead adults return in the spring when flows are naturally high, limited spawning data is available as spawning surveys are unsafe under high-flow conditions.

The Proposed Action consists of USACE doing the following in the North Santiam River:

- USACE will continue operation and maintenance of Big Cliff and Detroit dams in the North Santiam subbasin as stated in the Willamette Fish Operations Plan (WFOP, North Santiam chapter and Minto facility appendix) (USACE 2024a). USACE will continue to limit down-ramping below Big Cliff dam to a maximum nighttime 0.1 ft/hr and maximum daytime ramping rates to 0.2 ft/hr when not operating for flood-risk management.
- USACE will continue using the spillway for interim downstream passage for juvenile UWR Chinook salmon from above Detroit Dam and Reservoir. Juvenile UWR Chinook salmon will also have to pass Big Cliff reregulation dam 3 miles downstream, through turbines or spill when operating.
- USACE will combine the spillway with turbine releases for temperature management operations in summer to reduce the volume of the stratified upper layer of warm water in Detroit Reservoir. In the fall, they will combine use of the turbines and regulating outlets (ROs) with upper ROs available when reservoir elevations are below 1,540 feet and lower ROs when elevation drops below 1,365 feet, until the reservoir is fully mixed.
- For long-term passage, USACE proposes to complete design work from 2017 for fish passage from Detroit Dam forebay using a floating surface screen (FSS) to guide and collect juvenile UWR Chinook salmon and juvenile and kelt UWR steelhead to a point where they would be lifted into a truck and transported downstream to a release site below Big Cliff Dam (USACE 2017a).
- For long-term temperature management, USACE proposes to complete 2017 design reports, plans, and specifications and fund and construct a selective withdrawal structure (SWS). This would mix water from different reservoir elevations before releasing flows at Detroit Dam to meet new proposed temperature targets. This design includes the SWS providing an anchor for the above FSS, so it would be necessary to complete this before long-term passage construction (USACE 2017b).
- USACE will provide functioning facilities to trap-and-haul adult UWR Chinook salmon from the Minto Fish Facility to accessible sites above Detroit Dam and broodstock to Marion Forks Hatchery. USACE funds and manages the Minto Fish Facility, which was rebuilt during 2011 to 2013 to provide improved fish handling, hatchery spawning, and holding ponds. Most of the NOR Chinook salmon spawners and all of the UWR winter steelhead spawners collected at the Minto facility are returned to the river in the reach between Minto Dam and Big Cliff Dam, while some NOR spawners are used for broodstock or placed above Detroit Dam into Breitenbush River or the upper North Santiam River.
- For flow management, USACE will meet proposed targets with seasonal timing of flows released from Detroit Dam to the regulating Big Cliff Dam. These flows will be based on changes in Detroit Dam elevation and efforts to meet or exceed proposed lower flow minimum objectives. USACE proposes to use Detroit Lake elevation in the spring,

relative to the water control diagram, to determine flow levels (unless flood risk reduction or hydropower operations require higher flows).

5.6.1 Habitat Access and Fish Passage

5.6.1.1 Effects of actions to provide adult upstream passage for UWR Chinook salmon and steelhead

USACE proposes to continue funding for adult UWR Chinook salmon and steelhead collection at the Minto Fish Facility, as well as operations to sort, spawn, hold, and outplant spawners. The current Minto Fish Facility has been operating since 2013, when it was rebuilt "to meet RPA 4.6.1 of the NMFS 2008 Biological Opinion" (USACE 2024a). The PA noted, "USACE constructed the Minto Fish Facility to collect adult UWR Chinook salmon as broodstock (mature individuals used for breeding purposes) to supply eggs for Marion Forks Hatchery . . . [which was] constructed in 1951 to compensate for the loss of salmon and steelhead habitat caused by construction of both the Detroit and Big Cliff dams" (USACE 2024a). Marion Forks is upstream, 17 miles above Detroit Dam and reservoir, in the North Santiam River. It is funded jointly between USACE and ODFW. The Minto Fish Facility outplant broodstock target for UWR Chinook salmon adults is 750 (HOR) males and 750 females (USACE 2023a, NMFS 2019a). Chinook salmon collected at Minto Fish Facility are also used to outplant smolts in the Molalla River for UWR Chinook salmon recovery goals (HGMP 2019). No hatchery UWR steelhead have been produced since 1999 (Johnson et al. 2021). Other unlisted salmonid species collected at Minto include coho salmon and summer steelhead (non-listed) hatchery-origin adults. Given the large numbers of fish handled, the proposed maintenance of the facilities is key to successful spawning for both HOR and NOR UWR Chinook salmon and UWR steelhead in the North Santiam River.

USACE proposed to follow the Willamette Fish Operations Plan (WFOP) procedures to increase the survival of outplanted spawners, specifically 5.2.1 Fish Collection and Handling, and 5.2.2. Transport and Outplanting, and Section 6. Fish Facility Maintenance (USACE 2024a). NMFS (2019a) consulted on the Hatchery Genetic Management Plan (HGMP). The resulting Biological Opinion specified handling actions for UWR Chinook salmon. These actions include meeting thresholds for percent hatchery origin spawners (pHOS) while also allowing increases in natural-origin broodstock (pNOB) to enhance conservation genetics, when NOR UWR Chinook salmon adults are used for broodstock if returns are above the minimum abundance thresholds in the HGMP. These actions, combined with safer handling, can benefit the abundance and productivity of the UWR Chinook salmon in the North Santiam subbasin.

From video counts at a lower reach in the North Santiam River, at the Bennett Dam complex, fish managers have counts and timing of nearly all returns of adult UWR Chinook salmon and UWR steelhead (with limited spawning below the Bennett Dams area). The total average adult UWR Chinook salmon count is 3,831, and of those, an average of 18 percent are natural origin (NOR) returning to Minto Dam since 2013 (Figure 5.6-7). Prior to the new facility, the fraction of adult UWR Chinook salmon counted at Willamette Falls and then collected at Minto was 6.2 percent (1996–2010), and since 2013, it has doubled to 13 percent on average. This shows that improved handling at Minto Adult Fish Facility has increased the numbers that return there, although counts of adult UWR Chinook salmon at Bennett Dams have trended downward in the same period (Figure 5.6-7). This indicates that fewer adult UWR Chinook salmon are returning to the North Santiam River, with a larger fraction of the Bennett Dam returns moving upstream of Minto Fish Facility.

The fraction of Willamette Falls counts of UWR steelhead collected at Minto averaged 4.4 percent since 2013, with limited data prior to operating the new facility. UWR steelhead are currently not outplanted above Detroit Dam, and adult UWR steelhead collected at Minto Fish Facility will continue to be placed in the reach between Minto and Big Cliff dams under the PA. This is in part due to the lack of safe passage and the limited numbers of UWR steelhead returning to Willamette Falls and this subban. Since 2013, average counts for adult UWR winter steelhead collected at Minto are 172, with a high of 490 in 2024 and low of 34 in 2017 (Grenbemer 2024). From the Bennett Dam complex counts, we know there are many steelhead lower in the river, some of which can access the tributaries between Bennett Dams and Minto Fish Facility. Counts at Bennett Dams have averaged 668, with a low of 160 (2017) and a high of 1,426 (2024). In years with sufficient UWR steelhead returns to Minto, a small number of female/male pairs can be spawned and raised as 'surrogate fish' given there are no hatchery UWR steelhead that would be available for research monitoring and evaluation (RM&E).

The PA lists two current and two proposed UWR Chinook salmon outplanting sites above Detroit Reservoir (USACE (2024) Table 2.2-10, Current and Proposed Adult Release Sites), as well as the releases into Minto-Big Cliff reach from the Minto Fish Facility. North Santiam River outplanting operations were evaluated for returning UWR Chinook salmon adults to review how those placed in the Big Cliff to Minto reach (100 percent NOR Chinook salmon) compared to those placed above Detroit Dam, in most years 100 percent HOR adult Chinook salmon, with the exception of 2015, 2023, and 2024 (NMFS 2024c). At the Minto Fish Facility, UWR Chinook salmon fin-clip samples taken during handling provide genetic material for pedigree analysis of UWR spring Chinook salmon and winter steelhead. The cohort replacement rate (CRR) results and other information from pedigree analysis allow fish managers to evaluate and modify hatchery and natural-origin UWR Chinook salmon release strategies. The total CRR is estimated by determining the number of offspring successfully assigned to at least one parent (male or female) each year and dividing it by the number of candidate parents in that year. This requires waiting for the 3–5 years, during which the total cohort offspring return to the North Santiam River. When CRR values are less than one, the study population is not replacing itself. As this is currently the case, the declining productivity increases this UWR Chinook salmon population's overall extinction risk.

For the most recent of parents sampled during 2011–2015, O'Malley et al. (2023) found total cohort CRR values that ranged from 0.1 to 0.67, and a larger range for male CRR, ranging from 0.07 to 0.77. Female CRR had a narrower range, from 0.13 to 0.54. Adults from the lowest year CRR values (2014) were far from replacement values, and even those in the higher year (2011 for female CRR and 2012 for male CRR) were significantly below one, so that declining or ongoing low CRR values show decreased productivity and increased overall extinction risk. Another result was the difference in total lifetime fitness (TLF) noting: "mean TLF of NOR salmon reintroduced above Detroit Dam was greater than the TLF of HOR salmon outplanted above Detroit Dam as well as the TLF of NOR salmon reintroduced into the reach between

Minto and Big Cliff Dam in 2015" (O'Malley et al. 2023). This shows the value of testing strategies for outplanting and reintroduction into different reaches. With this information, managers chose to move fewer NORs into the Minto-to-Big-Cliff reach and more above Detroit Reservoir in 2023 and 2024. When the NOR adult returns of UWR Chinook salmon to Minto Dam are used to provide higher total lifetime fitness, we would expect greater CRR values. Until the CRR results are above 1, the overall productivity will continue to decline. The pedigree analysis program has had funding challenges, and as a result, decisions are made without sufficient current data analyses. The proposed action includes the WFOP section 5.2.1.17: "During processing/sorting, fin clip samples will be collected for genetic analysis from all natural-origin (intact adipose fin) adult Upper Willamette River (UWR) spring Chinook salmon and winter steelhead collected" (USACE 2024a, Appendix F). It also directs the samples to be preserved and stored but does not show timing for processing. NMFS Hatchery Biological Opinion (2019), in Term and Condition 3(a), required pedigree analysis based on processing these samples and those of HOR outplants in the North Santiam to be completed at least every 5 years, followed by reports on the results. The initial analyses were delayed and these continue to be behind schedule, which reduces the fish managers' ability to decide on appropriate outplanting actions, thereby reducing effective changes to increase abundance and productivity.

NMFS supports the ongoing pedigree analysis, with a response about outplanting changes to USACE and ODFW that emphasized how the latest genetic-pedigree results from the North Santiam River were critical in informing management decisions for natural-origin salmon collected at the Minto Fish Collection Facility. Regarding the North Santiam data, NMFS (2024) stated: "Without the results from these pedigree analyses, we would not know with certainty where the salmon were produced, and thus this information is critically important for management decisions each year." Pedigree analysis results provide information on the numbers of UWR Chinook salmon produced above Detroit Dam versus below the dam, which is the first step to evaluating the success of these operations. For ongoing outplanting during changes in passage, these analyses will inform co-managers so that natural-origin salmon can be integrated into the broodstock on an annual basis in accordance with the HGMP limits (NMFS 2019a). The hatchery broodstock program will use these results to test whether integration of NORs is improving the success of reintroduction and the fish managers work to move UWR Chinook adults from Minto Fish Facility to the best location for spawning and rearing survival. With this data and analysis, the upstream-passage and broodstock decisions can be optimized. Without it, UWR Chinook salmon outplanting changes under interim passage operations and later structural options will likely continue to result in CRR well below 1.

Facility maintenance is an ongoing process, about which NMFS addressed USACE and ODFW jointly regarding annual decisions for broodstock and reintroduction above federal dams in the North Santiam River (NMFS 2024c). NMFS highlighted a set of concerns about UWR Chinook salmon and UWR steelhead adult handling. NMFS noted that because of limitations in the McKenzie River hatcheries, the Minto Fish Facility is currently used to hold broodstock from two programs, stating: "The current funding issues at Minto, lack of preventative maintenance and inability to address ongoing maintenance and repair issues, poses risk to the recovery programs in two populations of salmon being held at this facility. It is therefore essential to ensure all of the current hatchery facilities are well maintained and operated to ensure fish health and not compromise recovery efforts above the federal dams."

Requests for necessary maintenance at Minto Fish Facility are often covered in WFPOM meetings[18], where the need for Minto replacement pumps were discussed in 2023 and early 2024. However, the pumps remain in need of repairs or replacement. High mortalities from disease were reported by ODFW and noted by USACE in September 2024:

> *Replacement pumps have been ordered but are not yet installed. The pumps are necessary to treat fish with formalin. Due to the lack of treatment, McKenzie stock adult Chinook, which are being held at Minto due to water supply issues in the McKenzie basin, have suffered higher than expected pre-spawn mortality. Approximately 40% of female fish have been lost. (Walker 2024)*

This highlights the complex nature of actions related to upstream passage of UWR Chinook salmon adults in the North Santiam River, the primary adults handled at this facility are vulnerable to disease when holding on site, as are other populations during overall Souir mitigation management. The outplanting for recovery goals of the UWR Chinook salmon and steelhead is essential to improve spatial structure and maintain or increase the diversity and abundance of spawners in the North Santiam Basin and the UWR ESU. Pedigree analysis studies and facilities maintenance are integral parts of the overall program for reintroduction above the USACE dams. Without this program working to ensure survival and improved decision-making, UWR Chinook and steelhead risk higher mortality and lower productivity.

Effects detailed from Spawner surveys

In past years, surveying during spawning seasons gave researchers data on the proportion of hatchery spawners (pHOS) to see any differences between UWR Chinook salmon hatchery-origin and natural-origin peak spawning time and prespawn mortality (PSM) rates. The pHOS has been high above Detroit Reservoir, as in most years 100 percent HOR spawners are out-planted. Yet, PSM was low in the surveys above the reservoir for the outplanted HOR adult UWR Chinook.

Below Detroit Dam, outside of the Minto to Big Cliff reach, the pHOS was approximately 60 percent to 80 percent (Figure 5.6-1). Spawner counts were not available between Big Cliff and Minto Dams, where pHOS was 0 percent, as no HOR fish are placed in that reach. The surveys' data were also used in the pedigree analysis (discussed above) and to inform life-cycle models for passage that included PSM and pHOS as potential factors affecting abundance, productivity, and extinction risk. These models were used in part when selecting long-term passage solutions, discussed in Section 5.6.1.3. Planning for improved passage from higher quality habitat upstream of the dams has been ongoing for many years, and monitoring migrating and spawning success is a necessary element in ensuring effective passage recovery actions are implemented. The UWR Recovery Plan noted that downstream passage at these dams was a key limiting factor (ODFW and NMFS 2011. The spawner surveys show how the North Santiam UWR Chinook population has changed, with reduced pHOS in some years; the reduced hatchery returns along the slightly higher natural origin returns cannot increase spawner abundance that move toward HGMP goals. Without improved survival for natural origin spawners offspring, the productivity remains low.

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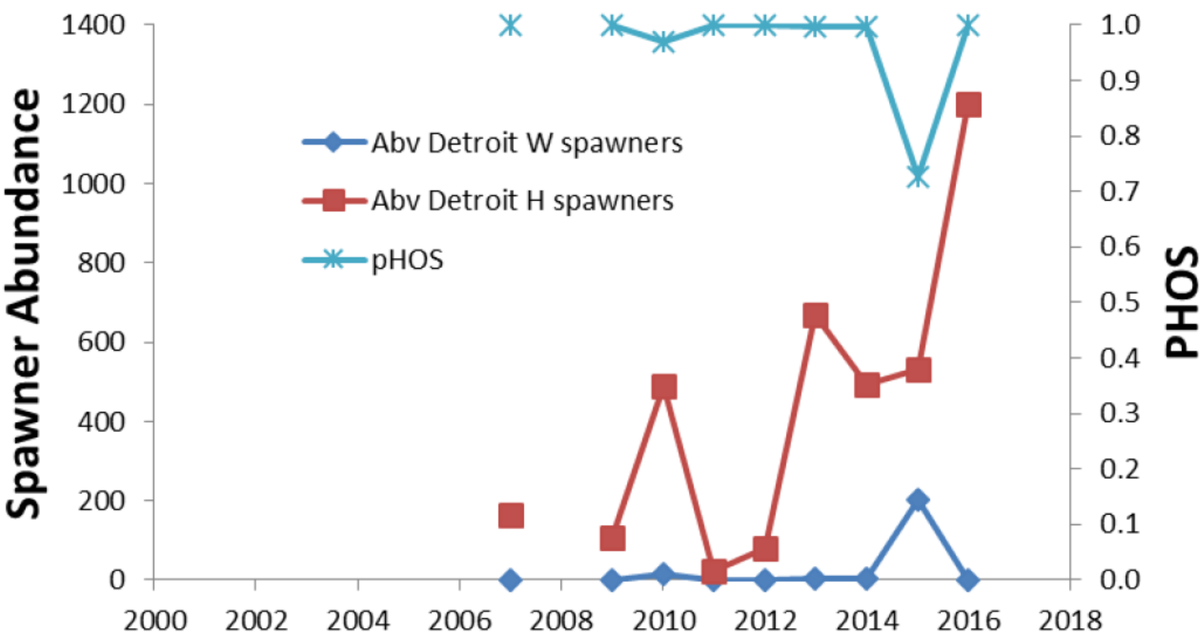
[18] See https://pweb.crohms.org/tmt/documents/FPOM/2010/Willamette_Coordination/ for WFPOM Meeting Minutes.

Below Detroit Dam, outside of the Minto to Big Cliff reach, the pHOS was approximately 60 percent to 80 percent (Figure 5.6-1). Spawner counts were not available between Big Cliff and Minto Dams, where pHOS was 0 percent, as no HOR fish are placed in that reach. The survey data were also used in the pedigree analysis (discussed above) and to inform life-cycle models for passage that included PSM and pHOS as potential factors affecting abundance, productivity, and extinction risk. These models were used in part when selecting long-term passage solutions, discussed in Section 5.6.1.3. Planning for improved passage from higher quality habitat upstream of the dams has been ongoing for many years, and monitoring migrating and spawning success is a necessary element in ensuring effective passage recovery actions are implemented. The UWR Recovery Plan noted that downstream passage at these dams was a key limiting factor (ODFW and NMFS 2011). The spawner surveys show how the North Santiam UWR Chinook population has changed, with reduced pHOS in some years. Reduced hatchery returns with slightly higher natural origin returns cannot increase spawner abundance to move toward HGMP abundance goals. Without improved survival for natural origin spawners, productivity remains low, and requires ongoing hatchery inputs to increase abundance.



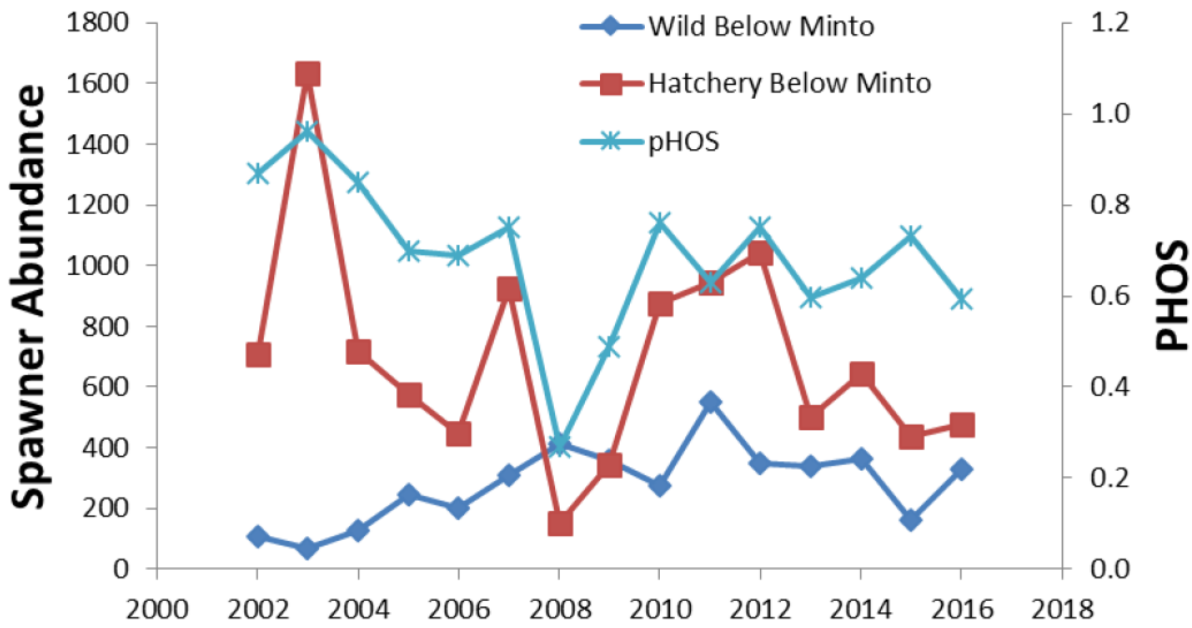


Figure 5.6-1 Spawner abundance above Detroit Reservoir, and below Minto Dam for both hatchery origin and natural origin ('wild') adult UWR Chinook salmon (2002-2017). The pHOS has been high above Detroit Reservoir, where most years 100% hatchery origin fish were outplanted. Source: Sharpe et al 2017a

5.6.1.2 Effects of Interim Reservoir and Dam Passage Operations

The proposed interim juvenile UWR Chinook salmon and UWR steelhead passage downstream from the upper North Santiam River will route juveniles through spill or turbine routes at Detroit Dam and at the Big Cliff reregulation dam downstream. When flows are prioritized through spill routes, more juvenile UWR Chinook salmon have been documented using that route. Spill operations can begin after the reservoir refills to 1,541 feet in the spring, usually by early April and extend through summer, although dates vary depending on hydrology and refill rates. USACE provided a summary of interim actions at the North Santiam dams (Table 5.6-1). All the passage routes have low efficiency (Beeman et al. 2014b, Beeman Adams eds. 2015, EAS 2024), from estimates of total UWR Chinook salmon entering the reservoir, detected within the forebay, approximately 25 m above Detroit Dam, and detected after passing downstream (Beeman et al. 2014b).

Table 5.6-1. Proposed Interim operations at the North Santiam dams for passage and temperatures. Source: PA Table 2.2-2 excerpt, USACE (2024).

Location	Description of Interim Operations by Location	Duration of Operation	Priority Outlet	Target Elevation
Detroit	Spring downstream fish passage and operational downstream temperature management spring through early winter	Mid-Mar to Fall	Spillway/ Turbines/ Upper ROs/Lower ROs	n/a
Detroit	Nighttime (dusk to dawn) RO prioritization for improved downstream fish passage	Winter	Upper ROs	Less than 1,500 feet and once downstream temperature management operations have concluded for the year
Big Cliff	Spread spill across as many spillbays as safety protocols allow to reduce downstream TDG exceedances	Year-round	Spillway	Discharges greater than powerhouse capacity

Juvenile offspring of the adult UWR Chinook salmon outplanted above Detroit Reservoir can currently attempt passage past Detroit Dam via spill when elevations allow, or via turbines during proposed spring and summer operations. The primary route at Detroit Dam in the fall is through the turbines, which are 60 feet above the upper ROs (1395 ft). During late summer or fall temperature operations, Detroit Dam upper ROs are open, but the lowest reservoir elevation (1,450 feet) will be more than 100 feet above the RO elevation (1,335 feet). UWR Chinook salmon are not expected to sound to that depth, with very few exceptions found during past studies. While USACE proposes prioritization (via night operations) of the upper ROs for winter passage, there is scant evidence of UWR Chinook salmon moving downstream through this route (Beeman 2015, PNNL 2012). Similarly, surrogate UWR steelhead outplanted in Detroit reservoir were not detected downstream at the Bennett Dam detection site in winter months over three years, although outplants below the dam were detected (Cogliati et al 2021).

Juvenile UWR Chinook salmon must then migrate to Big Cliff Dam, approximately 3 miles downstream, where passage is also primarily through turbines since spilling generally is only when flows are higher than the turbines' capacity. Based on the proposed actions and the implementation timeline, we expect few changes from these passage options in the next decade. Reports of the UWR Chinook salmon and steelhead[19] that are counted above Detroit Reservoir, downstream of both dams and, for some, further downstream are discussed in the following study results, which showed high mortality and injury rates. These results also show the limited passage efficiency of the interim passage options. The effects of this on the abundance of the populations above the dam are also reflected in the CRR or replacement rates, which are generally much lower than one, as noted in 5.6.1.1 above. Earlier studies of acoustic and PIT-tagged juvenile HOR UWR Chinook salmon (Figure 5.6-1) that were outplanted and tracked over different seasons show a range of mostly low passage efficiency and survival

[19] Juveniles that could be either rainbow trout or steelhead were counted in the screwtraps above and below dams, but *O. mykiss* captured, if not released for a study, are assumed to be primarily composed of resident rainbow trout since steelhead are not transported above the dam EAS (2024b).

values. These studies, on the whole, show insufficient numbers of UWR Chinook salmon and UWR steelhead that were released were able to safely migrate downstream from above Detroit Reservoir. This lowers abundance and productivity in the North Santiam populations, when NORS are moved upstream but cannot replace themselves with returning adults; instead, the lower river is a source for what is a sinking number of spawners.

In recent years, USACE contractors operated rotary screwtraps to count juvenile UWR Chinook salmon migrants from two sites, with flows through both spill and turbine routes. In spring 2024, they captured migrants entering the reservoir from the Breitenbush River and the North Santiam River (EAS 2024b, Biannual Report). On the Breitenbush River, they tallied juvenile UWR Chinook salmon, primarily subyearlings, and a few yearlings February 1 to June 30. From the Upper North Santiam River, they counted eight times as many juveniles, again mostly subyearlings with a few yearlings. The researchers used these counts and trap efficiency values to get expanded weekly passage counts.[20] These data are the basis for estimates in Figure 5.6-3.

The data shows most juvenile UWR Chinook salmon move into Detroit Reservoir from February to late April from the Breitenbush River, continuing into May from the North Santiam River. The total juvenile UWR Chinook salmon estimated expanded counts were 46,287 during sampling at Breitenbush River and 426,159 at the North Santiam trapping sites (EAS 2024b). Downstream, where UWR Chinook salmon have passed both Detroit Dam and Big Cliff Dam, the total count of juvenile UWR Chinook salmon expanded to an estimate of 13,174 juveniles through June 30 2024, mostly from the previous brood years, with a few from the 2023 broodyear (EAS 2024b, Table 19 and related text).

While UWR Chinook salmon juveniles may remain in the reservoir for several months and continue to move out during temperature spill operations into fall, the data for 2024 show a sharp dropoff in later June weeks. Estimates from 2024 counts show approximately 2.8 percent of total incoming UWR Chinook salmon juveniles migrated by June 30. Having so few migrate past the dam during proposed spill operations shows that many will be unable to navigate the reservoir during refill and leave via either spill or turbine routes. Most subyearlings from the 2023 brood

[20] 2024 rotary screwtrap efficiencies reported were 1.3% to 17.9% Breitenbush, and 1.1% to 15.6% North Santiam River (EAS 2024b, Tables 4 and 11). Confidence intervals are shown in the graphed weekly estimates (Figures 5.6.-3 and 5.6-4).

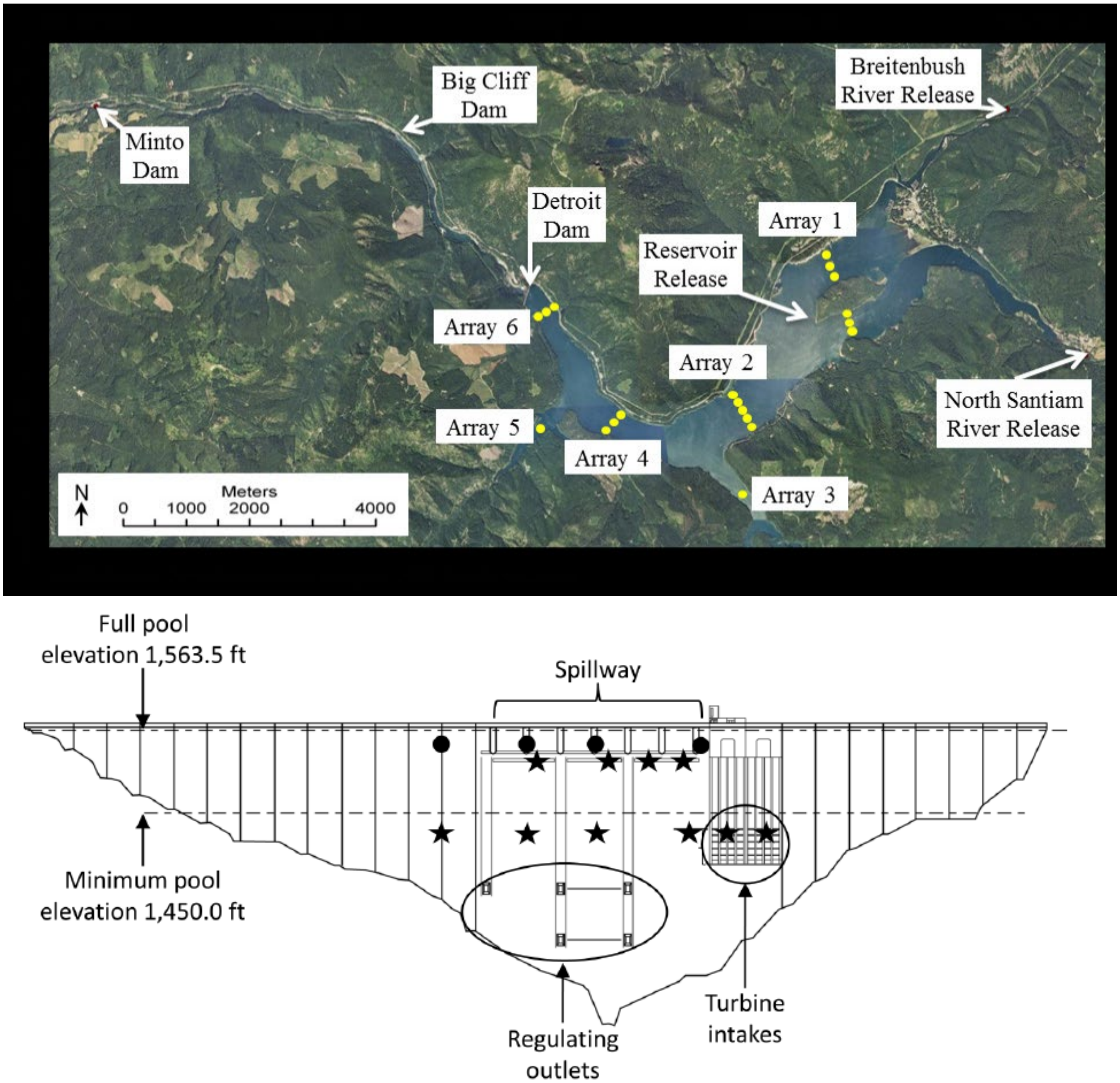


Figure 5.6-2 Top: Overview of the USGS 2012-14 study area showing fish release sites (arrows), and acoustic receivers (small circles) deployed in Detroit Reservoir and downstream on the North Santiam River. Bottom: Looking from the upstream side of Detroit Dam, this shows outlets and elevations of full and minimum conservation pool. For the 2013-14 study, this shows the locations of hydrophones on the upstream side of the dam. Stars represent hydrophones affixed to the dam face, and circles indicate hydrophones deployed from a floating platform attached to guide cables on the dam face. Source Beeman Adams eds. (2015) Figure 1-3 and Figure 1-6.

year are in the reservoir until later in the year or the next year or do not survive because of predation. Those that do leave later risk copepod infections that harm their ability to transition to marine life stages (Monzyk et al 2015b). Further, the diverse life-history of early and later migration is disrupted.

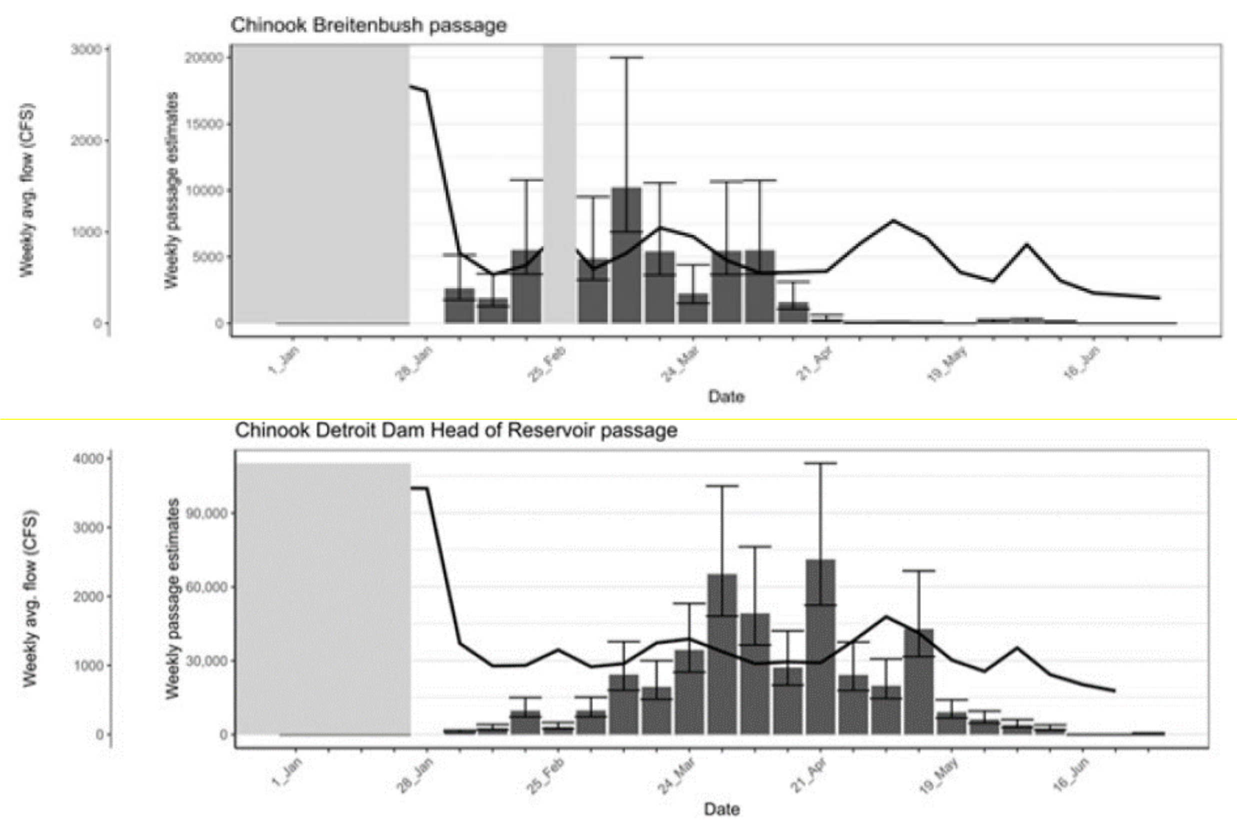


Figure 5.6-3 Spring 2023 estimates expanded from raw screwtrap data for UWR Chinook salmon juveniles (weekly counts) from above Detroit Reservoir. The upper graph data are UWR Chinook salmon from the Breitenbush River, and lower are from the North Santiam River. This also shows varying stream flow (black line) and has shaded out non-sampling weeks. Note change in y-axis scales. Source Figure 1 and Figure 7, EAS (2024a).

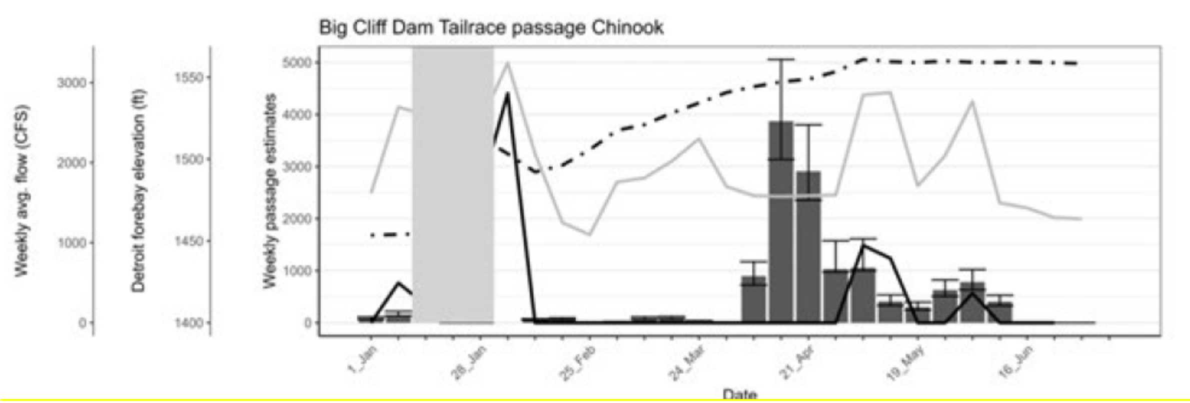


Figure 5.6-4 Spring 2023 passage estimates expanded from raw screwtrap data for UWR Chinook salmon (weekly counts) below Big Cliff Dam. The spillway outflow at Big Cliff Dam is the solid black line, turbine outflow from Big Cliff Dam is solid gray line, and Detroit forebay elevation is black dot dash line. Non-sampling weeks are shaded out (gray). Source Figure 13, EAS (2024a).

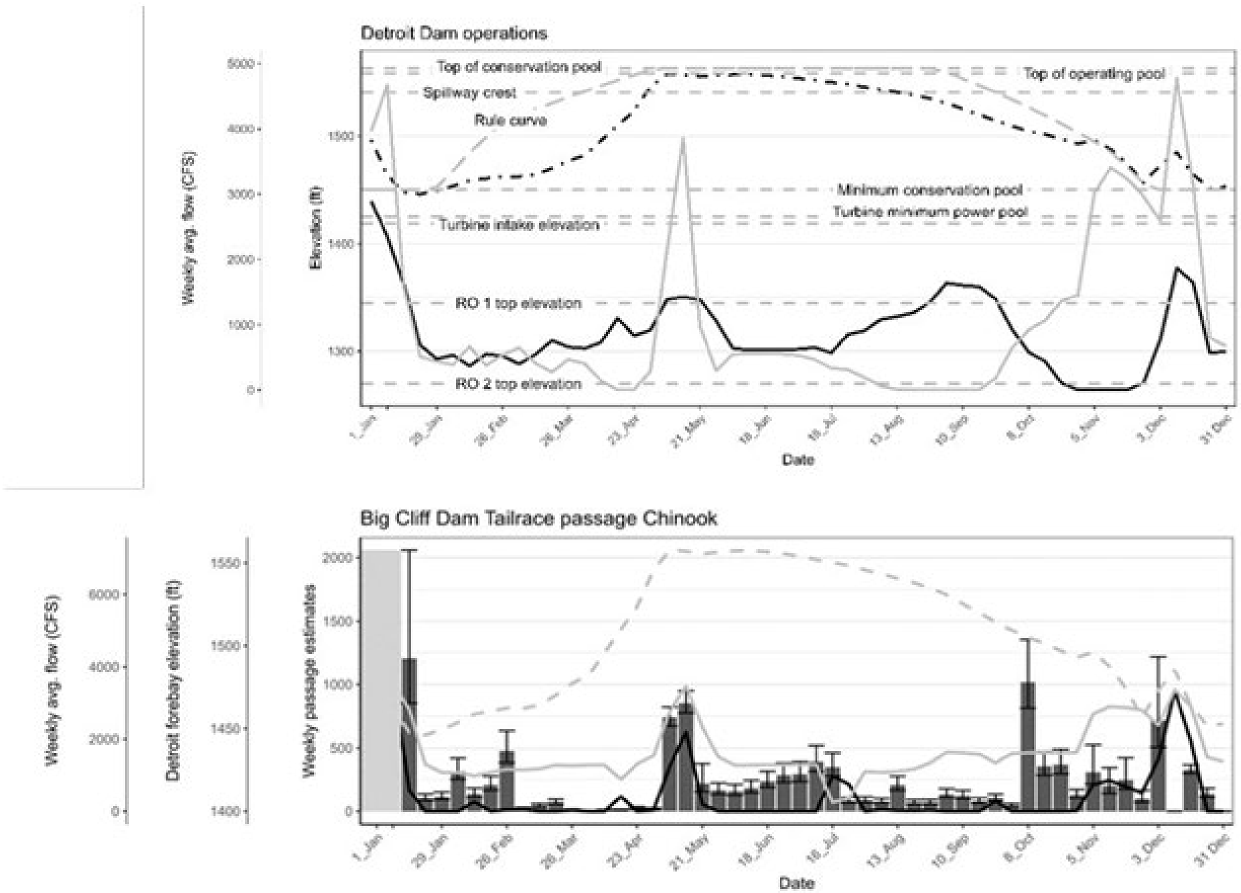


Figure 5.6-5 2023 Detroit Dam (top) operations with rule curve (gray long dash line), forebay elevation (black dot dash line), spring/summer spill or fall/winter RO outflow (black line) and Powerhouse outflow (gray line). Big Cliff Dam passage estimates (bottom) for juvenile UWR Chinook salmon with spill at Big Cliff Dam (black line), Powerhouse outflow from Big Cliff Dam (gray line), Detroit forebay elevation (gray dash line), and non-sampling weeks shaded out (gray) from 2023. Source: Figure 8, EAS (2024b)

Other more comprehensive studies measured survival probabilities of UWR Chinook salmon and steelhead for each of the two dams. They were able to contrast spring and fall routes, finding that no UWR steelhead passed in the fall. These studies were designed to compare spill, turbine, and RO routes, and used both PIT and acoustic tags (Beeman Adams eds. 2015, Kock et al 2015). They found clear route differences in survival and passage efficiencies. They summarized that spill operations were most effective for UWR Chinook salmon and steelhead passage in the spring, even if the powerhouse route was available more often. In the fall, the powerhouse was the primary route for UWR Chinook salmon, and for a short time had only the upper ROs passage option, counting one UWR Chinook salmon through that route (Table 5.6-2). These routes are proposed for Detroit Dam passage in spring and fall in the interim action period, and the study showed low efficiencies and survival through these routes.

Table 5.6-2 Counts from alternative routes taken by UWR spring Chinook salmon tagged with acoustic and PIT tags, released into Detroit Reservoir 2013-2014. Routes show percent of time in the seasons they were open. Spring routes through the spillway had the highest dam passage efficiency. Data from Beeman Adams eds. (2015), Table 1-7.

ROUTES, % of time	Spring	Fall
Weir spill, 100%	2	NA
Powerhouse, 49.7%	15	
Powerhouse, 83.8%		104
Spill, 21.1%	114	
PH and Spill, 8.6%	55	
All off, 20.7%	10	
All off, 14.2%		4
Regulating Outlet, 1.1% NA		1
Total	196	108

The dam passage efficiencies (DPE, the number of fish passing the dam divided by number detected at the nearest array, Figure 5.6-3) calculated by the authors for UWR Chinook salmon and steelhead varied in the study periods (Beeman Adams eds. 2015). Study fish of both species were released upstream or near the head of Detroit Reservoir during the spring and detected from May 8 to July 19, 2013 and released during the fall and detected from October 3, 2013, to April 10, 2014. The DPE estimates for spring were higher for reservoir elevations above 1,541 feet and highest when greater than 1,563.5 feet. In the fall, DPE were much lower but increased when elevations were below 1,500 feet, as the powerhouse intake is below 1,400 feet (Beeman Adams eds. 2015). Spring spill requires maintaining high elevations in the dam and can conflict with flow releases for multiple purposes, including UWR steelhead spawning and rearing and UWR Chinook salmon rearing. In the fall, juvenile UWR Chinook salmon have only the turbine route available for passage, which has a much lower associated survival rate (Table 5.6-3). For UWR steelhead, little more than half of the fish released into the reservoir were detected at the head of the forebay (reservoir passage efficiency, or RPE 0.518) and about one-third of those passed the dam (DPE 0.328). Since they released most UWR Chinook salmon and steelhead upstream of the reservoir in the streams, they also calculated the proportion released into the tributaries that were detected in the reservoir as stream passage efficiency (STRE), and once in the reservoir, the RPE shows those getting to the forebay and DPE shows those passing the dam. The fraction of UWR Chinook salmon and steelhead that pass the dam in spring is given by STRE * RPE* DPE from Table 1- 5 in Beeman Adams eds (2015):

UWR Chinook 0.799 * 0.883 * 0.712 = 0.502
UWR Steelhead 0.663 * 0.855 * 0.678 = .0.384
UWR Steelhead (reservoir) 0.518 * 0.328 = 0.170

And for fall, the fraction of those released above the reservoir that pass the dam were:

UWR Chinook 0.891 * 0.85 * 0.266 = 0.201
UWR Steelhead 0.258 * 0.286 = .074 to the forebay, as none passed the dam.

These show even for larger study fish, reservoir and dam passage are very low.

Table 5.6-3 Estimated survival probabilities by river reach at detection arrays for juveniles released in the spring and fall of 2013 between Detroit Dam and Portland. Spring survival for UWR Chinook salmon from Detroit Dam past Big Cliff to Minto Dam is 0.716*0.741=0.531, and fall survival is 0.622*0.670=0.417; spring survival for UWR Steelhead is 0.784*0.786= 0.616. Source: Beeman Adams eds. 2015 Table 1-13.

Season	River reach	Chinook salmon				Steelhead			
		Prob	SE	LCI	UCI	Prob	SE	LCI	UCI
Spring	Detroit Dam to Big Cliff Dam	0.716	0.032	0.649	0.775	0.784	0.058	0.651	0.876
	Big Cliff Dam to Minto Dam	0.741	0.037	0.662	0.807	0.786	0.068	0.625	0.890
	Minto Dam to Salem	0.670	0.046	0.574	0.754	0.700	0.084	0517	0.836
	Salem to Wilsonville	0.812	0.047	0.702	0.887	0.955	0.044	0.739	0.994
	Wilsonville to Portland	0.714	0.060	0.583	0.817	0.952	0.046	0.729	0.993
Fall	Detroit Dam to Big Cliff Dam	0.622	0.092	0.433	0.780				
	Big Cliff Dam to Minto Dam	0.670	0.114	0.424	0.848				
	Minto Dam to Salem	0.823	0.114	0.501	0.955				
	Salem to Wilsonville	0.921	0.088	0.523	0.992				
	Wilsonville to Portland	0.857	0.118	0.475	0.976				

Using the values above for the fraction released that make it past Big Cliff Dam to the next detection with the dam survivals from Table 5.6-3 at Minto Dam, shows a very small fraction survive past the USACE dams in spring:

UWR Chinook salmon 0.502 * 0.716 * 0.741 = 0.267

UWR Steelhead 0.384 * 0.784 * 0.786 = 0.237

For fall, the fraction surviving to past Big Cliff Dam to Minto Dam is much lower:

UWR Chinook salmon 0.201 * 0.622 * 0.670 = 0.084

The authors of this study note that once UWR Chinook make it past Detroit Dam, the Big Cliff reach is where mortality is highest:

> *The estimated survival was lower in the 11 km between Detroit Dam and Minto Dam (a reach including Big Cliff Reservoir and Dam) than in the remaining 241 km from Minto Dam to Portland. Estimating survival was not a primary objective of the study, so we used a single- release design rather than a multiple-release design commonly used to estimate survival over short distances such as passage at a dam. Our estimates of survival, therefore, incorporate mortality from factors including dam passage, predation, and effects of tagging and handling. (Beeman Adams eds. 2015)*

However, Cumulative survival to the final detection point at Willamette Falls was higher for steelhead and for fall juvenile UWR Chinook salmon migrants, possibly because of instream conditions downstream of the dams (Figure 5.6-6).

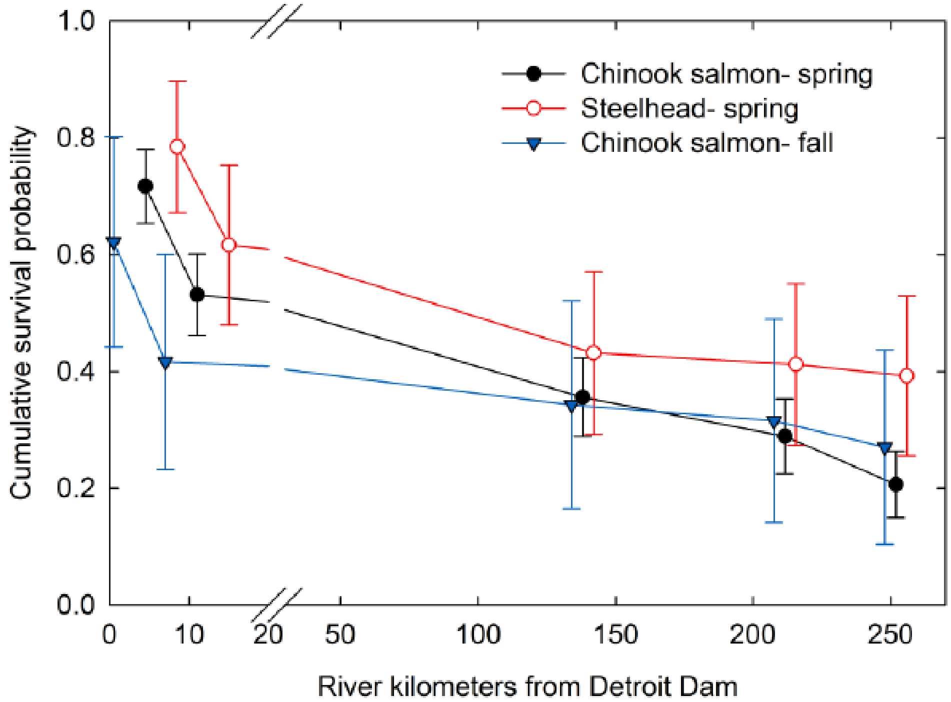


Figure 5.6-6 "Cumulative survival probabilities by season and species of fish passing Detroit Dam, Oregon, 2013 spring and fall study periods. Chinook salmon released in the fall and steelhead were plotted at -4 river kilometers (rkm) and +4 rkm, respectively, for clarity. The x-axis scale is broken between 20 and 30 rkm. Whiskers represent 95-percent confidence intervals." Source Beeman Adams eds. 2015, Figure 1-34.

Researchers in a similar study for passage of UWR Chinook salmon outplanted in 2014–2015 found a much lower DPE (0.075) and were unable to calculate survival rates from above Detroit Dam to Minto. They reported lower juvenile UWR Chinook salmon cumulative survival from below Minto tailrace to Portland, ranging from 0.236 vs. 0.389 (Kock et al 2015), compared to the 2013–2014 study results of 0.388 spring, and 0.650 fall (Table 5.6-3). Citing differences in temperatures at release, and study-fish source and size, they noted that the discrepancy "provides additional evidence to support earlier observations that factors such as release timing or fish source may have influenced observations in this study" (Kock et al 2015). Yet smaller UWR Chinook salmon (100 mm) used for this study are similar to those that enter the reservoir and attempt to pass the dams at a later point (EAS 2024). This may mean the earlier study (Beeman Adams eds 2015) had higher than expected survival rates for natural migrating juvenile UWR Chinook and steelhead, and that abundance and productivity is even lower.

One study focused on UWR steelhead, which no longer have hatchery juveniles produced. The researchers have been rearing natural spawner offspring at the Oregon Hatchery Research Center (OHRC), creating wild fish phenotypes in hatchery-reared fish to be used in studies (Cogliati et al 2023). They transported the OHRC subyearling UWR steelhead to the North Santiam Marion Forks hatchery for final rearing (Cogliati et al 2021). Their objectives were to evaluate effects of

North Santiam River dams on winter steelhead outmigration and survival with juveniles released 2014–2016. They tracked the juvenile UWR steelhead downstream detections, movement, and adult returns. Their detections of PIT tagged steelhead released below dams "consistently outperformed their counterparts above the dams, despite low detections overall" (Cogliati et al 2021). They concluded from tracking the UWR steelhead to Willamette Falls and the Columbia River estuary, that: "Reintroducing steelhead to historic habitat above dams in the North Santiam is unlikely to succeed until passage is improved" (Cogliati et al 2021).

These studies show that operational passage routes have overall low efficiency, low survival, and do not provide safe passage. This leads to lower productivity for UWR Chinook salmon and UWR steelhead, as the juveniles that do not survive passage will not contribute to replacement needed for recovery. USACE has proposed to continue to make these operational routes available. This will limit the abundance of UWR Chinook salmon migrants from above the dams, although the habitat is of high quality for spawning and rearing and many adult hatchery-origin, and recently natural-origin, UWR Chinook salmon are out-planted in that habitat. Under the proposed interim action, passage survival for UWR steelhead is so low that there is little to no benefit from outplanting adult UWR steelhead in the higher quality habitat above the dams Having only limited seasonal routes in USACE's proposed interim passage operations, with limited efficiency and survival, will further reduce productivity and abundance of UWR Chinook salmon and UWR steelhead.

Juvenile UWR Chinook salmon that reared below the dams migrated downstream at different times of year. Juveniles primarily reared briefly before leaving their natal reaches so that they were largely rearing in the lower Santiam, including below the South and North Santiam confluences and in the mainstem Willamette River (Schroeder et al. 2016). These juveniles passed the Willamette Falls antenna with a mean date of July 3 ranging over June 18–July 15 (Whitman et al. 2017). This is a very narrow window compared to other tributaries when they might rear longer in the full downstream habitat while growing during later summer. The limited outmigration timing might mean losing life-history stages or even the phenotype, leaving that population to lose spatial structure, diversity, and abundance of adults returning. USACE proposes to provide a structural passage option to migrating juveniles over most of the year; in contrast the existing route that has the largest number of migrants is only available for one to three months. With the longer-term structural passage more than 10 years away, the reduced abundance from high passage mortality persists.

5.6.1.3 Effects of Long-Term Passage Operations

USACE proposed a structural passage solution, which requires them to design and build a collector and operate it to attract juvenile UWR Chinook salmon and steelhead near the dam and then transport them downstream via 'trap-and-haul' methods. The construction of a temperature-control tower was combined with the fish passage as described in the PA:

> *USACE will complete the DDR [Detailed Design Report] phase of the Detroit Selective Withdrawal Structure (SWS). The Floating Screen Structure (FSS) design effort will follow with a plans and specifications phase and ultimately project construction. (USACE 2024a)*

The proposed FSS would be based on "gravity fed flow which may include pumps for supplementing flow to pass downstream migrating juveniles" and "[t]he FSS would be attached to the SWS at the face of the dam" (USACE 2024s). For the timeline of the combined projects, USACE anticipated completion of construction would occur in approximately December 2035. They would begin operating in spring 2036 for juvenile UWR Chinook salmon downstream passage.

The proposed FSS structural passage would improve passage for juveniles, and we would expect numbers of returning UWR Chinook salmon adults to increase over time (USACE 2023a, Figure 5.7-5). However, concerns remain over the proposed timeline, with possible delays in completing this effort. Higher risk over the years until the passage improves will delay the time to rebuild the North Santiam populations, given dates proposed in the implementation plan, and given other effects on flow and water quality, may reduce spawner populations.

UWR Chinook salmon spawners bounce between high and low counts at Bennett Dams and Minto Dam in recent years under interim passage. From counts of UWR Chinook salmon and UWR steelhead at the Bennett Dam's video cameras, adults passing Bennett Dams lower in the river can be compared to ongoing counts at Minto Fish Facility for both HOR (adipose-fin clipped) and NOR (unclipped) UWR Chinook salmon and for UWR steelhead (Figures 5.6-7, 5.6-9 respectively). Counts at the Bennett Dams, low-head dams used for municipal and agricultural diversions, provide an early estimate of UWR Chinook salmon and steelhead spawner numbers for the mid-river reaches. The UWR Chinook salmon HOR counts are much greater than NORs, reflecting the input of hatchery fish to mitigate for the dams. Counts increased slightly at Minto Dam, since the 2013-rebuilt facility improved spawner handling at that site, while NORs at Bennett have decreased considerably in the same time period. As noted above, UWR Chinook salmon outplanted upstream in reaches both below Big Cliff Dam and above Detroit Reservoir after collection at Minto Fish Facility have returned at well below replacement rates (O'Malley et al 2023). Therefore, it appears that the lower North Santiam River has been a 'source' of spawners to the 'sink' in the upper river, resulting in decreasing abundance of NOR UWR Chinook salmon. However, as also noted above, increased numbers of NOR UWR Chinook salmon outplanted above Detroit Reservoir, based early pedigree analysis results showing higher CRR (O'Malley et al 2023), are anticipated to improve the productivity for NOR UWR Chinook salmon. However, this depends on better passage downstream past Detroit and Big Cliff Dams.

In the proposed action, USACE described the "Adapt Hatchery" actions for UWR Chinook salmon:

> *Following the implementation of fish passage improvements, hatchery spring Chinook production will remain at production levels as defined in the HGMPs, and hatchery-origin returns (HORs) would continue to supplement natural-origin returns (NORs) in order to meet, but not exceed, the abundance thresholds as defined in the HGMPs, and until decision criteria are achieved for the following metrics: annual dam passage survival (DPS), measured in two separate years within the first five years, and cohort replacement rate (CRR) for three separate cohorts.*

After the fish managers reviewed the CRR from earlier years of UWR Chinook salmon, based on the result of the higher CRR values in 2015 (although well below one, or replacement), they repeated the 2015 outplanting of NORs above the Detroit Reservoir in 2023 and 2024 (NMFS SFD 2024)[21]. This reduced the number of NOR UWR Chinook salmon in the reach below Big Cliff, with possible benefits to the overall population in part because of the conditions in this reach. More details on those effects (temperature and TDG) are in Section 5.6.3. When NOR salmon are added, they create the potential for a more integrated population above Detroit Dam, which can result in greater overall abundance. However, until the pedigree studies are completed for these cohorts, it remains uncertain whether the low downstream passage efficiency and survival will keep the North Santiam River abundance and productivity for UWR Chinook salmon and steelhead far below targets for recovery. Results from samples processed and analyzed up to 2024 are expected by 2026.

USACE proposed to use the CRR values to change HOR Chinook salmon production over a period of 5 years to a reduced level of production, when CRR > 1 (2024 PA). Following successful passage implementation, USACE proposes:

> *…hatchery spring Chinook production will remain at production levels as defined in the HGMPs, and hatchery-origin returns (HORs) would continue to supplement natural-origin returns (NORs) in order to meet, but not exceed, the abundance thresholds as defined in the HGMPs.*

In the North Santiam HGMP, the abundance standard is: "3.3.1 Abundance of hatchery returns available for outplanting has a target of 1500 adults/750 females" (HGMP 2019). Once this standard is being met, proposed decision criteria for changes would be based on these metrics:

> *…annual dam passage survival (DPS), measured in two separate years within the first five years [following passage improvements], and cohort replacement rate (CRR) for three separate cohorts. If the CRR for Chinook is >1 based on a geometric mean, then the full credit for fish passage improvements will be applied. In this case Chinook production will be reduced over a period of five years to a Reduced Level of Production (see WVS DPEIS Appendix A). (USACE 2024a).*

Using CRR as a basis for reduced production for post-passage improvements, three cohorts are analyzed after 7+ years so that samples of adults returning as 3- to 5-year-olds for all three cohorts are available, along with processing and analysis time. Should the CRR > 1 metric not be met, proposed actions are to review CRR again in year 14, then: "If CRR remains < 1 after year 14, further assessment of the major factors affecting population performance (those relating to the WVS and those not) will occur to help inform management decisions" (USACE 2024a).

The proposed action to reduce hatchery production following improved passage is consistent with the HGMP 15.2 Outplanting Plan, as are limits on outplanting prior to the structural passage operations. This is described as: "until the long-term juvenile fish passage solution past Detroit is

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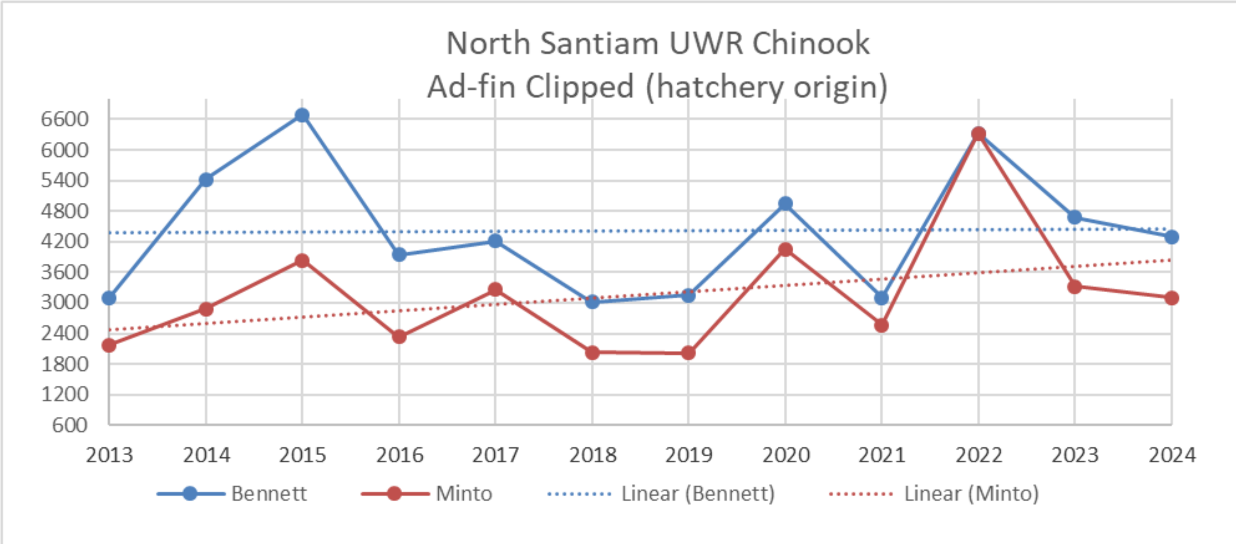
21 North Santiam HGMP noted: [I]n 2015, extreme drought conditions existed in the North Santiam basin that affected river flows and water temperatures below Big Cliff/Detroit Dams for adult and juvenile spring Chinook salmon. Based upon the risks and benefits of all options, the co-managers agreed to outplant some NORs above Detroit Dam.

implemented and approved by NMFS, up to 750 HOR females and 750 HOR males may be outplanted above Detroit Dam according to the disposition table" (HGMP 2019). Then increases are proposed to 'seed the habitat' prior to the improved passage:

> Four years prior to development of successful juvenile downstream passage at Detroit, the number of CHS annual outplants may be increased up to 2,000 females with an equal number of males. These will be HOR fish. NORs outplanted during this time will be determined on an annual basis by fisheries managers based on criteria outlined above. (HGMP 2019).

The structural passage, once fully implemented, will ultimately lead to fewer HOR fish in the upper basin. The NOR fish that return to the Minto Fish Facility will be outplanted at higher rates to the upper basin above Big Cliff and Detroit dams and will result in a growing number of NOR UWR Chinook salmon. This should in turn lead to higher productivity as seen in the pedigree analyses (O'Malley et al. 2023) and will move the UWR Chinook salmon North Santiam River population toward increased abundance and better spatial structure and diversity. Improved passage with higher survival is a crucial step for the UWR Chinook salmon ESU to improve population viability as noted in the UWR Recovery Plan (ODFW and NMFS 2011).



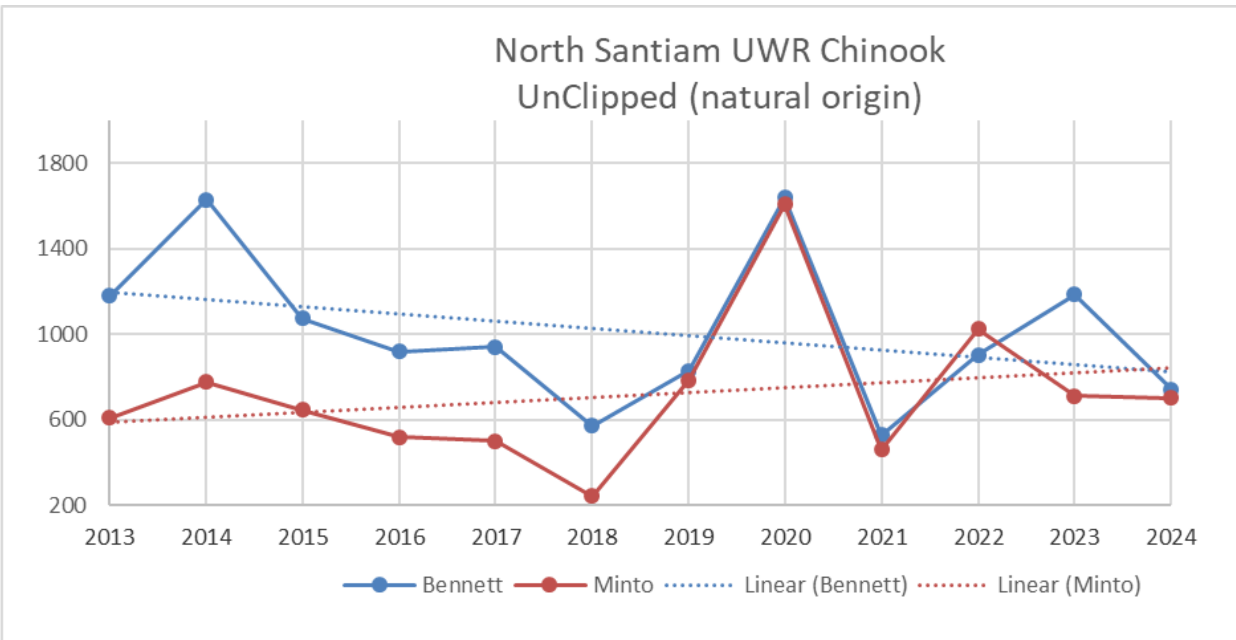


Figure 5.6-7 North Santiam hatchery origin ((HOR, upper graph) and natural origin (NOR, lower graph) UWR Chinook salmon counts. Both lower river counts at Bennett Dams (video counter) and the upper river Minto Fish Facility counts are shown. The Minto counts show an upward trend since 2018, in contrast to the strong downward trend for Bennett Dams NOR Chinook. Minto counts exceeded Bennett counts in 2022; due to very high flows, Upper Bennett Dam was not a barrier, so UWR Chinook and steelhead spawners passed this dam without being counted in the ladder, as happened in 2022. Note y-axis scales differ.

5.6.2 Flow Effects

Flood risk reduction is the priority authorized purpose for the Detroit Dam, and continuing hydropower production is also part of the proposed action. Flood prevention would decrease the magnitude and frequency of instantaneous peak flow events. Continuing these operations will contribute to the ongoing loss of habitat complexity in the North Santiam and the mainstem Willamette by substantially reducing the magnitude of channel-forming dominant discharge (generally 1.5- to 2-year) events and increasing the return intervals of larger floods. The result would be fewer side channels and alcoves, less large wood recruitment, and reduced movement of the full range of channel substrates.

USACE proposes downstream flows modified from those offered in the 2007 BA and used in the 2008 RPA (NMFS 2008a, Table 9.2-2). These are shown in Table 5.6-4, with the primary life history stage that would benefit. In addition to meeting minimum flow objectives, the 2008 RPA directed the USACE to develop a detailed study plan, with the "primary goal … to identify the relationships between river flow rates and habitat conditions for adult passage, holding, and spawning and juvenile rearing" in six tributaries, with the North Santiam identified as top priority (NMFS 2008a, RPA Measure 2.4.2). Once completed, the next step in the 2008 RPA Measure 2.4.3 was:

> *USACE, in coordination with the Services, will determine if the minimum and maximum flow objectives in Table 9.2-2 are appropriate. If the studies suggest that fish protection goals can be better met with different flow levels than those specified in Table 9.2-2, then USACE… will recommend any changes flow objectives in applicable tributaries to improve benefits to listed fish while continuing to meet Project purposes. The Services will inform the USACE whether they agree with the modified flow objectives.*

And in RPA Measure 2.4.4, they were to modify project operations, by January 2012:

> *Following completion of the studies specified in RPA measure 2.4.2 above and determination of revised minimum flow objectives as described in RPA measure 2.4.3 above, the USACE will complete system operational modeling and NEPA analyses, if appropriate, including consideration of all project purposes, to identify modified project operations that optimize dam operations to best meet tributary and mainstem minimum flows needed to protect fish.*

In response, USACE has proposed a new process to decide when to release flows to protect habitat and fish life history stages below dams. In the North Santiam River, USACE proposed to review Detroit Reservoir elevation in the spring, relative to the water control diagram[22], and set minimum flow levels based on whether the refill is at or below 90 percent of the volume or between 90 to 100 percent of refill on the water control diagram, also known as the rule curve. The modified flow objectives (Table 5.6-4) would be lower than those in the 2008 RPA during March–June if refilling the reservoir at less than 90 percent of the standard rule curve volume and for part of March and April when at 90–100 percent of refill. In September–October, they

[22] A generic Willamette Valley System Water Control Diagram is shown in the 2024 PA, Figure 2.2-1.

would also be reduced if the spring refill had been less than 90 percent, and in September if >90 percent refill. May–August minimum flow objectives would be higher if >90 percent refill. May–August minimum flow objectives would be higher if >90 percent refill.
The highest flows were defined for spawning below Big Cliff Dam—Mar 16 to May 31 for UWR steelhead and Sep 1–Oct 15 for UWR Chinook salmon, as shown in Table 5.6-4 (NMFS 2008a, Table 9.2-2). These flow targets can be difficult to meet in dry years, especially during spring refill, although USACE had predicted they could be met 95–99 percent of the time (Usace 2007). Since the 2008 RPA, if USACE found it hard to meet spring minimum flow objectives and projected difficulties in meeting flows throughout fall, the WATER team (FMWQT) considered lower alternatives (see for example, USACE 2016, showing how most 2015 flow objectives were unmet). These were informed by background information and modeling for hydrologic conditions and were also based on UWR Chinook salmon and steelhead timing and run size from mainstem and tributary counts, to reduce risk in their responses to the current conditions. If less harm was expected for UWR steelhead based on the many years with extremely low returns at Willamette Falls, then the spring spawning flows were at times reduced given the expectation that these would not limit habitat for the lower abundance. The proposed spawning flows would be reduced below 2008 RPA levels based on the reservoir refill level in the spring, which will limit available depth for holding spawners, area for redds, and limit the depth of water over the redds that are created. This focus on refill 'rule curve' for flow decisions does not include effects on UWR Chinook salmon and steelhead, which would cause lower spawning success when available habitat is reduced. This will lead to lower population abundance and productivity.

In the PA, USACE (2024) described the choices to set flows to a 'weighted usable area' (WUA) calculated from earlier studies as follows:

> *The minimum flow thresholds for both wetter and drier conditions increase then from the early minimum values according to optimal hydrograph shapes determined by Peterson, Pease, et al. (2022). The results of these studies indicate that water temperature is likely driving the shape of the optimal flow regimes they identified, and drive what is the best candidate for a minimum flow.*

The link between temperature actions in the North Santiam River and refill is in part due to the spill from upper levels of the reservoir during summer to reduce the volume of warm water remaining during the fall drawdown. Note, temperatures are discussed in Section 5.3.3 Water Quality Action Effects. The alternatives for lower flow use the weighted usable area (WUA) approach, but from these, the USACE selected a flow resulting in greatly reduced habitat areas in dry years, particularly for UWR steelhead (R2 Resource Consultants, 2013). USGS flow-habitat studies in progress show flows and habitat for spawning reaches at higher resolution (James White personal communication, Sept 18, 2024). These can also be informed by where redds were found in past spawner surveys (Sharpe et al 2017c), although the proposed action uses refill levels as the metric to determine when to reduce flows from 2008 RPA minimum targets.

Table 5.6-4 Tributary Minimum Flow Objectives for Detroit / Big Cliff releases. Highlighted proposed minima in orange are reduced from the 2008 RPA Minimum Flow Objectives, and increases are shown in green when on higher refill trajectory. October minimum flows apply for months not shown, unless flood risk reduction requires lower flows.

Start Date	Primary Use	Proposed Detroit & Big Cliff >90% rule curve	Proposed Detroit & Big Cliff <90% rule curve	2008 RPA Minimum Flow Objectives
1-Feb	Rearing/adult migration	1050	1050	1000*
16-Mar	Steelhead spawning	1050	1050	1500
1-Apr	Steelhead spawning	1200	1050	1500
16-Apr	Steelhead spawning	1500	1050	1500
1-May	Steelhead spawning	1550	1050	1500
16-May	Steelhead spawning	1600	1050	1500
1-Jun	Steelhead incubation	1550	1050	1200
16-Jun	Steelhead incubation	1500	1120	1200
1-Jul	Steelhead incubation	1400	1200	1200
16-Jul	Rearing/ adult migration	1250	1280	1000
1-Aug	Rearing/adult migration	1250	1050	1000
16-Aug	Rearing/adult migration	1250	1050	1000
1-Sep	Chinook spawning	1250	1050	1500
16-Oct to 31-Jan	Chinook incubation	1200	1050	1200

*Note, 2008 RPA minimum objectives did not include powerhouse flows that require 1050 cfs. Flows were rarely released below 1000 cfs, other than due to low refill elevation July-Sept 2015.

To coordinate during a dry year for lower flows, the 2008 RPA process relied on fish managers to review seasonal near-daily adult counts of UWR steelhead and UWR Chinook salmon at both Willamette Falls and at Bennett Dams to estimate spawner timing and run size. Proposed flows would also reduce juvenile rearing habitat during spring in the reaches below Detroit and Big Cliff dams, which are not characterized well by WUA methods, when the potential for off-channel habitat connections are lost (Rosenfeld and Naman 2021). Proposed lower flows are, at times, pitting one life-history stage (rearing vs holding) or UWR Chinook salmon and steelhead, against the other. When water temperature is higher, the off-channel habitat that is lost also reduces the areas with groundwater connectivity or hyporheic flows, reducing refuge for UWR

Chinook salmon and steelhead juveniles and lowering productivity by limiting their growth and survival.

UWR steelhead counts are overall quite low, and trend lines are nearly flat at the lower Bennett Dams and have a slight increase at Minto Dam with the higher returns in 2024 (Figure 5.6-8). The lack of spawning habitat from proposed lower flows in the spring will affect UWR steelhead spawners and is a threat to this declining population's productivity. In most years, counts at Bennett Dams are more than 15 percent of the Willamette Falls total returns (Figure 5.6-8, blue shading). The Willamette Falls counts declined over the past decade with a -59 percent change in the geometric mean of raw natural spawner counts for the UWR steelhead DPS (Ford et al 2022). An increase since then in the Willamette Falls geometric mean for 2020–2024 was also seen in the North Santiam. This was generally attributed to reduction in sea lion predation at Willamette Falls, and yet, there has been a continued decline in basinwide counts since 2000, which are reflected in North Santiam counts.

UWR steelhead are affected by changes in flow proposed during migration and spawning in known productive periods in the North Santiam (Table 5.6-4). Figure 5.6-9 (upper graph) shows that the 2008 RPA flows in the spring were often met in the North Santiam, although not in the hot dry years of 2015, 2021 (2023 also did not meet targets in March and April). These lower flows reduce the available spawning habitat that has sufficient depth of water to cover the redds. The lower counts of UWR steelhead in the ladder at Minto Dam compared to ladders at Bennett Dams shows many spawners move above Bennett Dams (Figure 5.6-8), and require sufficient flows to spawn successfully. The proposed lower flows are considerably lower than those released in spring of dry years such as 2016 and 2021, and are only matched by 2015. The proposed action would increase the number of years with these lower flows, causing spawning problems for already low population returns. With the overall larger declines shown in the Baseline (Figure 4.6-4), the reduced spawning areas for future returns would be very harmful to productivity in the North Santiam subbasin.

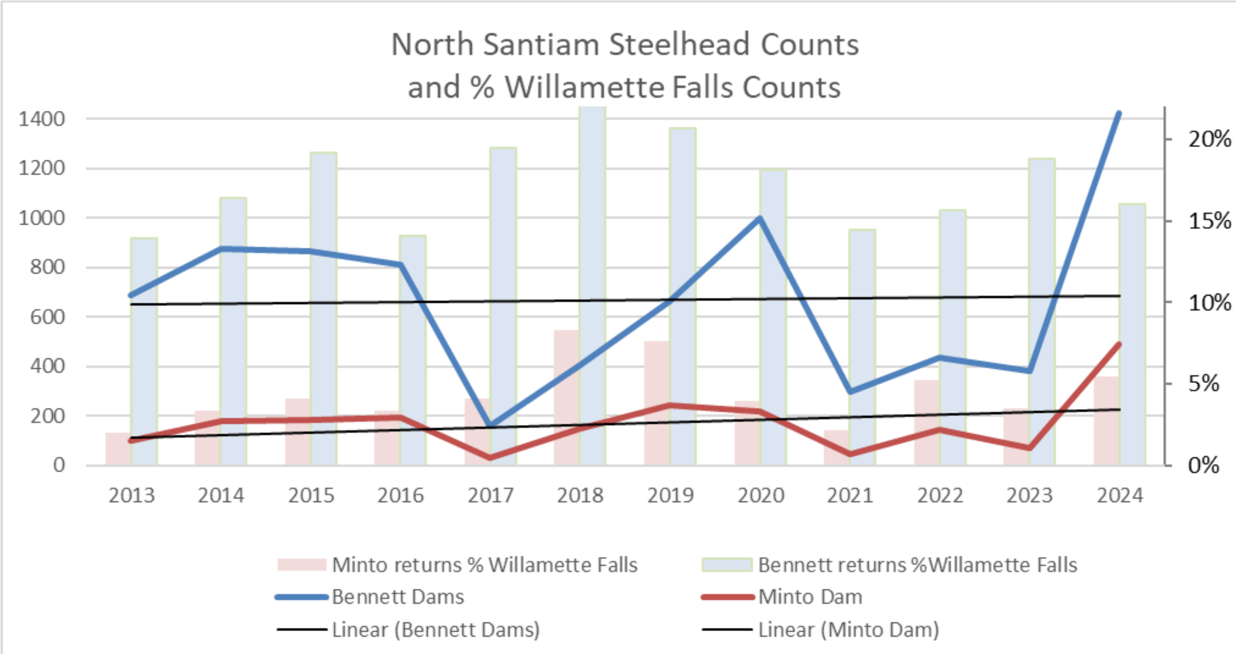


Figure 5.6-8 UWR steelhead counts at Bennett Dams and Minto Dam ladders show similar patterns and flat trendlines, although many more UWR steelhead pass the lower ladders, some of which spawn before Minto Dam. Those spawners are not tracked due to high flow conditions during their spawning. The percent of Minto counts from Willamette Falls total counts (Average at Minto over 2013-2024 is 4.4%, while at Bennett (not shown), the average is 17.4%) shows the variability in numbers of UWR steelhead that make it from the mainstem to the North Santiam.

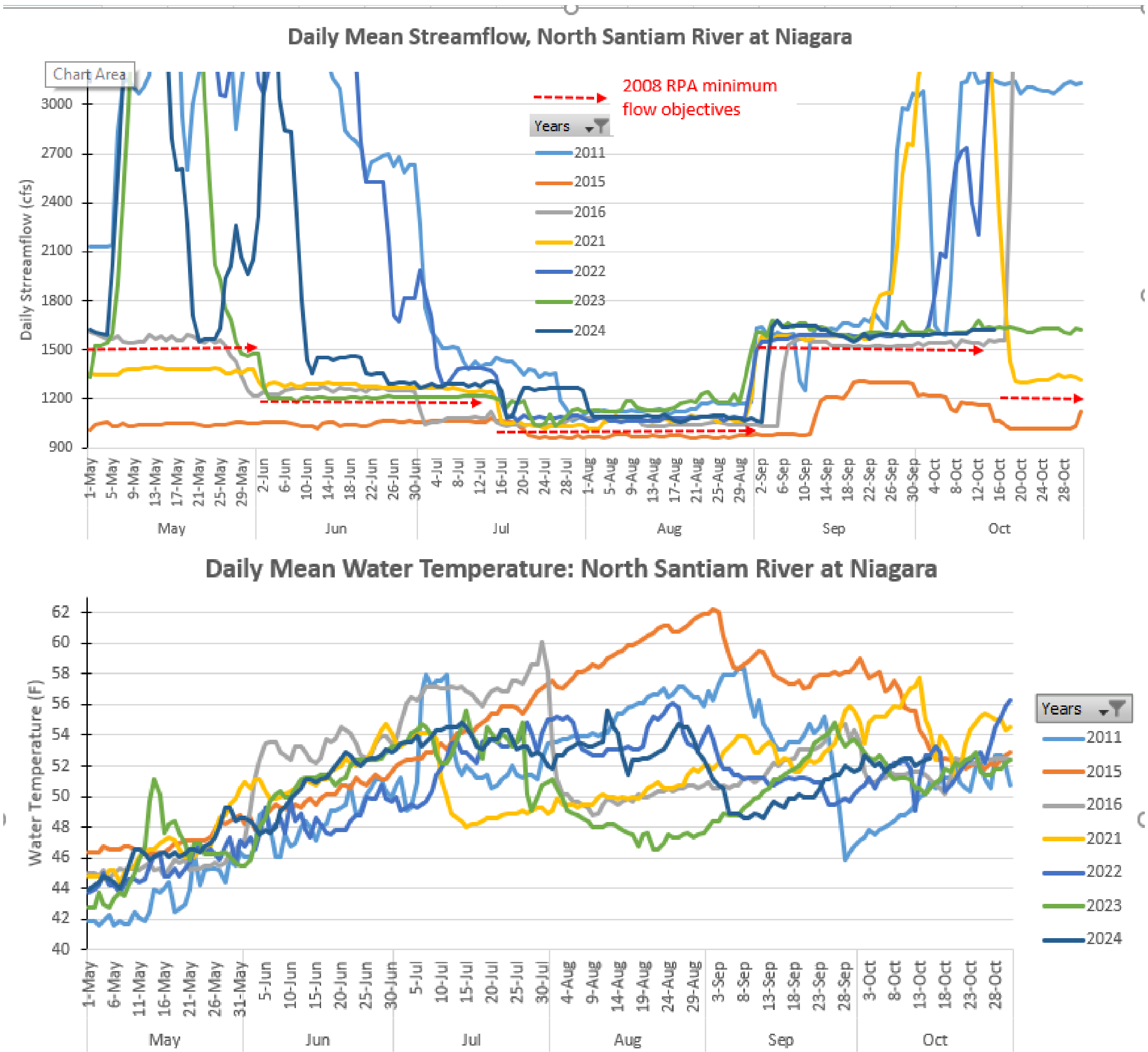


Figure 5.6-9 Flows and temperatures for 2011, 2015, 2016, representing years that were cool, hot, and moderately warm, respectively, and 2021-2024 with interim spill operations. Mean streamflow also shows the 2008 RPA minimum flow objectives, generally met except for 2015, and May of 2021. Temperature show that only 2021, part of 2024 exceeded 2015 high temperatures in fall, while all but 2015 were below target temperature from USACE (see Water Quality discussion below). Sharp drops in temperature are when spill source switches to at lower elevations to turbines, then ROs. Source: USGS gage 14181500

5.6.3 Water Quality Action Effects

The proposed action for interim temperature management (Table 5.6.2-1) would continue using discharges mixed from available different elevations to achieve current temperature targets

(USACE 2024a, Appendix F, WFOP, Chapter 2). USACE discharges from the spillway which mixes with flow from the turbines to meet spring and summer targets. Once the reservoir elevation is below the spillway level, they use turbines alone or mixed with cooler water from the RO depths in late summer and early fall. They can use the lower ROs in later fall if reservoir elevation allows. These actions can help with excessive warmth when the reservoir is drawn down. However, faster drawdown to the lower RO elevations earlier in fall 2021 caused the reservoir to fully mix earlier than usual, and no stratified cooler levels remained in less than a week (USACE 2022d, Rounds and Stratton Garvin, 2022). This showed the current limits to providing temperature within the target range.

Proposed flows during incubation for North Santiam River steelhead redds may shorten the period eggs are in redds as a result of warmer flows released during August in some years affecting the Minto to Big Cliff dams reach (Rounds 2010, Figure B4). Later in the fall, warmer temperatures will expose incubating UWR Chinook salmon juveniles to higher temperatures, speeding up their emergence from the redds. This leaves them vulnerable to higher flows that easily move them downstream prior to their developing feeding habits. Lower rates of survival in the estuary or marine environment are also likely for young fry that are swept downstream by winter flows once they emerge from redds. They can emerge one month earlier as shown in USACE regression of spillway use with estimated date of emergence (N.Buccola email to A.Mullan 07–15–2024). However, the interim temperature management can often meet the current summer temperature targets intended to protect the adult UWR Chinook salmon until October and November at which point the lower temperature maximum targets are often exceeded (Figure 5.6-10, USACE WFOP 2024, Appendix F, Table NS-4). This provides higher productivity for the spawning life history stages, albeit reduced by the shorter incubation effects.

In contrast, long-term temperature control is from the proposed Selective Water Structure (SWS), with a timeline for operations to begin in 2033. This would provide more flexibility in mixing flows from various levels, much like the Cougar temperature control tower in the South Fork McKenzie River. The proposed action shows this as a tradeoff for summer flows that are warmer in exchange for cooler fall flows as stratified upper layers of Detroit Reservoir would be mixed with the lower layers throughout the summer and fall. In Figure 5.6-11, this is shown by the lower temperature targets below Big Cliff Dam (labeled BCLO) for the NAA or DEIS 'no action alternative' compared to the AA or action alternatives higher temperature targets. Under the proposed action, lower temperatures would occur during October and November when current temperature targets are exceeded.

The overall effect of the proposed action to construct the SWS for long-term temperature management is to shift the interim warm water from fall to summer. In extreme hot and dry years, such as 2015, interim temperature operations cannot use spill as refill to the necessary elevation will not occur. The limited operations available kept temperatures above 60°F from August 18 to September 4. This shows how reduced refill can interfere with operational temperature management. However, the proposed SWS would target 60°F as the summer limit from mid-July to mid-August (Figure 5.6-11, BCLO graph) and, in so doing, would add warmer water to the reaches below the dams when Chinook salmon spawners are holding. This shifts temperature effects from incubation to adult UWR Chinook salmon holding and spawning. Most spawners will be affected below Minto Dam and in the Minto-to-Big-Cliff reach where all natural-origin UWR Chinook salmon have been out-planted until recently when a fraction has been placed above Detroit Dam. The harm to adult UWR Chinook salmon spawners from higher summer temperatures will not be offset by the lower incubation temperatures proposed, and so, the overall effects of the SWS are to reduce UWR Chinook salmon spawning success, leading to lower productivity.

UWR steelhead that return to Minto are outplanted in this reach also, and possible effects from the proposed SWS summer targets include incubation in warmer summer flow extending to redds, leading to earlier emergence for these juveniles. While a smaller percent of the total steelhead run are outplanted above Minto, they are returning in higher numbers than those below. This essential population segment requires protection from current operational passage effects. The UWR steelhead will not be moved upstream of the USACE dams until the long-term structural passage route is provided, and the lengthy time frame for that keeps them from high quality habitat above the dams.

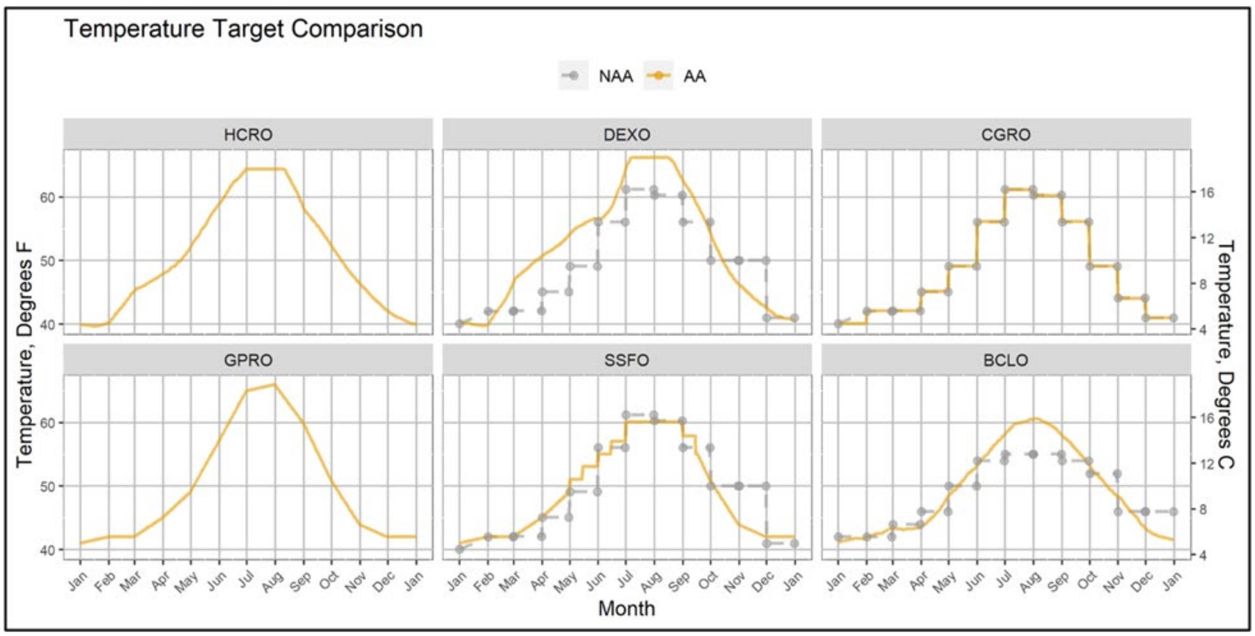


Figure 5.6-10. Temperature Targets Used at Each CE-QUAL-W2 Reservoir. For the USACE proposed actions, they noted these targets would be changed from the NAA to the Action Alternatives. In the North Santiam the targets are shown in the lower right hand graph, labeled BCLO. The proposed targets are higher than current for June- September, then lower in October-December. Source: Figure 2.2-2., from the PA, USACE 2024a.

Correlated with high temperatures, prespawn mortality[23] of UWR Chinook salmon has been high in some reaches in past years. When spawner surveys provided detailed information based on

[23] Pre-spawning mortality (PSM) was defined by female carcasses with 50% or more of eggs remaining. Sharpe et al (2017) noted: "The 50% threshold is arbitrary but in practical terms virtually all female carcasses had either essentially no eggs remaining or completely intact skeins." They calculated PSM by dividing the number of unspawned female carcasses by the total number of female carcasses where spawning status was observed.

repeated surveys over the spawning season, and collecting carcasses when possible, the link to temperatures was clear (Keefer et al. 2010, Bowerman et al. 2016). The highest PSM rate for UWR Chinook salmon spawners in the North Santiam River was 90 percent prior to the new ladder at Upper Bennett Dam in 2004 and the rebuilding of Minto Fish Facility in 2013. Below Detroit Reservoir, most recent surveys saw a PSM high of 63 percent in 2015 and a low of 3 percent in 2016. This may reflect the lower flows in 2015, as well as the high water temperatures. In the hot dry years, rapid handling can protect spawners if moved above the dams. Above Detroit Dam, estimated PSM was only 12 percent in 2015 and 5 percent in 2016. Maintaining temperatures that will reduce PSM is crucial to increasing the abundance, productivity, and spatial structure of North Santiam River populations of UWR Chinook salmon and UWR steelhead.

Moving UWR Chinook salmon after improved passage, and later UWR steelhead, above the Detroit Reservoir will prevent risk to the overall productivity. Improved passage, more than the SWS, will increase the abundance and productivity.

In summary, the proposed actions in the North Santiam River will cause:

- Increased prespawner mortality for UWR Chinook salmon
- Decreased growth and survival for migrating and rearing juvenile UWR Chinook salmon
- Reduced connectivity and suitability of off-channel habitat
- Faster incubation for UWR steelhead during interim and long-term temperature management and for UWR Chinook salmon during interim temperature management.
- For longer term temperature management, the adult UWR Chinook salmon will be harmed by selective summer releases of warmer water, and that will lead to lower productivity because of higher prespawn mortality.
- With long-term, structural passage for NOR UWR Chinook salmon and UWR steelhead, the higher quality upper-basin habitat will be available with higher productivity. In part, this will be because of higher survival during rearing and migration, better water quality in the habitat above Detroit Reservoir, and reduced HOR influences over the long term.
- Reduced transport of coarse sediment and large wood from flood risk management.

5.6.4 Effects on Critical Habitat

Designated critical habitat within the action area for the ESA-listed UWR Chinook salmon and steelhead in the North Santiam consists of freshwater spawning, freshwater rearing sites, and freshwater migration corridors and their essential physical and biological features (PBFs), described in the Rangewide Status of the Species and Critical Habitat.

PBF 1. Freshwater spawning sites

a) Water quantity. Flows during UWR steelhead spawning in spring are proposed to decrease in dry years during refill, dropping again in fall to limit UWR Chinook salmon holding and spawning habitat. Lower peak flows in winter can limit the creation and maintenance of channel complexity.

b) Water quality. Proposed lower flows in March–June may reduce access to in- and off-channel higher quality conditions for holding and spawning. Continued interim passage can cause higher temperatures in areas where UWR Chinook salmon redds are below the dam. Long-term passage through the FSS will provide more periods of normative flow.
c) Substrate. Continued operation of the dam to reduce high flows for flood-risk reduction, for refill in the spring, and again in the early winter after the proposed fall drawdown temperature operation will block transport of suitably sized substrate for spawning. This will not change with the long-term structural passage route.

PBF 2. Freshwater rearing sites

a) Water quantity. Flow-related habitat availability and connections will be reduced when proposed lower minimum flows are released in February–June. Continued operations to drawdown reservoirs and then refill them can reduce the high flows in winter and spring, which limits the creation of complex channels and the connectivity to the floodplain features used by juveniles prior to migrating. In the North Santiam basin, a significant percentage of juveniles are 'stayers' rather than 'movers' who leave in the first year following their emergence (Schroeder et al. 2016).
b) Water quality. Proposed lower flows in March–June can lead to higher temperatures when UWR steelhead eggs are still in redds.
c) Floodplain connectivity. Lower minimum flows proposed in spring, or lower flows in spring and winter for post drawdown refill, will reduce floodplain connectivity by increasing the likelihood of 'single channel' habitat. Recent work to restore lower North Santiam habitat enabled by funding and expertise of other federal agencies can limit this in those project reaches but will leave other reaches vulnerable to lower complexity.
d) Natural cover. Continued operations of Detroit and Big Cliff dams to refill will restrict movement of large wood from above the dam, and from reaches below where simplified single-channel habitat dominates, diminishing riparian forest benefits (shade, refuge, prey habitat, and cover from predators). After 2020 fires this loss was compounded. (https://www.fs.usda.gov/detailfull/willamette/fire/?cid=fseprd835368).

PBF 3. Freshwater migration corridors

a) Free passage. Lack of clear, safe passage routes because USACE operations at Detroit and Big Cliff dams impede juveniles from moving downstream, although adults are safely moved upstream to higher quality spawning and rearing habitat. The long-term passage solution via the diversion tunnel will improve this PBF, other than when the proposed tunnel shutdown to refill occurs in late spring and late fall, leading to extended periods when the refilling elevation may allow no passage route.
b) Water quantity. Subyearling 'movers'migrate throughout the late winter and spring, and they need flows to signal and assist their volitional migration.
c) Water quality. Similar to above, with juveniles exposed to higher temperatures during migration in spring under new minimum flows and fewer areas to find refuge because of reduced complexity from lower flows. Juveniles were found to move primarily as yearling smolts from the Detroit Reservoir during spring, and they need higher water quality for their slower migration, including natural temperature regimes.

d) Forage. When juveniles are moving out from above the Detroit and Big Cliff dams, the USACE operations can affect the availability of complex habitat elements. Dam operations during post-drawdown reservoir refill, flood risk reduction, and low minimum spring flows also reduce transport of large wood and coarse sediment, habitat elements that increase the diversity and abundance of macroinvertebrate prey.
e) Natural cover. Similar to above, migrating adults and juveniles need refuge from low flows (for temperature), high flows (for velocity), and predators.

5.7 Mainstem Willamette Effects

The Proposed Action includes the following operation and maintenance of the existing configuration of 13 WVS dams in major tributaries of the Willamette River that would be likely to affect listed UWR Chinook salmon or steelhead populations using the mainstem Willamette River for adult holding and migration as well as juvenile rearing and migration.

- Flow Management: WVS dam operations deliver a range of flows, including proposed new minimum flows for spring-through-fall minimum flow objectives. Flood-risk reduction also captures high flows.
- Temperature management: Short-term releases from WVS reservoirs to attempt to lower water temperatures when exceeding identified thresholds.

The effects of the proposed actions on mainstem elements are covered in this chapter.

5.7.1 Mainstem flow regime effects on migrating adults in the mainstem

The WVS dams are operated for flood-risk management as their highest priority, and this greatly reduces the range of peak flows in the mainstem Willamette River during spring runoff (Figure 5.7-1). Flows are also reduced during refill following deep drawdowns. Continuing hydropower production is also part of the proposed action. Flood risk management would decrease the magnitude and frequency of instantaneous peak flow events. Continuing these operations will contribute to the ongoing loss of habitat complexity in the mainstem Willamette by substantially reducing the magnitude of channel-forming dominant discharge (generally 1.5- to 2-year) events and increasing the return intervals of larger floods (Figure 5.7-1). The result would be fewer side channels and alcoves, less large wood recruitment, and reduced movement of the full range of channel substrates.

In the 2008 RPA, the Willamette River mainstem minimum flow objectives varied based on the month and year type. The minimum flows could be adjusted for seasonal conditions with approval by the Services. Each spring, a review of conditions with a forecast probability was considered beginning in April and then in mid-May, the year type was given by the total storage, with deficit years when below 0.9 million acre-feet (MAF), and adequate for total storage above 1.20 MAF. Between 0.9 and 1.20 MAF, the minimum objectives could be interpolated, or often the deficit levels were used. Within deficit years, if total storage was estimated to be below 0.9 MAF, lower flows were used. If flows were below the deficit level, there were opportunities to monitor the responses in migration timing and temperatures at Salem and downstream. USACE is proposing to modify drier years minimum flow objectives to be lower than 2008 RPA minimum objectives in spring and summer generally (Table 5.7-1, Figure 5.7-2). USACE also

proposes a new decision trigger described below, with reviews every 2 weeks to adjust the minimum threshold.

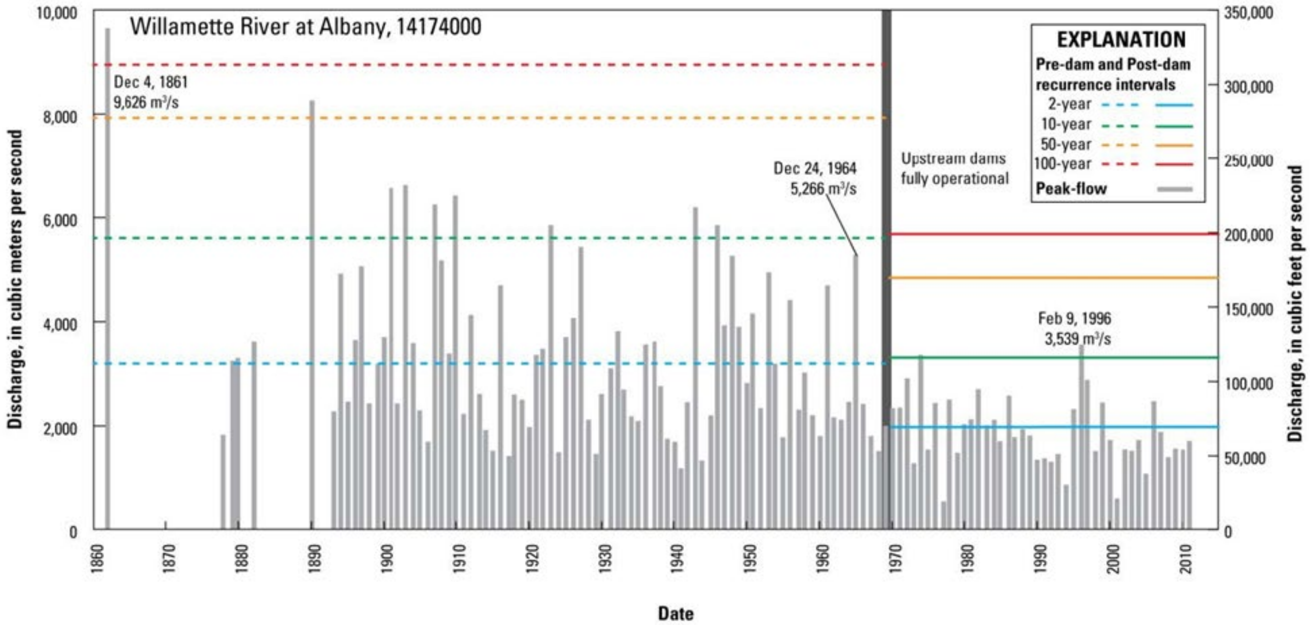


Figure 5.7-1. Changes in peak annual discharge for the mainstem Willamette River at Albany, Oregon pre- and post- dam flood risk management operations. High flows in April 2019 are missing; these were as high as 99,200 cfs (2809 cms) at Albany, and 145,000 cfs (4105 cms) at Salem. Source: Figure 18 from Wallick et al. 2013, and 2019 data from USGS gage 14174000.

In the 2008 RPA, the Willamette River mainstem minimum flow objectives varied based on the month and year type. The minimum flows could be adjusted for seasonal conditions with approval by the Services. Each spring, a review of conditions with a forecast probability was considered beginning in April and then in mid-May, the year type was given by the total storage, with deficit years when below 0.9 million acre-feet (MAF), and adequate for total storage above 1.20 MAF. Between 0.9 and 1.20 MAF, the minimum objectives could be interpolated, or often the deficit levels were used. Within deficit years, if total storage was estimated to be below 0.9 MAF, lower flows were used. If flows were below the deficit level, there were opportunities to monitor the responses in migration timing and temperatures at Salem and downstream. USACE is proposing to modify drier years minimum flow objectives to be lower than 2008 RPA minimum objectives in spring and summer generally (Table 5.7-1, Figure 5.7-2). USACE also proposes a new decision trigger described below, with reviews every 2 weeks to adjust the minimum threshold.

For lower flows during the refill and conservation season “approximately from March through October, including the filling season (spring) and the release season (summer)”, USACE proposed “new operational guidelines related to managing the regulation of flow” (USACE 2024a PA). The guidelines’ first step for releasing flows for mainstem flow targets is to review the daily water supply forecast, relative to the 30-year normal as shown in proposed action (USACE 2024a, Table 2.2-3. Mainstem Minimum Flow Thresholds). The total mainstem “seasonal volume normals” are calculated for a 30-year period (Table 5.7-2), which would be compared to annual forecasted volumes (NWRFC 2024a). The most recent normal values cover 1991–2020, while the previous normal covered 1981–2010. In the proposed action (USACE 2024a), these estimated supply volumes would be the basis for a modified flow regime in the mainstem, where the mainstem flow at Salem is based in part on releases from several of the USACE reservoirs during spring-fall as well as overland flows and smaller river inputs.

Table 5.7-1 Mainstem Willamette Proposed Minimum Flow Thresholds. The proposed flow thresholds are shown, with shading indicating values lower than 2008 RPA minimum flow objectives, originally proposed by USACE in 2007 (NMFS 2008a). Thresholds of <80%, and 80-100% for lower flows are similar to the deficit and below adequate 2008 RPA flow objectives. October flows are higher than current minimum flow objectives, in part due to releases during proposed reservoir deep drawdowns at Cougar Dam, Green Peter Dam, and Lookout Point Dam.

Time Period	**Forecast % of 30 Year Average***	**Salem Minimum Flow (7 day moving average)**	**Salem Minimum Flow (Instantaneous)**	**2008 RPA minimum flow in *deficit* or adequate years**
April	<80%	**12,000**	**12,000**	*15,000*
April	80-100%	**15,000**	**13,000**	15,000 - 17,800
April	>100%	17,800	14,300	17,800
May	<80%	**10,000**	**8,000**	*15,000*
May	80-100%	**13,000**	**12,000**	15,000
May	>100%	15,000	12,000	15,000
June 1 - 15	<80%	**8,000**	**8,000**	*11,000*
June 1 - 15	80-100%	**10,000**	**10,000**	11,000 - 13,000
June 1 - 15	>100%	13,000	10,500	13,000
June 16 - 30	<80%	**5,500**	5,500	*5,500*
June 16 - 30	>=80%	**7,000**	**7,000**	8,700
July	<80%	**5,000**	**5,000**	*5,000*
July	>=80%	6,000	**5,500**	6,000
August	<80%	**5,000**	**5,000**	*5,000*
August	>=80%	6,500	**6,000**	6,000-6,500
September	<80%	**5,000**	**5,000**	*5,000*
September	>=80%	7,000	**6,500**	7,000
October	<80%	7,500	6,000	13,000
October	>=80%	10,000	8,000	*5,500*

*Volume for Apr-Sept, see "Normal" in Table 5.7-2

Figure 5.7-2 shows current minimum objectives for the mainstem Willamette River average weekly flows (labeled BiOp, referring to the NMFS (2008) RPA) in both normal or deficit years[24] along with USACE's proposed minimum low and moderate flows (M30). Note that in most years, M30 and flows under NMFS 2008 RPA are the same during July through September other than the first half of August when proposed flows are slightly higher. However, during late summer, fewer adult UWR Chinook remain in the mainstem Willamette River (Figure 5.7-5). The proposed minimum instantaneous flows are also lower in moderate years, while proposed flows are higher in October (Table 5.7-1). Recent dry year's actual flows at Salem are also

[24] See Appendix D of the NMFS (2008a) RPA or USACE (2007) Supplemental BA. Deficit years are based on a threshold for anticipated 'conservation storage volume by mid-May' below 900 thousand acre-feet (kaf). Lower flows were released from April on, if the NRCS April forecast of Willamette Basin volume was near or below this threshold.

shown in Figure 5.7-2, with varying levels in spring for the warmest years. The water supply forecasts in 2015, 2016, and 2021 shown in Figure 5.7-3 include daily supply forecast and range during April through September, with a green line showing the 30-year normal (NWRFC 2024). When the 50 percent supply forecast estimate is less than 80 percent (at approximately 3800 KAF), USACE proposes the lowest minimum flow thresholds (Figure 5.7-2, M30 low Avg).[25]

Under the proposed action, the lowest forecasts would lead to lower spring (April–June) releases from dams to meet the mainstem target (Figure 5.7-2, M30 low vs. Deficit Avg BiOp). If the forecast is between 80–100 percent of normal, USACE proposes M30 mod targets, and, if greater than 100 percent of the average, USACE proposes to use 2008 RPA minimum objectives for adequate years (USACE 2024a, Table 2.2-3). For the three years shown in Figure 5.7-3, water supply forecasts during April and May were lower than the 80 percent threshold of the 30-year normal.

Table 5.7-2 The Northwest River Forecast Center averaged annual water supply over 30-year periods, as the normal (or average) volume of water from flows passing Salem during seasonal periods. For the hydrologic water year, October 1-September 30, the most recent 30-year normal was lower volume than the previous normal, while in each season shown, the previous normal was smaller. April-September are proposed as the measure to compare with a given year's forecast. Source: NWRFC Normals 2024b

WILLAMETTE - AT SALEM (SLMO3) Seasonal Volume Normals in KAF					
	Apr-Sep	Apr-Jul	Apr-Aug	Jan-Jul	Oct-Sep
30-Year Normal 1991-2020	4753.69	4324.49	4538.91	11460.76	16314.83
Previous 30-Year Normal 1981-2010	4672.36	4250.76	4468.19	11400.63	16390.50

[25] From Water Supply Forecasts for April-September, the 1991-2020 normal is 4754 thousand acre feet (KAF), so <80% =3803 KAF.

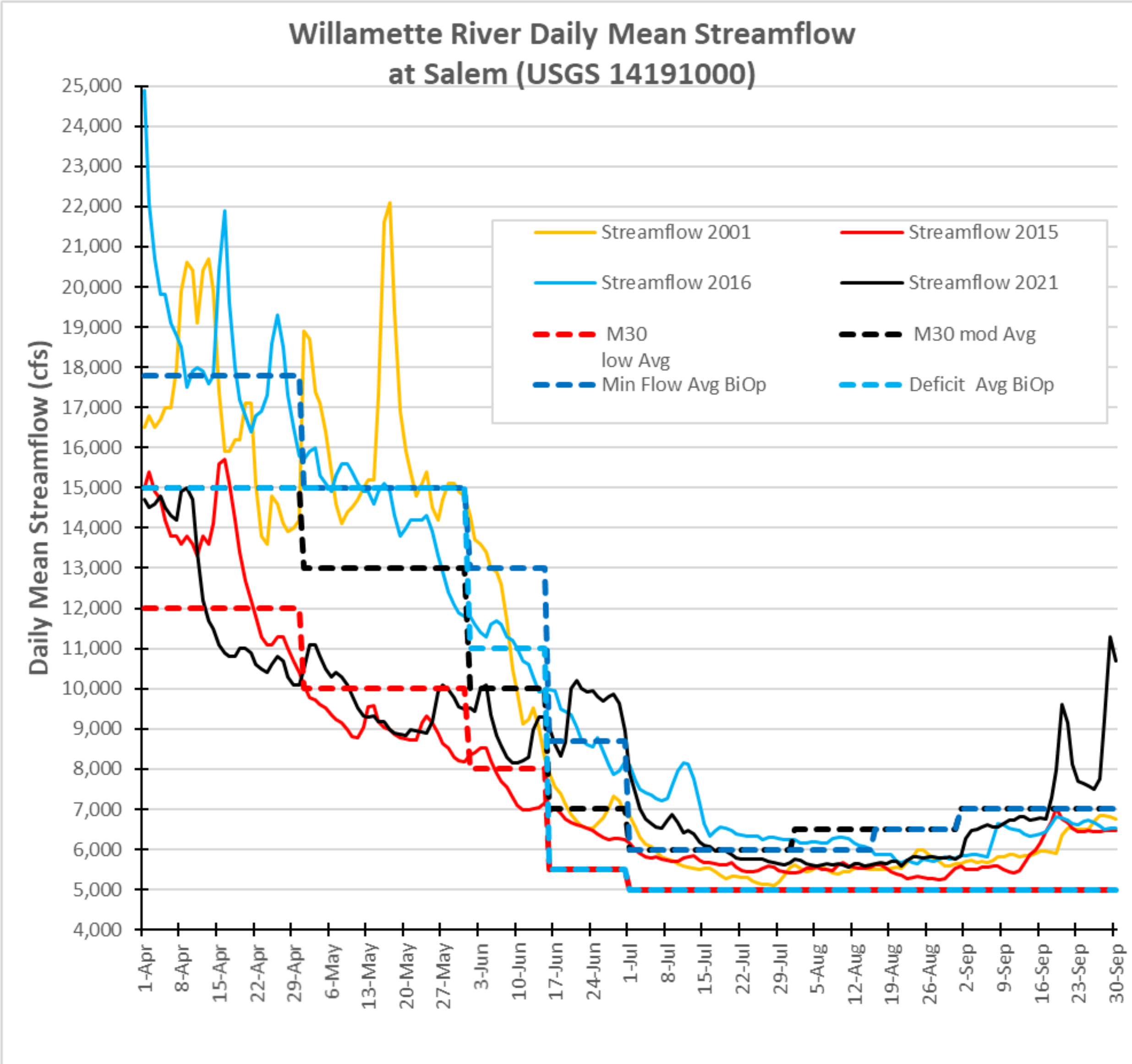
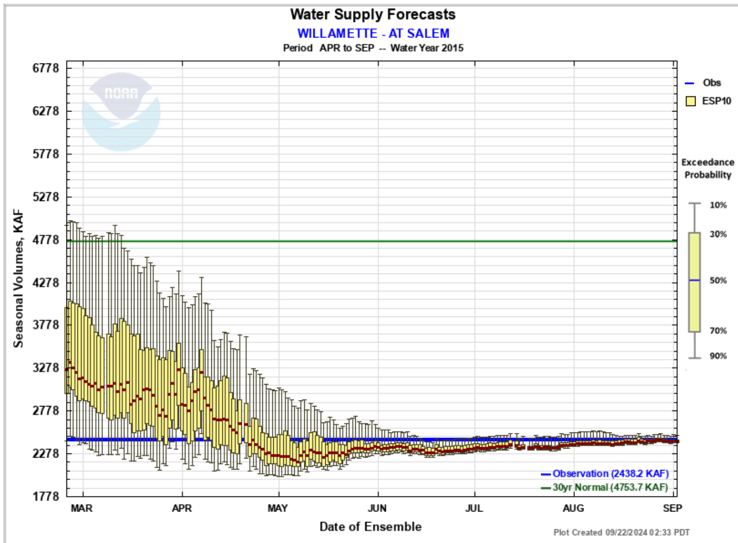
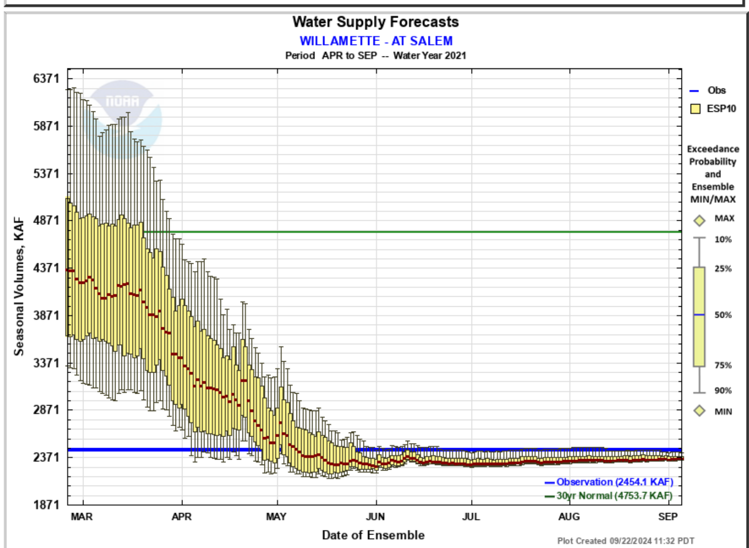


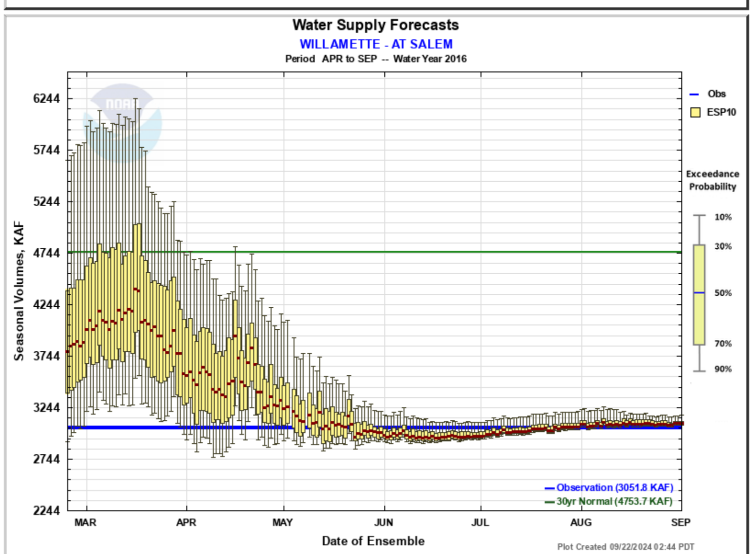
Figure 5.7-2 Hydrology of recent low flow years, with minimum flow objectives for the mainstem at Salem. M30 are the proposed action minimum average flows for moderate (mod Avg) and low Avg years, while BiOp flows show the 2008 RPA weekly averages for adequate and deficit years. (Data source: USGS Keizer gage 14192015)



Water Supply Forecasts
WILLAMETTE - AT SALEM
Period APR to SEP -- Water Year 2015
Seasonal Volumes, KAF
6778
6278
5778
5278
4778
4278
3778
3278
2778
2278
1778
MAR
APR
MAY
JUN
JUL
AUG
SEP
Date of Ensemble
Obs
ESP10
Exceedance Probability
10%
30%
50%
70%
90%
Observation (2438.2 KAF)
30yr Normal (4753.7 KAF)
Plot Created 09/22/2024 02:33 PDT



Water Supply Forecasts
WILLAMETTE - AT SALEM
Period APR to SEP -- Water Year 2021
Seasonal Volumes, KAF
6371
5871
5371
4871
4371
3871
3371
2871
2371
1871
MAR
APR
MAY
JUN
JUL
AUG
SEP
Date of Ensemble
Obs
ESP10
Exceedance Probability and Ensemble MIN/MAX
MAX
10%
25%
50%
75%
90%
MIN
Observation (2454.1 KAF)
30yr Normal (4753.7 KAF)
Plot Created 09/22/2024 11:32 PDT



Water Supply Forecasts
WILLAMETTE - AT SALEM
Period APR to SEP -- Water Year 2016
Seasonal Volumes, KAF
6244
5744
5244
4744
4244
3744
3244
2744
2244
MAR
APR
MAY
JUN
JUL
AUG
SEP
Date of Ensemble
Obs
ESP10
Exceedance Probability
10%
30%
50%
70%
90%
Observation (3051.8 KAF)
30yr Normal (4753.7 KAF)
Plot Created 09/22/2024 02:44 PDT

Figure 5.7-3 Recent dry (2015, 2021), and 'average' (2016) years water supply volumes for April to September. The red bar is the 50% or average value of the daily forecast, while yellow boxes represent 30% to 70% exceedance probabilities. In each of these years, the volume was below the 80% of the mean during spring months. Source: NWRFC Salem Water Supply Forecasts 2024b. Y-axis scales differ.

These lower flows will lead to increased water temperatures, particularly when combined with the effects of warmer air temperatures (Stratton Garven and Rounds 2022a, Rounds et al. 2022). This is the counterpoint of USGS models showing how higher flows reduce temperatures, summarized here:

> *Large amounts of water released from upstream dams can have a measurable effect on water temperature in the Willamette River, even at sites far enough downstream that the actual heat content attributable to upstream dam releases is minimal. Indeed, results of simulations made with CE-QUAL-W2 models show that flow augmentation of about 1,000 cubic feet per second (ft3/s) from upstream dam releases can decrease the average July water temperature in the Willamette River downstream of the Santiam River by up to 0.8 °C and can decrease daily maximum Willamette River temperatures downstream of the Santiam River by as much as 1.7 °C. (Rounds et al 2022).*

The warmer temperatures can harm UWR Chinook salmon holding below Willamette Falls and migrating in the warmer Willamette River mainstem until they reach their natal tributaries. Higher UWR Chinook salmon prespawn mortalities were associated with warm water temperature in the migration corridor and at below-dam collection sites (Keefer et al 2010). Risk of lower success for those that survive to spawn is also likely (Bowerman 2018). These effects would lead to overall lower productivity for UWR Chinook salmon from adult effects. When lower flows and warmer temperatures overlap with UWR juvenile steelhead migration, the risk of mortality from parasite infections also increases (WRI 2004, Kocan 2009). This means the UWR steelhead productivity would be reduced if fewer juveniles survive the pre-smolt life history stages.

In addition, numerous adult UWR Chinook and steelhead counted at the Willamette Falls ladders are not found at upstream counting sites. Before they enter their natal tributary, conditions in the mainstem Willamette River may be harmful and possibly more influential in predicting prespawning mortality levels (Zabel et al 2015). In a multi-year study, longer mainstem transit times were thought to be an important factor affecting migration success and prespawn mortality, particularly in warmer years (Jepson et al. 2015), where the exposure to warmer water can lead to lower survival before and after they enter their natal stream (Figure 5.7-5). These losses would further reduce abundance and productivity.

The two hottest years, 2021 and 2015 based on April–July average air temperatures, were ranked at 128 and 129 out of 130 years, respectively (NCEI 2022). For low flows and hotter air temperatures combined, these two years stand out from two recent comparable years with warm spring conditions, 2001 and 2016 (Figure 5.7-4). The effect of the conditions in the lower river on migrating spring UWR Chinook salmon is compounded by variable timing for the cumulative percent passing Willamette Falls (Figure 5.7-6). Surprisingly, 2021 returning adults were several weeks later than 2015, with timing closer to 2016, a wetter and slightly cooler year. Lower flows in April 2021 coincided with a lower percent of the cumulative run passing in April than in hot years 2001 and 2015. These UWR Chinook salmon spawners were exposed to higher temperatures from later run timing than is expected for hotter, drier years and would have experienced reduced spawning success, affecting overall productivity.

Studies on the effects of water temperature generally showed that higher temperatures downstream of the Willamette River induced an earlier run timing past Willamette Falls (Jepson et al. 2013) and that lower flows did not impede earlier migration for UWR Chinook salmon. However, the proposed minimum flows were rarely seen, and for April, flows would be similar to 2021 when lower flows exposed adults that held longer below Willamette Falls to very high water temperatures (Figure 5.7-5). This leads to increased risk of an additive effect of higher air temperatures and increasing water temperatures from lower flows. UWR Chinook salmon spawners in the mainstem Willamette River, above and below the Falls, will be at risk of reduced spawning success from accumulated thermal units that are linked to higher prespawner mortality.

To reduce water temperatures for short periods, USACE proposes to release daily pulses above minimum thresholds in response to target temperatures during April–June. These are described as "opportunistic/adaptable water releases for real-time water temperature management" (USACE 2024a PA). To decide whether to augment flows, USACE proposes to monitor 7-day average daily maximum water[26] (7dADM) temperatures (Keizer gage, USGS 14192015), and if over a threshold, along with forecasted air temperatures at the Salem airport over a stated limit, then USACE would release additional flows (Table 5.7-2). The thresholds are derived from the relationships between flow, air temperature, and water temperature during 2001–2018 (Stratton Garvin et al 2022a). This work builds on an earlier study that examined specific augmentation effects on water temperature (Stratton Garvin and Rounds 2022). This study's results showed that in July 2015, "the length of Willamette River within the study area classified as lethal for juvenile Chinook salmon would have been reduced by 6 to 8 percent using flow augmentation . . . and [augmentation would have] reduced the upstream extent of lethal conditions in early July and August of 2015, the most extreme hydroclimatological year in the study." Many UWR Chinook salmon spawners in 2015 had moved upstream into tributaries by July, with 80 percent having passed Willamette Falls by the end of May, when temperatures at Salem had reached lethal levels. Adult UWR Chinook salmon that would benefit are late spawners, and prior to the augmented flows, were likely exposed to higher temperatures. The pulses would likely reduce their risk of mortality relatively little. USACE did not propose to monitor UWR Chinook responses to the augmented flows, rather using temperature changes. The proposed program is inadequate to provide appropriate temperatures when most adult UWR Chinook spawners could benefit, and is at the cost of earlier flows when they are more likely to be in the river.

The proposed action would entail releasing pulses for temperature management after water temperature 7dADM is 64ºF (17.8ºC) in April–May and air temperature forecast is for 78ºF (25.5ºC) or higher. In early June, the proposed thresholds are 68ºF (20ºC) for water temperature 7dADM and 80ºF (26.7ºC) for air temperature. In late June, the proposed thresholds are 69ºF (20.6ºC) for water temperature 7dADM and 82ºF (27.8ºC) for air temperature (Table 5.7.3).

[26] The 7dADM is a calculation of the average of the daily maximum temperatures from seven consecutive days, made on a rolling basis.

Table 5.7-3 Mainstem Willamette proposed action augmented flow threshold water and air temperatures. Additional flows to augment minimum releases are proposed to lower water temperatures, when air temperatures are forecast to exceed limits. (7dADM is the 7-day average daily maximum.) Source: USACE (2024) Mainstem Willamette Minimum Flow Thresholds.

Time Period	**Target Water Temperature (7dADM)**	**Proposed Minimum Low Flow (7 day average)**	**Air Temperature Forecast range (7dADM)**	**Maximum Augmented Flow**
April-May	64ºF	8,000-12,000 cfs	83-92ºF	18,000 cfs
June 1 - 15	68ºF	8,000-10,000 cfs	89ºF	14,000 cfs
June 16 - 30	69ºF	5,500-7,000 cfs	92ºF	14,000 cfs

Similar pulses were tested during heat waves in late May and June of 2021, when lower flows and extremely high air temperatures combined to increase water temperatures above 70ºF (21°C). Results from 2021 indicate that increased flows earlier in May could have reduced water temperatures below 64ºF (17.8°C), with fish, consequently, being at less risk for temperature related stress. Later in June, augmented flow over a few days lowered the water temperatures when air temperatures spiked to record highs, which limited exposure to heat for the UWR Chinook salmon that had remained below Willamette Falls as temperatures rose to lethal levels. However, they were exposed for a longer period to warmer temperatures because of lower flows provided earlier. UWR Chinook salmon adults migrating past Willamette Falls in 2021 appeared to slow, as daily ladder counts dropped below 300 per day when the temperatures at the ladder exceeded 68ºF (20ºC) after May 18. UWR Chinook salmon counts rose again after June 12, when flows were increased and water temperatures dropped below 66ºF (19ºC) but dropped in later June when temperatures soared past 75ºF (24ºC), falling to daily ladder counts of zero going into July. The USGS 2022 study did not model nor report 2021 water temperature data, but the authors noted, "In years like 2015, when spring flows were relatively low, however, flow augmentation earlier in the year may have greater influence on stream temperatures" (Stratton-Garvin, Rounds 2022).[27]

The proposed augmentation provided a response after UWR Chinook salmon were exposed to higher water temperatures at and above the proposed 7dADM threshold while waiting for higher forecasted air temperatures, and because of lag time from dam releases to the arrival in the lower mainstem warmer areas. Proposed reductions from the minimum flows in the 2008 RPA may not be sufficiently mitigated by short-term augmentation. Other aspects of lower flows can also lead to harm or loss of critical habitat elements for which the shorter augmented flows would provide only short-term benefits. The combination of reduced flow with later releases after high water temperatures are experienced will increase PSM risk for UWR Chinook.

[27] USGS created a detailed model of flows and temperatures described for the Upper Willamette (from Salem upstream to Middle Fork Willamette River confluence, RM 185.28) and the Middle Willamette River (from Willamette Falls, RM 26.76 upstream to Salem, RM 85.50). The overall fit of the model to the temperatures at Salem (Keizer gage 14192015) was quite good (Figure 27, Table 3 in Stratton Garvin et al. 2022).

The proposed augmentation during hot and dry conditions can lower water temperatures. The triggers to release these flows depend on a high-water temperature average over 7 days, followed by high seasonal air temperature forecasts. Augmented flows are expected to lower the water temperatures as shown in validated models (Stratton-Garvin et al 2022a). However, in order to provide the augmented flows, USACE proposes lower flows in April and May that will increase refill of reservoirs. These lower spring flows would increase mainstem temperatures beyond the ideal range for migrating adult UWR Chinook. In a trial during 2021, these lower spring flows were tested and resulted in higher temperatures when adult UWR Chinook were in the lower river (April-May in Figure 5.7-4**)**. These lower flows can reduce migration signals for UWR Chinook salmon adults below Willamette Falls and induce warmer water temperatures over the weeks they are in effect and in 2021, adult UWR Chinook moved upstream slower than had been seen in earlier hot dry year (Figure 5.7-5). The augmented flows, while only for a few days, will require releases from upstream dams, which could impact the refill or spill operations. In sum, the proposed operations have uncertain benefits relative to the harm that may occur, and, because of insufficient data on UWR Chinook salmon responses, would require further research, monitoring, and evaluation (RM&E).

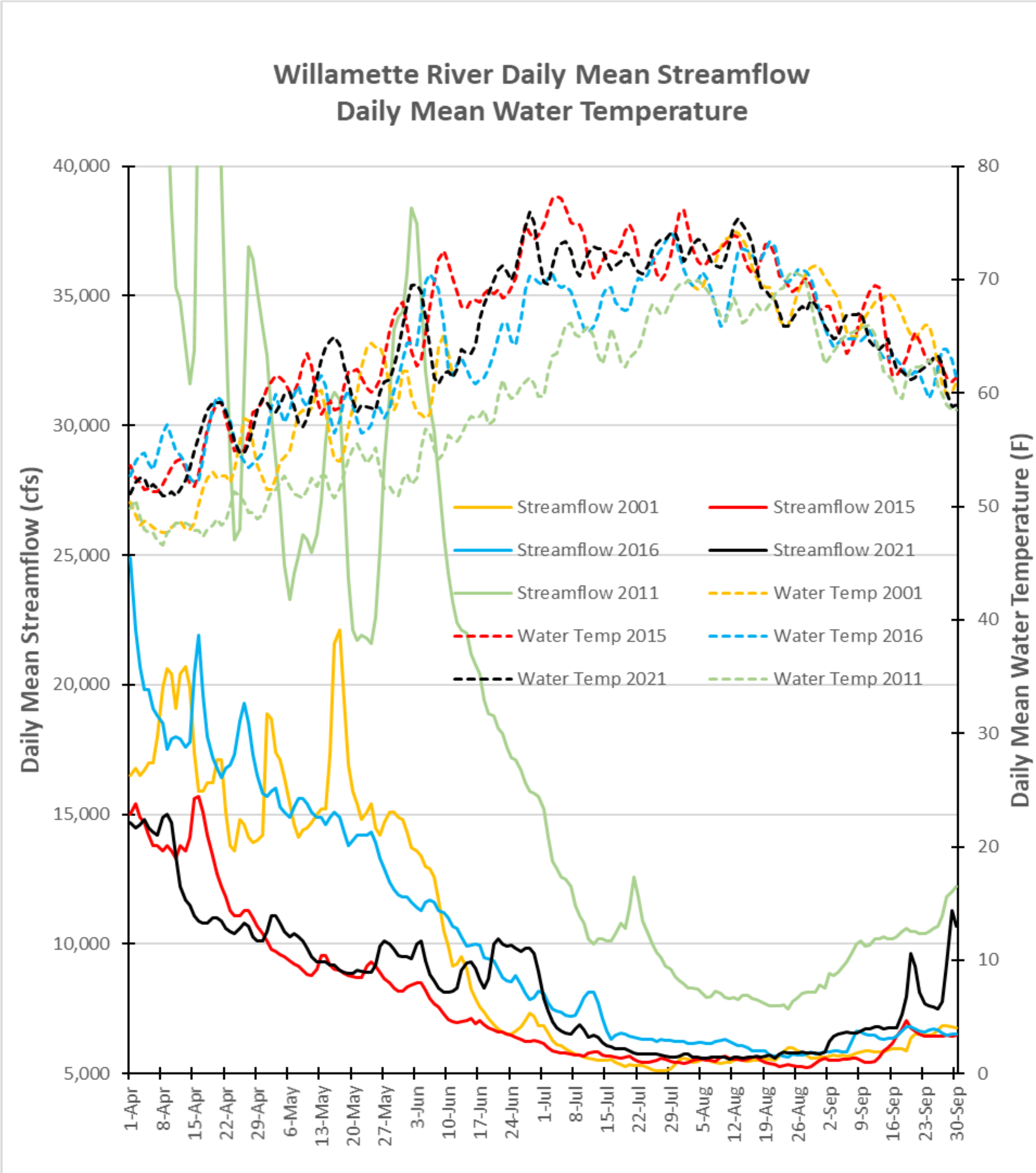


Figure 5.7-4 Daily mean streamflow and temperatures from USGS gage data for four warm or hot dry years, and one cool wet year (2011) in the last two decades had varying flows and water temperatures. 2021 and 2015 had lowest flows in the spring, up to mid-June. The 2021 and 2015 water temperatures had hotter water temperatures throughout spring and summer, as would be expected from hotter average air temperatures. In contrast, 2011 was much wetter and generally cooler until September. Source: Salem (flow) gage 14191000 and Keizer (temperature) gage 14192015

The augmented flows, although only for a few days, will require releases from upstream dams, which could impact the refill, spill, and tributary temperature operations. In sum, the proposed operations have uncertain benefits relative to the harm that may occur, because of insufficient data on UWR Chinook salmon and steelhead responses.

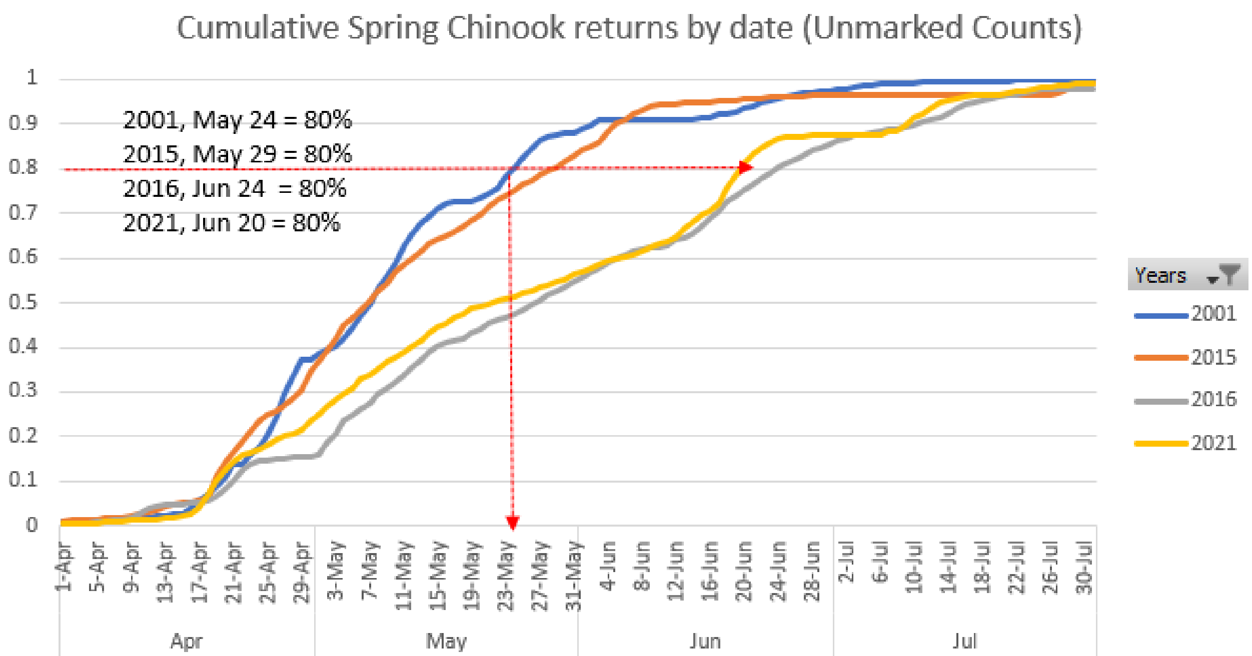


Figure 5.7-5 Cumulative percent of unmarked spring Chinook adults migrating past Willamette Falls for hot and dry years shown. In 2001 and 2015, 80% of the total run passed in May; in 2016 and 2020 80% passed 3 to 4 weeks later. For marked hatchery fish, timing was similar, with 2001 and 2015 reversed. If the 2021 migration was earlier, the Chinook would have had less exposure to May and June heat, and moved to tributaries sooner.

USACE proposes lower spring minimum flows relative to the 2008 RPA minimum objectives in years that are forecasted to have below average supply volumes. These are years that have the potential for higher risk to UWR Chinook salmon when migrating through the mainstem. The proposed flow regime would also harm UWR Chinook salmon and juvenile UWR steelhead during mainstem life-history rearing and migratory stages.

5.7.2 Effects on mainstem habitat availability and quality

Flows can determine the amount of physical habitat available to UWR Chinook salmon and UWR steelhead and the habitat quality from characteristics related to site-specific geomorphology such as velocity, depth, and slope. Lower flows resulting from a flattened hydrograph (Figure 5.7-1) persist from continued operations for flood-risk reduction, and refilling reservoirs in spring, in all below-dam reaches of the Willamette Basin. This prevents the formation and maintenance of complex habitats such as alcoves, side channels, and floodplain connections. The dams also block delivery of sediment and large wood, further simplifying downstream habitat. USACE proposed a mainstem flow regime similar to that included in the 2008 RPA but with lower spring minimum flows in below-average water-supply periods (Figure 5.7-2, Table 5.7-1). The periods of lower proposed flows are based on water-supply forecasts discussed above. These low flows will affect habitat availability and habitat quality related to temperatures, which together change habitat suitability. UWR Chinook salmon and steelhead will have lower quality and less rearing, holding, and refuge habitat. High flows are also affected by dam operations in the tributaries, with proposed actions to increase outflows during deep drawdowns in the fall with a refill period to follow in December, when high flows will be diminished until the affected reservoirs return to their respective minimum conservation pool elevations.[28]

The Oregon Department of Environmental Quality (ODEQ) reported on the use of lower Willamette River migration corridor cold-water refuge (CWR) habitat, noting: "significant knowledge gaps about use of existing CWR by adult Chinook for river mile 0–25 exist. These knowledge gaps should be addressed to inform setting specific habitat conservation and restoration priorities for CWR habitat" (ODEQ 2020).[29] Although this report was meant to address the lower river, similar efforts to improve knowledge gaps can help in higher reaches, and some efforts for juvenile habitat uses are available, as detailed below.

Numerous studies have been produced in recent years on the relationship of flow to physical habitat in the Willamette River (Hansen et al 2023, White et al 2022, Kock et al 2021). An earlier UWR Chinook salmon migration study tracked how juvenile salmon migrate and rear during different life-history stages (Schroeder et al. 2016). These authors tagged and recaptured juvenile UWR Chinook salmon over 10 years in natal tributaries and in the mainstem to identify migratory and rearing pathways. They found that peak migration of juvenile UWR Chinook salmon from the Willamette River was in June–July (subyearling smolts), March–May (yearling smolts), and November–December (autumn smolts). The fish were tagged with passive integrated transponders (PIT) tags and counted when recaptured in seine nets and when passing PIT tag detection systems in existing fish bypass facilities at Willamette Falls (Schroeder et al. 2016). Migration continued throughout the year, with numbers rising in the winter and peaking in the spring (April–June, Figure 3 in Schroeder et al. 2016). They distinguished between 'movers' that left natal streams in the first year and reared downstream and 'stayers' that migrated as autumn smolts or yearling smolts from the natal stream. The results of this large study of natural juvenile UWR Chinook salmon allowed rearing periods to be tallied separately for the mainstem and natal tributaries (Table 5.7-4). The results of this study indicate that diverse life-history strategies increase resilience to different environmental conditions, and these

[28] These include the Middle Fork Willamette, South Fork McKenzie and Middle /South Santiam rivers' passage operations, and fall-winter temperature operations on the North Santiam River.

[29] This report in response to NMFS (2015b) Biological Opinion on EPA approval of Water Temperature Standards, noted these specific gaps and research needs (among other species-specific data needs):

1. Counts or estimates are needed of the number and timing of fish of each species entering the Willamette River from the Columbia River.
2. Monitoring conducted in identified CWR areas during times the main stem temperature exceeds 18°C could positively establish fish use and abundance in CWR during warm conditions.
3. Repair and maintenance of the PIT tag antenna array in the fish way at Willamette Falls.
4. Data connecting thermal experience in the migration corridor with ultimate en-route mortality, pre-spawn mortality, or reproductive failure at the end of migration.

strategies may differ between subbasins. Hence, the diverse mainstem rearing habitat that enhances survival, and is affected by flows and temperatures, will be necessary to support the strategies used by different UWR Chinook salmon populations under different conditions. Lower releases from dams to meet lower flow targets in the mainstem will reduce the available rearing habitat for UWR Chinook salmon juveniles.

Table 5.7-4. Mean residence time (days) of juvenile UWR Chinook salmon within and downstream of natal areas in the Willamette River basin for movers (migrated as fry shortly after emergence) and stayers (remained in natal areas at least through their first summer of life). Subyearling was the dominant mover migrant type, and yearling was the dominant stayer migrant type. (From Schroeder et al. 2016, Table 2)

	Natal rearing		Downstream rearing	
Migrant type, smolt type (*n*)	Mean	SD	Mean	SD
Mover				
Subyearling (2237)	—	—	125.5	15.2
Autumn (242)	—	—	245.3	25.2
Yearling (97)	—	—	384.4	23.4
Stayer–fall migrant				
Autumn (212)	267.8	14.9	33.3	24.1
Yearling (922)	283.7	25.8	119.7	31.2
Stayer–spring migrant				
Yearling (867)	394.8	26.0	47.8	22.9

As described above, flows in the mainstem Willamette River have a strong influence on spring and summer temperatures. In addition to these effects, flows also determine the amount of habitat available to UWR Chinook salmon and UWR steelhead. The methods for measuring flow-habitat relationships can be complex, as with habitat suitability index models using common variables (e.g. depth, slope, velocity), to identify suitable habitat areas. This includes the lower resolution or one-dimensional approaches, IFIM and PHABSIM, which were provided for two Willamette tributary studies and produced habitat weighted usable area, or WUA (Gagner et al. 2014). In some cases, habitat is classified as suitable only when values of all physical variables fall within the defined range (Kock et al 2021). A research group formed an advisory group as part of the SWIFT effort (short for Science of the Willamette Instream Flows Team) and identified three ranges of acceptable conditions for juvenile UWR Chinook salmon (narrow, median, and broad) from a literature review (DeWeber and Peterson, 2020). If habitat values were within one of the ranges, a value of one was assigned, if not a value of zero, which then were combined to score areas across the parameters (Kock et al. 2021). Peterson et al (2021) extended the initial SWIFT work into structured decision making to attempt to optimize flow releases in the tributaries and mainstem. The results included multiple brood years and life-history stages to develop "four decision support models: adult Chinook salmon model, juvenile Chinook salmon model, steelhead trout adult to age-one model, and Steelhead trout smolt model." For the life-history stages below dams, the process of varying across different flows was optimized for Chinook salmon and steelhead below dams by adjusting flows in each season (not for those that spawn above, then rear and migrate below dams).

In the PA, USACE (2024) summarized the results from this work as: "The minimum flow thresholds for both wetter and drier conditions increase then from the early minimum values according to optimal hydrograph shapes determined by Peterson, Pease, et al. (2022). The results of these studies indicate that water temperature is likely driving the shape of the optimal flow regimes they identified, and driving what is the best candidate for a minimum flow." USACE's interpretation of this optimization model was that increased flows in the summer were more beneficial than the minimum flows in the spring. This leaves the UWR steelhead with lower flows when they are migrating up and down in the mainstem, as well as UWR Chinook during their early months of adult migration. More than half of out-migrating juvenile UWR Chinook salmon were observed rearing downstream of the natal river reach for several months in the spring. Reduction in habitat lowers potential productivity from these life history stages and leads to overall lower abundance.

White et al (2022) also looked at habitat availability related to flows but with higher resolution (using bathymetric lidar data sets) and included some steelhead information. They used the same habitat threshold ranges of narrow, median, or broad (Figure 5.7-6). Hansen et al (2023) tracked juvenile UWR Chinook salmon relative to these flow-habitat predictions in the mainstem and larger tributaries and provided an assessment of habitat use. In addition to conducting field studies on habitat attributes and fish presence over spring and early summer (April, June, July), they developed logistic regression functions to "produce probability-based predictions of habitat use for juvenile Chinook salmon based on water velocity and water depth" (Hansen et al 2023). The areas where they looked for habitat use included those defined as suitable by SWIFT measures and adjacent areas that did not meet the criteria used initially for the Peterson et al (2021) structured decision-making effort.

Hansen et al (2023) found larger fish in the faster, deeper water initially excluded from habitat suitability criteria. They also found smaller juvenile Chinook salmon more often in side channels in April, with observations in 71 percent of side channels observed versus 58 percent of main-channel areas (Table 4, Hansen et al 2023). In contrast, more large juvenile UWR Chinook salmon were observed in main-channel areas with faster, deeper water in June and July. A crucial point from their review is that fewer juvenile Chinook salmon were found in side channel areas overall, but during the fry life-history stage, they were using more side-channel areas. The study of those areas was limited to a few days in April 2021, a notably dry year with extreme low flows (Figures 5.7-2 and 5.7-4), so less side-channel habitat would have been available. These studies indicate smaller juvenile fish are rearing in the mainstem in April and growing to larger size, then rearing in different mainstem habitats in June and July. Flows support these variable habitats, and proposed reductions to the earlier flows will reduce the availability of suitable off-channel habitat for younger juvenile UWR Chinook salmon. Less growth prior to migrating to the estuary and ocean will lead to lower survival in first-year-ocean UWR Chinook salmon and reduced productivity.

Table 1. Range of habitat threshold for spring Chinook salmon and winter steelhead at pre-smolt and fry size classes.

[Habitat thresholds: NA denotes that the habitat criteria were not used for the specified species/size class; Inf (infinity) denotes that there is no limit on habitat criteria. Abbreviations: mm, millimeter; m, meter; m/s, meter per second; <, less than; >greater than]

Species	Size class	Hydraulic criteria	Habitat thresholds		
			Narrow	Median	Broad
Chinook salmon	Pre-smolt (>60 mm)	Depth (m)	0.046–0.686	0.05–1.07	0.046–Inf
		Velocity (m/s)	0.0–0.381	0.0–0.5	0.0–0.914
		Bed slope (degrees)	< 0.4	< 0.55	Any
	Fry (<60 mm)	Depth (m)	0.046–0.610	0.046–1.07	0.046–0.457
		Velocity (m/s)	0.0–0.152	0.0–0.381	0.0–0.457
		Bed slope (m/m)	< 0.4	< 0.55	Any
Steelhead	Pre-smolt (>60 mm)	Depth (m)	0.046–0.305	0.046–0.305	0.046–Inf
		Velocity (m/s)	0.0–0.533	0.0–0.99	0.0–1.07
		Bed slope (degrees)	NA	NA	NA
	Fry (<60 mm)	Depth (m)	0.076–0.381	0.076–0.610	0.076–1.524
		Velocity (m/s)	0.0–0.152	0.0–0.381	0.0–0.61
		Bed slope (degrees)	NA	NA	NA

Figure 5.7-6 The habitat availability model used for assessing the range of suitable habitat areas with varying flows. (Note: Chinook depths at the high end range from 2 to 3.5 feet, and for steelhead, 1 to 2 feet.) Source: White et al 2022.

White et al (2022) developed maps from high-resolution two-dimensional hydraulic models combined with habitat preferences for juvenile UWR Chinook salmon and steelhead that were in different life-history stages, fry and pre-smolt (Figure 5.7-6). Calculating available habitat at different flows, they found the relationship changed longitudinally as did temperatures, with more complex and cooler habitat upstream. They quantified the effects of streamflow on rearing habitat types. Using spatial scales matched to different mainstem geomorphic reaches, habitat estimates varied with streamflow, generally declining from upstream to downstream (although this differed by year type). Upstream from Corvallis, floodplain habitat "increases exponentially with streamflow, particularly in the two most-upstream reaches" in contrast with:

> *"considerably less floodplain habitat available downstream from Corvallis, particularly in the downstream most Newberg reach. The Salem reach is the notable exception, which has comparable amounts of floodplain habitat at the highest flows . . . concentrated at the Santiam River confluence and not representative of the larger reach . . . Newberg and Salem have small amounts of habitat located in the floodplain at low flows, which is a result of typically long and narrow channels inset into the floodplain, some of which are hydraulically connected to the primary channel at low flows."*

As they also noted, the area of geomorphic habitat units, such as side channel, floodplain, and primary channel, varied in response to the increase in flows. In their analysis, they found increasing areas for some geomorphic units, while overall modeled habitat declined with increasing flow. In the lower reaches of the Willamette River above Willamette Falls, the overall habitat that fit the model parameters of depth, velocity, and slope declined for flows between 5,000 cfs to 18,000–20,000 cfs, while the off-channel habitat area (defined as side channels and alcoves) increased for flows above 10,000 cfs. In the Salem reach, the floodplain habitat also increased with flow (Figure 5.7-7). The results for the reaches above Corvallis showed uniformly increasing overall habitat while channel features varied (not shown).

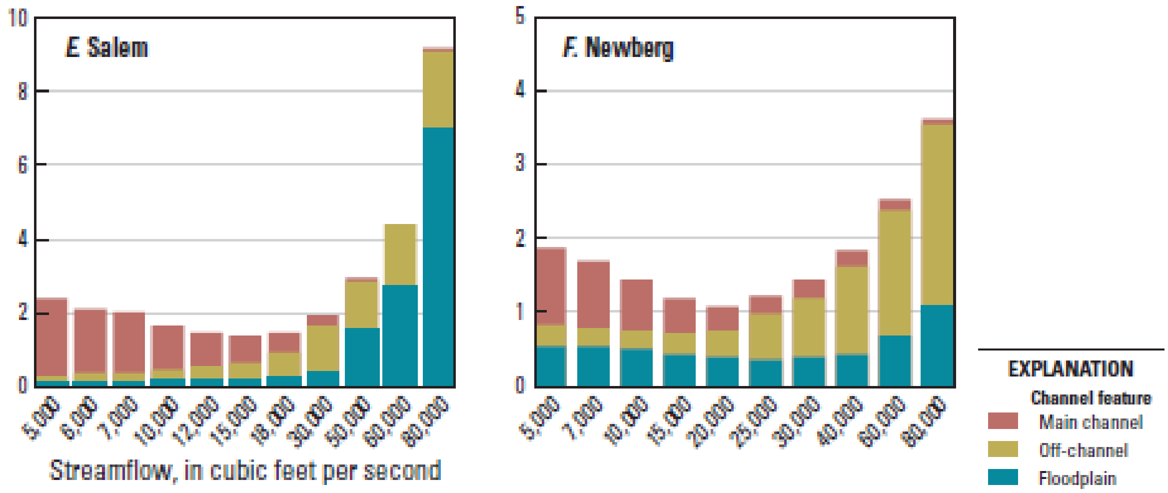


Figure 5.7-7 Overall habitat area and channel features areas (y-axis, square kilometers), change in response to streamflow (x-axis), and differences in the reaches shown; Newberg is downstream from Salem. Source: White et al (2022), figures 8e and 8f. Note scales differ on x-axis and y-axis.

The proposed April and May flows (10,000 to 12,000 cfs in lower flow years) could provide main-channel "hydraulically suitable" habitat area, however, with lower amounts of off-channel and floodplain habitat, as estimated by White et al (2022) (Figure 5.7-7). Yet, smaller juveniles rear in the spring in off-channel habitat and in floodplain habitat, which were found to grow as a fraction of the overall habitat at flows higher than 10,000 cfs (Figure 5.7-7). After growing, juveniles then use the main-channel areas where velocity and depth are greater (Schroeder et al. 2016, Hansen et al. 2023). In Figure 5.7-7, the usable main-channel areas are declining as flows increase over 5,000–7,000 cfs in the reaches near and below Salem. The different life-history stages of UWR Chinook salmon that are present at different times need both habitat types. Hansen et al 2023 showed this when they observed fry using the off-channel habitat in April and larger fish using the main channel with faster, deeper water in June and July. The flows proposed for the spring in dry years would limit the amount of off-channel habitat available to fry needed to grow into later pre-smolt and smolt stages, while the summer flows (5,000 to 7,000 cfs) provide increased main-channel habitat. The lack of off-channel habitat in spring, for rearing juvenile UWR Chinook salmon will result in reduced growth, which has been shown to reduce first-year ocean survival (Weitkamp et al. 2022). Lower survival in marine phases caused by a lack of suitable freshwater habitat will reduce abundance and productivity for all UWR Chinook salmon populations.

As the Schroeder et al. (2016) decade-plus study showed, UWR Chinook salmon juveniles use the mainstem for rearing throughout the year. The proposed flows during peak UWR Chinook salmon rearing periods will not provide sufficient habitat in the spring but are adequate in the summer. The spring reductions in flow in the proposed action create a shortfall of off-channel and floodplain habitat for rearing UWR Chinook salmon. Juvenile UWR steelhead from the upper South Santiam River were PIT-tagged in the reservoir above Foster Dam in March–May

2013 (Figure 13 in Monzyk et al. 2013). Time to detection downstream at Willamette Falls bypass array was on average 23 days (6 to 50 days range), with the last detection on May 30, 2013 (Monzyk et al. 2014). Proposed flows overlap with UWR steelhead migration in the mainstem Willamette River in April–May for both adults and juveniles. For the maximum depths considered suitable habitat (Figure 5.7-6), proposed flows that reduce off-channel habitat limit refuge from predation and increase mortality risk. The juvenile UWR steelhead in the mainstem are expected to be migrating quickly as they are generally 2-year olds, and hence, larger. Continued loss of this life-history stage will harm the productivity of the populations in the North and South Santiam rivers.

For reaches with lethal or stressful warm temperatures, the proposed flows will not provide suitable habitat for UWR Chinook salmon and steelhead. White et al. (2022) showed the temperature thresholds that were stressfully warm or lethally warm for the years 2015, 2016, and 2021 (Figure 9 A, B, C). Calculating the combination of hydraulically suitable habitat with the thermally suitable areas, they found notable changes in available habitat areas in dry years. For the 3 modeled years, "habitat area in both reaches was greatest in 2015; however, more than 90 percent of that habitat is thermally stressful (table 5; fig. 11). In contrast, total hydraulic habitat was 20 percent less in 2011 than in 2015 because of higher velocities, but 83 percent of that habitat was thermally suitable."

No areas were seen as lethally warm above Corvallis, but significant areas were seen as stressfully warm throughout most of the basin in drier years of 2015 and 2016. The McKenzie River and Middle Fork Willamette River UWR Chinook salmon populations are above Corvallis. Juveniles belonging to these populations would be able to migrate downstream as temperatures warmed up, but they would still be harmed moving into the lower river reaches where temperatures are lethally warm due in part to the proposed lower flows at Salem. Hence, off-channel habitat in upper-river reaches may be accessible but these habitats may not be sufficiently protective if stressfully warm. The harm from proposed flows in dry years to McKenzie River and Middle Fork Willamette River UWR Chinook salmon populations will lead to lower abundance and productivity

For adult UWR Chinook salmon, the overall habitat area is less crucial than the temperature, which would decrease with increased flows at lower levels during warmer periods. Off-channel habitats may provide cold-water refugia during upstream migration, although other features could limit its capacity (dissolved oxygen, found to vary in alcoves with temperatures suitable for coldwater species, leading to a squeeze in the amount of suitable depths, Barrett et al 2024). The proposed lower flows in the spring will reduce the amount of connected off-channel habitat.

Mainstem habitat is less functional when water temperature increases because of lower flows and increasing air temperatures, with corresponding reduced habitat for juvenile UWR Chinook in these periods. Recent years show highest average air temperatures in the 130-year record occurred during the months USACE has proposed lower minimum flow targets (NCEI 2024). The effects of higher water temperatures on migrating or holding UWR Chinook salmon spawners can increase the risk of prespawn mortality, and, ultimately, reduce overall productivity. Other life-history stages present during lower flows include UWR Chinook salmon subyearling and UWR Chinook salmon and steelhead yearling juvenile migrants. For UWR winter steelhead, the risk of higher temperatures is not expected to increase prespawn mortality because of their earlier run timing, although more than 15 percent of the adult UWR steelhead returned in months with the largest proposed drop in minimum flow from the 2008 RPA minimum flow objectives (Figure 5.7-2, Table 5.7-1).

UWR winter steelhead juveniles are at risk of temperature-related disease, as research has shown that the probability of a smolt returning as an adult is reduced when water temperatures exceed 59°F (15°C) during outmigration (WRI 2004, Kocan et al. 2009), and that threshold was crossed during low flows as early as late April in 2015, 2016, and 2021. Higher temperatures from proposed spring flows will affect their migration success, and reduced survival will lead to lower UWR steelhead productivity.

The effects of lower flows and higher water temperatures caused by the proposed action on migrating or holding UWR Chinook salmon spawners can increase the risk of prespawn mortality, and, ultimately, reduce overall productivity. Other life-history stages present during low flows include subyearling and yearling UWR Chinook salmon. The proposed flows in spring will remove off-channel and floodplain access as shown in above studies, affecting the growth and survival of the younger juvenile UWR Chinook salmon. For UWR winter steelhead, because of limited rearing in the mainstem, the risk of higher temperatures is not expected to have as great of an impact on them, although they migrate when temperatures can be warm enough to add to disease risk. Overall, lower flows causing temperature increases and reduced off-channel habitat will lead to reduced spawning success and lower productivity and abundance for UWR Chinook salmon. Further, for UWR Chinook salmon rearing and both UWR Chinook salmon and steelhead migrating juveniles in the mainstem, loss of specific habitat features that provide optimal conditions will reduce survival and productivity.

In summary, the proposed action in the Willamette River mainstem will cause:

- Increased prespawner mortality for UWR Chinook salmon
- Decreased growth and survival for rearing juvenile UWR Chinook salmon
- Reduced connectivity and suitability of off-channel habitat
- Increased disease susceptibility for UWR steelhead
- Fewer available habitat areas for refuge during juvenile UWR steelhead migration.
- Reduced channel complexity, transport of sediment and large wood from a flattened hydrograph

5.7.3 Effects on Critical Habitat

Designated critical habitat within the action area for the ESA-listed UWR Chinook salmon and steelhead in the mainstem Willamette River consists of freshwater rearing sites and freshwater migration corridors and their essential physical and biological features (PBFs), described in the Rangewide Status of the Species and Critical Habitat.

PBF 1. Freshwater rearing sites

a. Water quantity. Flow-related temperature increases, reduced habitat availability, and reduced habitat connectivity result from proposed minimum flows in February–June. Habitat-forming spring and winter flows are also reduced by flood-risk-reduction reservoir operations. This limits the creation of complex channels and the connectivity to the floodplain features used by rearing juveniles and during higher flows by both adult and juveniles.
b. Water quality. Higher temperatures during migration rearing in spring under proposed flows is paired with fewer areas to find refuge because of reduced complexity from lower flows. Areas that would be formed and connected annually are lacking, and less coarse sediment is transported, with loss of hyporheic zone functionality affecting temperature and dissolved oxygen.
c. Floodplain connectivity. Lower minimum flows proposed in spring, lower flows in autumn through spring post-drawdown refill, and lower flows for flood-risk reduction will reduce floodplain connectivity and increase the likelihood of 'single channel' habitat becoming prevalent.
d. Natural cover. The flood-risk-reduction operations and winter post-drawdown reservoir refills, along with proposed low minimum spring flows, restrict movement of large wood from above the dams through tributaries. Where simplified single-channel habitat dominates, riparian forests are reduced and disconnected along with features such as shade, refuge, and cover from predators.

PBF 2. Freshwater migration corridors

a. Free passage. Excessive mortality of adult Chinook salmon during migration and holding in the mainstem results from exposure to reaches that are at higher temperatures. Juveniles will migrate at different times and may experience reduced growth rates if feeding is disrupted because of a lack of connectivity or availability of suitable habitat, leading to exposure to stressfully or lethally warm reaches.
b. Water quantity. Similar to above in PBF 1.
c. Water quality. Similar to above in PBF 1.
d. Forage. Refuge and feeding are linked to habitat complexity and floodplain connectivity. Dam operations during post-drawdown reservoir refill, flood risk reduction, and low minimum spring flows removes large wood and coarse sediment, which are habitat elements that increase the diversity and abundance of macroinvertebrate prey.
e. Natural cover. Similar to above in PBF 1.

5.8 Clackamas/Molalla/Calapooia Effects

The three rivers in this section do not have USACE dams; all have revetments USACE proposes to maintain. Under the Proposed Action, operation of the USACE dams on upstream tributaries for flood risk management and to refill during the conservation seasons will continue to affect these rivers' confluence areas. Operations of the WVS dams upstream in the basin store sediment and large wood in the reservoirs, prevent recruitment of large wood and sediment from streambanks, stabilize formerly active bar surfaces, and diminish high flows that might otherwise be capable of creating new bars, side channels, and pools in their mainstem confluence areas and lower reaches. This would result in reduced amount and the quality of habitat for juvenile UWR Chinook salmon and steelhead that rear in lower reaches of these rivers. The reduced extent of riparian vegetation and lack of floodplain connectivity hinders recruitment of large wood into the aquatic system and reduces off-channel refugia, both habitat features needed to create resting pools for migrating adults and provide cover for rearing juveniles.

Aside from the potential habitat restoration noted below or unspecified restoration actions that may result from the BPA HTT funding, the Action Agencies do not propose any measures that would restore large wood, sediment, and channel complexity in the confluence of these rivers.

Another USACE proposed action is to maintain individual revetments when necessary and funded for bank protection. USACE proposes to maintain or repair revetments using more natural materials and nature-based engineering principles within the purpose of the project. These Congressionally authorized revetments are part of the environmental baseline. The effects of the repairs to the revetments from short-term construction impacts are covered in Section 5.1.9, General Effects of In- and Near-Water Construction. The effects of alterations to revetments that allow for increased access to off-channel habitats would be improved rearing conditions with velocity, depth, and prey base suitable for juvenile UWR Chinook salmon and steelhead. Specific mileage for revetments in each of the three rivers is included below.

5.8.1 Clackamas River

The Clackamas River confluence is 1.7 miles below Willamette Falls, and so can be affected by changes in flows from the upper Willamette River, during low flow periods. The proposed low minimum Willamette River mainstem flows will lower the total flow at the confluence with the Clackamas River which will affect adult holding and juvenile rearing for UWR Chinook and steelhead. This area is important in years with high water temperatures, as UWR Chinook adults for which the Clackamas is not their natal river will move up and hold to avoid the warmer temperatures (ODEQ 2020). In addition, the spawners from this sub-basin that are migrating into the Clackamas River must pass through the lower warmer flows at the confluence to get to better habitat above it.

The Proposed Action includes no hatchery programs in the Clackamas subbasin, but adult salmon and steelhead of hatchery origin from USACE programs upstream of Willamette Falls may stray into the natural spawning areas of the UWR Chinook salmon and LCR steelhead populations in the subbasin. This is more likely to occur under high water temperatures, such as was seen in the 2015 heat wave, as the Clackamas River is often 1-2°C cooler than the mainstem Willamette River (ODEQ 2020, Figure 3-11, USACE 2016, Figure 5-5, and USGS gage 14211010). To the degree that this occurs and that the stray hatchery origin spawners are successful at spawning in the wild, such straying would likely have a small, adverse effect on the abundance and productivity of the UWR Chinook Clackamas River population.

The USACE proposes to maintain 1.6 miles of revetments it has constructed along the lower Clackamas River between river miles (RMs) 1.5 to 20.1. As noted above, USACE proposes to maintain these with more natural materials and nature-based engineering principles. In so doing, alterations to revetments that allow for increased access to off-channel habitats would improve rearing conditions for UWR Chinook and other listed ESA salmonid species that are in this basin with velocity, depth, and prey base suitable for juvenile rearing habitat.

5.8.2 Molalla River

The Molalla River has one of the four UWR steelhead populations in the DPS, and one of seven for UWR Chinook salmon populations. The effects of the Proposed Action on Molalla populations of UWR Chinook salmon and UWR steelhead would be relatively small. The effects of the proposed actions to further flatten the mainstem Willamette River hydrograph reducing high flows at the confluence could cause minor reduction in abundance and productivity. USACE constructed 5.07 miles of revetments along streambanks in the Molalla subbasin; they propose to maintain these with more natural materials and nature-based engineering principles. In so doing, alterations to revetments that allow for increased access to off-channel habitats would improve rearing conditions for UWR Chinook and other listed ESA salmonid species that are in this basin with velocity, depth, and prey base suitable for juvenile rearing habitat.

Habitat restoration actions that may result from funding under the BPA Technical Assistance grant would improve conditions in the confluence area, as the intent of these grants is to assist restoration practitioners in final design and implementing river restoration actions. The proposed action may result in similar activities that provide biological uplift just as BPA's 2021 grant funding issued to the Molalla Riverkeepers to complete the permitting and final design, and provide outreach for the Molalla Confluence Floodplain Restoration Design.

The majority of the Chinook salmon spawning in the Molalla are of hatchery origin (NMFS 2019a). Naturally spawning hatchery fish may be providing a demographic boost to the population; although genetic pedigree analyses of natural production has not occurred in the Molalla River. There is more risk from low population abundance than hatchery induced selection (NMFS 2019a). The hatchery mitigation program is proposed to continue until changes described for review by NMFS and ODFW (Section 5.1 Basinwide Effects).

5.8.3 Calapooia

The Calapooia River has one of the four UWR steelhead populations, and is the southernmost population of the ESA-listed UWR steelhead DPS. As well, there is one of the seven UWR Chinook salmon populations in this river.

The effects of the proposed action to further flatten the mainstem Willamette River hydrograph reducing high flows at the confluence could cause minor reduction in abundance and productivity. USACE constructed approximately 1 mile of revetments along streambanks in the Calapooia subbasin; they propose to maintain these with more natural materials and nature-based engineering principles. In so doing, alterations to revetments that allow for increased access to off-channel habitats would improve rearing conditions for UWR Chinook salmon and steelhead in this basin with velocity, depth, and prey base suitable for juvenile rearing habitat.

Habitat restoration actions that will result from funding under the BPA Habitat Technical Team funding would improve conditions in the confluence area. The BPA 2024 HTT program granted funds to the Calapooia Watershed Council for the Albany Oxbows Floodplain & Habitat Restoration project (Whiting 2024). The applicants state that the project will breach berms in several locations to allow flow into the floodplain area within the oxbow lakes and to redistribute berm materials within the existing floodplain. As one technical reviewer noted this has the potential to increase inundation timing and duration, so could potentially increase physical habitat for juvenile UWR Chinook salmon at moderate to high flows. This will benefit the Calapooia River UWR Chinook population primarily, and with its location in the confluence area, could benefit other juvenile UWR Chinook populations for rearing at those higher flows. The applicants received funds for two technical assistance grants which led to this project's readiness for implementation. The ongoing proposed action of BPA funding the HTT program will continue to ensure there are changes in areas such as this anchor habitat to benefit rearing UWR Chinook, although significantly more floodplain areas remain disconnected (see Section 5.1 Basinwide Effects).

5.8.4 Effects on Critical Habitat

Designated critical habitat within the action area for the ESA-listed UWR Chinook salmon and steelhead in the mainstem Willamette River consists of freshwater rearing sites and freshwater migration corridors and their essential physical and biological features (PBFs), described in the Rangewide Status of the Species and Critical Habitat.

The mainstem of the Molalla River and Calapooia River and many of their tributaries have been designated as Critical Habitat for UWR Chinook salmon and steelhead. The mainstem Clackamas River and many of its tributaries have been designated as Critical Habitat for UWR Chinook salmon, LCR Chinook salmon, LCR coho salmon, and LCR steelhead.

For freshwater, spawning, rearing, and migration sites there is a minor effect from maintenance of revetments and lower mainstem Willamette River flows, by reducing floodplain connectivity, and limiting the riparian vegetation and stream processes that enable formation of complex habitats and deep pools. The lack of these contribute to elevated summer water temperatures, particularly in the lower part of the watersheds or confluences. Habitat restoration projects that could provide access to off-channel habitat, and improve conditions in the lower rivers would reduce these impacts.

5.9 Effects of the Willamette Valley System Proposed Actions on the Lower Columbia River, Estuary [and Plume]

This section considers the effects of the Proposed Action on listed fish and fish habitat characteristics in the lower Columbia River and estuary, from the confluence of the Willamette

River near Portland, Oregon, (Columbia RM 100) to the mouth and in coastal areas occupied by Southern Resident killer whales influenced by Willamette Project operations (i.e., within the Columbia River plume). All of the salmonid populations and ESUs/DPSs considered in this Opinion use these Columbir River reaches to varying extents for parts of their life cycles.

The Proposed Action (USACE 2024a) includes the continued operation and maintenance of the existing configuration of 13 WVS dam operations in major tributaries of the Willamette River, contracts issued by Bureau of Reclamation for withdrawal of water released from storage for irrigation use, hatchery-produced anadromous salmonids, including spring Chinook and summer steelhead from the Willamette Hatchery program, that pass through the lower Columbia River and estuary as juveniles and adults.

The proposed action effects would be from the following:

Water quantity from flow management: WVS dam operations deliver a range of flows, including proposed new minimum spring-through-fall flow objectives. Flood-risk reduction as a primary purpose of these dams also captures high flows during all months of the year, although less so during the conservation season. The conservation season is approximately from March through October, including the filling season (spring) and the release season (summer). For these months, USACE releases flows to meet minimum levels in the mainstem Willamette at Salem. These overlap with the diversions of flows for irrigation, including those that are contracted by Bureau of Reclamation from storage volumes in the WVS reservoirs.

Hatchery Releases: As described in the baseline, Upper Willamette River (UWR) Chinook hatchery production is a large portion of adult returns (65-85% since 2019) of the UWR Chinook ESU These releases have effects on the Columbia River ESU/DPSs and the Southern Resident killer whales

5.9.1 Water Quantity and Habitat Effects

The Proposed Action would continue to reduce average monthly Columbia River flows below the Willamette confluence in some months, with an estimate of less than 1%, in average flows (USACE 2023a). However, during low flow years, the proposed action includes a reduction in the minimum flows released, based on a review of the Northwest River Forecast Center daily water volume supply forecast, relative to the 30-year normal (NWRFC 2024a) as shown in proposed action (USACE 2024a, Table 2.3-3. Mainstem Minimum Flow Thresholds). More details of this change in minimum flows are in Section 5.7 Mainstem Willamette Flow Effects, in particular Table 5.7-1. Briefly, when volume forecasts are 80% to 100% of the 30-Year Average, results in reductions of minimum flows compared to existing 2008 RPA minimum flows (NMFS 2008a) of 2,000 to 3,000 cfs or 13-16% in April and May. If the volume forecast is less than 80% of the 30-Year Average, the reduction from current 2008 RPA minimum flows would be greater, 3,000 to 5,000, or 20-33% in April, May and the first half of June. Generally, these months have higher flows in the Columbia River, although shifts in snowmelt are changing this pattern. For the spring freshet, runoff peaks in the spring and early summer, and has aided transit to the estuary and ocean for juvenile salmon and steelhead. Columbia Basin dams including those in the WVS, alter this flow regime by holding water in reservoirs, and reduce the volume and velocity of the spring flow; predicted shifts from climate change include less snow and more rain during winter months, resulting in a smaller snowpack, earlier spring runoff, and lower summer river flows (NWPCC 2024, https://www.nwcouncil.org/reports/columbia-river-history/climate/).

In the Mainstem Effects section, Figure 5.7-3, shows recent dry (2015, 2021), and 'average' (2016) years water supply volumes for April to September for the Willamette are shown, with forecast and actual volumes well below the 30-year average. These years were also drier than normal for the Columbia River at Bonneville, with volumes observed percent of the normal 30-year average in 2015 only 65%, for 2016, 89%, and for 2021, 81% during April-July (NWRFC 2024b). When the proposed lower releases coincide with the lower flows from below average volumes in the Columbia, as in 2015, the effects of the proposed minimum flow will be around 3% (for 5,000 cfs drop from WVS when Columbia River spring flows are around 150,000 cfs as was seen in 2015). This small total change in flows from the WVS are likely to have only a slight to negligible effect on travel time and susceptibility to predators for spring migrating juvenile UWR Chinook, UWR steelhead, LCR coho, CR chum, UCR spring Chinook, SR spring/summer Chinook, SR sockeye salmon, LCR steelhead, MCR steelhead, UCR steelhead, and SR steelhead. In average or higher years, the reductions of Willamette River flows during refill are likely to have a negligible effect in terms of increased travel time for these species.

Another effect is flow-dependent habitat elements. Lower flows can disconnect off-channel habitat, and leave fewer areas for refuge during juvenile migration. The lower hydrograph that results will reduce channel complexity, and the transport of sediment and large wood, although this would have a very small negative effect from materials trapped in WVS reservoirs to the mainstem lower Columbia. As noted in the basinwide section, peak bed-material flux was estimated downstream of the Santiam River confluence, to decrease from 199,000 tonnes/year without dams to 72,000 tonnes/year with dams (O'Connor et al 2014). Most of this would have been deposited in the Willamette tributaries and mainstem above the dam, but some fraction of unknown size would have also been transported to the Columbia at higher flows. This habitat-related loss continues with the flood risk reduction and refill operations, but is expected to be lower than other mining and dredging activities in the Columbia River but with a small percent reduction.

When the proposed flow reductions from the Willamette change habitat elements from the confluence with the Columbia River and reaches downstream, the effects on the Columbia River species will be modulated by their migration timing and use of habitat where flows affect availability or quality. The stock composition of subyearling Chinook salmon was examined by genetic identification methods for Chinook salmon found in floodplain wetland and mainstem habitats of the lower Willamette River (Teel et al 2009). They found that lower Columbia River populations were present in both wetland (17%) and river (16%) samples in spring 2005, and subyearlings from summer-fall-run populations in the middle and upper Columbia River contributed to spring wetland samples in 2006 (26%). For species using these areas of the

Willamette River and confluence, effects will be more pronounced during dry years, when the lower flows combine with reduced runoff in the Columbia River.

5.9.2 Hatchery Effects

The Chinook hatchery production can affect the Columbia River species through competition, or from predation shifts to the UWR Chinook salmon juveniles. Some evidence of possible density-dependent effects on salmon and steelhead growth and survival has been shown, although the competition factor with hatchery-origin fish remains poorly understood. An alternative mechanism suggested by Nickelson (2003) was that predators attracted to large aggregations of hatchery fish could make natural-origin fish in the same area more susceptible to piscivorous fish, birds, and mammals. In the proposed action the WVS hatcheries funded by the USACE would have reduced outplanting, when future returns have cohort replacement rates (CRR) equal to one or greater (see Basinwide Effects, section 5.1) for three cohorts. While most of the cohorts studied have had much lower than one values, the potential for reductions in hatchery outplanting may reduce the total number of UWR Chinook in the Columbia until the CRRs for returning natural origin fish rise during the period of reduced hatchery outplanting , as is expected.

In summary, the habitat and hatchery effects of the reduced flows are:

- Reduced connectivity and suitability of off-channel habitat, and fewer areas for refuge during juvenile migration.
- Reduced channel complexity, transport of sediment and large wood.
- Slightly increasing travel time and susceptibility to predators for spring migrating juvenile in the Columbia River.
- Potential competition of natural-origin Chinook with UWR Chinook hatchery-origin fish.
- Reduced total UWR Chinook in the Columbia when cohort replacement rates are near one, and hatchery outplanting is reduced.

5.9.3 Effects on Critical Habitat to Columbia River Species

As noted above, there would be slight to negligible effects on the functioning of habitat elements that correspond to PBFs of critical habitat (water quantity, water quantity, water quality, passage, forage, and natural cover) in this part of the action area.

5.9.4 Effects to Southern Resident Killer Whales and Critical Habitat

In this analysis, NMFS considers effects of the proposed action on the Southern Residents by qualitatively evaluating the reduction of prey availability caused by the action. The best available information indicates that salmon are the primary prey of Southern Residents throughout the year and that the whales predominantly consume Chinook salmon. UWR steelhead likely make up only a small part of their diet, therefore this section focuses on the effects of the proposed action on the availability of their primary prey, Chinook salmon, in the action area. Based on spatial and temporal overlap analyses, UWR Chinook salmon are available to Southern Residents in the whales' designated critical habitat found in the outer coastal range during the late winter and early spring. However, at current UWR Chinook salmon run sizes (and possibly due to low sample sizes in SRKW diet studies), there is little evidence that they make up a significant proportion of the SRKW diet (Hanson et al. 2021; NMFS and WDFW 2018). Lower Columbia River spring Chinook salmon ESU populations, which follow similar migration timing and routes, were estimated to make up 17.5% of their mid-winter and early spring diet composition. This means that given their spatio-temporal overlap with SRKWs, the UWR Chinook salmon populations have the potential to contribute to their diet more significantly once recovered to higher abundances. The proposed action has the potential to affect Southern Residents indirectly by reducing availability and inhibiting recovery of Chinook salmon, but is unlikely to result in take due to UWR Chinook making up a very minimal proportion of their overall diet.

Short-Term and Long-Term Effects on Southern Residents

The lack of safe and effective downstream passage at 10 of the 13 WVS dam projects prevent adult Chinook salmon from volitionally accessing a large proportion of historical spawning and rearing habitat in four sub-basins as described under the environmental baseline. The Big Cliff and Detroit dams block access to 43 percent of historical habitat overall, and 71% of historical spawning habitat for Chinook salmon in the North Santiam subbasin; Foster and Green Peter dams block access to 40 percent of historically available habitat in the South Santiam for Chinook and up to 85% of historical spawning habitat; Cougar Dam blocks access to 9 percent of historically available habitat for Chinook salmon in the South Fork McKenzie and 25% of historical spawning habitat; and the four WVS dams in the Middle Fork Willamette block access to over 70 percent of historical Chinook salmon habitat in that subbasin, including 95% of the historical spawning habitat (ODFW and NMFS 2011). Until downstream passage conditions are improved, and adult reintroduction programs are more fully established, the potential size of these populations will be substantially limited; including 3 of the 4 populations identified as core ESU populations by the Recovery Plan (ODFW and NMFS 2011).

Upper Willamette River Chinook salmon generally have suffered substantial population declines. Historic returns have been estimated to be near 300,000; at the time of listing (1999), natural-origin returns to populations in the most affected basins were near 30,000; and now, just 25 years later, total returns to those basins combined are less than 5,000. Until downstream passage is improved, the proposed action will continue to hold production to numbers that are low and likely to get lower since habitat and water quality downstream of the WVS projects in these four sub-basins is reasonably certain to continue to degrade.

This proposed action affects four of the five major Chinook salmon populations remaining in the UWR Chinook salmon ESU, including three of four core populations and the one genetic legacy population (ODFW and NMFS 2011). Given the current declining status of all four affected populations, the survival and recovery of each one is essential to the survival and recovery of the UWR Chinook salmon ESU. The continued delay in providing safe and effective downstream passage in the four major affected sub-basins is expected to reduce the likelihood that these populations will achieve viability, due to reduced abundance and productivity of UWR Chinook salmon ESU. The proposed action will continue to limit natural-origin population production until downstream passage solutions are implemented, and until then, climate change effects could further reduce the size of these natural-origin populations. As described above in the section on effects on UWR Chinook salmon, the historical spawning habitat below the WVS projects is not sufficient to produce the numbers of fish needed to achieve a viable population, and these habitats may continue to warm and degrade with continued climate change and population growth. Hatchery programs, which account for a large portion of the production (65-85% of adult returns since 2019) of this ESU, may provide a short-term buffer, but it is uncertain whether hatchery-only stocks could be sustained indefinitely. On the other hand, if downstream passage solutions are found and implemented prior to further population decreases, and natural-origin adult returns begin to improve, there is the possibility that these improvements would be offset by a reduction in hatchery production (under the proposed action's hatchery measure).

Assuming that downstream fish passage facilities are constructed according to the timeline presented in the proposed action, it would be another 10 years until some improvements are made to the South Santiam sub-basin (2033), another 12 years for the North Santiam downstream passage facilities (2036), another 18 years for improvements to passage at Cougar Dam in the McKenzie and another 20 years until downstream passage facilities are complete in the Middle Fork Willamette sub-basin. And this does not account for the time that may be needed to adjust and optimize the performance of the new passage structures in order to reach effective levels of fish guidance efficiencies and survival rates. In this time period, these Chinook salmon populations are at risk of further decline and possibly at risk of reaching levels that are incapable of recovery due to climate change, poor habitat quality downstream of the dams, and poor passage survival for naturally-produced Chinook above the dams.

However, based on the best available data, the UWR Chinook salmon are not currently an important part of the whales' diet. Hanson et al. (2021) did not detect UWR Chinook salmon DNA in their samples, but their sample size was relatively small. Although UWR Chinook salmon have not been detected in the diet of SRKWs, the spatial and temporal overlap between the whales and expected migration timing of the ESU suggest that they are a potential prey for SRKWs during this important time. This is a time of presumed prey limitation for SRKWs, given that the diet is more diversified during this time (Hanson et al. 2021) and SRKWs appear in worse body condition as compared to the late summer/fall season (Fearnbach et al. 2020).

The potential contribution of UWR Chinook salmon to the SRKW diet can be estimated in terms of possible UWR Chinook salmon returns to the mouth of the Lower Columbia River, which would be an approximated number of UWR Chinook salmon located within the SRKW late-winter/ early spring habitat. If the recent five-year average annual total of adult Chinook salmon returns to Willamette Falls is 29,000, and lower Willamette Fisheries is estimated to impact 15% of returns to the mouth of the Willamette (34,117), and lower Columbia commercial and recreational fisheries are estimated to impact 4% of returns to the mouth of the Columbia, then the recent 5-year-average total adult UWR Chinook salmon return to the mouth of the Columbia would be about 35,539. An estimated 1,194,594 Chinook salmon were present in the Washington and Oregon coastal region in recent late winter/ spring seasons (NMFS 2024d). Therefore, estimated UWR Chinook salmon adult returns to the mouth of the Columbia River would make up less than 3% of this total coastal zone abundance.

The weakened UWR Chinook salmon ESU's demographic structure, with declines in abundance, spatial structure, and diversity, will result in a long-term suppression, if not future decline, in UWR Chinook salmon's small contribution to the Southern Resident Killer Whale diet. This has the potential to affect SRKW's in the following ways: fewer populations contributing to Southern Residents' prey base; reduced diversity in life histories, spatial structure, and resiliency of their prey base; greater ESU-level risk relative to stochastic events, and diminished redundancy that is otherwise necessary to ensure there a margin of safety for the salmon and Southern Residents to withstand catastrophic events.

In summary, the proposed action, in the long term, would have the adverse effect of reducing what is currently a very small percentage of Chinook salmon thought to be available to the Southern Residents during a critical time of year. Given the small percentage of they prey base that is made up of UWR Chinook, not take is estimated for SRKW as result of the proposed action. Assuming that the total number of UWR Chinook salmon adults in the ocean will not increase under the proposed action, at least until structural improvements are complete, and is likely to continue trending downward, the long-term effect to Southern Resident Killer Whales is likely to be negative, but minimal. Other Chinook salmon stocks affected by the proposed action have also been found to contribute to the SRKW diet at a critical time of year (LCR Chinook salmon, SR spring and fall Chinook salmon, UCR Chinook salmon), but the very minor effect of the proposed action on these other Chinook salmon stocks is not likely to affect their population abundances. For this reason, these other Columbia River ESA-listed Chinook salmon groups were not considered in this analysis.

Southern Resident Killer Whale Critical Habitat

NMFS published the final rule designating critical habitat for Southern Residents on November 29, 2006 (71 FR 69054). Critical habitat includes about 2,560 square miles of inland waters including Puget Sound, but does not include areas with water less than 20 feet deep relative to extreme high water. The PBFs of Southern Residents critical habitat are: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging.

In September 2021, NMFS revised the critical habitat designation for the SRKW DPS by designating six additional coastal critical habitat areas along the U.S. West Coast (86 FR 41668, August 2, 2021). The revision added to the existing critical habitat approximately 15,910 square miles of marine waters between the 6.1-meter and 200-meter depth contours from the U.S.-Canada border to Point Sur, California. The same physical or biological essential features listed above were identified for coastal critical habitat, and each coastal area contains all three physical or biological essential features identified in the 2006 designation. SRKW critical habitat areas do not overlap with the action area of this specific proposed action; however, species affected by the proposed action spend a significant proportion of their lives in the SRKW critical habitat area and are considered to be a component of the SRKW prey base.

Sufficient quantity, quality and availability of prey are an essential feature of the critical habitat designated for Southern Residents. Increasing the risk of a permanent reduction in the quantity and availability of prey and the likelihood for local depletions in prey in particular locations and times reduce the conservation value of critical habitat for Southern Residents.

The proposed action would not have any effect on marine water quality or passage of Southern Residents but may reduce the quantity of prey available to SRKW to a minimial degree, given the small percentage of their diet that is comprised of UWR Chinook and UWR steelhead. The previous discussion of the effects on Southern Residents as a result of decreased prey availability is also relevant to effects on the prey feature of critical habitat. As described previously, project operations would reduce the small fraction of UWR Chinook that make up the overall SRKW diet. This reduction does not result in take of SRKW based on the the small poroportion of adverse effect likely to accrue to individual and the species as a result of the proposed action.

5.10 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation [50 CFR 402.02]. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

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 *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline and Integration and Synthesis sections of this Opinion.

Non-federal actions that are likely to occur within the reasonably foreseeable future within the action area, include but are not limited to, continued population growth, which increases demand on municipal and agricultural water supplies as well as other extractive resources such as timber and land. Increasing populations with the Columbia Basin, which includes the Willamette Basin, will result in expanded urbanization and all attributes necessary to support urban growth such as increased housing, expanded transportation systems and road infrastructure, and upscaled utility systems, all of which are associated with various environmental impacts that cumulatively degrade critical habitat and could impact individual UWR Chinook salmon and UWR steelhead. In-water work associated with private doc replacements, small and medium dredging activities for vessel access, pile driving, and shoreline armoring are all activities that NMFS expects to continue within the Willamette Branch and along the Lower Columbia River corridor. Additionally, population growth will continue to contribute to continued and expanded use of these and natural resources, which regardless of regenerative potential, are likely to contribute to the level of environmental stress already present for UWR Chinook salmon and UWR steelhead.

State and Private Lands Forest Management

State-sponsored activities such as land and forest management will continue. The Oregon Department of Forestry (ODF) will continue forestry practices, while the Department of State Lands will continue to manage state lands and impacts thereof according to state regulations. Some of these activities include some level of offset for adverse effects on the riparian environment; or other habitat restoration efforts to conserve aquatic habitat within the action area.

State Hatchery Management

ODFW carries out many non-federal actions related to hatchery production of fish, such as rainbow trout, to optimize recreational fishing opportunities for anglers. ODFW outplants hatchery fish according to Hatchery Genetic Management Plans intended to reduce genetic introgression and minimize habitat competition with ESA-listed salmonid species including UWR Chinook salmon and UWR steelhead. Improvements to hatchery programs are likely to continue to benefit the ESA-listed species covered under this opinion, and it is likely that improvements will continue to be made as the state of hatchery science improves and more data on the effects of hatchery out planting is collected.

Wildfires

Wildfires within the Willamette Basin are occurring with more frequency and severity than in previous decades. In 2020, three major fires directly impacted the action area for this proposed action. These fires and their impacts are summarized below. Wildfire events similar to these are likely to increase in frequency and severity in the future given the effects of climate change; however, there is not to predict how many or how often such fires will occur in the future. Activities such as hazard tree removal, riparian tree tipping (tipping burned trees into streams to create fish habitat), and replaning efforts are typical post fire actions that occur on the landscape in response to wildfires. NMFS anticipates those activities would continue for future fire events and are likely to occur within the action area, specifically within riparian areas containing designated critical habitat of ESA-listed salmonids.

The Beachie Creek Fire heavily impacted several communities in the North Fork Santiam River and Little North Fork River drainage including Jawbone Flats, Elkhorn, Gates, Mill City, and Lyons/Mehama. Highly valued natural and cultural resources were also threatened or damaged (USDA 2024). The Holiday Farm Fire burned on the Willamette National Forest, Bureau of Land Management-NW Oregon, and lands protected by the Oregon Department of Forestry-South Cascade District (USDA 2024). The Lionshead Fire has heavily impacted several communities in the Santiam drainage and Breitenbush area, including the loss of 264 resident homes in Detroit. Highly valued natural and cultural resources were also threatened (USDA 2024). Impacts from these fires, including reduced riparian vegetation and increased input of fine sediment into streams, will persist for years into the future.

Fires like these exacerbate existing stressors on critical habitat for ESA-listed salmonids in the Willamette Basin by reducing shade that helps maintain cool water temperatures, increasing the risk of channel-modifying landslides, and can lead to large amounts of turbidity caused during heavy-rain events.

Habitat Restoration

Watershed councils and tribes will continue to implement habitat restoration projects on various scales benefiting critical habitat PBFs for species covered under this Opinion. Several projects within the Willamette Basin have been implemented and have demonstrated habitat benefits. For example, the Confluence Project is a stage-zero project that reconnected a large floodplain area and created resiliency during the 2020 fire season that would not have otherwise been possible in its previous constrained and channelized state. Tribes have been successful at purchasing land for conservation and have used current science to improve timberland management practices to be less impactful on ESA-listed fish species and their designated critical habitat. ODFW will also continue to carry out its work to conserve and protect the state's natural resources and will likely continue to implement or contribute to the implementation of habitat-restoration projects that may help to offset the adverse effects of population growth and urbanization.

Southern Resident Killer Whale- Focused Work

Changes in ocean use policies as a result of non-federal government action are highly uncertain and may be subject to sudden changes as political and financial situations develop. Examples of actions that may occur include development of aquaculture projects, changes to state fisheries which may alter fishing patterns, installation of aquaculture, hydrokinetic or wind energy projects near areas where SRKWs are known to occur, designation or modification of marine protected areas that include habitat or resources that are known to affect marine mammals in general, and coastal development which may alter patterns of shipping or boating traffic. However, none of these potential state, local, or private actions, can be anticipated with any reasonable certainty in the action area at this time, and most of those described as examples would likely involve federal involvement of some type given the federal government's role in regulating activity in the ocean across numerous agencies and activities.

Summary of Cumulative Effects

State, tribal, and private entities have implemented and plan to implement actions designed to improve the statuses of UWR, MCR, LCR, and SR salmon and steelhead, as well as SRKW, eulachon, humpback whales, green sturgeon, and all of their designated critical habitats. Some actions have already been implemented. Their effects to date are reflected in the current status of the species and the environmental baseline and may make further contributions to the species' survival and recovery in the future. It is likely that additional actions will be implemented as described in this section, and future benefits would accrue to the species covered under this Opinion. The future adverse effects of regional population growth, land use change, and climate change are reasonably certain to occur and would be partially mitigated by ongoing recovery efforts and Oregon's efforts to manage water quality. In aggregate, we expect habitat conditions throughout the basin to be adversely affected by climate change throughout the 30-year life of the action and by the adverse effects of population growth within the action area. These cumulative effects will make restoration and recovery objectives both more important, and more difficult, to achieve.

5.11 Integration & Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 5) to the environmental baseline (Section 4) and the cumulative effects (Section 5.10), taking into account the status of the species and critical habitat (Section 3), to formulate the agency's biological opinion as to whether the proposed action is likely to: 1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or 2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

5.11.1 Climate Change

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. In fresh water, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon and change the species with which they interact. When combined with the effects of the proposed action, stressors on UWR Chinook salmon and UWR steelhead such as those caused by modified flow regimes, lack of refuge, and areas/periods of poor water quality are exacerbated by climate change. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and in locations where the greatest warming occurs may affect egg survival, although several factors impact intergravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Crozier et al. 2019). For migrating adults, climate-induced changes in freshwater flows and temperatures, alone or when compounded with the effects of the action, will likely increase exposure to stressful temperatures can alter migration travel times and increase thermal stress accumulation for ESUs or DPSs with early-returning (i.e. spring- and summer-run) phenotypes associated with longer freshwater holding times (Crozier et al. 2019, FitzGerald et al. 2020). Rising river temperatures increase the energetic cost of migration and the risk of en route or prespawning mortality of adults with long freshwater migrations, although populations of some ESA-listed salmon and steelhead may be able to make use of cool-water refuges and run-timing plasticity to reduce their thermal exposure (Keefer et al. 2018a, Barnett et al. 2020).

At the individual scale, changes in winter precipitation will likely affect incubation and/or rearing stages of most populations. Changes in the intensity of cool season precipitation, snow accumulation, and runoff could influence migration cues for fall, winter, and spring adult migrants, such as coho salmon and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al. 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Crozier and Zabel 2006; Crozier et al. 2010, Crozier et al. 2019).

At the population level, the ability of organisms to genetically adapt to climate change depends on how much genetic variation currently exists within salmon populations, as well as how selection on multiple traits interact and whether those traits are linked genetically. Managing to conserve and augment existing genetic diversity may be increasingly important with more extreme environmental change (Anderson et al. 2014), though the low levels of remaining diversity present challenges to this effort (Freshwater 2019). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers. Applying this concept to climate change, Anderson et al. (2014) emphasized the additional need for populations with different physiological tolerances. Loss of the portfolio increases volatility in fisheries, as well as ecological systems, as demonstrated for Fraser River and Sacramento River stock complexes (Freshwater et al. 2019, Munsch et al. 2022).

Climate change is likely to amplify or further compound the effects of the proposed action outlined above. The proposed action would not contribute to increased genetic diversity, thus maintaining the current vulnerability associated with the current level of diminished genetic diversity, which is especially significant for the genetic legacy of Santiam populations of UWR Chinook salmon and steelhead. Furthermore, climate change is likely to continue to exacerbate temperature-mediated impacts on migration timing, egg incubation rates, and exposure to predation as UWR and non-UWR salmonids proceed through their life cycle stages. In recognition of these challenges, it is becoming increasingly critical to consider how proposed adaptive management of the WVS can best maintain or increase resiliency of the species and critical habitat as well as implementing conservation to offset effects of the action combined with ongoing effects of climate change.

5.11.2 Species Integration & Synthesis

5.11.2.1 UWR Chinook

The Recovery Plan for UWR Chinook salmon and UWR steelhead (NMFS 2011) identified seven demographically independent populations of spring Chinook salmon in the UWR Chinook salmon ESU: Clackamas, Molalla, North Santiam, South Santiam, Calapooia, McKenzie, and the Middle Fork Willamette. The WLC-TRT classified the Clackamas, North Santiam, McKenzie, and Middle Fork Willamette populations as “core populations” and the McKenzie as a “genetic legacy population.” (NMFS 2011). Recent viability trends identified in the 2022 Biological Viability Assessment for Pacific Salmon and Steelhead (Ford ed. 2022), indicate that UWR Chinook salmon viability is declining, with a moderate extinction risk. Climatic conditions (drought and warm ocean waters) and the prospect of long-term climatic change, in conjunction with the inability of many populations to access historical headwater spawning and rearing areas, are considered major near- and long-term risks to this ESU (Ford ed. 2022). The Long Tom, Calapooia, and Coast Fork populations of UWR Chinook salmon are not essential for recovery of the species, and NMFS considers those subbasins low priorities for UWR Chinook salmon recovery. The primary populations of focus for this analysis are the populations affected most directly by the Corps’ proposed action (i.e., North Santiam, South Santiam, McKenzie, and the

Middle Fork Willamette), where USACE-operated hydropower dams and re-regulating dams are located.

Willamette Mainstem

Major drainage subbasins to the mainstem Willamette River that represent natal freshwater habitats of independent populations of Chinook salmon and steelhead include the Clackamas, Molalla, Santiam, Calapooia, McKenzie, and Middle Fork rivers. The Clackamas River enters the Willamette River below Willamette Falls, and thus, is not as impacted by USACE dam operations as those tributaries and subbasins above the falls. Nevertheless, the Clackamas population is benefiting from the implementation of improved volitional fish passage, fish sorting, and robust habitat restoration efforts carried out by PGE and should be considered as prime examples of what may be achieved with proper design and planning. The Molalla River population of UWR Chinook salmon has limited viability information, according to the 2022 Viability Assessment (Ford ed. 2022), "Abundance information is limited to anecdotal reports, recreational catch reports, and recent surveys, all of which are insufficient to provide a useful estimate of abundance; however, it is reasonable to assume that the abundance of natural-origin Chinook salmon is very low." Similarly, there has been limited monitoring of spring Chinook salmon in the Calapooia River, primarily because of low adult returns; however, based on what information does exist, the Calapooia River population is at a critically low level, at or near zero (Ford ed. 2022). The Calapooia River does not have any USACE-operated dams covered under the proposed action, and the only portion of the Calapooia subbasin included in the action area is the lowest 33.5 miles of the basin, through which ESA-listed UWR Chinook salmon adults and juveniles migrate to spawning grounds or rearing habitats. The McKenzie, Santiam, and Middle Fork UWR Chinook salmon populations and associated impacts of the proposed action are described in greater detail in the following sections.

In general, Willamette River mainstem effects of the proposed action would result in lower spring (April–June) releases to meet the proposed mainstem targets. Lower releases in the mainstem will reduce the available habitat for rearing UWR Chinook salmon juveniles. Over half of out-migrating juvenile UWR Chinook salmon were observed rearing downstream of natal river reaches for several months in the spring. Reduction in habitat lowers potential productivity from these life history stages and leads to overall lower abundance. Cuts in earlier flows will reduce the availability of suitable off-channel habitat for younger juvenile UWR Chinook salmon. Less growth prior to migrating to the estuary and ocean will lead to lower survival in first-year-ocean UWR Chinook salmon and reduced productivity. Lower flows will lead to increased water temperatures when combined with the effects of warmer air temperatures. The flow regime in the proposed action would cause higher UWR Chinook salmon prespawn mortalities as a result of lower flows that result in warm water temperatures in the migration corridor, and due to summer or fall releases at below-dam spawning and collection sites; these effects would lead to lower overall productivity for UWR Chinook salmon.

McKenzie River

The McKenzie River population of UWR Chinook salmon has been a bellwether for natural production in the upper Willamette River basin, with the majority of historical spawning habitat still accessible. The long-term trend in abundance between 2015 and 2019 is -2 percent, and juvenile-tagging studies indicate that total survival through Cougar Reservoir and Dam has been poor (Beeman et al. 2013, Ford ed. 2022). The McKenzie River population remains well below its recovery goal, despite having volitional access to much of its historical spawning habitat (NMFS 2024a).

A total of six major dams are present in the subbasin, four of which are owned by the Eugene Water and Electric Board (EWEB). EWEB's Smith River Dam, Carmen Diversion Dam, and Trail Bridge Dam on the upper McKenzie River are not part of the action area but do presently block Chinook salmon from historical spawning habitat. EWEB also owns Leaburg Dam on the lower McKenzie River at approximately RM 29, which was originally constructed to divert water into a power canal as part of the Leaburg-Walterville Hydroelectric Project. Leaburg Dam does not block fish passage when the adult fish ladders are operating. The two remaining dams, Cougar Dam on the South Fork McKenzie River (constructed in 1963) and Blue River Dam on the Blue River (constructed in 1969), are owned by USACE. This subbasin also has two hatcheries, Leaburg and McKenzie Fish Hatcheries.

Under the proposed action, downstream flows will be lower than historical and recent flows during Cougar Reservoir refill periods following drawdowns and delayed refill (spring). The flows that result will reduce floodplain connectivity. Cuts in minimum flows during February–April also can reduce the availability of suitable off-channel habitat for younger juvenile UWR Chinook salmon. Less growth prior to migrating to the estuary and ocean will lead to lower survival in first-year-ocean UWR Chinook salmon and reduced productivity. Delays in permanent long-term fish passage prolong high mortality risk for juvenile UWR Chinook salmon during passage through the turbines and ROs. Drawing down Cougar Reservoir in the fall for both flood-risk management and access to the regulating outlet causes releases of warmer water, as Cougar temperature control tower operations cease below 1,571 feet elevation. The warmer water can induce faster incubation and earlier emergence from eggs in the spawning areas of the South Fork McKenzie River. Furthermore, continued operation of the dam to reduce high flows for flood-risk reduction will block transport of suitably sized substrate for spawning. Proposed long-term passage may allow for the movement of appropriately sized sediment to reduce the coarsening of downstream reaches in the South Fork McKenzie.

North Santiam River

Data available for the NMFS viability assessment in 2022 demonstrated that UWR Chinook salmon adult natural-origin returns to the North Santiam River, as measured at Bennett Dam and through redd and carcass surveys, exhibited a decrease in abundance and strongly negative productivity (Ford ed. 2022). In this assessment, the 5-year average abundance (for 2015–2019) for natural-origin Chinook salmon spawners was 354 fish, a 12 percent decrease from the previous period (401 average spawners from 2010–2014), although it was similar to the average for 2005–2009 estimates (333). However, estimates of NORs at Bennett Dam from 2015–2019 ranged from 573 to 1,059 (geometric mean of 849), suggesting either considerable prespawning mortality or an undercount of spawners.

Mattson (1948) estimated that 71 percent of the spring Chinook salmon production in the North Santiam subbasin occurred in areas that have since been blocked by Detroit and Big Cliff dams. Minto Dam is located upstream of Packsaddle Park, not far below Big Cliff Dam, on the North Santiam River. The older Minto fish facility was upgraded to NMFS standards in 2013 and is located adjacent to Minto Dam on the north riverbank. Minto Dam creates an impassable barrier that encourages migrating fish to enter the facility's fish ladder. Presently, natural-origin fish that reach the fish handling facilities at Minto Dam are released above this fish barrier to spawn in the North Santiam River reach between Minto and Big Cliff dams. While this "sanctuary" reach is populated with natural-origin adult Chinook salmon, temperature and dissolved gas conditions that would result from the operations under the proposed action will contribute to elevated prespawning mortality levels (Sharpe et al. 2017b). Furthermore, the current lack of safe downstream passage in the proposed operatonal routes at the North Santiam dams results in migration delay and direct mortality of juvenile Chinook salmon. Any juveniles produced above these facilities must first find attraction flows at the face of the dams, then pass through available routes (Beeman et al. 2014b).

In this subbasin, there is also a complex of dams and water diversions at Geren Island near the town of Stayton, Oregon (Santiam River Mile 29). There are a total of five fish ladders at this location and two of them, the Upper and Lower Bennett fishways, pass the vast majority of adult salmon and steelhead arriving at this location. Improvements were made to the off-ladder fish trap as part of the USACE Minto adult fish facility construction in 2011. In 2011 and 2012, volitional passage at upper Bennett Dam was blocked to facilitate collection and sorting of (hatchery steelhead) fish in the Bennett ladder trap, but it was discontinued because it caused delay and physical injuries to UWR Chinook salmon adults.

Under the proposed action, continued outplanting above Detroit Dam with natural-origin spawner UWR Chinook salmon is resulting in cohort replacement rates (CRR) lower than one. When CRR values are less than one, the population is not replacing itself. Declining productivity increases this population's overall extinction risk. Proposed lowered flows in spring and fall will cause decreased growth and survival for migrating and rearing juvenile UWR Chinook salmon by reducing connectivity and suitability of off-channel habitat. Since these overlap with increased use of habitat downstream (following peak migration from above the dams), this will lead to reduced abundance. Temperatures from warm flows downstream of dams in summer and fall will cause increased prespawn mortality for UWR Chinook salmon. Temperatures downstream of dams in fall and winter will cause faster incubation for UWR Chinook salmon during interim temperature management. Both of these will decrease abundance and productivity. Because of delays in the design, contracting, and construction of the elements needed for the proposed Detroit Dam long-term passage, harm from current passage routes will continue to cause mortality for UWR Chinook, reducing productivity of this core population.

South Santiam and Middle Santiam Rivers

The NMFS 2022 Viability Assessment determined that the "long-term trend" (2015–19) for South Santiam River natural-origin Chinook salmon is declining, –3 percent (Ford ed. 2022). For the 2015–2019 period, the 5-year spawner abundance geomean for the entire South Santiam River was 337, a 45 percent decrease from 2010–14. The Foster Dam counts, which represent fish migrating to the upper South Santiam River, had a geomean of 305 for this same period; however, this does not account for prespawn mortality or fallbacks. A combination of both Foster AFF returns and spawner abundance estimates for areas below Foster Dam provide evidence for decreasing abundance since the peak returns in 2011 (and 2004). Based on spawning survey abundance estimates (2002–2018), and adult UWR Chinook salmon counts at Foster Dam (2001-present), adult Chinook salmon returns (hatchery and natural-origin) were increasing for a few years beginning in 2010; however, since 2011, natural-origin returns have been in near-steady decline. The estimated proportion of natural-origin adult UWR Chinook salmon returns to the South Santiam spawning area below Foster Dam during this time period (2002–2018), ranged between 22 and 65 percent and averaged 45 percent. Last year (2023), just 283 natural-origin Chinook salmon adults returned to Foster Dam's adult fish facility. Even if 65 percent (highest proportion observed, based on past estimates from 2002–2018) of all 2023 natural-origin returns to the South Santiam basin spawned below Foster Dam, the 2023 natural-origin run size for this population could not have been much larger than 800 fish.

Under the environmental baseline, the South Santiam Basin contains two major impassable dams, a low head-dam (Foster Dam) that blocks volitional access to the upper South Santiam River and a high-head dam (Green Peter Dam) that currently blocks access to Quartzville Creek and the Middle Santiam River. These dams block or limit volitional access to an estimated 85 percent of the historical production area for UWR Chinook salmon and steelhead (ODFW and NMFS 2011). For UWR Chinook salmon specifically, ODFW (2005) estimates that 70 percent of the subbasin's population once spawned in areas that are (volitionally) inaccessible now, and McElhany et al. (2007) note that the inaccessible areas held some of the best habitat for the species.

Under the proposed action, temperatures from warm flows downstream of dams in summer and fall will cause increased prespawner mortality for UWR Chinook salmon. Increased temperatures caused by the proposed action in the fall and winter will cause faster incubation for UWR Chinook salmon during interim temperature management. The combination of increased prespawner mortality and faster incubation will decrease abundance and productivity for this core and genetic legacy population. Additionally, outplanting above Foster Dam with natural-origin spawner UWR Chinook salmon and steelhead is resulting in cohort replacement rates much lower than one. When CRR values are less than one, the population is not replacing itself. The proposed action would cause declining productivity and increase overall extinction risk.

Middle Fork Willamette

The Middle Fork subbasin is home to a native run of UWR Chinook salmon. Historically, the run of UWR Chinook salmon in the Middle Fork Willamette may have been the largest population of these fish above Willamette Falls (Hutchison 1966a; Thompson et al. 1966). Most recently, during the 2015–19 Viability Assessment review period, the geomean dropped to 20, a 78 percent decrease in spawner abundance. Natural-origin spawners are limited to spawning in the mainstem Middle Fork Willamette River below Dexter Dam, below Fall Creek Dam and Little Fall Creek, where conditions were especially poor during 2015–19, and above Fall Creek Dam, where the majority of natural-origin fish return (Sharpe et al. 2017b). Abundance estimates from past spawning surveys show 92 NORs of 1,209 spawners from 2010–2014 and 20 NORs of 407 spawners from 2015–2019. Twenty natural-origin spawners puts this population at 0.3 percent (less than 1 percent) of the population recovery goal.

The Middle Fork Willamette River UWR Chinook salmon population is at a very low abundance, even with the inclusion of natural-origin spring-run Chinook salmon spawning in Fall Creek. While returns to Fall Creek Dam number in the low hundreds, prespawn mortality rates are very high in the basin. The viability assessments for the UWR Chinook salmon ESU conducted for the recovery plan (ODFW and NMFS 2011) and by McElhany et al. (2007) put the Middle Fork Willamette population at a very high risk of extinction. Though the most recent NMFS status review did not provide updated assessments for each UWR Chinook salmon population, current hatchery-origin adult abundance in the Middle Fork is now lower than it was in the 2000s and natural-origin abundance has not improved (NMFS 2024a). Therefore, the Middle Fork Willamette Chinook salmon population likely remains at a very high risk of extinction and thousands of fish below its recovery goal (of 5,820 natural-origin spawners).

In summary, the proposed actions in the Middle Fork Willamette River will not reduce ongoing high prespawner mortality for UWR Chinook salmon below dams from higher temperature releases. The proposed action would also reduce survival for migrating and rearing juvenile UWR Chinook salmon, and result in high injury rates due to slow travel times through reservoirs, and downstream through the mainstem Willamette River. The proposed action would also reduce Middle Fork Willamette River off-channel habitat quality, connectivity and availability during refill and flood risk management operations. The proposed flow management regime would result in lower flow targets during dry years affecting temperatures and mainstem Willamette River targets, which can increase pre-spawn mortality of adult UWR Chinook during migration.

5.11.2.2 UWR Steelhead

The 2011 Recovery Plan identified four historical demographically independent populations for UWR winter steelhead: the Molalla, North Santiam, South Santiam, and Calapooia (Myers et al. 2006). The UWR steelhead DPS includes all naturally spawned winter-run steelhead populations in the Willamette River and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive). The North Santiam and South Santiam rivers are thought to have been major production areas (USFWS 1948) and these populations were designated as “core” and “genetic legacy” (McElhany et al. 2003). The four “east-side” subbasin populations are part of one stratum, the Cascade Tributaries Stratum, for UWR winter steelhead. Recent viability trends identified in the 2022 Biological Viability Assessment for Pacific Salmon and Steelhead (Ford ed. 2022), indicate that UWR steelhead viability is declining, with a moderate to high extinction risk. Again, the primary focus of this analysis is on the populations most directly affected by the proposed action (i.e., North Santiam River and South Santiam River populations), which are also genetic strongholds for the species, and thus, key for recovery of the species. Steelhead populations in the Molalla River and the Calapooia River are relatively data-poor and their abundance estimates are highly uncertain; the most recent Viability Assessment indicates that the Calapooia River supports several hundred spawners (Ford ed. 2022), although there is a downward trend in recent years (2016-2024, see Figure xx Environmental Baseline).

Willamette Mainstem

Winter steelhead counts at Willamette Falls provide a complete count of fish returning to the DPS. In the last 5 years, counts of steelhead at Willamette Falls experienced a marked decrease, with a record low count in 2017 of 822 fish. During the 2016–17 return year, pinniped predation at Willamette Falls became a concern. Increases in the pinniped population at the falls, in conjunction with low steelhead returns, resulted in an estimated 25% predation rate on winter steelhead (Steingass et al. 2019). With the initiation of pinniped control measures in 2019 and improvements in the steelhead run size, predation levels fell to an estimated 8 percent in 2019 (Steingass et al. 2019). Overall, there was a 59 percent decrease in the geometric average for 2015–19 relative to 2010–14. Abundances at Willamette Falls appear to have recovered since the 2017 low, with a recent (unofficial) count of 5,510 winter-run steelhead (Ford ed. 2022).

The proposed action will result in increased risk of mortality for juvenile UWR steelhead pre-smolts because of lower flows that reduce off-channel habitat they can use for refuge from predation. Additionally, when lower flows and warmer temperatures overlap with juvenile UWR steelhead migration, the risk of mortality from parasite infections increases. UWR steelhead productivity would be reduced if fewer survive as pre-smolts. For temperature-related disease, research has shown that the probability of a smolt returning as an adult is reduced when water temperatures exceed 59°F (15°C) during outmigration. Under the proposed action, risk of higher temperatures is not expected to increase prespawn mortality of UWR steelhead because of run timing, although 10 to 15 percent of adults return in months with the proposed largest drop in minimum flows.

North Santiam

Currently, the best measure of UWR steelhead abundance is the count of returning winter-run adults to Upper and Lower Bennett dams (Figure 85). Recent passage improvements at the dams and an upgraded video counting system have contributed to a higher level of certainty in adult estimates. While there are steelhead spawning below the dams and some survey data are available for areas downstream of the dams, it is likely that these dam counts approximate the population run size. The Bennett Dam counts may also approximate spawner counts, given that post-dam prespawn mortality is thought to be low for winter steelhead, and the contribution of non-native early-winter-run fish above the dams is also thought to be low (Johnson et al. 2018). There are substantial differences in abundance estimates for winter-run steelhead in the North Santiam River using index surveys, mark/recapture with radio-tagged steelhead, and the Bennett Dam counts. In light of the uncertainty in abundance estimates for this population, the calculation of short- and long-term trends would convey an unjustified precision. In general, there has been a long-term decline in the abundance of this population.

The proposed action is expected to result in water temperatures raised in summer, which will cause faster incubation for UWR steelhead during both interim and long-term temperature management. Higher water temperatures will reduce productivity of this core and genetic legacy population by disrupting the timing of critical life cycle stages such as incubation and emergence which could result in mortality. Continued operation of the dam to reduce high flows for flood-risk reduction will block transport of suitably sized spawning substrate and large wood that promotes habitat complexity. Spill operational passage can cause harmful levels of total dissolved gas below Big Cliff Dam. This reduces the survival and, hence, abundance of UWR steelhead.

South Santiam and Middle Santiam

Winter steelhead abundance was estimated at 1,480 ± 721 in 2016, and 157 ± 60 in 2017 (the record low year). Further, Mapes et al. (2017) reported that there were considerable differences between their abundance estimates for South Santiam River tributaries and those generated using the existing index reach-based approach. Therefore, longer time series are less meaningful, in that abundance estimates before 2009 were developed using index surveys to allocate Willamette Falls counts. Finally, Foster Dam counts reflect only a portion of the overall abundance, and the proportion of winter steelhead ascending the Foster fish facility ladder can vary from year to year depending on water conditions, due to temperature effects of the upstream Green Peter reservoir releases. Overall, index and Foster Dam counts reflect the general trend of winter steelhead counted at Willamette Falls, with a slight rebound, in part resulting from reduced sea lion predation at the falls, but also from an earlier strong year class.

Generally, the proposed action will result in increased water temperatures in summer and will cause faster incubation for UWR steelhead during deep drawdown operations. The proposed action will reduce productivity of this core and genetic legacy population.

5.11.2.3 Other Salmon Species

The action area includes the Lower Columbia River and estuary within the Lower Columbia River subbasin. The Columbia River and its tributaries are the dominant aquatic system in the Pacific Northwest. The 1,214-mile-long Columbia River drains 259,000 square miles of the northwestern United States and southern British Columbia, Canada, into the Pacific Ocean. Currently, 23 mainstem and more than 300 tributary dams regulate the flow of the Columbia River to the Pacific Ocean (Bottom et al. 2005). Saltwater intrusion from the Pacific Ocean extends approximately 23 miles upstream from the river mouth at Astoria. Coastal tides influence the flow rate and river level up to Bonneville Dam at RM 146.1 (ISAB 2000). Mainstem habitat in the Lower Columbia River has been substantially altered by basinwide water management operations, the construction and operation of mainstem hydroelectric projects, the growth of native avian and pinniped predator populations, the introduction of non-native species (e.g., smallmouth bass, walleye, channel catfish, and invertebrates), and other human practices that have degraded water quality and habitat function.

Within the Lower Columbia River subbasin, including the action area, flooding was historically a frequent occurrence, contributing to habitat diversity via flow to side channels and deposition of woody debris. The Lower Columbia River estuary is estimated to have once had 75 percent more tidal swamps than the current estuary because tidal waters could reach floodplain areas that are now diked. These areas provided feeding and resting habitat for juvenile salmonids in the form of low-velocity marshland and tidal-channel habitats (Bottom et al. 2005).

Dams built on the river between the 1930s and 1970s significantly altered the timing and velocity of hydrologic flow and reduced peak season discharges. Availability of aquatic habitat for native fish, particularly those that rely heavily on low-velocity side-channel habitat for holding, feeding, and rearing, has declined as a result of these changes to habitat-forming processes. Aquatic habitat components that have been affected by these changes include the amount and distribution of woody debris (e.g., controlled flows and navigation management discourage free transport of large wood), rates of sand and sediment transport, variations in temperature patterns, the complexity and species composition of the food web, the distribution and abundance of salmonid predators, the complexity and extent of tidal marsh vegetation, and seasonal patterns of salinity.

In general, aquatic habitats in the action area have been extensively modified from their historical condition, yet they continue to provide a wide range of important habitat functions for ESA-listed species. We also expect the cumulative effects of state and private actions within the action area and climate change to continue to have negative effects on ESA-listed salmon species and their habitat. We expect that adults and juveniles of all salmon species covered in this opinion will migrate through the action area because it includes the Lower Columbia River, where all species, UWR and Columbia/Snake River, will migrate and thus, potentially be exposed to the downstream effects of dam operations in the Willamette Basin. These effects include water quality and water quantity variability, which could negatively impact migration and rearing. However, for Columbia/Snake River species, the effects of the action on water quantity and quality in the mainstem Columbia River are more attenuated. When combined with the effects of climate change, baseline conditions, and status of species, those effects are likely to impact individual salmon in the action area but are unlikely to be of the magnitude necessary to cause a measurable effect on abundance, productivity, spatial structure, or diversity of any of the affected LCR, SR, MCR, or UCR salmon or steelhead. This is due to the upstream location of project dams and subsequent dampening of the most impactful effects of dam operations the further downstream from the WVS ESA-listed salmon occur.

5.11.2.4 Southern Resident Killer Whales

The Southern Resident killer whale DPS is composed of a single population that ranges as far south as central California and as far north as southeast Alaska. While some of the downlisting and delisting criteria have been met, the biological downlisting and delisting criteria including sustained growth over 14 and 28 years, respectively, have not been met. The SRKW DPS has not grown; the overall status of the population is not consistent with a healthy, recovered population. Considering the status and continuing threats, SRKWs remain in danger of extinction.

Because UWR Chinook salmon make up a small portion of the prey base that sustain SRKWs, and the proposed action may result in a very slight reduction of prey base for SRKWs, the loss of prey is not expected to be significant enough to harm individuals. What adverse effects may accrue to indivual whales, are not likely to translate to species level impacts that would prevent their overall recovery.

5.11.2.5 Species Summary

Overall, the status of the salmon and steelhead included in this opinion are poor. In particular, recent trends for UWR Chinook salmon and UWR steelhead are concerning, and both species remain far from recovery goals. The condition of the environmental baseline in the action area does not support conservation of UWR Chinook salmon and UWR steelhead because:

- Under the environmental baseline, dams in the Willamette Basin block much of the productive spawning habitat for these species. Operations of these dams also negatively affect the quality of downstream habitat by altering sediment routing, decreasing LWD, and changing the type of available habitat (i.e., reducing the access to floodplain habitat)
- Urbanization, agriculture, and industrial development has reduced habitat quality in the Willamette River and its tributaries. As a result, the habitat available to UWR Chinook salmon and steelhead is degraded and less capable of supporting viable populations of these species.
- In 2008, NMFS issued a jeopardy biological opinion on operation of the WVS. Implementation of some elements of the RPA in this opinion have been delayed. As result, the reduced harm and improvements in population VSP expected from the RPA have not been fully realized.
- Recent hatchery reforms have reduced negative impacts from hatchery production of UWR Chinook salmon and steelhead, but some adverse effects continue.
- Impacts from climate change are evident in the basin, especially increased summer water temperatures and higher prevalence of catastrophic wildfire.
- Pinniped predation on UWR Chinook salmon and steelhead in the lower Willamette River increased substantially beginning in 2017. Recent pinniped control measures have reduced predation levels.

Cumulative effects from activities such as timber harvest, agriculture, irrigation withdrawals, hydropower, lack of fish passage, and human population increases are expected to continue. Some habitat restoration is also reasonably certain to occur, but many improvements will be needed before any listed species may recover. Future effects of climate change in the Willamette Basin are likely to be mostly negative on UWR Chinook salmon and steelhead.

Adults and juveniles of all species covered in this opinion will be impacted in some way by the proposed action (but extremely minimally for Columbia/Snake River species); however, UWR Chinook salmon and UWR steelhead would accrue the highest and most direct effects of the proposed action. For the other species analyzed in this Opinion, effects of the action scaled up to the species level are not expected to appreciably alter the abundance, productivity, spatial structure, or diversity of any of these populations even when climate change is considered. All salmonid species covered in this Opinion could be exposed to the effects of in water work, which could take the form of increased turbidity, habitat disturbance, riverbank armoring, construction noise and disturbance; and hydraulic fluid, grease, fuel, and lubricant releases in and around construction areas. For UWR Chinook salmon and UWR steelhead the proposed action would cause:

- Prespawn mortality of UWR Chinook salmon.

- Faster incubation of UWR Chinook salmon eggs, reducing survival.
- Mortality of migrating UWR Chinook salmon juveniles by reducing the quality of migration habitat.
- Dissolved gas levels below WVS dams sufficient to cause adverse effects and reduced survival for both species given the specific characteristics of the WRB.
- Water temperatures in the fall and summer that would exceed levels harmful to UWR steelhead. This will reduce the survival of migrating adults.
- Mortality of migrating UWR steelhead juveniles by reducing the quality of migration habitat.
- Faster incubation of UWR steelhead eggs in fall and winter, reducing survival.

When the effects of the proposed action are added to the environmental baseline and cumulative effects, the proposed action would appreciably reduce the likelihood of both the survival and recovery of UWR Chinook salmon and UWR steelhead in the wild by reducing their numbers and reproduction.

The other salmon covered under this Opinion, and SRKWs were likely to be adversely affected at the individual-level by the proposed action, but those effects would not rise to the level of population-level impacts. For SRKWs these effects are not likely to rise to the level of take. For these species, the proposed action would not appreciably reduce the likelihood of both survival and recovery.

5.11.3 Critical Habitat Integration & Synthesis

This section summarizes the effects on designated critical habitat combined with the effects of climate change, the environmental baseline, and current status of critical habitat to describe the overall impact the proposed action is likely to have on physical or biological features for critical habitat of each species or category of species. In this analysis, salmonid critical habitat is discussed collectively for all salmon species covered under this opinion because they share the same PBFs to support conservation including water quality, water quantity, free passage, forage opportunities, rearing habitat.

5.11.3.1 Salmonid Critical Habitat

NMFS designated critical habitat for UWR Chinook salmon and steelhead on September 2, 2005 (70 FR 52630). Essential features of designated critical habitat include attributes of substrate, water quality, water quantity, water temperature, food, riparian vegetation, access, water velocity, space, and safe passage that are associated with viability for the ESU and DPS. The Molalla, Callapoia, Long Tom, Coast Fork, Clackamas, and Lower Columbia Rivers are included in the action area; however, for purposes of focusing on the primary effects of the proposed action, this analysis includes a general overview of existing critical habitat in those six areas. Overall, systemic habitat concerns are significant across the Willamette Basin and include lack of habitat access and fish passage, lack of habitat complexity and floodplain connectivity, degradation of downstream habitat, instream flow issues, and degraded water quality, which all persist (NMFS 2024a).

Molalla/Calapooia/ Long Tom/ Coast Fork/Clackamas/Lower Columbia Rivers Habitat Summaries

The Molalla and Calapooia rivers are dominated by flow modifications, channel confinement, and in-stream barriers. These anthropogenic features have reduced access to off-channel habitats essential for juvenile rearing and winter refuge, decreased connectivity between habitats throughout the subbasins, and curtailed the dynamic processes needed to form and maintain habitat diversity (WRI 2004). The Coast Fork Willamette River and Long Tom River subbasins include numerous partial or complete barriers to fish passage from dams and road culverts that prevent access to critical habitat. This includes six structures constructed and maintained by USACE: Dorena, Cottage Grove, Fern Ridge dams and three concrete drop-structures on the Long Tom River below Fern Ridge. The lowermost drop-structure on the Long Tom River, known as the Monroe drop structure, has an existing fish ladder that is nonfunctional. The significance of these fish passage barriers that exist under the environmental baseline varies since the Long Tom and Coast Fork UWR Chinook populations are not likely essential for supporting overall viability of the ESU. Several major flood-control or hydropower facilities have been developed in the Clackamas River subbasin; however, power producers have taken steps to ensure volitional passage is safe and effective, in addition to completing several habitat restoration projects that have improved critical habitat for salmon and steelhead over time along the Clackamas River.

Critical habitat for salmonids existing in the Lower Columbia River has been significantly degraded over the historical condition with the development of the estuary, Federal Navigation Channel, and habitat effects from the Columbia River System, which in combination have led to large reductions in several key estuary habitat ecotypes (Fresh et al. 2005; Sol et al. 2021; L. A. Weitkamp et al. 2022). Since 2000, there have been ongoing efforts to restore estuary habitat by federal, state, and local entities. One of the largest efforts has been the Lower Columbia River Estuary Partnership (LCEP), which is an interstate/federal group formed under the EPA's National Estuary Program (see 33 U.S. Code § 1330). Since the year 2000, LCEP has helped restore more than 28,387 acres of estuarine habitat in the LCRE. These efforts to improve the environmental baseline through restoration actions, are slated to continue as described in the 2019 NMFS biological opinion for the continued operation and maintenance of the Columbia River System (CRS), where 300 acres of habitat will be restored per year.

Much of the UCR spring-run Chinook salmon (endangered) and UCR steelhead (threatened) critical habitat is degraded (NMFS 2022g). Both UCR spring-run Chinook salmon and UCR steelhead scored low risk of climate vulnerability in estuary stage sensitivity because of their rapid migration from fresh water to the early marine stage (Crozier et al. 2019). Critical habitat includes portions of the action area where adults and juveniles migrate through the Lower Columbia River and the Columbia River estuary and important habitat where juvenile salmonids feed and complete the process of acclimating to salt water while avoiding predators. Habitat has improved since the 2016 5-year status review, including in the Lower Columbia River and estuary. These ESUs/DPSs are likely to experience short-term effects from poor water quality and reduced habitat forming processes.

McKenzie/North Santiam/South Santiam/Middle Fork Willamette Critical Habitat Summaries

Human-caused alterations of the hydrologic regimes of the lower McKenzie River and its principal tributaries have generally diminished flow-related habitat quantity and quality and limited the production potential of accessible habitat in much of the basin. Recent agreements to meet minimum stream flows at the Leaburg-Walterville Project, Blue River Dam, and Cougar Dam have likely provided sufficient flow for upstream migration and juvenile rearing habitat requirements, but these flow increases do not address water temperature conditions in the South Fork McKenzie. Large storage dams in the subbasin have reduced the magnitude and frequency of large flow events in the mainstem McKenzie, preventing channel-forming processes that maintain complex habitat for rearing UWR Chinook salmon. Habitat restoration efforts by the U.S. Forest Service below Cougar Dam on the South Fork McKenzie River were recently completed, representing a major effort to enhance the floodplain; however, it may be some years before the full measure of success for this effort can be evaluated. Redd counts in the restoration area dramatically increased in 2018 and 2019 (Ford ed. 2022).

Most of the land along the reach of the North Santiam from Mehama to its confluence with the South Santiam River, as well as the 12-mile mainstem Santiam River, is used to grow agricultural crops or graze livestock. The remainder consists of urban areas, coniferous forests, mixed deciduous forests, and riparian forests that now comprise less than 7 percent of the vegetation (E&S 2002). Most of the subbasin's residential and rural-residential development is downstream of the USACE dams on the valley floor and in the foothills. Reduced flood-flow frequency and magnitude prevents important geomorphic processes that create and renew riparian habitat. This, in combination with the trapping of large wood and sediment from reaches above WVS dams, has heavily influenced the physical habitat in tributary reaches. The direct effects on habitat are still occurring because of the modified flows below Detroit and Big Cliff dams. These include: loss of habitat complexity, impacts to the quantity and types of riparian vegetation as well as recruitment and plant succession, reduced gravel and large woody debris recruitment, reduced avulsion, bed armoring and stabilization of the channel. The consequences, despite flow-related reductions in the lower river's transport capacity, have been a loss of finer textured gravel bars below Big Cliff Dam and a scouring of some areas near this dam down to bedrock with scattered boulders. This type of channel coarsening reduces the diversity of riverbed substrates and the availability of spawning habitat for anadromous salmonids.The lower portion of the subbasin contains only 25 percent of the original extent of floodplain forest, and there has been significant loss of wetland, floodplain, and off-channel habitats and associated habitat complexity.

Under the environmental baseline, the South Santiam Basin contains two major impassable dams, a low-head dam (Foster Dam) that blocks volitional access to the upper South Santiam River and a high-head dam (Green Peter Dam) that currently blocks access to Quartzville Creek and the Middle Santiam River. These dams block or limit volitional access to an estimated 85 percent of the historical production area for UWR Chinook salmon and steelhead (ODFW and NMFS 2011). There is limited natural spawning in the lower South Santiam River, Thomas and

Crabtree creeks, and Wiley Creek, with the majority of spawning occurring below Foster Dam. Reproductive success in many of the reaches below Foster Dam is likely limited by habitat degradation, although, even historically, the majority of Chinook salmon spawning was above the site of Foster Dam (Mattson 1948, Parkhurst et al. 1950a). However, the South Santiam River is the least influenced by high water temperatures compared to other UWR tributaries. The most protected area lies below Foster Dam where temperature increases are buffered by releases of deep cold water from Green Peter Reservoir. In contrast to the North Santiam Basin (highly permeable geology with sustained base flows), the South Santiam Basin is of low permeability, tends to quickly transition precipitation to runoff, and is considered flashy in nature (Tague and Grant 2004).

The lower subbasin of the Middle Fork Willamette contains only a small fraction of the original floodplain forest. Remaining floodplain forests are interspersed with areas of farmland, pastureland, highways, residences, and other development. Roads next to stream channels have increased channel confinement and reduced riparian vegetation and canopy cover. As a result of these land alterations, riparian vegetation within 100 feet of the small tributaries of the lower Middle Fork Willamette is generally in poor condition. Changes in riparian canopy cover have increased summer high water temperatures on some tributary streams (WRI 2004). Additionally, the Jones Fire in the Fall Creek watershed in 2017 likely had immediate and long-term effects on fish survival in the basin. Similarly, areas burned in the Willamette River basin in 2019 and 2020 will suffer from the loss of riparian habitat and the deposition of sediment and ash from denuded hillsides.

When added to the baseline, cumulative effects, and status of designated critical habitat, the proposed action will result in adverse modification of critical habitat physical biological features (PBFs) for UWR Chinook salmon and UWR steelhead. For these species, the proposed action would perpetuate severe floodplain disconnection by lack of habitat restoration that would otherwise reconnect floodplain and side channels; maintaining lack of access to habitat for rearing and migration by delaying implementation of structural passage; interrupting forage and rearing opportunities by construction activities associated with maintaining revetments, and perpetuating harmful water temperatures that contribute to degraded water quality.

The proposed action, when added to the environmental baseline, cumulative effects, and status of designated critical habitat, would adversely affect designated critical habitat for all other ESA-listed salmonid species addressed in this Opinion by reduced water quality (i.e., increased water temperatures) and reduced water quantity during dry water years. Increased water temperatures and reduced flows would contribute to already stressed downstream habitat functions needed to support spawning, migration, and rearing. However, critical habitat for species other than UWR Chinook salmon and UWR steelhead is impacted to a lesser degree.

5.11.3.2 Southern Resident Killer Whale Critical Habitat

Designated critical habitat for SRKWs along the U.S. West Coast includes approximately 15,910 square miles of marine waters between the 6.1-meter and 200-meter depth contours off the coasts of Washington, Oregon, and California from the U.S. international border with Canada south to

Point Sur, California. The final rule designating critical habitat includes "*prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth*", as one of the physical or biological features necessary to support conservation of species (86 FR 41668, August 2, 2021). The status of this PBF is poor and the subject of much ongoing research to fully understand how the decreasing prey base is contributing to the decline of the species. Because the proposed action could reduce prey abundance to a very small degree, as discussed previously, this critical habitat PBF would be adversely impacted. However, the effects of the proposed action are not expected to threaten the continued persistence of the SRKW because of the small portion of their overall diet that UWR Chinook salmon make up, and the very limited effects of the proposed action on other potential prey species. Operation of the WVS will not impact other PBFs associated with SRKW critical habitat including water quality or passage conditions for migration and rearing.

5.11.3.3 Critical Habitat Summary

Overall, the status of the salmon and steelhead critical habitat included in this opinion is poor. Under the environmental baseline, the condition of critical habitat does not adequately support conservation of UWR Chinook salmon and UWR steelhead because:

- Under the environmental baseline, dams in the Willamette Basin block much of the productive spawning habitat for these species. Operations of these dams also negatively affect the quality of downstream critical habitat by altering sediment routing, decreasing LWD, and changing the type of available habitat (i.e., reducing the access to floodplain habitat). For UWR steelhead, critical habitat is not designated above Big Cliff and Green Peter dams but is designated in the trap-and-haul area above Foster Dam. For UWR Chinook salmon, critical habitat is designated in the trap-and-haul areas above Foster, Lookout Point, Cougar, Falls Creek, and Hills Creek dams. Critical habitat for UWR Chinook salmon is not designated above Big Cliff or Green Peter dams.
- Urbanization, agriculture, and industrial development has reduced critical habitat quality in the Willamette River and its tributaries downstream of the WVS dams. As a result, the critical habitat available to UWR Chinook salmon and steelhead is degraded and less capable of supporting conservation of these species. Rivers and tributaries are constrained by existing revetments and training structures, water quality is consistently compromised in many reaches used by these species, and forage and rearing areas are limited by lack of habitat access caused by revetments and dams.
- In 2008, NMFS issued a jeopardy biological opinion on operation of the WVS. Implementation of some elements of the RPA in this opinion have been delayed. As result, the reduction of adverse effects or improvements in critical habitat quality expected from the RPA have not been fully realized.
- Impacts from climate change are evident in the basin, especially increased summer water temperatures and higher prevalence of catastrophic wildfire. These factors have further degraded the condition of critical habitat for UWR Chinook salmon and UWR steelhead.

Critical habitat for all salmon and steelhead species covered in this opinion will be impacted in some way by the proposed action; however, UWR Chinook salmon and UWR steelhead critical habitat would have the highest level of impact from the proposed action. For the other species' critical habitat analyzed in this Opinion, effects of the action are not expected to appreciably alter the conservation value of critical habitat even when climate change is considered. For UWR Chinook salmon and UWR steelhead the proposed action would cause:

- An increase in the temperature PBF resulting in prespawn mortality of UWR Chinook salmon.
- An increase in the temperature PBF resulting in faster incubation of UWR Chinook salmon eggs, reducing survival.
- A reduction in the quality of migration critical habitat resulting in mortality of migrating UWR Chinook salmon juveniles.
- Degradation of the water quality PBF by increasing dissolved gas levels below WVS dams.
- High water temperatures in the fall and summer. This will reduce the survival of migrating adult UWR steelhead.
- A reduction in the quality of migration critical habitat, resulting in mortality of migrating UWR steelhead juveniles.
- An increase in the temperature PBF resulting in faster incubation of UWR steelhead eggs in fall and sinter, reducing survival.

The status of critical habitat for UWR Chinook salmon and steelhead is poor, and the current quality of PBFs cannot support conservation of these species. The adverse effects on critical habitat PBFs caused by the proposed action are likely to further impair the ability of critical habitat to support conservation of these species. Cumulative effects and future effects of climate change on UWR Chinook salmon and steelhead critical habitat quality are expected to be mostly negative. When the effects of the proposed action are added to the environmental baseline and cumulative effects, the proposed action is likely to appreciably diminish the value of critical habitat as a whole for the conservation of UWR Chinook salmon and steelhead and critical habitat.

The action area contains designated critical habitat for other ESA-listed salmon and steelhead species in addition to UWR Chinook and UWR steelhead, including those species of LCR, UCR, SR, and MCR. Additionally, designated critical habitat for SRKW is located within the action area. Critical habitat for all of these ESA-listed species will be adversely impacted by the proposed action. For SRKW, the prey abundance PBF will be affected by limited UWR Chinook salmon production, which make up a possibly very small portion of their diet. Critical habitat PBFs, including water quality, rearing habitat availability, forage opportunities, refuge, and habitat access will also be negatively affected for the non-UWR salmonid species covered under this Opinion. However, these effects would not be sufficient to diminish the value of critical habitat as a whole for the conservation of these species.

5.12 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is likely to jeopardize the continued existence of UWR chinook salmon, and UWR steelhead, and will destroy or adversely modify designated critical habitat. It is also NMFS' biological opinion that the proposed action is likely to adversely affect LCR chinook salmon, UCR spring chinook salmon, SR spring/summer chinook salmon, SR fall chinook salmon, CR chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, MCR steelhead, UCR steelhead, SR steelhead, SR steelhead, and SRKW, and their designated critical habitats.

6 Reasonable and Prudent Alternative

"Reasonable and prudent alternatives" refer to alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the federal agency's legal authority and jurisdiction, that are economically and technologically feasible, and that would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat (50 CFR 402.02).

Introduction

In Section 8 of this Opinion, NMFS concluded that the USACE (2024) Proposed Action (PA) would jeopardize the continued existence of UWR Chinook salmon and UWR steelhead, and destroy or adversely modify their designated critical habitat. NMFS reached no jeopardy and no adverse modification conclusions for the 11 other listed salmonid species, and southern resident killer whales, and concurred NLAA for green sturgeon, eualchon, and humpback whales. Therefore, NMFS is providing the USACE, BPA, and the BOR with the following reasonable and prudent alternative (RPA) that NMFS believes will avoid jeopardizing the continued existence of UWR Chinook salmon and UWR steelhead, and avoid destroying or adversely modifying their critical habitat, as required by ESA section 7(b)(3)(A). The RPA is intended to be fully implemented in order to avoid jeopardy.

The majority of dam operations and structural improvements fall under the purview of the Corps and BPA; however, the Bureau of Reclamation (BOR) is also an Action Agency for this consultation. NMFS is consulting on BOR's proposed action which includes existing irrigation contract water marketing program and BOR's issuance of new contracts and maintaining existing ones such that the total water marketing program would not exceed 95,000 acre-feet. The effects of BOR's water contracting program, up to 95,000 acre-feet, were previously considered and are addressed in the 2008 WVSBiological Opinion, in RPA 9.3 Water Contract Program (NMFS 2008a). The 2008 RPA 9.3 elements will remain operative except where modified by this RPA. Issuance of new contracts beyond the 95,000 acre-feet cap requires additional ESA section 7 consultation, which NMFS will undertake subsequent to this consultation.

NMFS' RPA includes modification to several measures in the PA (USACE 2024a) and adds new measures that, collectively, NMFS believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat. The RPA focuses, in large part, on improvements to actions proposed by the

USACE in the PA with an emphasis on interagency coordination, monitoring, and facilitating expedient actions to address fish passage and water quality issues. Each group of RPA actions is focused on a specific element of the proposed action, i.e., adaptive management, flows, water quality, fish passage, hatcheries, and habitat. RM&E is included for each category. NMFS' assessment of how the RPA avoids the likelihood of jeopardy and destruction or adverse modification of critical habitat is based on the benefits attributed to successful timely completion of these measures in combination with the proposed action. In the event there are inconsistencies between the PA and RPA, this RPA should be read as modifying the PA.

Many elements of this RPA are closely related to one another and; therefore, the reader is likely to see cross references to overarching measures, such as AM or implementation timing, applied to many RPAs throughout this section.

6.1 Project, the Action Agencies Adaptive Management RPAs

AM Overview

Adaptive management and interagency coordination between USACE, NMFS, and other agencies is described in the 2024 PA. In summary, the Adaptive Management Plan (AM Plan) outlines the governance structure, the annual adaptive management process for inter-agency collaboration, engaging with stakeholders, and incorporating new information into management priorities. The AM Plan also outlines the decision criteria relevant to monitoring and evaluating the success of measures at achieving stated objectives. NMFS supports the general concept of using knowledge gained from monitoring and evaluation efforts to inform decision making in coordination with all agencies on a regular or prescribed cycle. In this case, USACE proposes to implement an annual adaptive management cycle. The proposed AM Plan provides a foundation for facilitating decision making in data-poor situations; however, there are some aspects of the AM Plan that should be updated to improve overall certainty of biological benefits and to expedite corrective actions when necessary.

The Corps represents their proposed AM plan using Figure 9-1 below. The AM Plan is organized by basin-wide measures and by sub-basin. The proposed action includes both long-term measures, as well as interim measures. Within each section of the BA the following components are described for each measure included in the proposed action (USACE 2024a):

- Measure Definition and Function
- Constraints
- Performance Metrics and Targets
- Research, Monitoring, and Evaluation
- Risks and Uncertainties
- Decision Triggers and Adaptive Actions
- Decision-Making and Collaboration

The AM Plan framework also provides an avenue for new information to be incorporated and inform and adapt implementation moving forward.

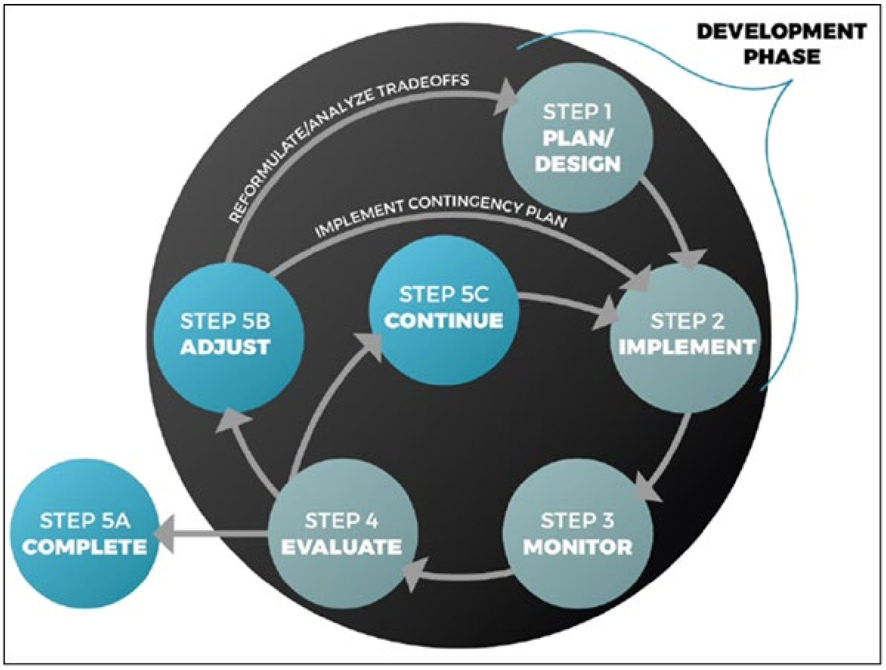


Figure 6.1-1 Proposed adaptive management plan process map provided by USACE (2024 proposed action).

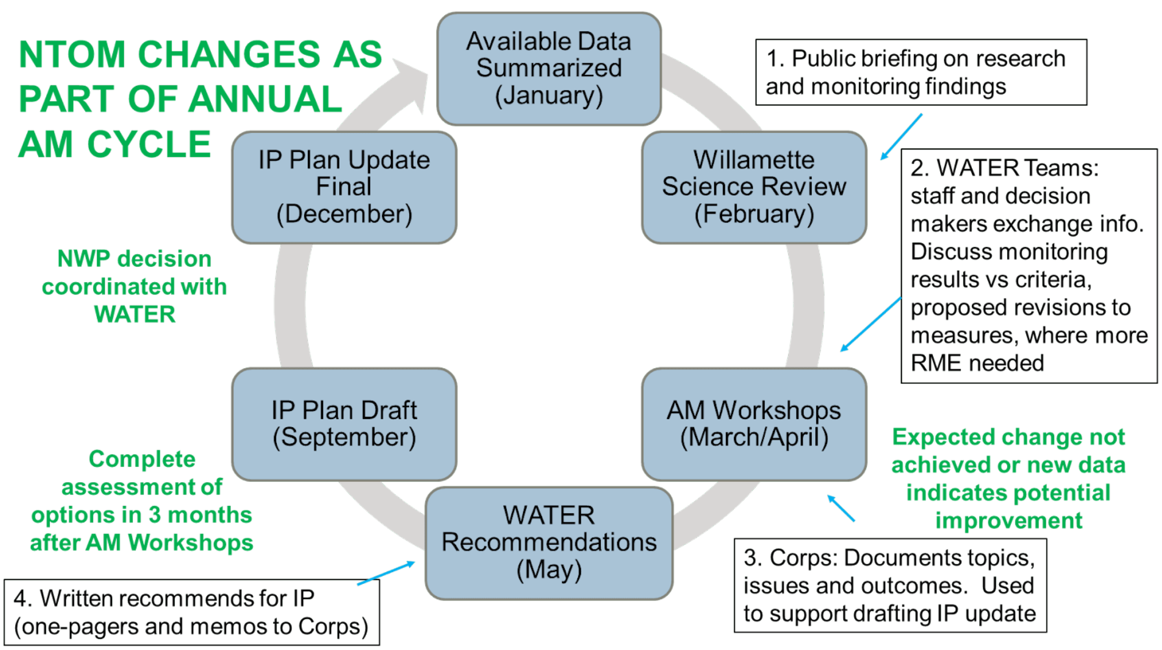


Figure 6.1-2 Adaptive management proposed annual cycle of coordination and decision making (USACE 2023a).

Most elements of the current coordination structure including the Willamette Team for Ecosystem Restoration (WATER) Technical Teams, WATER Steering Team, and WATER Manager's Forum, which were implemented as part of the 2008 RPA, will remain in place and have been integrated into the proposed AM Plan. However, USACE is proposing a revised structure for the technical team level, where the current RM&E Technical Team will be subsumed by each of the four Technical Teams in order to more closely associate monitoring and evaluation requests with specific Project operations (Figure 9-3).

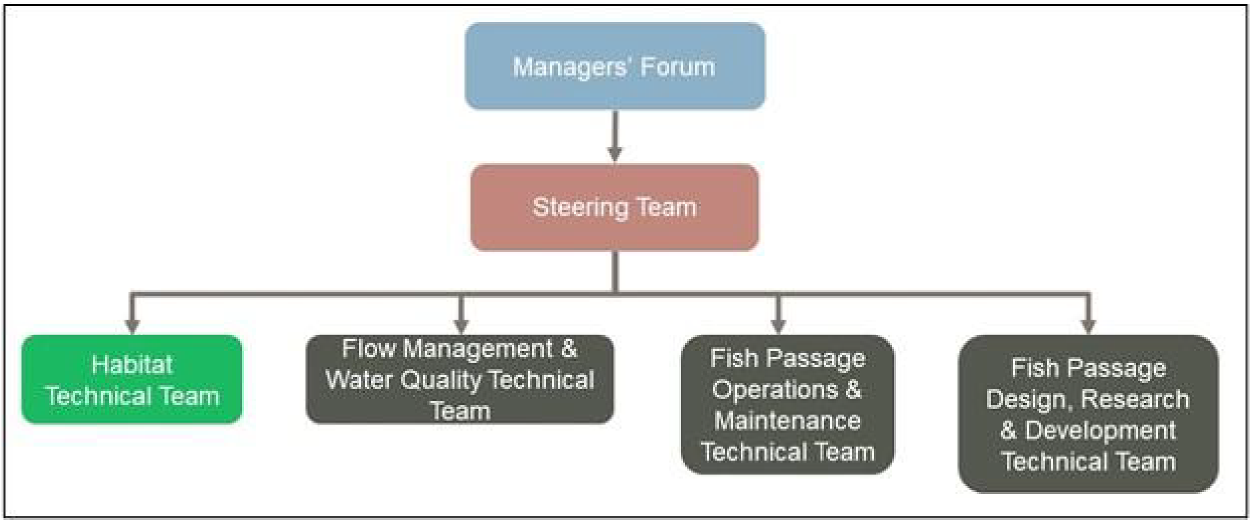


Figure 6.1-3 Proposed WATER Structure under new AM Plan (USACE 2024a).

The entities listed as included in the Manager's Forum and Steering Team are "key participating . . . federal and state agencies and Tribes with fisheries and water resource management responsibilities in the Willamette River Basin."

Additionally, the PA continues actions and reviews that are part of the Willamette Fish Operations Plan (WFOP) chapters, which are updated annually with input from USACE, BPA, and federal, state, and tribal fish agencies. Revisions to the WFOP will include those actions listed as the Interim Operations (see Table 2-1 BA, Updated Appendix A, USACE Aug 2024), and others resulting from the proposed Near-Term Implementation Plan update process (Table 2.3-2. Summary, USACE July 2024 Updated PA). The PA described this in the Implementation Plan (Section 2.5.12, 2024 PA) as "an annual AM Process that would revolve around science updates and the generation and sharing of information about proposed action performance, then using that information for adjustments to the Near-term measures and plan." (2024 PA Section 2.5.12).

Revisions to the WFOP will also incorporate changes adopted through coordination with NOAA Fisheries and USFWS as part of this ESA Section 7 consultation and RPA, and through consideration of other regional input and plans such as the UWR Recovery Plan (ODFW and NMFS 2011).

RPA 1 Adaptive Management

RPA 1.1 The Corps will modify the proposed AM Plan and the annual WFOP to include ongoing plans for reintroduction of natural-origin UWR Chinook and UWR steelhead. The Corps will update the WFOP with fish disposition tables in Hatchery Genetic Management Plans (HGMPs, ODFW 2019), covered in the NMFS Hatchery Biological Opinion (2019b) to integrate any changes in the reintroduction actions as part of the AM implementation process. As part of the RPA, USACE shall ensure pedigree analysis and spawner survey data are available to help inform changes in distribution of natural origin fish to their natal areas above and below Corps dams (see RPA 4.3.8). NMFS intends to work with ODFW and USACE to develop clear criteria for when and where further reintroduction of natural-origin fish collected at adult fish facilities should occur, and determine the most appropriate methods for assessing effectiveness. NMFS will share this information with the Corps to inform the content of the AM Plan and the WFOP. This modification to the AM Plan shall occur by the end of year three after signing this Opinion. Additionally, USACE shall ensure that adult fish handling methods minimize, to the extent practicable, adverse effects on reintroduced fish as specified in the WFOPs for each subbasin. The Corps shall annually provide a prioritized list of fish facility maintenance needs that is coordinated with appropriate operators (ODFW), so they are considered as part of the annual AM implementation and budget cycle.

Rationale for RPA 1.1: Currently, there is no consistent criteria for determining when outplanting natural fish collected at Corps facilities for reintroduction above the dams is appropriate. Currently, pedigree analyses provide cohort replacement rates (CRRs) from salmon produced from above the dams, and outplanting of returning natural origin adults occurred when CRRs were demonstrated to be greater than values for spawners below dams, or when adverse conditions were expected below dams (for instance during the 2015 heat wave). Reintroduction initiatives and guidance have been provided in various forums (NMFS 2019a, Green Peter Injunction Outplanting Plan 2021), but formal plans have yet to be finalized due to lack of improved passage actions and the annual availability of pedigree analyses (described in RPA 4.3.8). Amending the AM Plan to include development of reintroduction criteria and plan formulation by the end of year three after signing this Opinion will help to ensure that reintroduction of natural origin fish occurs when it is appropriate to do so, which will in turn support the continued existence of UWR Chinook and steelhead species.

RPA 1.2 Because the RM&E team is proposed to be subsumed under the four technical teams, USACE must ensure that each technical team considers and recommends the steps necessary for monitoring prior to start of actions. Provide prioritization information and materials from each team's recommendations to facilitate written feedback.

USACE shall schedule an annual RM&E focused meeting with WATER team representatives to review all RM&E recommendations across all technical teams. This meeting could occur in the spring in line with the AM planning cycle noted in Figure 9-2 above. Prior to this meeting, USACE shall disclose in writing which studies are selected to be funded each fiscal year, accompanied by an explanation of why any specific studies prioritized by NMFS are not funded.

Rationale for RPA 1.2: In the past, USACE failed to implement NMFS' recommended RM&E, and studies not ranked highly by NMFS were funded. Monitoring of actions was not consistently available to ensure that RPA measures translate into biological benefits to UWR Chinook salmon and steelhead as a result. This RPA will ensure that RM&E prioritization reflects the study needs that would benefit UWR Chinook salmon and steelhead through informed decision making. USACE, who sponsors and facilitates the WATER Technical Teams, will ensure that engagement opportunities are provided to inform other teams of each team's RM&E needs. This RPA will ensure that NMFS engagement is considered to reduce harm associated with continued operation and maintenance of the WVS.

RPA 1.3 Define specific corrective actions to be taken through adaptive management throughout implementation. For each basin, specify what actions USACE would take to remedy or modify poor performance of interim measures or other operational/structural elements of ongoing operations, and identify dates by which corrective action would be taken in coordination with NMFS. This ensures that the AM process includes a commitment to correct for underperforming operations or other undesirable outcomes with a reasonable amount of certainty, rather than just studying and discussing them. The Corps shall provide a timeline for specific actions and information needed within the first year after this Opinion is signed, for an agreed upon subset of all interim measures; others interim measures will follow in the second year.

Rationale for RPA 1.3: The Corps' AM Plan includes the key elements of coordination, information gathering, information processing, and decision making. However, it lacks specificity regarding the decision triggers and corrective actions that would be taken when necessary. It is important for USACE to identify which actions would occur in response to knowledge gained through the AM process. Without closing this loop, the AM Plan lacks completion and accountability in any given situation year to year. Under the current plan, many years would pass before a remedy to minimize take of UWR Chinook salmon and steelhead may be implemented.

RPA 1.4 The Action Agencies will provide NMFS with draft study results and design feasibility studies for review. The Action Agencies will address comments received from NMFS when finalizing a document.

Rationale for RPA 1.4: The intent of the RPA is to ensure that NMFS feedback and review does not become aggregated or lost within the context of the larger WATER review processes. NMFS plays a unique role during the implementation phase of measures. This consultation involves many measures that are awaiting analysis of study results and design feasibility studies before specific decisions can be made. NMFS anticipates that it will be closely involved in review of all facets of these studies and analyses to ensure that decisions made are consistent with the proposed action and this RPA.

RPA 1.5 The Action Agencies shall conduct RM&E as determined through AM implementation, and RM&E elements of other portions of this RPA, consistent with general provisions intended to minimize harm to ESA species while allowing for necessary data gathering activities.

- The Action Agencies shall minimize take by working with NMFS staff to coordinate research and monitoring activities they fund with those of other funding and implementing agencies. This is to ensure that necessary data are being collected in a manner that minimizes overall disturbance to fish and reduces the impacts on listed species.
- The Action Agencies shall continue to support monitoring and coordination forums and other efforts that the region's tribes, state agencies, other Federal agencies, non-governmental organizations (NGOs) and other entities participate in to coordinate monitoring actions.
- The Action Agencies shall minimize the impact of take resulting from the proposed RM&E actions by implementing harm minimization measures to be provided by NMFS and/or included in contract specifications. (See list of general provisions provided as an appendix to this Opinion).

Rationale for RPA 1.5: RM&E is an essential component of AM implementation and is necessary to determine efficacy of almost every operation or measure implemented by the Action Agencies. RM&E activities must be carried out in a manner that minimizes harm to UWR chinook and UWR steelhead, to the maximum extent possible. Therefore, contractors and Action Agencies must follow harm reduction protocols provided through the contract specifications and/or by NMFS; doing so will reduce take while gathering critically important information needed to make management decisions under the AM implementation plan.

6.2 Flow Management RPAs

The modified flow regime proposed by USACE in the PA has the potential to harm various life stages of UWR Chinook and steelhead, especially during very dry years. The impact of this proposed flow regime is one of the key drivers for the jeopardy determination; thus, it requires significant coordinated planning to establish a less harmful flow management plan that would contribute to avoiding jeopardizing the existence of UWR Chinook and UWR steelhead.

RPA 2 Flows

RPA 2.1 The Corps will abide by the 2008 mainstem and tributary Willamette flow management and water contracting RPAs (NMFS 2008a, RPAs 9.2 and 9.3), as they have been implemented adaptively with NMFS coordination, for at least the first year following the signature of this Opinion. During the first year of implementation, USACE, BOR, and NMFS will develop a joint Flow Management Plan (FMP) including an annual coordination process that would be undertaken by the Flow Management and Water Quality Technical (FMWQT) team. The FMP must be completed in coordination with, and receive concurrence by NMFS, within one year of this Opinion being signed. If the FMP is not completed within one year of NMFS signing this Opinion, USACE shall continue to meet 2008 RPA mainstem and tributary Willamette flow objectives when possible and coordinated with NMFS, until the FMP described above is implemented. This plan development will occur concurrently with section 7 consultation with BOR on its contracting program, for which the proposed action will need to be considered to develop the flow management regime. NMFS and the Corps will determine which small groups will need to be convened to facilitate plan development.

This FMP will be implemented through a documented annual coordination effort similar to the current process followed by the FMWQT Team during each water year. This coordination process will require the agencies to document critical decisions on any flow modification in real time throughout the year, via Memos of Coordination. After reviewing these memos NMFS may provide a letter acknowledging and concurring with that change. The FMP will also include potential mitigation options to offset adverse effects of anomalous events within the Corps' control that result in adverse water quality impacts that are likely to occur through implementation of the FMP, and it will also include environmental flows that are intended to benefit habitat and other species.

Rationale for RPA 2.1: The RPA outlined above will maintain the 2008 RPA mainstem and tributary Willamette flow objectives for at least the first year after this Opinion is signed, while the agencies work together to develop a new flow management plan that will reduce harm to migrating, rearing, and spawning UWR Chinook salmon and steelhead; while also considering other consultations that impact flows including, BORs water marketing program, the HGMP Opinion, and the Willamette Basin Review.

Please refer to "RPA 4.2: Comprehensive Basin-Wide Monitoring Program to Inform Adaptive Management Decision-Making" for flow RM&E related to fish passage and migration.

RPA 2.2: The USACE will continue to abide by the ramping rates at all WVS projects as outlined under the 2008 Opinion RPA (RPA measure 2.6, Tables 9.2-3 and 9.2-4) and current Willamette Fisheries Operations Plans.

Rationale for RPA 2.2: Since the Action Agencies did not include information about ramping rates at the WVS projects in the Proposed Action, it is included as an RPA to reiterate the need to continue adhering to the 2008 RPA ramping rules, as outlined in the 2008 Opinion (NMFS 2008a).

6.3 Water Quality Management RPAs

The adverse effects of the PA on listed fish and critical habitat include water temperatures and TDG levels that exceed healthy limits for ESA-listed salmonids in areas where listed fish continue to rear, spawn, and migrate and where inadequate passage conditions prevent ease of migration beyond the affected areas. The PA also causes adverse effects on critical habitat conditions downstream of the dam due to temperature and TDG exceedances of thresholds. The water quality measures in the below RPA will minimize effects of the proposed action, including reducing mortality due to high water temperatures and TDG.

Some of the measures in this section of the RPA provide interim protection for listed fish and critical habitat by requiring the Action Agencies to implement and monitor ongoing or new temperature control measures in the next few years.

RPA 3 Water Quality

RPA 3.1 Basin-Wide: The Action Agencies will continue to carry out operational measures using existing dam conduits such as spillways, regulating outlets, and turbine outlets attempting to achieve established temperature target minimums and maximums (in WFOP), and reduced total dissolved gas (TDG) concentrations below Project dams, including Detroit/Big Cliff, Green Peter/Foster, Hills Creek, Lookout Point/Dexter, and Fall Creek, unless operating for flood conditions.

Rationale for RPA 3.1: Currently, listed fish are rearing, migrating, or spawning in inadequate habitat below the Project dams. Water quality problems are one of the major limiting factors in this habitat and prevent proper functioning of critical habitat directly below all of the Project dams listed above. Therefore, until long term solutions for effective passage through the reservoirs and dams from upstream functional habitat are available, it is important to maintain the habitat below the dams for listed fish.

RPA 3.2 Mainstem Willamette Temperature Management: Via pulses of flow, USACE proposes to attempt to reduce water temperatures below thresholds during migration for WCR Chinook and steelhead by releasing flows from WVS reservoirs above the proposed minimum flows, based on regression models predicting water temperature from flow and air temperature (Stratton Garvin et al. 2022a and 2022b), or updates to these models. The goal is to reduce the effects of heat waves and hot air temperatures on water temperatures. NMFS and USACE shall coordinate when these pulse events are proposed, to decide if these releases are appropriate, based on the following:

- Life history stages for UWR Chinook salmon and steelhead that are expected to be present in the mainstem.
- Adjusting the proposed timing to prevent longer periods of warm temperatures, using the proposed 7-day average daily maximum (7dADM) trigger, or if higher water temperatures are present, to begin releases earlier.
- The trade-offs between releasing water for mainstem temperatures and reduced stored water for instream flow targets later in the spring or summer.

Rationale for RPA 3.2: Past experiments with the 'pulsed' releases reduced temperatures as predicted, and earlier responses to higher water temperatures could provide sensitive life history stages, particularly Chinook adults, with relief sooner, especially when flows are lower than minimum objectives. As RPA 2.1 notes these will be the same as the 2008 RPA until the joint flow management plan is completed, and the benefits of past and ongoing changes can be reviewed as part of that plan.

RPA 3.3 Middle Fork Willamette. Implement alternative passage operation timing in Lookout Point and Dexter reservoirs and below Dexter Dam by continuing to review and modify the passage and temperature operations, using a combination of physical modeling, review of existing data and further RME to find an optimal mix of Lookout Point spill, turbine, and RO flow. This will reduce high temperature exposure in the reservoir and downstream, and lower prespawn mortality risk. USACE shall reduce temperatures during fall deep drawdown passage actions by modifying the timing relative to reservoir conditions (for mixing of layers, amount of potential natural cooling, etc.). USACE shall also review spawner conditions for adults handled in the newly rebuilt Dexter adult fish facility and move spawners upstream to release sites as early as practicable to avoid exposure to higher temperatures.

Rationale for RPA 3.3: The proposed action operational temperature target for Lookout Point and Dexter reservoirs is 3-6 degrees higher than the targets used currently (proposed action Table 2.2-7), contributing to existing warm temperatures causing additional stress to UWR Chinook salmon. Temperatures recently observed in the summer months in Middle Fork Willamette reservoirs and below Dexter Dam already consistently exceed temperatures that cause stress to adult Chinook salmon. Modifications to operational passage and temperature management as described in this RPA, will improve downstream holding conditions for spawners.

RPA 3.4 North Santiam Temperatures and TDG operational measures. Prioritize lower temperature blend and minimize TDG below Big Cliff. If spill at Detroit for temperature or passage is limited by elevations or TDG values, mix regulating outlet (RO) flows with turbines to improve temperatures when adults are holding or spawning. Use multiple spill gates to reduce TDG, along with turbines during periods migrating juveniles are not expected to be passing through Big Cliff, based on monitoring. By the end of March 2026, the Action Agencies will evaluate the feasibility of operations at Detroit/Big Cliff Dams, if modified, to improve downstream temperature and TDG conditions for Chinook salmon spawners during warmer periods. This will include a review of forecast informed reservoir operations (FIRO) noted below in the interim passage (4.12.1), to increase likelihood of refill to spillway elevation, and provide spill as late as possible.

The AM Plan should review the effects of maintaining the cooler flows provided by mixing between turbines and spillway, using Detroit turbines only when the spillway and ROs are not available, and incorporating the upper and lower ROs when elevations allow. Further, TDG abatement structures below Big Cliff Dam, with phase I expected to be tested in 2026, should provide additional flexibility for temperature operations, with lower risk of excessive TDG.

Rationale for RPA 3.4: The additional efforts to provide cooler water below Big Cliff Dam will improve habitat and survival for adult Chinook holding or spawning in these reaches. Other benefits include potential lower incubation temperatures from RO use in the fall. Reducing TDG will increase survival of rearing and migrating juveniles affected by current spill and RO use.

RPA 3.5 North Santiam Assessment of water quality structural and operational alternatives. With RM&E from recent biological and physical data for Detroit Dam and Big Cliff Dam operations to improve downstream temperature conditions, assess the operational and structural model results for average, and dry / hot years. Complete an assessment of the operational and structural water quality alternatives, including effects on different populations and life history stages, and provide as a report no later than December 2027. This should be prioritized prior to continuing work on the proposed selective water structure (SWS). This analysis will inform selection of the most appropriate downstream water quality control methods, and will build on updated information developed through injunction temperature control operations at Detroit Dam with spill, turbine, and regulating outlet releases to manage downstream temperatures. The Corps will update past evaluations using spawning surveys and genetic pedigree study results, to build on earlier cohort replacement rates (CRR) results for Chinook salmon spawning at sites above Minto Fish Facility and Detroit Dam.

If after this process and reviews outlined in RPA 4.13.5, the EDR team and NMFS staff determine that constructing and operating the SWS delay the benefits of safe passage for UWR Chinook salmon and steelhead in the North Santiam, then operational alternatives will continue to be implemented and modified via the AM Plan with input from WATER's FMWQT team.

Rationale for RPA 3.5: While the design for the SWS showed benefits of mixing warmer and cooler waters, similar to the operations of the temperature control tower at Cougar, the modeling results for the SWS operations show a tradeoff between warmer summer temperatures and fall cooler temperatures, in essence exchanging effects on spawners in the summer with those on fall incubation in the reaches downstream of Big Cliff Dam. If the benefits to spawners upstream outweigh those to downstream reaches, with future passage achieved sooner for upstream juveniles migrating juveniles, the SWS necessary actions should be reconsidered.

RPA 3.6 South Santiam Operations and Temperatures. Following the AM Plan, monitor changes in operations from Green Peter spill and drawdown passage, then revise actions, if necessary, to ensure appropriate temperatures below Foster for upstream migration, holding, spawning, incubation, and rearing. Adjust weir timing so adults enter Foster adult facility ladder. If 2024 plans to delay fall drawdown to lower spawning temperatures are successful, adjust future operations, with further analysis of effects on duration and success of juvenile fish passage past Green Peter and Foster Dams. (See details in RPA 4.2).

Rationale for RPA 3.6: To monitor and modify effects of the Green Peter spillway and deep drawdown RO passage measures to avoid exceeding Foster temperatures targets. This will decrease the effects on spawning from higher temperatures during fall drawdown, as well as spill temperature effects during migration, and rearing below Foster Dam.

RPA 3.7 Monitor sediment distribution, initially at Lookout Point/Dexter and Green Peter / Foster. The Corps will continue to coordinate the USGS 2024 Deep Drawdown Turbidity Sediment Study to measure fine sediment load mobilization and suspensions from Lookout Point and Green Peter fall drawdown operations following objectives and methods currently described in the August 2024 Bi-annual Status Report (USACE 2024c). Continue to monitor as long as deep drawdown operations take place at these projects. Propose and implement management operational measures to reduce loads downstream with monitoring. Additionally, study turbidity changes in the Cougar and Fall Creek drawdowns to augment past studies in order to inform AM decisions. Report annually to WATER FPOM and other teams and coordinate proposed improvements to operations to provide potential modifications.

Rationale for RPA 3.7: Fall drawdown passage operations have resulted in increased turbidity events. The effects of increased turbidity during deep drawdowns on fish physiology, fish passage, and other environmental factors should be tracked to determine whether such operations are affecting migrating juveniles, or spawning in reaches below dams. This proposed analysis began in 2024 and will continue annually in order to will inform adaptive management decisions on operational passage.

RPA 3.8 Compile water quality data from existing sources into an accessible database. The Action Agencies will monitor and upload hourly water quality data for metrics listed below to a database. The database will be accessible for NMFS to query at any time and export hourly water quality for monitoring and assessing the effects of operations on water quality metrics that may also affect fish survival and passage. The Action Agencies will also provide the WATER technical teams with a summary of the most recent data and compare with prior years' data for the same locations, especially when it is useful for comparing the effects of different operations, between or among years, or similar operations under different environmental conditions (between or among different time periods).

- TDG
- Temperature
- Turbidity
  Summary data for available metrics will be completed by summer 2025 in the AM process. Additional measurements and database development to ensure that water quality can be routinely tracked and queried will be completed before the 2026 AM process.

Rationale for RPA 3.8: This RPA would synthesize existing and newly collected information into a single, easy to access, repository that can be exported to an Excel file and used as needed. The information is critical for the AM decision making process and needs to be quickly generated and accessed for timely analysis within the annual AM cycle.

Please refer to RPA 4.2: "**Comprehensive Basin-Wide Monitoring Program to Inform Adaptive Management Decision-Making" for water quality RM&E related to fish passage and migration.**

6.4 Fish Passage RPAs

Specific passage measures, agency coordination, and providing timely passage, are necessary to improve viability of adults passed above dams and improve juvenile fish passage conditions that do not meet NMFS criteria. Therefore, NMFS includes the RPAs below to expand upon and improve the fish passage elements of the proposed action provided by USACE.

RPA 4 Fish Passage

RPA 4.1: Flood risk operations and structural failure-related operations will be managed in accordance with the WFOP, and other appropriate Action Agency emergency procedures. Such actions will be used as a last resort and will not be routinely used in place of other operations outlined in the WFOP. They may be modified for brief periods of time due to unexpected equipment failures or other conditions. These events can result in short periods when projects are operating outside normal specifications due to unexpected or emergency events. Where there are significant biological effects of more than one to two days duration resulting from structural failures or other dam-related events impacting fish, the Action Agencies will develop and implement appropriate actions to address the situation in coordination with the WATER Technical Teams and the in-season management process. If concurrence on a specific action or operation is needed immediately, coordination can be done via email and/or scheduling an emergency meeting with the Services.

If any dam project structure or operation malfunctions or needs to be placed out of service for repair, and it may affect ESA-listed fish species but is not considered an emergency, the Action Agencies will both notify and discuss with NMFS prior to taking further action. The Action Agencies will follow the notification protocol described in the WFOP.

Rationale for RPA 4.1: Inevitably, unforeseen events will occur that require timely decisions. For those instances, NMFS provides this RPA to memorialize a prescribed, step-wise, process for decision making and coordination.

RPA 4.2: Comprehensive Basin-Wide Monitoring Program to Inform Adaptive Management Decision-Making

Institute a comprehensive, multi-basin monitoring program to inform adaptive management decision-making using the following monitoring objectives to develop the program, including but not limited to: evaluating juvenile survival, evaluating adult survival, evaluating project operation effects (such as flow and water quality effects) on fish migration and survival, monitoring smolt-to-adult returns, fish status and trend monitoring, and prioritizing fish passage related maintenance issues.

The Action Agencies will install, operate and maintain passive integrated transponder (PIT) tag detection arrays at each of the following locations, as deemed technically feasible by the Corps and PIT detection technology experts. The Corps and Action Agencies (and the WATER technical teams) will consider installing the arrays using the following order of prioritization and within the following timeframe, unless it is proven that no technologically feasible location exists within an area. If the Corps and the WATER technical teams agree that a different order of prioritization is preferable, NMFS will consider their justifications for doing so and may provide concurrence.

These PIT tag detection array designs, specific locations, and the order of installation will be confirmed through coordination with the NMFS, USFWS, and the WATER technical teams. Design, operation and maintenance should be coordinated with and by Pacific States Marine Fisheries Commission Staff to ensure these systems meet criteria for the PIT Tag Information System (PTAGIS) database. All detections and original tag release information will be uploaded to PTAGIS on a frequent basis (weekly, if not daily). After installation, studies will be conducted to establish detection efficiencies for each location. The current PIT tag detection array in the South Santiam (i.e. at Lebanon Dam) may count toward the South Santiam location requirement (between Foster Dam tailrace and the lower South Santiam), if NWFSC staff agrees that the maintenance issues at the Lebanon PIT array can be resolved with an improved design.

1st Priority by February 2028:

- In the Willamette Falls ladders to track adults;
- Below Willamette Falls Dam (within 500 meters of the tailrace);
- Below Big Cliff dam;
- In the Green Peter Dam tailrace;
- In the Cougar powerhouse and RO tailraces;
- In the Hills Creek Dam powerhouse and RO tailraces;
- In the Dexter Dam powerhouse and spillway tailraces;
- In Lookout Point powerhouse and spillway tailraces;
- Between Foster Dam tailrace and the lower South Santiam confluence (e.g. Lebanon).

2nd Priority by February 2029:

- Between Big Cliff Dam and the North Santiam confluence;
- Between Cougar Dam and the lower McKenzie confluence;
- Between Dexter Dam and the lower Middle Fork Willamette confluence;
- In the Fall Creek Dam tailrace.

After successful installation of PIT detection in at least one of the four critical sub-basins and also at the Willamette Falls locations, by 2028 the Action Agencies will initiate a juvenile Chinook and steelhead PIT tagging program through capturing, tagging and releasing natural-origin fish found above USACE dam projects prior to the start of their downstream migration and hatchery-origin fish prior to release, and possibly even natural-origin fish found below USACE dam projects. The PIT tagging and detection program will work to collect the following information to help inform decision-making for WATER technical teams and the Adaptive Management process. Some of this information will require the collection of fish length (or life history category) data at tagging, tagging/release date, and the ability to assign this data to an individual PIT tag code. If installation of a PIT array detector at any of the aforementioned locations is deemed infeasible, RSTs or active tags may be considered as acceptable monitoring alternative. When critical information is needed to assess the effectiveness of a continued, new or modified operation (or structure), or to meet take monitoring requirements as outlined in the Incidental Take Statement (Chapter 11) it may be necessary to use more than one method of monitoring. Use the protocol from Columbia River for minimal harm to tagged fish.

Reporting

The Action Agencies will analyze and summarize the PIT tagging and detection data by species on an annual and multi-year basis at intervals agreed upon by the WATER technical teams and Adaptive Management Team that are certain to inform the adaptive management process and critical decisions for the following year (both dam and reservoir operation plans and budget prioritization decisions). The information to be included in annual and multi–year reports will incorporate flow and water quality data to fully inform the effects of previous year project operations, along with the climate and environmental conditions that can vary within and among years.

Annual Reports will include figures, tables and analysis that summarize the following information. WATER technical teams and the Adaptive Management process will determine the importance and usefulness of these data summaries over time, and may make additional recommendations to add or remove analyses over time.

- Total fish tagged (and released) by species, natural-origin vs. hatchery-origin, release location, release date.
- Figures of total juvenile UWR Chinook salmon and steelhead detected at each downstream detector (in tributaries, at or below projects), by date, along with daily average tributary river flow (one figure for each sub-basin and one split between hatchery-origin and natural-origin), ideally with life history stages identified.
- Figure of total juvenile UWR Chinook salmon and steelhead detected at or below Willamette Falls Dam, by date, along with daily average river flows at Albany and Salem (split between hatchery-origin and natural-origin, and sub-basin of origin, ideally with life history stages identified), and any pertinent water quality data.
- Figures of juvenile UWR Chinook salmon and steelhead weekly average travel times from detectors in tributaries (at or below projects) and Willamette Falls, by date (using date of first detection below USACE dams), along with daily average flow in the Willamette at the Albany and Salem gages, and daily average (respective) tributary flow (one figure for each sub-basin of origin, with another showing the split between hatchery-origin and natural-origin).
- Cumulative percent of adult UWR Chinook and steelhead runs passing Willamette Falls adult fish ladder by date along with daily average flow (below Willamette Falls) and Willamette River temperature daily minimum and maximums (near Willamette Falls). Highlight dates when mainstem pulse flows were delivered, their release locations and total flow released. If possible, split and compare among sub-basin of origin and hatchery-origin vs. natural-origin.
- Figures of adult UWR Chinook and steelhead average travel times between Willamette Falls and detection locations in natal tributaries (or at AFFs) by date of arrival at Willamette Falls along with pertinent flow or water quality information. Highlight dates when mainstem pulse flows were delivered, and source, if possible. If possible, split and compare among sub-basin of origin and hatchery-origin vs. natural-origin.
- Figures of total daily UWR adult Chinook salmon and steelhead at each of the adult fish facilities (AFFs) (Minto, Foster, Cougar, Dexter) by date along with daily pertinent river flow and water quality (TDG, temperature) data, and also pertinent associated project operational data (i.e. turbine, spill, RO flows that may influence adult attraction to the AFFs). Split between hatchery-origin and natural-origin.

3-Year Reports will include figures, tables and analyses that summarize the following data from all previous years in which data was collected:

- Among year comparisons of juvenile downstream travel times, juvenile downstream migration timing, and survival rates using detections by sub-basin of origin, size or life stage categories, migration season, hatchery vs. natural-origin.

- Among year comparisons of adult upstream travel times, adult migration timing and adult freshwater migration survival rates (all groups together and separated by sub-basin of origin, and hatchery vs. natural-origin groups).
- An analysis and summary of the relationships between the aforementioned fish passage and migration metrics, pertinent dam project operations and co-occurring environmental conditions.

Rationale for RPA 4.2: Releasing PIT-tagged fish into a basin with multiple arrays will be an efficient method of acquiring migration data. The consistent collection and summarization of this data will allow for a comprehensive understanding of how dam and reservoir operations are affecting reservoir and dam passage, and migration of UWR juvenile and adult Chinook salmon and steelhead. Tracking the requested metrics for fish passing through USACE projects, and through downstream reaches affected by dam operations (including the Willamette River mainstem) will be essential to informing the proposed Adaptive Management processes. Not only will this monitoring effort inform effects on overall UWR Chinook and steelhead from proposed dam operations and modifications, but most importantly, how individual populations and sub-groups are affected by the operations and conditions unique to their sub-basins. It will also be critical for assessing how individual populations are responding to passage conditions, flow and water quality changes over time, and inter-annual differences in climate and precipitation within each sub-basin. Flow, TDG, turbidity and temperature affect essential migratory habitat for juvenile and adult salmon and steelhead, migration timing and their ability to survive during downstream migration to the ocean, and upstream to their spawning grounds. Willamette River mainstem temperatures exceed temperatures considered safe for juvenile and adult salmonids. Proposed pulse flows and other operations affecting mainstem Willamette River temperatures require monitoring to measure the magnitude and duration of lowered temperatures, and their ability to improve migratory corridor habitat conditions. In contrast, active tagging studies can be more costly, and are limited by active tag battery lifespans. Rotary screw trap monitoring can also be costly, and is limited by low trapping efficiencies at most sites.

RPA 4.3 Adult Upstream Migration, Collection and Out planting - Multiple Sub-Basins

RPA 4.3.1: The Action Agencies will install temperature probes in each of the adult fish facility ladders and create a website where the real-time temperatures can be viewed in relation to the river temperatures directly below the fish ladder entrances.

RPA 4.3.2: Install PIT detectors, or comparable fish detecting sensors in all adult fish facility ladders, and ensure that any PIT detectors currently present in these ladders are maintained and fully operational: Minto, Foster, Cougar, Dexter and Fall Creek. Keep new and old detectors operational and upload detection data from each facility to PTAGIS, or other comparable database, on a monthly basis, or more frequently when operations are changing weekly.

Rationale for RPA 4.3.1-4.3.2: These RPAs will improve transparency between the Action Agencies and NMFS (and all Regional stakeholders) in regard to issues that may be affecting any facility's ability to attract and collect adult UWR Chinook salmon and steelhead in a timely fashion, and the safe and timely transport of adults to their release sites. This information can also be used by the WFPOM and Adaptive Management Team to identify instances when the adult facility ladder conditions are not efficiently and effectively attracting and collecting adults, and thus could be delaying them in their arrival to critical spawning ground habitat. This information will also alert the WFPOM and Adaptive Management Team to dam operations or other conditions including flow and water quality factors that may delay adult salmon and steelhead arrival to critical spawning ground habitat, and could cause higher prespawn mortality or reduce their ability to successfully reproduce.

RPA 4.3.3: The Action Agencies will conduct UWR Chinook salmon spawning surveys for fish affected by the USACE dam operations in two of the four sub-basins per year. They will alternate each set every other year in the North Santiam and South Santiam Rivers. In the McKenzie and Middle Fork Willamette Rivers, surveys above the dams are also needed to understand handling and pHOS effects. The selected sub-basins and survey protocols must be reviewed by NMFS, and coordinated through the annual Adaptive Management process. Collection of data will include prespawn mortality assessments, counts of all fin-marked or intact adipose fins, and tissue samples for genetic pedigree analyses. Results for the previous years surveys will be submitted to NMFS by March 1st of the following year.

RPA 4.3.4: The Action Agencies will create a task group within the WFPOM Team to advise them of a consistent template and method for updating adult fish facility counts and adult outplant counts. The task group will also compile and verify past adult fish facility collection data and outplanting data that will be summarized for ease of comparison with future returns and outplanting efforts.
The new template for adult returns and outplants will include the following:

- Number of adults returning to the facility by species, date, origin (natural-origin or hatchery origin), sex (male or female) - as subcategories of natural-origin and hatchery-origin, including running totals by date for the entire year. The data for an entire year of operation will not be split up by month, but will be added to the same workbook over the course of a year.
- Identification of updated calculations for timing of 10-year average of 25% return, 50% return and 75% return.
- Identification of ladder operation dates (dates open/ closed).
- Facility minimum and maximum temperatures by date, in the sorting pool, also for other locations as other loggers are added.
- Number of adults outplanted by date, release site, origin (natural-origin or hatchery-origin), sex (male or female - as subcategories of natural-origin and hatchery-origin),
- Release site stream temperature at time of release for each release date.
- Annual summaries for past years (since data collection began) will include the following for UWR Chinook salmon and steelhead:
    - Dates when 25%, 50%, 75%, and 100% of the run had been collected (analyzed individually for hatchery-origin and natural-origin groups, as well as natural-origin males vs. natural-origin females).
    - Figure for each adult facility showing adults collected by date for the whole year (split by hatchery and natural-origin, males and females).

- Figure for each sub-basin showing adults outplanted by date for the whole year (split by site, and males and females, possibly with a note on the origin, especially if it has changed over time).

RPA 4.3.5: In addition to the proposed "Maintenance of Existing and New Fish Release Sites Above Dams" in the Proposed Action (USACE 2024a), the Action Agencies will assess current and potential adult release sites and report as part of the Adaptive Management process by 2031. The updated assessment will include:

- Determination of whether the UWR Chinook salmon spawning habitat accessible from each site has adequate temperatures during months of release, and will likely remain so under anticipated climate change. This may require the installation of new stream gauges at proposed sites, and in some cases spawner surveys to determine if high temperatures cause prespawn mortality. When available, use climate change models for stream temperatures in spawning reaches.
- Determination of whether UWR Chinook salmon spawning habitat available is sufficient for the number of adults to be released there (no major issues limiting production).
- Where spawning habitat no longer meets minimal UWR Chinook salmon spawning requirements, determine necessary habitat restoration work.
- Determination of new release sites with adequate stream temperatures, including anticipated changes over the next 30 years.
- A proposed adult release site list (where landowner access and release site needs are met) that is specific to steelhead spawning habitat requirements which would be used for future steelhead releases in areas above Green Peter and Detroit Dams.

RPA 4.3.6: Beginning in 2025, or at the soonest possible opportunity to secure contract support, the Action Agencies will continue to conduct rotary screw trap (RST) operations for at least one location above reservoirs (below an adult release site and below spawning habitat), in order to monitor and assess productivity over time. NMFS recognizes this won't be possible at Quartzville Creek in the Middle Santiam for lack of BLM approval to place an RST (in a Wild and Scenic River reach), so other methods will be used at this site. This operation will be carried out in conjunction with the PIT Tagging Program for natural-origin juvenile UWR Chinook and steelhead outlined under RPA 4.2. This monitoring work will occur during known periods of outmigration and when conditions are safe for conducting RST sampling activities. The duration of this monitoring effort should be determined through the Reintroduction Program / Adaptive Management Team. The Action Agencies will consult with the Adaptive Management and WATER RME Team about proposed RST sites, fish sampling and tagging methods, and trap efficiency test plans and methods prior to the start of field work.

The Action Agencies will submit a monthly report to NMFS and the Adaptive Management Team's Reintroduction Team with the number of fish collected at the screw traps (by date and size and species) below reintroduction areas. At the end of each year, RST results from the most recent year will be summarized by the Action Agencies along with data from all previous years for each individual reintroduction area. This should include migration timing (frequency of fish by date), size of fish at outmigration by date, and estimated total juvenile outmigrant population size by year. The Action Agencies will include spawning survey data (for new release sites) in the same report and will be similar to the information reported for current spawning surveys taking place above Green Peter Dam. This information will help inform Adaptive Management process decisions related to Reintroduction Plan efforts, release site performance etc.

Rationale for RPAs 4.3.3-4.3.6: These RPAs are related to updating, improving, and monitoring the success of the adult reintroduction efforts at locations above USACE dams, and to informing the adaptive management process for this effort. Since a large percentage of the historical UWR Chinook salmon and steelhead spawning habitat is located above USACE dams, and a proportion of this habitat is likely to be more resilient to predicted climate change effects on stream temperatures and flows, adult release and reintroduction success is a critical component of the RPA for UWR Chinook salmon and steelhead populations in the affected basins. The rationale for RPA 4.3.4 specifically, is that while the action agencies are currently required to collect and maintain this data for all adult fish facilities and outplanting efforts, there are inconsistencies in how each facility reports its data (how counts are categorized by groups) and how often the spreadsheets are updated on the FPOM website (and made available). The data is currently reported bi-weekly, which makes it challenging for an end-user to summarize or visualize the timing of the returns for an entire "run" over that year, and also to compare information among different years or look at trends over time.

RPA 4.3.7: The Action Agencies will ensure completion of existing genetic pedigree sample lab analysis and distribute analysis results by early 2027. They will also continue pedigree analysis reporting on a consistent basis with funding requests submitted annually. The contracted work will include genetic pedigree sample lab analysis, data analysis, and reporting needed for currently unanalyzed sample groups from the North Santiam, South Santiam, McKenzie and Middle Fork Willamette sub-basins. With input from NMFS, the Action Agencies will ensure annually contracted studies will prioritize critical information for making adaptive management process decisions. The information collected and analyzed by this project will evolve over time along with reintroduction plan goals, and passage improvements, and may include future UWR steelhead samples.

Rationale for RPA 4.3.7: Recent genetic pedigree analyses will continue to be an essential tool for the comparison of natural and hatchery origin fish recruitment success in the reintroduction and outplanting efforts. The timing and funding to complete lab and data analysis and reporting was inconsistent or nonexistent in recent years. Ensuring pedigree analysis is completed annually for the UWR Chinook salmon adult samples, and for future UWR steelhead samples, will provide necessary information for the implementation of the outplanting in ongoing or updated reintroduction plans in a responsive fashion. Ensuring that the genetic pedigree results are updated is critical to informing the Adaptive Management process and the Reintroduction Plan in a timely fashion.

RPA 4.4 Adult Upstream Migration & Collection in the Middle Fork Willamette Sub-Basin

RPA 4.4.1: Before completing construction of the new Dexter Adult Fish Facility in May 2026, the Action Agencies in coordination with the Adaptive Management Team and WATER's Willamette Fish Passage and Operations Management Team, will decide how to assess adult attraction and collection performance at the new facility. USACE plans on additional work in 2026 to install juvenile fish screens. They note that the new facility will be tested and commissioned prior to the 2026 adult collection season.

The AM Plan teams will provide advice on the annual start and end dates for operation of the fish ladder, and collection of fish to move above the Lookout Point and Hills Creek facilities. These dates will ensure collection of most natural-origin and hatchery-origin Chinook salmon adults to support the survival of the Middle Fork Willamette population and adult Reintroduction Plan goals, and limit exposure to warm, stress-inducing temperatures in the river. Any natural origin adult returns that may be outplanted, or collected for broodstock, should be prioritized for optimal survival to avoid jeopardy.

Rationale for RPA 4.4.1: Improved handling of adult Chinook in the Middle Fork will lower prespawn mortality, and improve productivity and abundance. The new adult facility will be ready in 2026 for collection, with juvenile screens following soon after. Before then the reintroduction goals for Chinook will guide the ongoing outplanting, and any modifications will be agreed on as part of the WFOP.

RPA 4.5 Adult Upstream Migration & Collection in the South Fork McKenzie

RPA 4.5.1: The Action Agencies, in coordination with the Adaptive Management Team and in WATER's Willamette Fish Passage Operations & Maintenance regional forum, will assess adult attraction and collection performance at the Cougar Dam Adult Fish Facility. The WATER team will recommend changes in operations, including modifying current recycling adult returns, where spawners are floy-tagged and returned to South Fork McKenzie lower reaches.

Rationale for RPA 4.5.1: These changes will lead to more efficient collection of natural-origin and hatchery-origin Chinook salmon adult returns to support the HGMP, Reintroduction Plan, and contribute to avoiding jeopardy. This process will lead to review and modifications that benefit ladder operations.

RPA 4.6 Adult Upstream Migration, Collection & Outplanting in the South Santiam Sub-Basin.

RPA 4.6.1: Assess Spring / Summer Dam operation effects on temperatures below Foster Dam and in the Foster Adult Fish Facility. By 2026, provide a report to NMFS and the Adaptive Management Team regarding how modified passage operations at Green Peter and Foster affect river temperatures below Foster Dam, and temperatures in the Foster adult fish facility and ladder by comparing temperatures observed in these two locations in previous years.

RPA 4.6.2: Develop and assess feasibility of sorting spawners at Foster Adult Fish Facility. Prior to completing the design of the proposed Green Peter adult fish facility, the Action Agencies in coordination with fish managers and WATER will evaluate other alternatives for how adults returning to the Foster Adult Fish Facility will be selected for transport and outplanting at sites above Green Peter Dam and Foster Dam. This alternatives analysis process will be carried out under the AM process and coordinated with the Reintroduction Plan (refer to RPA 1.1) Team, prior to moving forward. Alternatives considered should include, but are not limited to the following:

- Feasibility and effectiveness of separating fish only at the Foster Adult Fish Facility, based on return timing, or a subset of juveniles marked during outmigration (CWT or fin clips). This reduces handling of adult spawners and avoids high water temperatures in the Foster Reservoir release site.
- Adjustments to the salmon outplanting strategy in the South Santiam basin based on pedigree analysis results, potentially reducing releases above Foster Dam, and moving more adult Chinook salmon, and initial tests of natural origin Chinook and steelhead above Green Peter Dam.
- If NMFS finds the proposed Adult Fish Facility is necessary, the Action Agencies will consider potential release sites for transported adults with the best possible conditions, minimizing additional stressors (i.e. temperature conditions; recreational use, etc.).

Rationale for RPA 4.6.1 and 4.6.2: Changes in Green Peter operations are shown to have effects on the temperatures below Foster. The potential benefits will require that temperature data tied to the timing of changes is reviewed, and inform modifications to ensure the passage operations minimize harm to spawning, incubating, and rearing steelhead and Chinook salmon that spawn in large numbers below Foster Dam.

The 2024 PA proposed to release all unmarked adult Chinook and steelhead collected at Foster adult facility into Foster Reservoir, and anticipated adults will volitionally migrate upstream into either the South Santiam River or the Middle Santiam (Figure 4.6-1). Spawners will be exposed to Foster Reservoir conditions, and if they move to the Middle Santiam River, they will be handled at a second adult facility to be transported upstream of Green Peter Reservoir. The potential for increased prespawn mortality requires that other solutions be reviewed and tested before the construction of a new adult facility in the Middle Santiam.

Figure 6.4-1 Foster Reservoir, in which the USACE proposes to place fish where they would migrate into either Middle Santiam or South Santiam Rivers. Source USGS gage data website (accessed 08/23/2024), https://waterdata.usgs.gov/monitoring-location/14186100/

RPA 4.7 Adult Outplanting in the North Santiam Sub-Basin

RPA 4.7.1: Along with conducting adult Chinook salmon spawning surveys below Big Cliff and above Detroit Reservoir to inform outplanting, the Action Agencies will collect genetic samples from Chinook salmon adults. This will adults spawning below Minto Adult Fish Facility, adults collected at Minto that spawn in the Minto to Big Cliff reach, and adults transported to release sites above Detroit Reservoir to inform the North Santiam genetic pedigree analyses. Should results from the next North Santiam genetic pedigree analysis update corroborate recent results demonstrating greater success for above dam spawners from 2015 (O'Malley et al. 2023), then the proportion of natural-origin adults transported above Detroit will be increased.

Rationale for 4.7.1: While the ongoing outplanting of hatchery origin UWR Chinook salmon above Detroit Reservoir continues, in recent years the results from a single year of outplanting natural origin Chinook salmon showed higher cohort return rates (CRR) although still far below one, or replacement levels. This led to further outplanting in a wider range of conditions. When these newer cohorts are analyzed, higher CRR values will be considered a trigger to increase outplanting of natural origin Chinook salmon in reaches above Detroit Reservoir with anticipated higher survival of adults and offspring.

RPA 4.8 Interim Juvenile Downstream Passage - Multiple Basins

RPA 4.8.1: Until long-term passage is implemented at Project dams and reservoirs in subbasins with ESA-listed salmonids, the Action Agencies will carry out interim operational measures to pass juvenile migrants as safely and efficiently as practicable through Project reservoirs and dams under current dam configurations and physical and operational constraints, consistent with authorized Project purposes. Interim actions (many of which began under the 2021 injunction) are proposed with modifications from RM&E results following the annual AM Plan in coordination with the WATER Management Team Forums (see further details in Section 9.1).

The Corps will review existing information on juvenile downstream fish passage in each of the sub-basins to determine where data and information gaps exist. This exercise should be completed with a report synthesizing the information no later than the end of FY 2028. Additionally, for the purposes of transparency and for strengthening the Adaptive Management process, the Corps will provide NMFS with synthesized operational data at its request, which will likely be on a weekly to monthly basis. Regular data requests are likely to include but are not limited to the following:

- Hourly average total flow through the project by time of day and date;
- Hourly average flow through the project spillways by time and date;
- Hourly average flow through the project turbines by time and date;
- Hourly average flow through the project regulating outlets by time and date;
- Hourly average flow through any other major routes used in the future, such as the Cougar diversion tunnel;
- Hourly regulating outlet gate size openings;
- Hourly spill gate openings;
- Hourly reservoir elevation.

Alternatively, the Corps could maintain a public-facing database with weekly or monthly updates of this same information.

Rationale for RPA 4.8.1: To improve transparency about USACE dam operations and strengthen the adaptive management process by sharing basic dam operation data with the NMFS. This includes providing data in a format that will be easy to access and use for data analysis and questions that arise in the in-season management and adaptive management processes.

RPA 4.8.2: The Action Agencies will, in coordination with and review by the NMFS, assess factors affecting juvenile survival through the following Project reservoirs, including predation, parasites and disease, as recommended by the WATER Management Teams and the Adaptive Management process: Detroit and Big Cliff, Green Peter and Foster, Cougar, Lookout Point and Dexter, Hills Creek, and Fall Creek.

These evaluations will be developed consistent with the Adaptive Management Plan process described above in RPA measure 1. At minimum, two reservoirs will be selected for study each year through a prioritization process including a review of any recent research or survey data. The Action Agencies must seek NMFS' review of evaluation proposals. Comments submitted by NMFS on draft evaluation proposals must be considered and responded to by the Action Agencies in writing prior to initiating any research-related activities anticipated in this RPA. The Action Agencies will begin these studies in 2026, and through the AM Plan determine the frequency for further studies.

Rationale for RPA 4.8.2 In one reservoir, Lookout Point on the Middle Fork, USACE has funded studies of past and current fish behavior under operations including spring spill passage, summer temperature spill and RO operations, and fall deep drawdown passage. This should continue as these operations change. Similar studies should be conducted for Cougar Reservoir on the South Fork McKenzie River, Green Peter and Foster Reservoirs in the South & Middle Santiam Rivers, and Detroit and Big Cliff Reservoirs on the North Santiam Rivers. This will improve AM Plan inputs by providing updated information as operations for temperature and passage change conditions.

RPA 4.9 Interim Juvenile Downstream Passage in Middle Fork Willamette Basin

RPA 4.9.1: Evaluate Interim Operations at USACE Projects on the Middle Fork Willamette. The Action Agencies will evaluate the effectiveness of interim passage operations at USACE dams on the Middle Fork Willamette, potentially through the use of PIT tagging natural-origin Chinook salmon captured in North Fork Middle Fork and above Hills Creek Reservoir, and bulk release of PIT-tagged hatchery-origin Chinook salmon in Hills Creek, Lookout Point and Dexter reservoirs. The need and duration of this monitoring would be determined by the WATER technical teams through the AM process.

These ongoing efforts could be combined with the use of active tags or acoustic imaging technology near the forebay side of spillways and regulating outlets at Hills Creek Dam, Lookout Point Dam and Dexter Dam, to evaluate the following during spring, summer and fall interim operations through the Middle Fork Willamette dam complex:

- Timing of movement of juveniles from both Hills Creek and the North Fork Middle Fork to and through the Lookout Point reservoir and past Lookout Point and Dexter Dams.
- Timing of use of ungated spring spillway route at Lookout Point and Dexter.
- Correlations between increasing spillway discharge and passage rate.
- Regulating outlet passage rate in summer months when used to reduce downstream temperatures.
- Movement of predatory fish species (northern pikeminnow, small and largemouth bass, crappie and walleye) passing downstream and out of Lookout Point reservoir during drawdown operations.

Rationale for RPA 4.9.1: The evaluation of interim operations for efficacy of juvenile downstream passage in the Middle Fork Willamette will inform the adaptive management process whereby decisions will be made regarding when and where corrective action may be needed in the form of structural measures or modified operations.

RPA 4.9.2: Investigate Feasibility of Improving Passage Conditions through Lookout Point and Dexter Dams. The Action Agencies will investigate the feasibility of improving downstream fish passage at Lookout Point Dam, based in part on review of spring ungated spill, and fall deep drawdown studies to be completed by 2028 including the following:

- Investigate Lookout Point spring spill passage efficiency and survival.
- Investigate various Lookout Point reservoir drawdown rates and elevations to improve fish passage efficiency and survival (including reservoir destratification / temperature effects).
- Investigate fall drawdown temperature effects on Chinook salmon adult attraction and survival to Dexter Adult Fish Facility.

The Action Agencies (in coordination with WATER Management Teams) will also evaluate Dexter Dam for the following: 1) current spillway passage efficiencies; 2) spillway passage survival rates and injury rates, 3) how these compare to turbine passage, and 4) whether structural modifications of the Dexter spillway could markedly improve these fish passage metrics.

Once estimates for passage efficiencies and survival rates for each set of operations are established, the WATER Management Teams (through the Adaptive Management process) should assess whether the Lookout Point spill and drawdown operation is comparably effective for juvenile passage through Lookout Point and Dexter reservoirs and dams as the proposed floating surface structure passage. The above evaluations of combined operations at Lookout Point and Dexter reservoir and dams should conclude by 2029. This would allow an earlier start date for structural design work in 2030. The Engineering Design Report (EDR) and alternatives analysis for long-term structural downstream fish passage at Lookout Point is currently proposed to begin in 2034.

Rationale for RPA 4.9.2: The feasibility of using operational spill for juvenile passage in the spring over Lookout Point and Dexter Dam hinges on the feasibility of refilling these reservoirs to their spillway elevations following fall drawdown operations. It is not yet certain if both spring spill and fall drawdown operations will be possible in drier winters. Therefore, the assessment of these interim passage operations, individually, to determine which may be a more effective and safe means of passage, or if either has room for improvement via structural modifications (to spillways, ROs, etc.), is important to the Adaptive Management process and improving juvenile survival rates through the Middle Fork reservoir in the near-term.

RPA 4.9.3: The Action Agencies will evaluate fish passage parameters through the Hills Creek Dam regulating outlets including fish passage efficiency, survival, and injury rates under varying sets of conditions (season, time of day, reservoir elevation, flow, gate openings). If passage efficiency, survival, and injury rates are not shown to improve, via changing some of the conditions noted, the Action Agencies will improve passage conditions through both the powerhouse and the regulating outlets, as the juvenile Chinook salmon are using both routes under current conditions. In addition, without significant improvements by 2030, USACE will begin to evaluate the potential to improve passage via structural modifications. NMFS will provide a timeline for structural passage design work after the 2030 check in.

Rationale for RPA 4.9.3: USACE did not consider any operations other than nightly RO prioritization (6 to 10 PM) when reservoir elevation is less than 1460 ft, with no evidence that juveniles safely pass through the RO. The RPA requires modifying the RO operation to increase efficiency and reduce harm and mortality for this interim operation. Further, it moves to evaluate alternatives if the RO remains unsafe, although the USACE did not include any potential structural alternative downstream passage solution at Hills Creek Dam unless the "UWR Chinook downstream passage is not successful in at least 3 out of 4 of the proposed locations where passage is proposed." This would leave Hills Creek with no changes in the term of the current Opinion, as further evaluation would be late in the overall implementation schedule, not until 2049.

RPA 4.9.4: Action Agencies will optimize the timing of the fall drawdown operation for juvenile fish passage from Fall Creek reservoir. Current operations are to completely evacuate the reservoir to or near streambed, and hold for approximately two weeks at 680 ft elevation (PA Section 2.3.4, Fish Passage). USACE has also noted that depth to intake and flow are key variables, and data show most juvenile Chinook move during the drawdown, fewer when at the lowest elevation. Ideal timing should be assessed for start and duration of the operation, then used to improve outmigration. The evaluation should also note alternative windows over which the operation can increase life history diversity, and USACE should add these to improve passage life history stages in addition to yearlings in the fall.

Rationale for RPA 4.9.4: The Action Agencies proposed to continue operational passage at Fall Creek and described as long-term passage to be "implemented immediately after the ROD." While no changes are considered, this RPA requires that improvements in timing would be implemented after review of options other than continuing operations used from 2011- 2021, with the pool at the lower elevation for two weeks before refilling to minimum conservation pool, with no passage provided outside the fall drawdown. Also, timing of the drawdown could be affected by the proposed use of Fall Creek storage to augment flows in the Middle Fork Willamette by using the inactive pool, and this should be examined for effects on passage.

RPA 4.10 Interim Juvenile Downstream Passage in the McKenzie Sub-Basin

RPA 4.10.1 Starting in 2025, the Action Agencies will conduct the following analyses or studies to assess juvenile passage at Cougar, and will use these studies to inform the Adaptive Management Process through the WATER Technical Teams:

- Assess whether there is a relationship between past and current regulating outlet RST data on juvenile fish injury and survival rates and regulating outlet gate opening size.
- Collect and analyze data to establish juvenile passage survival rates through the turbines under various conditions (reservoir elevation, flow, use of the water temperature control tower). Use results to inform the best times for limiting turbine use.
- Collect and analyze data to establish optimal fall drawdown timing for reducing copepod exposure. Investigate whether there is a potential to reduce copepod population sizes in the reservoir through drawdown operations.
- Use the above studies, and other relevant information (including pedigree analyses) to inform changes in the RO modification expected to begin construction in 2027. (See also RPA 4.13.1.**)**

Rationale for RPA 4.10.1: These studies are needed to inform the adaptive management process, and to improve juvenile passage in the near term. They will also help determine if proposed RO modifications are necessary, or instead shifting to the diversion tunnel as a feasible fish passage solution preempts construction of the proposed RO modifications.

RPA 4.11 Interim Juvenile Downstream Passage in South and Middle Santiam Sub-Basins

RPA 4.11.1: The Action Agencies will optimize overall effectiveness of interim juvenile passage operations through Foster and Green Peter reservoirs and dams, by conducting the following analyses or studies that have already been funded in years 2027-2030, and supplementing with the other data collection efforts as soon as they are funded. They will use these studies to inform the Adaptive Management Process in coordination with WATER technical teams, prior to making operational changes:

- In addition to RST data summaries for Chinook salmon at Green Peter head of reservoir and tailraces, and steelhead and Chinook salmon at Foster head of reservoir, assess data from PIT-tagged juveniles. These may be from those tagged at the head of Green Peter and Foster reservoirs, or hatchery-origin tagged juvenile Chinook salmon released above, below, or in Green Peter and Foster reservoirs. Analyze timing and survival of tagged fish detected at screw traps, Lebanon Dam and other downstream PIT tag arrays. Summarize date of release and the date of detection for each detection location, and compare release size for hatchery-origin vs. natural-origin groups. This data will be presented by date in reference to operations at Green Peter Dam (spill, regulating outlet, turbine flow or combinations) and Foster Dam (spill and turbine flow and elevations). This information will be used to inform the Adaptive Management process.
- Using the PNNL radio frequency- tag study data, and any other applicable data from ongoing RST sampling or PIT tag detections, determine reservoir and dam passage survival rates for the spring spill and fall drawdown operations. Determine whether any differences in reservoir and dam passage survival rates among years could be attributed to changes made to the spill or drawdown operations between 2023 and 2025. Use this information to inform the Adaptive Management process beginning in 2027, with changes in operations no later than 2028.
- For ongoing drawdown operations, align the active tag studies at Lookout Point and Green Peter to track fish to the Willamette Falls.

- In 2028 (year 5 of monitoring), review combined reservoir, dam passage, and downstream survival. Assess whether structural modifications to the regulating outlet and/or spillway could improve fish passage conditions through Green Peter Dam, and work with NMFS to determine what fish passage survival rates could be attained with improved passage.
- For Foster data on fish timing of entry to the reservoir, and next detections in the reservoir or downstream of Foster Dam, review how operations affect reservoir and dam passage of steelhead and Chinook salmon at different life history stages. Use this information to inform the Adaptive Management process beginning in 2025, with changes in operations no later than 2027. If no further improvements are possible with operations by 2028, structural downstream fish passage solutions in early stages (proposed to begin in 2025) should continue with a target to complete construction in 2030.
- Design operations with forecast informed reservoir operations (FIRO) to improve Green Peter reservoir refill timing to ensure elevation is achieved for spring spill passage operations at Green Peter Dam.

Rationale for RPA 4.11.1: These studies and modifications to interim operations are needed to inform the adaptive management process and will improve passage in the near term, and to provide data for decisions and timing of alternative structural passage, which would contribute to reducing harm to the species.

RPA 4.12 Interim Juvenile Downstream Passage in North Santiam Basin. The Action Agencies will modify operations at the North Santiam reservoirs and dams to improve passage timing and survival.

RPA 4.12.1: The Action Agencies will optimize overall effectiveness of interim juvenile spring spill passage operations through Detroit and Big Cliff Dam by testing the following operations that have been funded in years 2025-2027, and supplementing with other data collection efforts not funded during that time, as soon as possible; and will coordinate these studies with the WATER technical teams to inform the Adaptive Management Process:

- When hydrologically possible, maintain Detroit reservoir elevation above spillway crest for spill passage throughout the months of April and May.
- Action Agencies will coordinate the implementation of forecast informed river operations (FIRO) to improve Detroit refill capabilities, aiming to attain spillway crest by April 1st, and continue to refill when deemed within flood risk management guidelines. This will benefit passage and temperature operations, particularly after winter or early spring in a dry year, by capturing precipitation when flood risks are sufficiently low.
- During dates that Detroit Dam is operated for spring spillway passage, Big Cliff Dam spill gate operations will be timed to allow passage for juveniles after they traverse the length of Big Cliff Reservoir.
- By year 2028, conduct an updated active tag fish passage study during spring spill operations to assess and estimate fish passage efficiency for combined Detroit and Big Cliff, route-specific mortality rates (spillway, powerhouse), and proportion of fish passing through each route. This will build on the Beeman and Adams (2015) study.

- In the short term, use survival study results to identify for the Adaptive Management process a set of operations at each project that supports highest overall passage and survival rates through both projects, including identification of windows during which turbine flow should be minimized or avoided.
- If survival through Big Cliff Dam via spillway and turbine routes is found to be <80%, investigate potential structural improvements to spillway design, and/or installation of new turbines to achieve improved dam survival at Big Cliff.

Rationale for RPA 4.12.1: These studies are needed to inform the adaptive management process and to modify operational passage to reduce harm and mortality.

RPA 4.12.2: The Action Agencies will test and improve effectiveness of interim juvenile fall drawdown operations through Detroit and Big Cliff Reservoirs and Dams with the following operations in years 2025-2028, and will conduct studies to measure effectiveness, as part of the Adaptive Management process with input from the WATER Technical Teams:

- In the fall, draw Detroit reservoir elevation down to no more than 50 feet above upper RO for passage (1395 ft), when possible given hydrology and hydropower activity in the North Santiam and other subbasins.
- Design and conduct a study, or use existing data, to optimize RO gate openings at Detroit for survival and reduced harm, while also considering temperature implications downstream, as well as turbidity effects.

Rationale for RPA 4.12.2: In addition to operations put forward in the proposed action, this RPA calls for increased daily hours of spill to optimize signals for migration, and increased possibility for RO outlets to be accessible by lowering reservoir elevations. These will add an option for greater survival for juvenile migrants, allowing diverse migratory life history stages.

RPA 4.13 Long-Term Juvenile Downstream Passage

In all subbasins with USACE dams, overall population trends are downward, with a negative 4% long term spawner abundance, and a 31% drop from 2015-2019. Yet one population in the UWR Chinook ESU consistently reverses this trend, as Clackamas spawner abundance was upward in both time frames, 6% increase over 15 years, and 91% increase from 2015-2019 (Ford ed. 2022, Tables 44 and 45). A crucial difference is that the Clackamas hydropower dams have safe downstream passage for juveniles since PGE began operating surface collectors (beginning in 2013 and 2015), and these have been designed to meet NMFS Anadromous Fish Passage Design survival criteria (NMFS 2011c, and NMFS (2022h) current design manual). Clackamas Chinook spawner counts continually are over the 10-year average since the addition of safe passage routes. This indicates the importance of juvenile passage, also noted in the previous Biological Opinion (NMFS 2008a), and in the 2011 UWR Recovery Plan (ODFW and NMFS 2011). The USACE has funded improved adult collection facilities and ongoing outplanting, and both provide a strong basis for the possible recovery of each population above subbasin dams, but these are not sufficient. The habitat above dams, overall higher quality than below, improves rearing for juveniles and will have better temperature regimes as climate continues to change. The missing piece is safe downstream passage for UWR Chinook salmon in all four subbasins, and for UWR steelhead in the two Santiam subbasins. This RPA provides specific solutions and urgent timelines for juvenile passage.

The proposed action includes a timeline for implementation (Figure 9.4-1), which extends until 2054. While the timeline includes several structural measures and timing of operations, the focus of this RPA is on the downstream passage elements of the long-term implementation plan. Each structural fish passage measure as proposed is associated with a high level of implementation uncertainty. The high level of uncertainty associated with implementation timing, and the very long time horizon for construction to occur at many of the project sites, is difficult to correct for in an RPA. However, NMFS provides the following RPA elements intended to add efficiency and reprioritize structural measures where possible. Inevitably, the sequence of structural passage measures will need to be coordinated with NMFS throughout the implementation of this Opinion.

Through the AM process, the Action Agencies, and NMFS will evaluate the information gathered through RM&E measures, and any other sources of information such as ESA recovery planning including life cycle modeling, university studies, and local monitoring efforts, to determine whether the scheduled action, or an alternative, will provide the most effective means to achieve benefits to ESA-listed fish. If the information confirms that the scheduled action is best suited to addressing the effects of the Project, the Action Agencies will implement each measure by or before the dates shown. If the information shows that an alternative action would provide similar biological benefits, is technically feasible, and would be more cost-effective, then the Action Agencies will implement the alternative action. The Action Agencies may need to complete appropriate NEPA analyses and obtain authorization and funding prior to beginning the initial project development phase for each structural measure. Each project may also require additional site-specific ESA section 7 analysis to assess potential take pathways and ensure adequate and appropriate take coverage is in place prior to work beginning.

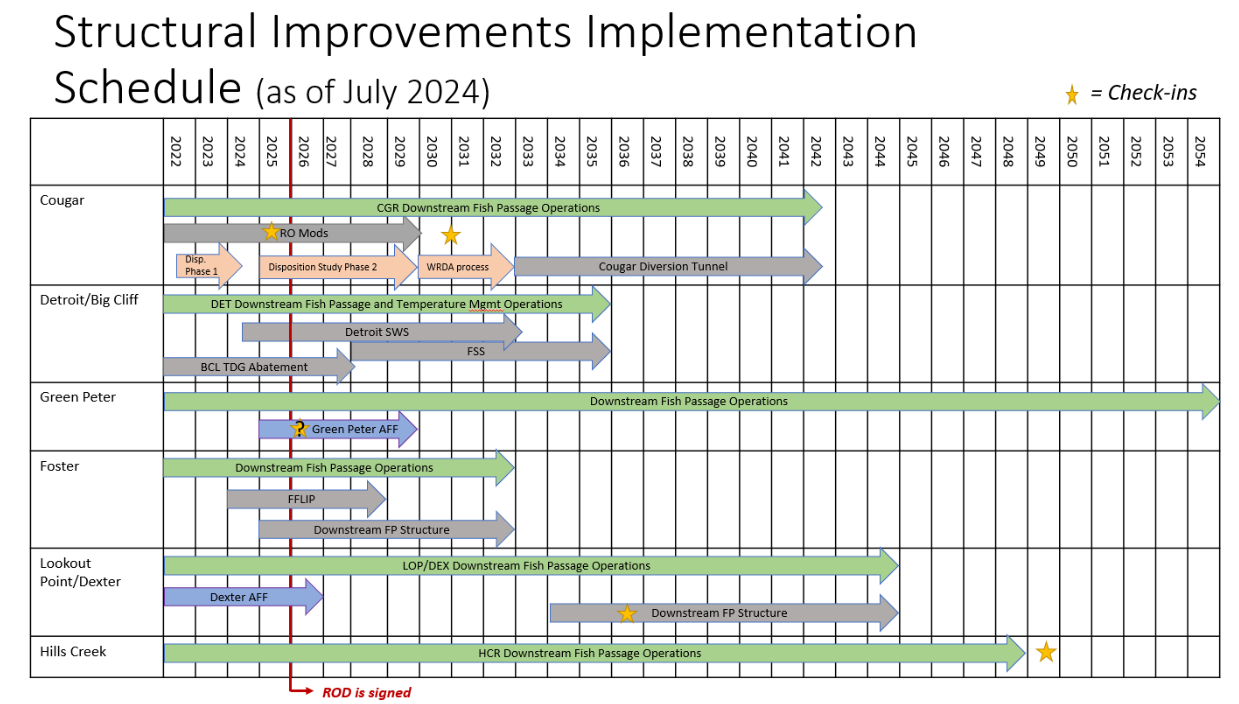


Figure 6.4-2 Willamette Valley System Structural Improvements Implementation Schedule from the Proposed Action (USACE July 2024).

4.13.1: Lookout Point Dam. The Action Agencies will take necessary steps to implement the Lookout Point juvenile downstream fish passage structure. The Action Agencies will establish a checkpoint for the end of 2030 in conjunction with completion of the Lookout Point Feasibility Study. The major decision associated with that milestone will be "go/no go" decisions on the feasibility of Lookout Point fish passage facilities. The Action Agencies will complete construction of any structural fish passage facilities at lookout point by December 2037. By March 2038, the Action Agencies will begin operating downstream fish passage facilities at Lookout Point that will enable collection of fish from above Lookout Point, and passage volitionally or by transport to habitat downstream of Dexter.

Rationale for RPA 4.13.1: The Action Agencies would begin work to implement downstream fish passage at Lookout Point Dam several years sooner than scheduled under the proposed action, with construction being completed by 2037. This RPA would expedite safe and effective fish passage at Lookout Point Dam for UWR Chinook; thus, reducing the amount of time that could pass with inadequate fish passage operations.

4.13.2: Cougar Dam. The Action Agencies will investigate the feasibility of downstream fish passage at Cougar Dam through the existing diversion tunnel (Figure 4.13-1), replacing existing operational alternatives. Since the currently proposed RO modifications are not scheduled for construction to begin until 2027 and completion in 2029, the comparison between the two projects can be completed. This will include a test drawdown to elevations that would optimize fish passage as determined by NMFS and the Corps. Using data from the ODFW 2011 report on fry and smolt passage and survival through the tunnel, the test will incorporate peak timing for passage at lower elevations, and add months for which past data had no trap operation (July – November).

If found feasible, and after completing the disposition study to deauthorize hydropower and other authorized uses, USACE will design, construct and operate the necessary components to ensure the diversion tunnel can provide safe and effective fish passage. The Action Agencies will make "go/ no go" decisions after completing the Cougar Disposition Study, on the feasibility of the Cougar diversion tunnel as a safe and effective passage option. The decision to move forward on the use of the diversion tunnel aligns with seeking deauthorization earlier for hydroelectric production and irrigation purposes. If deauthorised, this will allow diversion tunnel passage after drawdown to elevations near or below the top of the tunnel (1300 feet) that provide improved passage efficiency, with longer duration of flows through the diversion tunnel route. Regardless of the outcome of the disposition study, the Corps will continue to pursue use of the diversion tunnel as a long-term fish passage measure.

The Action Agencies will complete construction of structural modifications needed for use of the tunnel, to meet fish passage criteria, and for general operation and maintenance, by December 2034 and by 2035, begin operating the diversion tunnel for downstream fish passage at Cougar Dam. Operations should provide year round passage when flood risk management allows, and optimize the passage through the river above the dam, rather than the proposed refill to levels that would leave juveniles stranded above the dam.

If the safety and effectiveness of the diversion tunnel are not found acceptable by USACE and the Services, the work on RO modifications could continue after 2029. Further review of additional safe passage routes would continue at that time, to ensure higher survival than using the turbines and the RO, even with modifications, given the reservoir entrainment that results from refilling.

Rationale for RPA 4.13.2: This RPA requires USACE to explore timing and elevations for downstream passage through the Cougar Diversion tunnel, and to begin doing so by 2028. The effect of this RPA is to expedite studies to determine if the use of the diversion tunnel is a feasible fish passage solution, and to determine actions needed to make the tunnel a viable option. Given data on fry and smolt passage and survival when the tunnel was used during 2002-2004 construction of the Cougar temperature control tower, this measure is expected to deliver the highest efficiency and survival thereby increasing the overall productivity of South Fork McKenzie Chinook. This work will result in information necessary to determine if the diversion tunnel is the safest and most effective fish passage method at the Cougar Dam. If not, other structural passage routes will be considered.

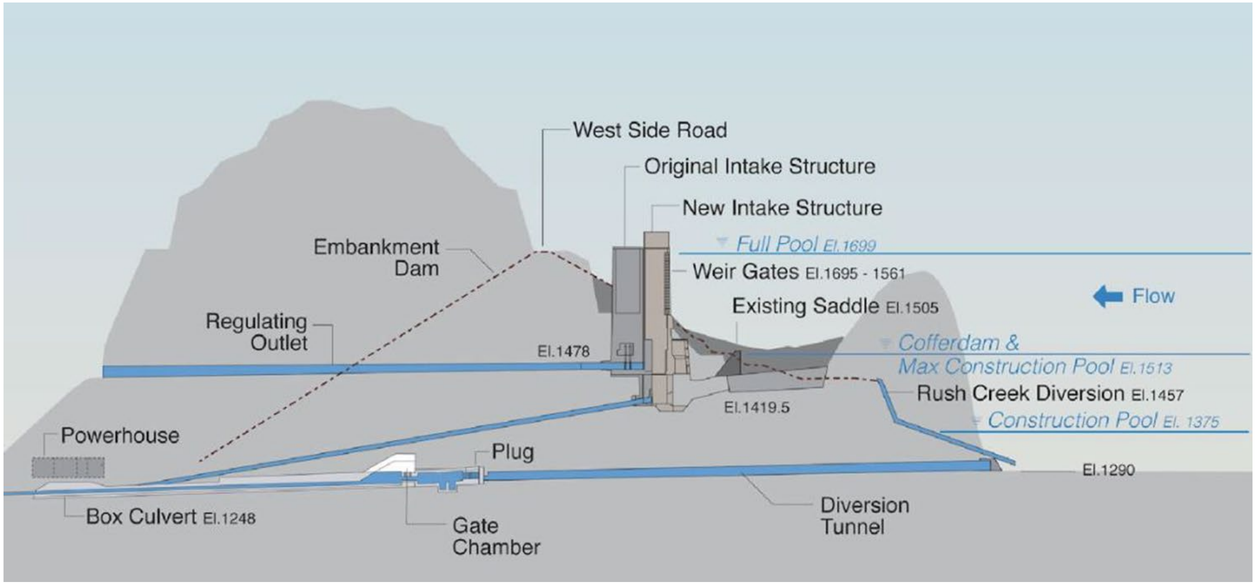


Figure 6.4-3 Cross sectional view of routes through the Cougar Dam, and elevations of the reservoir full pool, as well as elevations during the period the diversion tunnel was used when the water control tower intake structure was built.

4.13.3: Green Peter Dam. If the continued operational fish passage efforts at Green Peter Dam have inadequate survival and efficiency estimates, as determined by NMFS, after four consecutive years of spring spill and fall deep drawdowns (2023-2026), USACE will explore structural fish passage options, which also may move fish safely below Foster Dam rather than travel through a second reservoir and pass another dam. The USACE will develop a plan to move forward with a fish passage solution, which may or may not include a structural solution, in coordination with NMFS, by the end 2027. Based on the solution selected, NMFS and USACE will establish a mutually agreed upon implementation date for the action. NMFS recognizes this assessment and coordination process will be integrated within the proposed AM process, as will other decisions regarding outplanting UWR natural origin Chinook salmon and steelhead above Green Peter reservoir.

Rationale for RPA 4.13.3: This RPA provides a plan for assessment and corrective action at Green Peter Dam if the ongoing deep drawdown operations result in suboptimal fish passage on an ongoing basis. This RPA provides the level of certainty needed to ensure fish passage at this dam does not continue jeopardizing the existence of UWR Chinook and future outplanting of UWR steelhead (see RPA 4.6.2). The proposed action failed to lay out a plan if the deep drawdown operations are not successful. Therefore, this RPA provides the corrective action and ensures that it would take place within enough time to minimize adverse impacts on the UWR Chinook and over time, re-introduced UWR steelhead populations.

4.13.4: Foster Dam. USACE will improve the design process and accelerate the timeline for the Foster Dam structural passage with shorter design and construction timing to complete a structural solution by 2030. USACE proposes ongoing operational passage through Foster Dam spillways for steelhead and Chinook salmon to overlap with design work on a structural downstream fish passage solution, beginning in 2025. Proposed solutions include conceptual designs for a structure to provide a surface route, by possibly using a weir internal to the spillway, with past experience informing the design process. While this is noted as likely to be a simple structure, the timeline shows completion of construction in 2033, but the timeline will be sped up for earlier improvements of both natural origin UWR Chinook and steelhead outplanted in the South Santiam.

Rationale for RPA 4.13.4: Recent returns data analyzed in South Santiam genetic pedigree studies showed extremely low Chinook cohort return rates (O'Malley et al. 2023). Given all-natural origin fish returning to the Foster adult facility are currently outplanted above Foster, this required earlier completion of structural passage will prevent or reverse downturns in the populations of steelhead and Chinook salmon in the South Santiam, unless other actions are slowing the decline in return rates as seen in studies (See RPA 4.11.1).

4.13.5: Detroit Dam. With the objective of increasing natural origin production, the Action Agencies will coordinate a review of the 2017 EDR for Detroit Dam downstream fish passage via a floating screen structure (FSS) with the NMFS Biologists and Fish Passage Engineering staff. USACE will provide NMFS with a summary report on the expected benefits of including a selective water structure (SWS, or water temperature control tower) as part of the downstream passage facility design, as well as the additional time required to complete design and construction. The report will include a summary comparing the expected number of days downstream flow and temperature targets (in WFOP) would be met below Big Cliff Dam using modeled water year types, with and without the SWS structure, and dates of the year when temperature targets would be met for each scenario.

The Action Agencies will take necessary initial steps beginning in early calendar year 2026, to review the existing EDR and recent downstream juvenile passage structures, and effective design alterations, if appropriate. The Action Agencies will establish a checkpoint by the end of calendar year 2026 with a major decision to build only the passage structure, based on benefits and tradeoffs of the proposed SWS temperature operations compared to current operations for UWR Chinook and steelhead in the North Santiam.

The Action Agencies will complete construction of structural fish passage facilities by December 2033. By March 2034, the Action Agencies will begin operating downstream fish passage facilities at Detroit that enable collection of steelhead and Chinook salmon from above Detroit, with volitional passage or transport to habitat downstream of Big Cliff Dam.

Rationale for RPA 4.13.5: Optimizing the fish passage structure design at Detroit Dam will provide improved downstream passage past Detroit and Big Cliff dams, increasing spatial distribution by providing safe access to and from historical habitat. By addressing the primary impediment to spatial distribution and productivity for the North Santiam populations of UWR Chinook salmon and steelhead, this RPA will support increased abundance and productivity. As a result, by protecting and restoring these populations, there is reduced risk that the Proposed Action will cause jeopardy to the UWR Chinook salmon and UWR steelhead ESUs. With respect to critical habitat, this RPA will address the Habitat Access pathway by improving access past a physical barrier, and thereby improve the status of PBFs for spawning, rearing, and migration of the North Santiam populations of Chinook salmon and steelhead.

RPA 4.13.6: Hills Creek Dam. USACE shall initiate the planning process for downstream passage at Hills Creek Dam by 2030, and determine alternatives to RO operations. Begin design for safe downstream fish passage using the timeline NMFS provides with the expectation of implementing downstream fish passage by 2042, seven years before USACE would have scheduled a check-in, with unknown outcome.

Rationale for 4.13.6: This RPA is intended to expedite the timeline for assessing feasibility and subsequent implementation of downstream fish passage at Hills Creek Dam. It will improve the potential for offspring of reintroduced spawners to successfully migrate from the Middle Fork Willamette through the mainstem Willamette.

6.5 Hatchery Management RPAs

The following actions are included in the RPA for Hatcheries. These actions are necessary for reducing short- and long-term risks faced by the Chinook ESU and steelhead DPS adversely affected by the PA, thereby increasing the viability of the affected populations. USACE is concurrently implementing the 2019 Hatchery Biological Opinion for the Upper Willamette; and therefore, NMFS does not duplicate measures contained therein (NMFS 2019a) in this RPA.

RPA 5 Hatcheries

RPA 5.1: The Action Agencies will assess, in coordination with NMFS and ODFW, its hatchery production levels for spring Chinook salmon after implementing improvements for fish survival through Corps reservoirs and dams. This coordination will be in accordance with the schedule and review in RPA 4.13 (Long-term juvenile downstream passage). USACE will also confer with NMFS and ODFW to review information leading to a potential decision to reduce hatchery production and associated funding prior to implementing any change. NMFS must concur with approve such modifications when those decision points are reached.

Rationale for RPA 5.1: The Corps' PA includes the following phased sequence of monitoring and evaluation to determine when it would be appropriate to reduce hatchery production. After year seven following fish passage operational or structural improvement, if the geometric mean for cohort replacement rate (CRR) for UWR Chinook is greater than one, based on a geometric mean of replacement rates for the three cohorts returning 3-5 years, 4-6 years, and 5-7 years after downstream passage is provided, then full "credit" for dam fish passage improvements will be applied and Corps-funded UWR Chinook production will be reduced over a period of five years to a "Reduced Level of Production" above the dams.

If the geometric mean for CRR is less than one, then mitigation credit reductions will not occur and would be reassessed again after year 14. If the geometric mean of CRR is less than one for cohorts completing return in years 12, 13, and 14, then Corps-funded UWR Chinook release would be reduced over a period of five years to the Reduced Level of Production above the dams.

Using the method described above could result in a few good years of cohort returns artificially skewing results in a positive direction for the purposes of this evaluation, when in reality, a population could still be trending downward when examined over a much longer period of time. Additionally, the calculator does not offer a means of increasing hatchery production if necessary when an overcorrection is made. The calculator only supports decreased production with no way to estimate increased needs in production if, over time, USACE finds production has been reduced too much. The calculator instructions, in fact, include reduced production after years 12, 13, 14 etc., even when CRR does not equal or exceed one; however, the proposed action indicates no reductions would be made without further negotiations with NMFS and ODFW, which does not not equate to agreement or approval by those agencies.
The calculator instructions should be updated to more closely reflect the language in the PA regarding agency coordination during these later years of implementation. Requiring coordination with Corps, ODFW, and NMFS is a backstop measure to ensure that all factors influencing CRR and USACE decisions on funding are considered and accounted for and that all agencies are in alignment with the outcome of the subsequent determinations. This requirement does not preclude USACE from using the proposed calculator or CRR as a metric; but rather, it serves to ensure that all information is considered when making the decision to reduce production and funding.

RPA 5.2: Coordinate with ODFW to develop a solution for Chinook salmon McKenzie River hatchery production. Currently, the McKenzie Hatchery does not have an appropriate water supply for normal hatchery operations due to the dewatering of Leaburg canal, and no fixes are currently available which threatens hatchery production and reintroduction goals. Leaburg Hatchery has limited capacity to accommodate additional production and will be affected by Eugene Water and Electric Board's future decisions about Leaburg dam and reservoir, where Leaburg Hatchery water intake is located. Leaburg Dam is also essential for removing hatchery salmon from the fish ladders in order to meet pHOS objectives established in the Hatchery Biological Opinion (NMFS 2019a). All of these issues require the agencies to work together and develop a new permanent, long-term solution for the hatchery Chinook salmon program that is needed for reintroduction and mitigation. USACE will work with ODFW to find necessary locations for diversions, broodstock collection, and production of hatchery Chinook salmon necessary to meet reintroduction needs above dams in the McKenzie basin. The Corps must coordinate with ODFW and devise a solution, which will be dependent upon EWEB's plan for decommissioning of the Leaburg Dam. Once EWEB develops a plan, the Corps should work with NMFS and ODFW within two years of that plan being finalized to establish a path forward to address these issues and implement the plan within two years of the plan being developed. This timing will accommodate the decision-making process through AM as well as the USACE 2-yr funding cycle, while minimizing fish exposure to less than ideal conditions.

Rationale for RPA 5.2: The McKenzie Chinook salmon hatchery program is necessary for conservation/reintroduction objectives for Cougar and Blue River projects, and moving fish above other non-Corps projects in the basin. Solutions to ongoing problems with locations for fish handling and hatchery rearing will ensure reintroduction efforts can continue.

RPA 5.3: Coordinate with ODFW to develop a plan to implement corrective action to meet adult holding needs at the Willamette Hatchery to ensure high survival of broodstock for outplanting and reintroduction needs above Dexter/Lookout Point/Hills Creek dams. This action shall be implemented by the end of year three following the signature of this Opinion.

Rationale for RPA 5.3: The holding facility at Willamette Hatchery was constructed in a former earthen rearing pond from the original hatchery. It is inadequate for current adult holding needs; consequently, the adults are overcrowded in the pond, not easily captured, and overly stressed which contributes to high pre-spawn mortality of collected broodstock. Costs are higher than necessary because more adults have to be collected and transported from Dexter to the hatchery to make up for poor survival. Timing for implementation of this RPA will accommodate the decision-making process through AM as well as USACE 2-yr funding cycle, while minimizing fish exposure to less than ideal conditions.

RPA 5.4: Hatcheries RM&E: The Action Agencies will continue to work cooperatively with the WATER team to ensure that WVShatchery program management decisions are informed by appropriate monitoring efforts, including expanding PIT infrastructure necessary to determine adult abundance for broodstock management decisions, and to assess overall survival, not only passage at specific dams. Expanded PIT tag infrastructure or other comparable monitoring methods should be in place within three years after signature of this Opinion.

Rationale for RPA 5.4: Timing for implementation of this RPA will accommodate the decision-making process through AM as well as USACE 2-year funding cycle, while minimizing the length of time that passes without systemic survival information. Currently, most data is collected as juvenile fish pass through specific dams using rotary screw traps with inconsistent collection efficiencies and which are vulnerable to the effects of flow variations. PIT tag arrays have the ability to measure passage and survival through the entire system when placed strategically throughout the Willamette Basin with specific locations to be coordinated with NMFS. This more holistic information is necessary to accurately assess fish passage and survival, and to make more accurate decisions regarding hatchery production level adjustments.

6.6 Habitat Improvement RPAs

In this Opinion, NMFS describes adverse effects of the proposed action operations and maintenance on downstream physical habitat. The proposed action would continue to degrade existing rearing, holding, and spawning habitat below dams and in the mainstem Willamette River, reducing abundance and productivity of UWR Chinook salmon and UWR steelhead. Further, as described in the Rangewide Status of the species section of this Opinion, degraded juvenile rearing habitat in the lower reaches of most tributaries is one of the key factors limiting productivity of most populations of UWR Chinook salmon. Even when other limiting factors are addressed to increase productivity (e.g., water temperature and/or fish passage), restoration of juvenile rearing habitat in reaches downstream of the dams will still be necessary to ensure adequate habitat is available for this life stage. Habitat restoration work will prevent further declines in abundance and productivity of UWR Chinook salmon and UWR steelhead associated with the proposed action effects on downstream habitat, and will be necessary to ensure success of other actions required in this RPA by addressing limiting factors associated with other life stages.

RPA 6 Habitat Improvement

RPA 6.1: The Action Agencies will work with NMFS and other partners within the first year after signing of this Opinion, to develop a plan to increase the amount of habitat restoration completed annually, in comparison to the past decade, through the implementation of the "Willamette Habitat Mitigation Program" (WHMP) in collaboration with the Habitat Technical Team. This plan shall include an implementation pathway that ensures action will be taken according to an agreed upon timeline.

Additional habitat restoration is necessary to improve conditions for UWR Chinook and steelhead prior to the long-term improvements to downstream juvenile passage conditions. Once proposed long-term fish passage solutions are implemented and proven effective, habitat restoration requirements for the program may be reduced by agreement with the Services. The purpose of the program will be to protect and restore aquatic habitat to address limiting habitat factors identified in the UWR Recovery Plan (ODFW and NMFS 2011). The program's primary focus will be to restore: (1) off-channel habitat (including side-channel restoration and floodplain reconnection) in the Willamette River mainstem and lower reaches of its tributaries; and (2) cold-water refuges along or near the Willamette mainstem (defined as at least 2°C cooler than the mainstem water temperature). The Action Agencies will work closely with the Habitat Technical Team to accomplish the following:

1. Designate members for a technical workgroup to update scoring criteria, review, and score projects. The new project criteria will build off of the past HTT/TRT criteria, but will be focused on prioritizing off-channel and cold-water refugia habitat restoration projects that will provide the greatest benefits to Willamette basin ESA-listed salmonid populations.
2. Invite local non-profit organizations, institutions of higher education, commercial (for profit) organizations, and state, local, and tribal governments to submit proposals for habitat restoration.
3. Seek cooperative relationships with other major habitat restoration funding sources in the Willamette basin and consider strategically providing matching funding for projects that meet new WHMP objectives.
4. Annually evaluate proposals with technical workgroup reviews and scoring, followed by final project funding approval by the Habitat Technical Team, who will determine that the proposals are consistent with project selection criteria and ESA-listed species recovery plans.
5. Meet the new program goals over the Biological Opinion term, or until long-term fish passage measures are implemented focusing on the following types of projects:
    a) Off-channel habitat restoration, including alcove, side-channel habitat, and floodplain reconnection, by prioritizing funds in the following ways:

- By location: 1) On the mainstem Willamette River; 2) In the lower reaches of the Middle Fork Willamette, the McKenzie, the South Santiam and the North Santiam; 3) In the lower reaches of west side tributaries to the Willamette River.
- By project type: 1) Side-channel restoration and/or floodplain reconnection, particularly projects that re-establish hyporheic connections; 2) forested wetland reconnection and restoration.

b) Creation, restoration or protection of cold water refugia along the mainstem Willamette River.

Matching funding for capacity or engagement grants that are specifically targeted at working with landowners with property on the mainstem Willamette River or along the lower reaches of the east side tributaries also has the potential to contribute toward meeting the program goals listed above in part 5 a) or b).

Off-Channel Habitat (Alcove, Side-Channel, and Floodplain Reconnection)

To support project selection the Action Agencies will establish a technical workgroup to provide habitat metrics for evaluating project proposals for their benefits to juvenile ESA-listed Chinook salmon and steelhead. This group will be composed of experts on restoring salmonid off-channel habitat and may be subsumed as a WATER technical sub-team, if appropriate. They will use information on the relationship between actions and habitat and salmon productivity models to establish these evaluation metrics. Retrospective review of previous projects will inform this process.

Project proponents will identify location, treatment of limiting factors, targeted populations or life history strategies, appropriate reporting metrics, and estimated biological benefits based on the metrics. Project proposals will clearly describe anticipated quantitative habitat metrics which can be used to evaluate the benefit to ESA-listed salmonids.

Cold-Water Refuges

In cooperation with the Habitat Technical Team and the Services, the Action Agencies will identify and fund cool water refuge protection, creation, and restoration projects over the course of the Biological Opinion term beginning in Fiscal Year (FY) 2028 to enhance functionality or provide additional access to cold-water refuges (CWR) habitat along the mainstem Willamette River. The technical workgroup will review past reports on the existing CWRs in the mainstem Willamette (ODEQ 2020, Hansen et al 2023, others), as well as past funded projects.

To develop the list of priority projects, the Action Agencies will use existing temperature data sources (see ODEQ 2020, Smith et al 2020), or fund FLIR flights to find cold water areas in the tributaries and mainstem Willamette. Improvements to CWR are expected to support the habitat quality of cooling areas, and protect those waters from warming. Additionally, CWR projects may improve conditions in deeper areas where salmonids may find cooler bottom water.

Rationale for RPA 6.1: Establishing a habitat restoration program focused on addressing the most critical habitat challenges presented by the proposed action for UWR species is intended to organize restoration efforts in a manner that will be most successful. The program elements outlined above are likely to expeditiously improve designated critical habitat and support avoidance of jeopardy for the species and continued adverse modification of designated critical habitat and EFH. The tripling of this program's efforts (in comparison to recent years) will be critical for offsetting the continued impacts of delayed passage improvements. Once the proposed long-term fish passage implementation goals are met, the scope of the WHMP on an annual basis could be reduced.

In addition to delayed passage improvements, the proposed action will limit habitat complexity in the streams below the projects, including the mainstem Willamette River. Flood control dams alter the natural hydrograph by dampening natural fluctuations in river flows and limiting interactions with the floodplain which reduces the river's ability to maintain any remaining habitat complexity or create new complexity.

The proposed action also includes refill of reservoirs for recreation, and the use of reservoir stored water for fish and wildlife, hydropower, agricultural irrigation, and municipal and industrial water supplies. Removing water from the Willamette tributaries and the mainstem and reducing flows to a minimum can lead to increased temperatures. Spring and summer temperatures in the Willamette mainstem are and will be increasingly problematic for migrating salmonids, often reaching over 70 F for days to months. Off-channel areas of the Willamette River mainstem can connect to groundwater, or benefit from hyporheic flows, resulting in lower water temperatures which juveniles use to escape warm river temperatures. CWRs serve a similar role to salmonid species, particularly spring Chinook salmon. Providing cooler and more productive off-channel habitats along critical migratory corridors is essential to the survival and for avoiding jeopardizing the existence of these species.

RPA 6.2: Identify and evaluate potential habitat restoration projects near adult release sites above reservoirs. This RPA is related to other measures regarding reintroduction planning (RPA 1.1 in the Adaptive Management section and RPA 4.3.5 "Update Assessment of All Current and Potential Adult Fish Release Sites").

The Action Agencies will form a technical team to identify potential projects for habitat improvements located near current or potential adult release sites above the USACE projects, or potential spawning habitat adult fish could conceivably reach prior to the end of the known spawning season. This could take the form of an HTT sub-team or an independent team outside the HTT and WATER teams. Potential projects could also include the addition or creation of holding pools and structural cover near release sites for fish recovery post-release. The technical team will produce an assessment report which includes a list of feasible projects throughout all four sub-basins that provide the greatest uplift in terms of improved spawning and rearing success (productivity). The report will identify location, treatment of limiting factors, targeted population or populations, appropriate habitat improvement metrics, and estimated biological benefits based on achieving those metrics. Pertinent new information on climate change and potential effects of that information on limiting factors will also be considered. This technical team process will operate under the following guidelines:

- The Action Agencies will convene a team of technical experts on the subject of Chinook and steelhead spawning and rearing habitat restoration design and related benefits. Members of the team will have the knowledge and skills needed to estimate how a particular habitat restoration would improve current limiting factors for spawning and rearing.
- As part of this assessment, the Action Agencies will reach out to local watershed councils, local county soil and water conservation districts (SWCD), non-profit organizations, or land trusts who work with landowners to partner with them and to establish landowner relationships. This work can build on past efforts by Benton SWCD and others in the Willamette Valley.
- Based on information produced by the updated assessment of current and potential adult release sites (see RPA 4.3.5), the technical team will produce a list of potential habitat restoration projects in areas near current or potential future adult release sites. The team will aim to include at least one project for each current or potential site.
- Projects proposals will be developed for each project site on the list, with a map of the proposed project location and boundaries, and a schematic with basic project elements to be restored or added. Each proposal will clearly describe qualitative and quantitative habitat metrics which can be used to evaluate and prioritize the project list (spawning gravel area, hyporheic flows, large wood additions, temperature range).
- The technical team will create a set of agreed-upon evaluation criteria for scoring the projects. The scores should represent the overall habitat quality improvement potential for each project. Members will score the projects and report average scores.
- The draft final report will be sent out to members of the Reintroduction Plan Team (set up under the Adaptive Management process, see RPA 1.1) for their review, and the final report will be completed and submitted to the Services by December 2035.

Rationale for RPA 6.2: The proposed action identified existing and additional adult release sites to be maintained in reaches above Willamette tributary dams and reservoirs, noting that proposed sites may require minor improvements in some cases. This RPA requires that habitat restoration at existing sites, and at new release sites should be carried out where needed.

RPA 6.3: The Action Agencies will assess the current revetment structures. In addition to the efforts described in the proposed action under "Maintain Revetments Using Nature-based Engineering /Alter for Ecosystem Restoration" (USACE 2024a), the revetments will be considered for potential habitat values if modified. The Willamette River Basin Bank Protection Program (WRBBPP) consists of 193 existing bank protection structures, 83 of which are maintained by USACE and 105 of which are owned and maintained by local non-federal sponsors and are not part of this consultation.

The WRBBPP assessment will include the following steps in addition to those outlined in the proposed action:

- The assessment process may be informed by the previous revetment study funded by USACE (Hulse et al. 2013), confirming information is valid and current at the time of the report finalization.

- The feasibility assessment will include all 105 bank protection structures to review how USACE Nature-based Engineering programs would enhance potential floodplain connectivity via either notching, setting back, or partial or complete removal of each revetment. Potential benefits of reconnecting the floodplain of the reconnection for ESA-listed fish and wildlife species would be assessed as part of this study.
- The Action Agencies and partners will work with local groups to communicate with cooperative and interested landowners about the benefits of floodplain reconnection and gauge their interest.
- The Action Agencies will provide the Habitat Technical Team with the results of this feasibility assessment by December 31st, 2030.
- Once the assessment report is complete, the Action Agencies will use applicable existing authorities and programs to fund floodplain reconnection projects.

Additionally, the Corps and NMFS will work together to develop a pilot project on Corps-owned revetments, by identifying a willing non-federal project sponsor to determine if the project purpose could be modified to include ecosystem restoration.

Rationale for RPA 6.3: In the proposed action (USACE 2024a) for the USACE revetment system (WRBBPP), the Action Agencies indicate that they had not identified funding sources or a timeline for conducting their feasibility study or follow-up actions. This measure requires the USACE to secure funds for the study and complete it by December 31, 2030. It also requires the Action Agencies to partner with local groups on establishing landowner relationships and educating landowners about floodplain reconnection as part of the feasibility study. Once completed, the Action Agencies would fund floodplain reconnection projects. The effect of this measure is that feasible locations for floodplain reconnection will be identified by December 2030, and will be considered for funding through applicable authorities and programs. When projects are funded and carried out, the effect will be improved rearing, holding, and migratory habitat.

RPA 6.4: The USACE will continue to use existing authorities and programs for land and water resource stewardship on the lands it administers at the 13 Willamette projects to carry out aquatic and riparian habitat projects to benefit ESA listed fish species. These actions will be carried out consistent with the project design criteria identified in the “SLOPES V Restoration” or most recent version thereof, (NMFS 2013c) or other applicable biological opinions. If these projects meet SLOPES V Restoration project design criteria, as determined by NMFS, incidental take may be covered under that consultation.

Rationale for RPA 6.4: This measure was included in the 2008 Biological Opinion (NMFS 2008a) but was not included in the current Proposed Action (USACE 2024a). By reinserting this measure in the RPA, NMFS aims to ensure that continued on-site activities are reviewed and modified, if necessary, to avoid adverse effects on listed UWR Chinook salmon and UWR steelhead. Further, on-site habitat projects that benefit UWR Chinook salmon and UWR steelhead should be funded through this program. This measure will provide benefit to listed anadromous fish because it will ensure that there are adequate protections for listed salmonids when the Action Agencies are conducting projects that benefit other species.

RPA 6.5: During annual maintenance operations, the Action Agencies will collect large wood that accumulates at Project dams and make it available for habitat restoration projects above and below Project dams.

Rationale for RPA 6.5: This measure that is not addressed in the Proposed Action is aimed at restoring large wood transport past Project dams. The continuing effects of Project operations on large wood transport were discussed in detail in each of the major tributary Effects sections. Lack of large wood in downstream fish habitat continues to reduce available rearing and holding habitat for juvenile and adult UWR Chinook salmon and steelhead. This measure ensures that large wood that collects in the reservoirs will be made available for restoration projects.

6.7 Effects of the Reasonable & Prudent Alternative

In this section we explain why NMFS believes implementing this RPA would avoid the likelihood of jeopardizing the continued existence of UWR Chinook and UWR steelhead, as well as avoid the likelihood of destruction or adverse modification of their critical habitats.

The primary adverse effects of the PA are lack of effective passage through the dams, continued lack of access to off-channel habitat, adverse effects on flows and temperature, and hatchery management decisions being made in the absence of the full suite of information. The RPA will improve spatial structure (via habitat access; geographic range), diversity (moving natural origin fish above dams when safe, hatchery broodstock management), productivity (improved passage and conditions below the dams), and abundance (reduced mortality rates), which are the four VSP parameters. Improvements in these four VSP parameters will increase viability and reduce the risk of extinction to the affected populations and to the UWR Chinook salmon ESU and UWR steelhead DPS. The RPA provides increased certainty that PA measures intended to benefit listed species will be accomplished within reasonable time periods to prevent an appreciable reduction in the likelihood of both survival and recovery and prevent diminishing the value of critical habitat as a whole for the conservation of a listed species.

6.7.1 Adaptive Management Implementation

Restoration of productivity is key to adequately addressing the effects of the PA because the extremely low numbers of wild fish caused by lack of or inadequate access to historical habitat are the major factors contributing to the species' decline. Lack of access to good habitat above the dams, injury and mortality associated with inadequate passage facilities, and restriction to degraded habitat below the dams has caused steep declines in numbers and has reduced the functioning of PBFs of critical habitat. Requiring USACE to work with NMFS to develop and implement reintroduction plans that will ensure that reintroduction of natural origin fish occurs when it is appropriate to do so based on passage and habitat attributes, which will in turn support the continued existence of UWR Chinook and steelhead species.

Improving RM&E decision transparency and coordination is an essential element for successful implementation of the AM Plan. NMFS supports the concept of an AM Plan, and USACE has provided a solid foundation from which to build a more robust AM effort, including more prescriptive engagement from NMFS regarding RM&E decisions. The outcome of this requirement will ensure that data collection efforts are focused on areas and operations that are most in need of monitoring; and thus, will result in better informed decisions to increase benefits to species, and/or minimize further harm. Additionally, it is critical that all monitoring be carried out using best management practices that would minimize harm to individual fish and critical habitat. The AM RPA would ensure that all monitoring would be implemented in a manner that results in the least harm, thereby conserving the health and fitness of fish or habitat studied.

The AM plan includes the major check-in and decision points that are typical of an AM cycle; however, corrective action that would be taken when and if a prior management decision results in less than optimal results is absent from the proposed action. In addition, data proposed for collection was limited for fish responses to the actions. Without knowing what action would be taken to correct for any given situation, NMFS has no certainty regarding the outcome or efficacy of the AM process or decisions. Requiring the identification of what corrective actions would be taken pending the outcome of monitoring results will ensure that as little time will lapse as possible before corrective action is taken, thus reducing the time ongoing harm associated with an operation could persist. The data collected to provide the basis for corrective action is crucial.

6.7.2 Flows

This RPA is intended to provide NMFS, the Corps, and BOR the opportunity to coordinate the formulation of a durable and effective flow management plan that will reduce harm to ESA species. In the meantime, the 2008 RPA flow targets would be maintained. The overall benefit to UWR chinook and UWR steelhead is to continue applying a flow regime with higher flow targets, particularly during drier years, while drafting a comprehensive plan that would be expected to improve flow management throughout the system while retaining the ability to adaptively manage

RM&E associated with flow monitoring (found under RPA 4.2 under section 9.4) will be used to modify project operations and flows to improve UWR Chinook salmon and UWR steelhead migration cues, travel times, rearing and spawning habitat, and overall survival in the tributaries below Project dams and in the mainstem Willamette River. Life stages affected will be fry and juveniles from stranding, smolting juveniles during migration, adults during migration and holding, and eggs in redds from dewatering associated with Project ramping.

6.7.3 Water Quality

These RPA measures require that AM processes will be informed by data for life history stages for UWR Chinook salmon and steelhead affected by different operations. Willamette Basin projects have dramatically affected water temperatures below federal dams, and also affect other important water quality parameters to the detriment of listed species. The RPA studies are necessary to document geographically-specific effects, their relevance to protection and the water quality RPA measures, and the tangible options for addressing these concerns.

The effects of continued in-season management coordination will be to sustain temperatures below Project dams that are close to ideal for the particular life stages of salmon and steelhead present below dams. Some of this will be from modified versions of the proposed pulses to reduce higher temperatures in the mainstem during lower flows. It also includes keeping tributary downstream temperatures cool enough in the summer to prevent prespawn mortality of Chinook salmon, cool enough to prevent excessive acceleration of incubating salmon eggs, and not so cold as to delay in Chinook adult upstream migration. In-season TDG exceedances will also be monitored and reduced by modified actions, especially during spawning and incubation and rearing, but also when downstream migrating juveniles are likely to be present. The in-progress work to construct structures that will abate higher TDG below Big Cliff will be monitored, to provide feedback for potential additional structural elements.

In-season water quality monitoring and management via possible operational adjustments will allow ongoing data reviews. These demonstrate whether operations maintain temperature and TDG within targets ideal for listed salmon to increase their ability to survive during migration to the spawning grounds or to the next life stage, and increase overall productivity. Improved water temperatures below Big Cliff, Dexter, and Foster Dams will result in increased survival of adult and juvenile life stages, and possibly longer incubation stages, causing increases in abundance and productivity for UWR Chinook salmon and steelhead in the Santiam Rivers. Below the Middle Fork Dams, attaining appropriate temperature regimes will increase survival of adults holding in river, or transported upstream. Another effect of this measure is to improve the value of critical habitat by improving temperature in spawning and rearing areas.

RM&E elements will allow NMFS to track water quality impacts with physical and biological data. In addition, the required reporting will contribute to the AM Plan effectiveness, moving to modify actions when necessary. Monitoring and evaluation of operational passage measures effects on water quality is essential to assessing the efficacy, and contribute to improving survival via the adaptive management process.

6.7.4 Fish Passage and Implementation Timing

Adults that return to facilities in their natal stream are passed upstream to access historic and often higher quality habitat. The outplanting RPAs are provided to improve the adult fish handling, release sites, and the monitoring to inform any modified reintroduction plans with ongoing adaptive management.

The effects of this RPA will ensure that AM processes and decisions are based on annual data collected from spawner surveys, PIT tag detections for adults and juvenile migrants, and supplemental data during operational and structural passage changes. Genetic pedigree analysis on location-specific natural origin and hatchery origin fitness and cohort return rates will inform outplanting and reintroduction plans. Prior to timelines for major decisions such as building adult and juvenile passage facilities and changes in natural origin fish outplanting, alternatives will be fully reviewed and informed by studies.

Juvenile passage with high efficiency and survival is the overarching goal; the RPAs that address operational and structural passage will increase abundance, productivity, and spatial structure. The RPAs for structural passage require earlier start and completion dates to sooner provide benefits and reduce risk from ongoing declines.

Effect of RPA 4.2 Monitoring and reporting on adult and juvenile passage and migration:

The above-dam adult outplanting, and juvenile downstream fish passage RPAs require major changes in how Action Agencies will monitor and inform adaptive management decisions. This RPA for PIT tagging infrastructure and fish tracking combined with other methods across multiple life history stages will affect how dam operations, resulting flow and temperatures, and operational passage, are evaluated for multiple life history stages throughout each year. The RPA effects will include useful reports to inform major decisions regarding timing of operations, and to provide background information for important shifts from operational to structural passage solutions. Additional hatchery fish production and release of hatchery fish may be necessary for the purpose of meeting this RPA measure. While the effect of additional hatchery releases for RME purposes may have a slightly negative effect on natural-origin juvenile UWR Chinook salmon and UWR steelhead rearing and migrating in areas below dams, the benefit in terms of information gained and needed for an effective adaptive management process for the recovery of ESA-listed salmon and steelhead is assumed to greatly outweigh the expected cost.

Effect of RPAs 4.3-4.8 Adult Upstream Migration and Spawning Success:

New release sites will be chosen to allow safe transfer of fish from the truck, adequate recovery in pools without recreational pressure or poaching, and reasonable proximity to quality holding and spawning habitat. Existing sites will be reviewed to ensure they provide the same level of transfer safety and recovery, or will be modified to improve conditions. This will be essential to ensure reduced harm, with Chinook salmon or steelhead anticipated during current outplanting, and if modified reintroduction results in response to the provision of safe passage. Data collection of timing, handling and release site conditions, and fish conditions will provide the AM planning process with necessary information to modify actions when not optimal.

The effect of this measure will be to improve long-term productivity and increase probability that reintroduction efforts are successful, ultimately increasing the fraction of adult fish that successfully spawn. This measure will also decrease adverse effects on critical habitat by providing a component of safe passage.

Effect of RPAs under 4.8 to 4.12 Interim Juvenile Downstream Passage:

The Proposed Action described limited studies, and actions that follow, to precede steps the Action Agencies would take prior to decisions to construct downstream fish passage structures, or make major operational changes to improve downstream fish passage at Project dams and reservoirs. Although it will take several years to investigate, design, and install structural downstream fish passage facilities at those Project dams where such facilities are found to be necessary and feasible, interim fish passage measures will continue. Interim measures include the deep reservoir drawdowns to access ROs, and spillway operations in spring to improve passage downstream through reservoirs and dams. In these RPAs for each of the subbasins, the result will be improved decisions under the AM Plan, with additional data informing modified actions.

The effect of this RPA in modifying interim actions with better data should be increased juvenile survival in the following subbasins: North Santiam, South Santiam, McKenzie, and Middle Fork Willamette. Improved downstream survival would help to address limited spatial access by increasing the likelihood that the interim actions will result in sustainable production above the dams. Increased survival past the dams will also improve productivity and abundance of populations by increasing the total available spawning and rearing habitat while limiting dam-related losses. This RPA will decrease adverse effects on critical habitat by providing or enhancing a component of the PBF, "migration corridors free of obstruction," until more permanent passage options are being developed.

Effect of RPA 4.13. Long Term Juvenile Downstream Passage:

The effect of the measures below will be to ensure passage review and improvement in six subbasins within a shorter timeframe than that in the proposed action. Higher survival of juvenile migrants will increase the returns of adults, and address the lack of safe downstream passage as the most significant limiting factor for viability of UWR Chinook salmon and steelhead. With respect to critical habitat, this measure will improve access past physical barriers, and thereby improve the status of PBFs for spawning, rearing, and migration of UWR Chinook salmon and UWR steelhead populations.

Effect of RPA 4.13.1-Lookout Point reservoir and dam downstream passage:

The Proposed Action offers a potential Floating Surface Collector (FSC) solution for long term passage, with the final selection as part of engineering and design phases. The implementation schedule begins this process in 2034, completing by 2044. The effect of this RPA will be to provide improved downstream fish passage past Lookout Point and Dexter dams, by completing construction and operating in 2038. This earlier timeframe will increase spatial distribution by providing safe access to and from historical habitat. The RPA addresses one of the primary impediments to spatial distribution for the Middle Fork Willamette Chinook salmon population, and will support increased abundance and productivity, increasing the likelihood that the proposed action will avoid additional harm of the population.

Effect of RPA 4.13.2-Cougar downstream passage:

The Proposed Action identifies disposition studies, reports, and Congressional (WRDA) actions that will be completed for USACE to make a recommendation on deauthorization or change in authorities at Cougar Dam. These steps are prior to design and construction of elements needed to provide safe passage through the existing diversion tunnel. The effect of this RPA will be initial testing to inform studies, and requirements to complete all studies earlier. This will condense the overall timing to provide the fish passage before further declines in adult returns. The RPA also prevents potentially unnecessary construction of the proposed RO modifications, in favor of determining, and using, if appropriate, the diversion tunnel for passage.

Lack of access to historical spawning and rearing habitat above Cougar Dam is a key limiting factor affecting population numbers and spatial distribution for the Chinook salmon population. The effect of this RPA will be to provide safer and effective downstream fish passage at Cougar Dam through the diversion tunnel route, much sooner than proposed, thereby increasing spatial distribution by providing safe access to and from historical habitat. By addressing a primary impediment to population growth and spatial distribution for the McKenzie Chinook salmon population, this measure will support increased abundance and productivity of this core population, reducing the likelihood that the PA will cause jeopardy. Efforts to increase the viability of this population are essential, because it has had the potential to be one of the strongholds for the ESU.

With respect to critical habitat, this measure will address the Habitat Access pathway by improving access past a physical barrier, and thereby improve the status of PBFs for spawning, rearing, and migration of the McKenzie Chinook salmon population.

Effect of RPA 4.13.3-Green Peter Reservoir and Dam downstream passage:

The Proposed Action identifies the current spring spill and fall drawdown operations as the long-term passage solution. This RPA requires USACE to explore structural fish passage options if current efforts at Green Peter Dam are inadequate, beginning in 2027. The effects will be to provide safe and effective downstream fish passage at Green Peter Dam, increasing spatial distribution by providing safe access from historical habitat. If the structural solution moves fish below Foster Dam and reservoir, the higher likelihood of survival and increased adult returns will further benefit the Middle Santiam population. The structural solution will also reduce downstream effects of operational passage from impeding spawning and incubation for fish below Foster Dam.

The effect of the improved downstream passage will address the loss of access to historical habitat above Green Peter dam and the risk of genetic introgression by hatchery fish interbreeding with those of natural origin in the lower South Santiam below Foster Dam, which are at very high risk of extinction. This RPA minimizes time lost before fish protective measures become effective at improving fish survival and habitat affected by current operations. With respect to critical habitat, this RPA will address lack of habitat access, by minimizing time before access is improved, and thereby improving the status of PBFs for spawning, rearing, and migration of UWR Chinook salmon and UWR steelhead.

Effect of RPA 4.13.4-Foster Reservoir and Dam downstream passage:

The Proposed Action for interim passage is for ongoing spillway operations with a delayed refill, and fall drawdown of up to 10 feet. The implementation schedule shows completion of a structural solution in 2033. The effects of the RPA will be to provide safe and effective downstream fish passage earlier, by 2030 and thereby increase adult returns to the Foster adult facility, which includes UWR Chinook salmon and steelhead recruits from populations above Foster Reservoir, and Green Peter Reservoir.

Effect of RPA 4.13.5-Detroit and Big Cliff Reservoirs and Dams downstream passage:

This RPA will allow use of the upstream habitat for more natural origin Chinook salmon and steelhead, reducing reliance on downstream habitat that is limited by ongoing Project operations. Lack of access to historical spawning and rearing habitat above Project dams restricts spatial distribution for the North Santiam populations of Chinook salmon and steelhead to habitat below Big Cliff Dam, other than the primarily hatchery-origin Chinook adults transported to sites above Detroit Dam. Additionally, providing structural passage sooner will remove the limits of operational passage dependent on specific elevation with lower survival. Safe downstream fish passage past Detroit and Big Cliff is essential to ensure that the reintroduction efforts will successfully reestablish natural origin fish production above these dams.

The RPA requires review of how the two structures in the proposed action are linked: a selective water structure for water temperature control and the attached floating screen structure. The review will ensure an effective solution for downstream fish passage, given recent advancements in the design and operation of these structures. This RPA also ensures use of upstream habitat sooner to provide significant improvements to survival for juvenile Chinook salmon and later, for steelhead when reintroduction begins, to prevent the natural-origin populations trend toward increasing risk of extinction.

With respect to critical habitat, this RPA will address the lack of habitat access by improving access past a physical barrier, and thereby improve the status of PBFs for spawning, rearing, and migration of the North Santiam populations of Chinook salmon, and steelhead to follow the provision of safe passage.

Effect of RPA 4.13.6 Hills Creek Reservoir and Dam downstream passage:

This RPA will provide safe downstream passage, and improve access from the habitat above Hills Creek reservoir. It will reduce impacts of climate change where warmer streamflows are particularly harmful to spawning adults and redds during incubation. The Middle Fork Willamette Chinook population has been at extremely low return levels for natural origin fish with less than 100 returning to the Dexter Dam, the lowest in the subbasin, in recent years; none of these have been placed above Hills Creek Reservoir. Few hatchery Chinook spawners are outplanted, and none in some years. Expanding spawner numbers that can fully use habitat upstream of Hills Creek reservoir requires safe passage for juveniles downstream. The RPA addresses one of the primary impediments to spatial distribution, and supports increased abundance and productivity, increasing the likelihood that the Middle Fork population will trend toward a “viable” status. With respect to critical habitat, this measure will address the lack of habitat access by improving access past a physical barrier, and thereby improve the status of PBFs for spawning, rearing, and migration of the Middle Fork Chinook salmon population.

6.7.5 Hatcheries

The RPA 5.1 minimizes adverse effects of hatchery production on natural origin fish. It would also ensure that hatchery management decisions are made with all information being considered and with all agencies involved. Hatchery mitigation responsibilities are intended to offset the adverse effects of operations and maintenance of the WVS, current and proposed through the proposed action. Reductions in hatchery production should be closely coordinated with ODFW and NMFS prior to the Corps making the decision to do so. This RPA also serves to ensure that the use of CRR as the metric for determining when hatchery production is reduced over time is applied appropriately, and not in isolation from other factors that should also be considered.

The McKenzie Chinook salmon hatchery program is necessary to offset the adverse effects of operations and maintenance of the WVS and to reach conservation/reintroduction objectives for Cougar and Blue River projects. This RPA (5.2) is intended to address water supply issues that inhibit normal operation of the hatchery. Agencies must work together to develop long-term solutions to support the UWR chinook hatchery program which is needed for mitigation by the USACE. RPA 5.3 would improve adult holding conditions by making necessary improvements at the facility at the Willamette Hatchery to ensure survival of broodstock for outplanting and reintroduction needs above Dexter, Lookout Point, and Hills Creek Dams.

Expansion of PIT tag infrastructure, as required under RPA 5.4 and 4.2 would help to inform the adaptive management process and would minimize the amount of time that would pass without systemic survival information. More accurate and regular passage and survival data would also inform decisions regarding hatchery production level adjustments.

6.7.6 Habitat Restoration

Improving habitat is an ongoing need as the effects of reservoir and dam operations continue to reduce and harm habitat that UWR Chinook salmon and steelhead require during migration, rearing, and spawning life history stages. The effect of this RPA will be to build on the Habitat Technical Team efforts to prevent and offset adverse impacts of the WVSon elements of critical habitat, such as degraded rearing and migration habitat in the mainstem Willamette and lower reaches of its tributaries. These effects are caused by reduction in channel-forming flows and the resulting loss of complexity, compounded by maintenance of revetments for which the USACE continues to be responsible. The RPA requires the Action Agencies to engage restoration technical experts and practitioners to provide a comprehensive program of projects that focus on reconnecting the floodplain, enhancing cold water refuge areas, and providing large wood blocked by the dams to restoration projects. The RPA should result in increased abundance and productivity for UWR Chinook salmon and steelhead and/or improve localized habitat conditions so they are more conducive to supporting relevant life stages. For projects funded in the Willamette River below the falls, UWR Chinook are likely to also benefit, and LCR Chinook salmon, LCR steelhead, and LCR coho salmon would see small increases in abundance and productivity.

6.7.7 The USACE, BOR, and BPA Implementation Decision

This Biological Opinion has determined the proposed action would jeopardize the continued existence of UWR Chinook salmon and UWR steelhead, and the proposed action will also result in adverse modification of their designated critical habitat; therefore, NMFS offers a reasonable and prudent alternative to avoid jeopardy. USACE, BOR, and BPA are required to notify NMFS of its final decision on whether it will implement the RPA (50 CFR 402.15(b)).

7 Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a 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 further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). “Harass” is further defined by guidance as to “create 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.” “Incidental take” is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this Incidental Take Statement (ITS).

7.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take will occur as a result of the implementation of the proposed action and Reasonable and Prudent Alternative. Categories of actions resulting in incidental take are: WVS operations, adult collection, transportation and release (plus associated hatchery actions), habitat improvement, BOR’s water marketing program, and RME activities. The following sections specify the amount or extent of take that NMFS anticipates will occur as a result of these actions.

7.1.1 Amount or Extent of Take from Operation of WVS Dams & Reservoirs

NMFS has estimated the expected injury, harm, and/or mortality attributable to proposed operation of the WVS (including effects on water quality and the effects of the Bureau of Reclamation’s Water Marketing Program measure) in Chapter 5, Effects]; and Sections 6.3 and 6.4]). In this section, NMFS summarizes the expected incidental take of ESA-listed UWR

Chinook salmon and UWR steelhead resulting from implementation of the proposed action and Reasonable and Prudent Alternative (RPA), including the development of surrogates for the amount or extent of take anticipated where it is not practical to numerically estimate take in terms of individuals of the listed species. Effects on individuals of the other 12 (likely to adversely affect) ESA-listed species considered in this Opinion (LCR steelhead, LCR Chinook salmon, LCR coho salmon, CR chum salmon, MCR steelhead, SR steelhead, SR fall Chinook salmon, SR spring/summer Chinook salmon, SR sockeye salmon, UCR steelhead, UCR spring Chinook salmon, and Southern Resident Killer Whales) would not rise to the level of take.

Juvenile Life Stages and Steelhead Kelts

NMFS expects passage and reservoir mortality of downstream migrating UWR Chinook salmon and steelhead juveniles and UWR steelhead kelts to slightly decrease, remain at recent levels, or slightly increase because of the implementation of the proposed Adaptive Management Plan that aims to optimize operations for downstream passage and flow and water quality targets, while also operating for other WVS authorized purposes (flood control, power generation etc.). Estimates of take resulting from project operations for juvenile UWR Chinook salmon and steelhead (and steelhead kelts) are found in Table 7.1-1. These include maximum mortality rates observed in survival studies conducted for project dam reservoirs and "concrete" dam passage survival studiesand represent NMFS' best estimates of the maximum annual mortalities (1 - survival) that may be observed under the proposed action and RPA. For locations where mortality rates have not been estimated, NMFS uses estimates from a similar location or a similar species as surrogates. These estimates include quantifiable direct mortality from the operation of the WVS; unquantifiable, indirect mortality from other potential sources that occur in the reservoirs (e.g., predation, hatchery-related effects, disease); and unquantifiable "natural" levels of mortality (i.e., mortality in the reservoir reach that would have occurred without human influence). Since the effects of WVS dams and reservoirs on juvenile life stages and steelhead kelts often cannot be separated from other factors leading to take, this was chosen as the most reasonable surrogate to capture the amount or extent of take.

The estimates in Table 7.1-1 represent higher levels of mortality than those that can be attributed to the operation and maintenance of the WVS alone. As it is not practical to determine the precise amount of juvenile migrant mortality occurring only as a result of the proposed operation and maintenance of the WVS, we are using the ranges of past survival studies designed to assess WVS effects and associated mortality estimates as surrogates for the amount or extent of anticipated take. Doing so provides a standard for determining when take has been exceeded. The proposed action and the RPA include measures intended to reduce and/or maintain the effects of many of these factors, such as improving downstream passage conditions and reducing reservoir time, which may reduce mortality from predation, disease, and parasites. Based on our review in the opinion, we anticipate that those measures will be successful in maintaining or reducing associated mortality. Accordingly, the annual maximum take and mortality rate estimates provide a useful indicator of the overall amount of take anticipated for migrating UWR Chinook salmon and steelhead juveniles (and UWR steelhead kelts) resulting from the proposed action. These provide a benchmark to assess whether the effects of the proposed action, in terms of take of UWR Chinook salmon and steelhead juveniles and UWR steelhead kelts, become greater than expected.

The relationships between proposed tributary flows, mainstem Willamette River flows, water quality, and the functionality of spawning/incubation, rearing, and migratory corridor habitats below WVS dams are explained in Effects Sections. Quantitative estimates of take resulting from the effects of WVS operations on water quality for incubation, rearing, and migratory life stages of UWR Chinook salmon and steelhead present below WVS project dams are not available, nor would this take be simple to estimate and monitor. For example, it would be difficult to estimate the actual number of UWR Chinook salmon and steelhead that emerge from redds below Big Cliff Dam, Foster Dam, Cougar Dam, Fall Creek Dam, and Dexter Dam. It is also not practical to determine the precise amount of mortality that is occurring solely as a result of the WVS dam operations and their effects on flow and water quality. Implementing beneficial flow and temperature operations—using regional forums for adaptive management—is the most useful indicator for whether or not conditions to minimize take are occurring for UWR Chinook salmon and steelhead when they are present below WVS projects at various life stages. Therefore, as a surrogate, the extent of take indicator for mainstem incubating eggs, and emerging and migrating fry, will be the operation of the WVS dams in accordance with the water management operations and adaptive management processes specified in the proposed action and RPA, including targets codified and updated annually in the Water Management Plan and Willamette Fish Operations Plan (WFOP) (2025 and thereafter).

Below Dam Adult Spawners

The relationships between proposed tributary flows, mainstem Willamette River flows, water quality (including temperature, turbidity, and total dissolved gas), and potential effects on adult-migration timing and prespawning mortality are explained in Sections 5.1-5.10.

NMFS expects prespawning mortality rates below WVS projects (Table 7.1-1) to remain at or near recent levels under the proposed operations and Adaptive Management Plan. For locations where prespawning mortality rates have not been estimated, NMFS uses estimates from a similar location or a similar species as surrogates. These estimates of prespawning mortality rates below WVS projects capture all sources of prespawning mortality and represent NMFS' estimates of the maximum annual mortalities (1 - survival) that may be observed under the proposed action and Reasonable and Prudent Alternative. These estimates encompass all sources of mortality including dam operations to support fish passage, flow and temperature operations, and environmental factors that are not related to the proposed action. They still serve as a useful measure of incidental take because operation of the dams combined with operation of the adult fish facilities directly results in effects on flow and water quality that affect UWR Chinook salmon and UWR steelhead below dams, including adult migration timing and travel times to spawning grounds. These estimates include quantifiable direct mortality from the operation of the WVS; unquantifiable, indirect mortality from other potential sources that occur during adult upstream migration (increased stress from warm temperatures, low oxygen, pollution, human interactions [anglers and river recreators]); and unquantifiable "natural" levels of mortality (i.e., mortality that would have occurred without human influence). NMFS recognizes that prespawn mortality rates are positively correlated with water temperatures experienced during migration and the percentage of hatchery fish on spawning grounds (pHOS) (Bowerman et al. 2018).

7.1.2 Amount or Extent of Take from Adult Fish Facilities, Adult Transport and Release and the Willamette Hatchery Mitigation Program

Levels of expected incidental take for adults attributable to adult handling operations at the adult fish facilities per the RPA and proposed action are based off of the highest level of adult returns and adults transported and released in the last 20 years (or as long as the action has been occurring and data has been recorded). These data were used and then added to based on the potential for increased returns after proposed improvements are made to downstream fish passage conditions in each subbasin (Table 7.1-1). The levels of expected mortality rates for adults during transport to release sites plus the potential for post-release mortalities are based off of prespawning mortality rate estimates from past above-dam spawning surveys. Since the effect of handling, transporting, and releasing adult fish to locations above dams cannot be separated from other factors leading to prespawning mortality, this was chosen as the most reasonable way to capture the amount or extent of take.

The overall goal of the hatchery measure in the proposed action is to adjust WVS hatchery production (for mitigation obligations and conservation needs) under the condition that cohort replacement rates exceed a 1.0 average once long-term downstream-fish-passage measures are complete and natural-origin adult counts begin to increase over time. The proposed action measure only includes the possibility of reducing production and releases, not increasing them. The proposed action's hatchery measure will also ensure that the Willamette Project hatchery mitigation programs do not jeopardize the continued existence of the listed species. Therefore, additional incidental take coverage for the production from these hatchery programs and associated releases is not needed in this Opinion, as it has already been assessed and covered under the NMFS 2019 Biological Opinion, "Evaluation of Hatchery Programs for Spring Chinook Salmon, Summer Steelhead and Rainbow Trout in the Upper Willamette River Basin" (NMFS 2019a).

7.1.3 Extent of Take from Administration of Bureau of Reclamation's (BOR's) Water Marketing Program

The water marketing program will continue to comply with the 2008 RPA (WVS Biological Opinion, NMFS 2008a); thus, the total water marketing program would not exceed 95,000 acre-feet. The relationships between actions that will occur as a result of administering water contracts, habitat condition, and carrying capacity (a factor in population abundance and productivity) are explained in Chapter 5.

Reclamation will administer existing irrigation contracts and write new contracts for irrigation use of stored water up to 95,000 acre-feet provided that: the contract is consistent with the irrigation storage allocation; it is possible to fulfill the contract under USACE's operating plan; and it complies with all other applicable laws and treaties. Reclamation will subject water service contracts to conditions that meet ESA constraints, per the 2008 RPA (NMFS 2008a) and water being made available by USACE.

Because the effects of this program are intertwined with the effects of the flow and water quality measures in the proposed action and the RPA, the take indicator for this program is the same as the take indicator identified in Section 7.1.1. Take for various life stages of UWR Chinook salmon and steelhead (present below the lowest dams) is assumed to be exceeded if flow and dam operations are both: a) inconsistent with the annually adopted Flow and Water Management Plan and Willamette Fish Operations Plan (WFOP) (beginning in 2025); and b) are not in compliance with in-season adaptive management operations that are agreed upon by the WATER Flow and Water Quality Management Team (FWQMT) when regular Flow and Water Management Plan and WFOP targets cannot be met.

7.1.4 Extent of Take from Implementation of Habitat Measures

Under the RPA, habitat-restoration projects could be implemented in the mainstem Willamette River and in any of the tributary sub-basins with Project dams or revetments. Habitat-restoration projects and revetment-restoration projects can have temporary negative effects during construction (e.g., sediment plumes, localized and brief chemical contamination from machinery, or the destruction or disturbance of some existing riparian vegetation). These effects are expected to be minor, occur only at the project scale, and persist for a short time (no more and typically less than a few weeks).

Coverage for take of ESA-listed salmonids for habitat projects developed for the purpose of implementing the RPA (and proposed action) measures, and authorized, funded, or carried out by the action agencies, will require separate ESA section 7 consultations if not covered by an existing programmatic consultation. Therefore, a take estimate and take coverage for those projects is not provided here.

7.1.5 Extent of Take from Implementation of Long-Term Fish Passage Measures

The interim operations for the WVS in the proposed action are a major source of take for ESA-listed UWR Chinook salmon in all four major sub-basins subject to effects of the interim operations (and for ESA-listed UWR steelhead in sub-basins where adult reintroduction efforts are currently underway) because of the associated high injury and mortality rates that UWR Chinook salmon and steelhead juveniles (and UWR steelhead kelts) experience passing through the reservoirs and dams. The long-term fish-passage measures in the proposed action and the RPAare anticipated to help reduce high mortality rates associated with downstream passage that may be observed under the interim operations These long-term improvements and their timelines were considered in the effects analyses.

Accordingly, the implementation timelines also serve as clear standards for determining when take is exceeded. Take of juvenile and adult UWR Chinook salmon and steelhead is assumed to be exceeded if the deadlines for the implementation of the long-term fish passage measures, as stated in the RPA, are not met.

7.1.6 Amount or Extent of Take from RM&E activities

This section identifies the amount or extent of incidental take caused by the RM&E actions (see Effects of the proposed action [Chapter 5] and Effects of the RPA [Chapter 6]). Under the PA and RPA, the Willamette Project Action Agencies, or their contractors, are required to implement the following RM&E actions:

1. Support performance monitoring and adaptive management related to current and future flow management actions and plans (RPA measure #4.2 under section 6.4);
2. Support performance monitoring and adaptive management related to water quality actions (RPA measures under RPA 3 under section 6.3);
3. Support performance monitoring and adaptive management related to fish passage and adult collection, transport and reintroduction measures (RPA measures under section 6.4);

The estimated amount of incidental take caused by the RM&E actions is presented in Table 7.1-2. Many of these RM&E actions will result in short-term adverse impacts on listed salmonids. The primary adverse effects the proposed monitoring activities will have on listed species will be in the form of sublethal incidental take caused by observing, capturing, and handling fish, 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. Incidental mortalities are unintentional fish deaths that occur during the normal course of the RM&E.

When additional hatchery fish production and release of hatchery fish is needed for the purpose of meeting any RME requirements included in this proposed action and RPA, and it exceeds current take coverage found in the Willamette River Basin Hatchery Program Biological Opinion (NMFS 2019a), additional take coverage is provided through this Incidental Take Statement. The estimated take for all RME included in table 7.1-2 is very unlikely to be maximized for all listed purposes within the same year. However, for the purposes of analyzing the effect of additional hatchery releases for RME purposes above the dams, we will assume that all of the take for hatchery juveniles is used in all sub-basins and within the same year. This would amount to an additional 150,000 to 255,000 hatchery Chinook salmon per sub-basin and an additional 62,000 hatchery surrogate steelhead released in each of the Santiam sub-basins. Given that all of these juvenile fish would be released above the dam projects, likely into the highest reservoir in each sub-basin, the percentage of releases that would survive to areas downstream of the dam projects, where interaction between hatchery-origin and natural-origin juveniles are more likely, would be minimal in comparison to the mitigation hatchery juveniles regularly produced and released below the dam projects. In all scenarios, other than the North Santiam, where estimated survival rates may be higher, less than 5 percent of the maximum release would survive to areas below the dam projects, and this would equate to less than 1 percent of the hatchery release within each sub-basin downstream of the dams. If higher survival rates through the North Santiam dam projects continue to remain higher, this would provide justification for lower release numbers for monitoring purposes in that sub-basin. The same would also be true if downstream passage survival rates improved in other sub-basins during the interim operation period. While the effect of additional hatchery releases for RME purposes may have a slightly negative effect on natural-origin juvenile UWR Chinook salmon and UWR steelhead rearing and migrating in areas below dams, the benefit in terms of information gained and needed for an effective adaptive management process for the recovery of ESA-listed salmon and steelhead is assumed to greatly outweigh the expected cost.

7.1.6.1 Amount or Extent of Incidental Take from Flow RM&E Actions

Incidental take from flow RM&E actions may include harassment of adults and juveniles during construction or maintenance of monitoring stations and/or during measurement of physical and biological metrics, although the effect of incidental take from this work is expected to be minor. In addition, juvenile and adult UWR Chinook salmon and steelhead may be handled or tagged for flow RM&E studies determined by the Adaptive Management process, but will not exceed total estimates for annual RME needs (Table 7.1-2). NMFS has determined that mortalities, based on consideration of similar studies to date, are likely to be less than 3% of fish captured and/or handled, on average. Therefore, mortality of up to 3% of juvenile Chinook and steelhead captured and/or handled is expected as incidental lethal take (mortality).

7.1.6.2 Amount or Extent of Incidental Take from Water Quality RM&E Actions

Incidental take from water quality RM&E actions may include harassment of adults and juveniles during construction or maintenance of monitoring stations and/or during measurement of physical and biological metrics, although the effect of incidental take from this work is expected to be minor. In addition, juvenile and adult UWR Chinook salmon and steelhead may be handled or tagged for water-quality studies determined by the Adaptive Management process but will not exceed total estimates for annual RME needs (Table 7.1-2). NMFS has determined that mortalities, based on consideration of similar studies to date, are likely to be less than 3 percent of fish captured and/or handled. Therefore, mortality of up to 3 percent of juvenile UWR Chinook salmon and steelhead captured and/or handled is expected as incidental lethal take (mortality).

7.1.6.3 Amount or Extent of Incidental Take from Fish Passage, Migration and Reservoir Survival RM&E Actions

Incidental take from research monitoring and evaluation studies (RM&E) includes maximum annual sublethal take estimates and percent mortality (of annual total take per category). These studies may include studies on salmon and steelhead migration, movement, reservoir survival, predation rates, and dam passage metrics (including fish guidance efficiency (FGE), dam project and route-specific survival rates). The amount or extent of take expected from each of these activities is shown in Tables 7.1-2.

7.1.6.4 Amount or Extent of Incidental Take from RM&E Actions Associated with Adult Collection and Transport to Release Sites

No incidental take for adult collection and transport associated with RM&E actions is expected to exceed take already identified for actions associated with adult fish facility operation, collection, and transport to adult-release sites (see section 7.1.2 above), as addressed in Table 7.1-1.

7.1.6.5 Summary of Amount or Extent of Incidental Take from All RM&E Actions

As a result of implementing the RM&E actions required by the PA and the RPA, NMFS' best estimate of the average take that is likely to be experienced by the salmon and steelhead species considered in this Opinion is provided in Table 7.1-1.

Table 7.1-1 Estimates of the annual (quantifiable) amount of incidental take of UWR Chinook salmon and UWR steelhead (juveniles, kelts and adults) associated with proposed (and RPA) operation of WVSdams and reservoirs, and with adult fish facility collection, transport and reintroduction actions. Percent mortality limits apply to total fish returns or total fish impacted within one year. Take for each category is expected to vary on an annual basis but is not expected to exceed these levels / rates over multiple years.
*Pre-spawning mortality rates for below dam locations are based off of studies conducted since 2015, with an additional buffer for anticipated interannual variability.
**Adult transport mortality rates include mortality from handling, transport and pre-spawning mortality post release. from above dam spawning surveys conducted since 2015 (see Section 7.1-2).

CHINOOK						
			AMOUNT of TAKE		MORTALITY LIMIT	
SUBBASIN	FEATURE	LIFE STAGE(S)	NOR	HOR	NOR	HOR
North Santiam	Pre-Spawning Mortality Below Detroit Dam	Adults			70%	70%
	Minto Adult Fish Facility		5000	10,000	2%	2%
	Adult Transport from Minto Adult Fish Facility		5000	5000	15%	15%
	Detroit Dam	Juveniles			50%	50%
	Detroit Reservoir				40%	40%
	Big Cliff Dam				35%	35%
	Big Cliff Reservoir				40%	40%
South Santiam	Pre-Spawning Mortality Below Foster Dam	Adults			20%	20%
	Foster Adult Fish Facility		3000	3000	2%	2%
	Adult Transport from Foster Adult Fish Facility		3000	2000	40%	40%
	Foster Dam	Juveniles			40%	40%
	Foster Reservoir				70%	70%
	Green Peter Dam				35%	35%
	Green Peter Reservoir				70%	70%

Table 7.1-1 Continued from above.

CHINOOK						
			AMOUNT of TAKE		MORTALITY LIMIT	
SUBBASIN	FEATURE	LIFE STAGE(S)	NOR	HOR	NOR	HOR
McKenzie	Pre-Spawning Mortality Below Cougar Dam	Adults			35%	35%
	Cougar Adult Fish Facility		3000	1,000	2%	2%
	Adult Transport from Cougar Dam Adult Fish Facility (or other)		5000	5000	10%	10%
	Leaburg Dam Fish Sorter		5000	5000	2%	2%
	Cougar Reservoir	Juveniles			90%	90%
	Cougar Dam				60%	60%
Middle Fork Willamette	Pre-Spawning Mortality Below Fall Creek Dam	Adults			60%	60%
	Fall Creek Adult Fish Facility		3000	500	2%	2%
	Fall Creek Adult Transport		3000	500	85%	1%
	Fall Creek Reservoir	Juveniles			70%	70%
	Fall Creek Dam - RO				20%	20%
	Pre-Spawning Mortality Below Dexter Dam	Adults			90%	90%
	Dexter Adult Fish Facility		1000	10,000	2%	2%
	Adult Transport from Dexter Adult Fish Facility		1000	5000	80%	80%
	Dexter Dam	Juveniles			70%	70%
	Dexter Dam Reservoir				80%	80%
	Lookout Point Reservoir (Kock, Perry et al. 2019a)				80%	80%
	Lookout Point Dam				30%	30%
	Hills Creek Dam				60%	60%
	Hills Creek Reservoir				90%	90%

Table 7.1-1 Continued from above.

STEELHEAD				
			NOR	
SUBBASIN	FEATURE	LIFE STAGE(S)	AMOUNT OF TAKE	MORTALITY LIMIT
North Santiam	Pre-Spawning Mortality Below Detroit Dam	Adults		25%
	Minto Adult Fish Facility		1000	2%
	Adult Transport from Minto Adult Fish Facility (if needed)		1000	15%
	Detroit Dam	Juveniles /Kelts		50% / 50%
	Detroit Reservoir			40% / 5%
	Big Cliff Dam			25% / 50%
	Big Cliff Reservoir			25% / 5%
South Santiam	Pre-Spawning Mortality Below Foster Dam	Adults		10%
	Foster Adult Fish Facility		1000	2%
	Adult Transport from Foster Adult Fish Facility		1000	20%
	Foster Dam	Juveniles		40%
	Foster Dam	Kelts		40%
	Foster Reservoir	Juveniles / Kelts		50% / 5%
	Green Peter Dam			40% / 40%
	Green Peter Reservoir			50% / 5%

Table 7.1-2 Estimates of annual (quantifiable) incidental take for UWR Chinook salmon and UWR steelhead associated with proposed RME and RPA RME actions and activities.

Above / Below Ops Monitoring, Retintroduction Monitoring & Comprehensive Monitoring Program

	CHINOOK - JUVENILES				CHINOOK - ADULTS			
Sub-basin	Hatchery Origin		Natural Origin		Hatchery Origin		Natural Origin	
	Take	Mortality	Take	Mortality	Take	Mortality	Take	Mortality
McKenzie	25,000	3%	60,000	3%	100	0	200	0
Middle Fork	50,000	3%	30,000	3%	100	0	500	0
North Santiam	50,000	3%	120,000	3%	100	0	200	0
South Santiam	50,000	3%	60,000	3%	100	0	200	0

	STEELHEAD - JUVENILES				STEELHEAD - ADULTS			
Sub-basin	Hatchery Origin		Natural Origin		Hatchery Origin		Natural Origin	
	Take	Mortality	Take	Mortality	Take	Mortality	Take	Mortality
McKenzie	n/a	3%	n/a	3%	n/a	n/a	n/a	n/a
Middle Fork	n/a	3%	n/a	3%	n/a	n/a	n/a	n/a
North Santiam	10,250	3%	10,250	3%	100	0	100	0
South Santiam	9,250	3%	9,250	3%	150	0	15	0

Active Tagging Studies

	CHINOOK - JUVENILES				CHINOOK - ADULTS			
Sub-basin	Hatchery Origin		Natural Origin		Hatchery Origin		Natural Origin	
	Take	Mortality	Take	Mortality	Take	Mortality	Take	Mortality
McKenzie	2500	3%	1000	3%	200	5	200	5
Middle Fork	5000	3%	1000	3%	200	5	200	5
North Santiam	5000	3%	1000	3%	200	5	200	5
South Santiam	5000	3%	1000	3%	400	5	200	5

	STEELHEAD - JUVENILES				STEELHEAD - ADULTS			
Sub-basin	Hatchery Origin		Natural Origin		Hatchery Origin		Natural Origin	
	Take	Mortality	Take	Mortality	Take	Mortality	Take	Mortality
McKenzie	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Middle Fork	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
North Santiam	2500	3%	1000	3%	50	5	200	5
South Santiam	2500	3%	1000	3%	50	5	300	6

Reservoir Survival Studies

	CHINOOK - JUVENILES				CHINOOK - ADULTS			
Sub-basin	Hatchery Origin		Natural Origin		Hatchery Origin		Natural Origin	
	Take	Mortality	Take	Mortality	Take	Mortality	Take	Mortality
McKenzie	100,000	5%	5000	250	10	2	10	2
Middle Fork	200,000	5%	5000	250	10	2	10	2
North Santiam	200,000	5%	5000	250	10	2	10	2
South Santiam	200,000	5%	5000	250	10	2	10	2

	STEELHEAD - JUVENILES				STEELHEAD - ADULTS			
Sub-basin	Hatchery Origin		Natural Origin		Hatchery Origin		Natural Origin	
	Take	Mortality	Take	Mortality	Take	Mortality	Take	Mortality
McKenzie	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Middle Fork	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
North Santiam	50,000	5%	5000	250	10	2	10	2
South Santiam	50,000	5%	5000	250	10	2	10	2

7.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat when the RPA is implemented.

7.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 CFR 402.02).

The following reasonable and prudent measures (RPMs) and their related terms and conditions (T&Cs) are necessary or appropriate to minimize incidental take and to monitor the incidental take of the ESA-listed species resulting from implementation of the proposed action and RPA. This includes operation and maintenance of the WVS, operation of the adult fish facilities and associated outplanting and hatchery program, administration of Reclamation's water contract program, and required RM&E activities included in the proposed action and the RPA. The RPMs and T&Cs are intended to avoid or minimize adverse effects of Project operations and RME actions on listed fish species and on designated critical habitat.

The USACE, Bureau of Reclamation, and BPA must comply with all of the following reasonable and prudent measures and related terms and conditions, which are non-discretionary.

1. Minimize incidental take during in-water work activities associated with implementation of the proposed action and RPA (including any construction associated with proposed dam operation and maintenance work) through the use of best management practices and timing (approved in-water work periods). Use methods to minimize adverse effects on listed species or water quality, riparian habitat, or other aquatic system components of critical habitat.

2. Minimize the impacts of WVS operations and maintenance activities (in the proposed action and the RPA) on UWR Chinook salmon and steelhead juveniles and adults through monitoring and evaluation of the take by implementing the measures specified in Section 7.4, #2.

3. Minimize incidental take from operation of adult fish facilities, and handling, sampling, and transport activities related to adult outplanting and reintroduction efforts by implementing the measures specified in Section 7.4, #3.

4. Minimize incidental take from general Research, Monitoring, and Evaluation activities. The action agencies (or their designated contractors) shall monitor the level of take of ESA listed species associated with specific RME actions and will report the observed take to NMFS' designated WVS take-determination coordinator no later than 6 months after the completion of the RME action (i.e., when fieldwork has been completed). Take reports are also a condition of annual take authorization renewals.
    a. The action agencies shall minimize the impact of take resulting from RME actions including evaluating effects of flow and water quality conditions on fish, fish survival and passage studies, and fish predation studies.

   b. The action agencies shall reduce the impact of take by working with NMFS staff to coordinate research and monitoring activities with other funding and implementing agencies to ensure that necessary data is being collected in a manner that minimizes impacts on listed species. Coordination includes following standardized collection protocols and data sharing. This will reduce take by reducing the potential numbers of fish needed to perform similar research activities.

5. Ensure completion of monitoring and reporting to demonstrate compliance with the requirements of this ITS. To better understand how to minimize take from activities associated with hydrosystem operations and improve effectiveness of take minimization activities on fish, the action agencies will report information related to implementation of the proposed action. This information supports adaptive management and revision of operations based on information learned. The required information includes annual implementation plans, annual and project-specific reports, and take reports, as outlined in Term and Condition 5 below. This information will provide a record to document implementation of the proposed action and RPA and assist NMFS in determining if the proposed action is being implemented in a manner that is consistent with the analysis in this opinion or, conversely, if re-initiation triggers defined in 50 CFR 402.16 have been exceeded.

7.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The USACE, BOR, and BPA, have a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

These terms and conditions constitute no more than minor changes because they only provide further elaboration on the more general measures in the PA and RPA.

1) <u>The following terms and conditions implement reasonable and prudent measure 1:</u>

For all actions involving construction in or near waterways, and not requiring a separate ESA-consultation process, the action agencies must submit project construction plans to NMFS for review. This will ensure that best management practices to control, avoid, and mitigate potential detrimental effects on listed salmonids and critical habitat are implemented at the project site.

NMFS will be reviewing the submitted construction plans to advise the action agencies regarding whether or not those plans are likely to meet the most up-to-date best management practices or additional methods that NMFS deems appropriate for limiting take and avoiding take exceedances. Best management practices for in-water work were outlined in detail in the Incidental Take Statement's Terms and Conditions in the 2008 WVS Biological Opinion (NMFS

2008a). Though some of these best management practices have been updated since 2008, those Terms and Conditions may be used as a general guide for development of construction best management practices.

2) <u>The following terms and conditions implement reasonable and prudent measure 2.</u>

Monitor and evaluate the impacts of WVS operation and maintenance activities in the proposed action and the RPA on UWR Chinook salmon and steelhead juveniles and adults by implementing the measures below:

a. Evaluate Dam and Reach Survival Rates for Juveniles:

   The action agencies, in coordination with NMFS through the annual planning process, shall annually estimate project and reach survival rates of juvenile UWR Chinook salmon (from Detroit Reservoir to below Big Cliff Dam, Green Peter Reservoir to below Foster Dams, Cougar Reservoir to below Cougar Dam, Fall Creek Reservoir to below Fall Creek Dam, and Lookout Point Reservoir to below Dexter Dam) with PIT tag detectors, or other monitoring methods, compare averages of the resulting annual mortality estimates (1-survival) to the values reported in Table 7.1-1, and inform NMFS of the results of this comparison. If it is possible to acquire steelhead juveniles from the hatchery surrogate program to also estimate reservoir and project survival rates for applicable reaches in the North Santiam and South Santiam sub-basins to compare to values reported in Table 7.1-1, then steelhead shall also be included in these annual survival studies. When efforts to improve downstream juvenile passage conditions at Hills Creek begin, and efforts to introduce adult Chinook salmon above Hills Creek Dam continue, the action agencies shall also conduct survival studies through Hills Creek Reservoir and Hills Creek Dam on an annual basis and compare study results to values reported in Table 7.1-1.

b. Evaluate Returning Adult Chinook Pre-spawning Mortality Rates Below Dams:

   The action agencies shall annually estimate adult prespawning mortality rates for UWR Chinook salmon in previously surveyed spawning reaches below Big Cliff Dam, Foster Dam, Cougar Dam, Fall Creek Dam, and Dexter Dam and compare these estimates to the values reported in Table 7.1-1, and report to NMFS.

c. Monitor Effects of Temperature, Turbidity, and Dissolved Gas (TDG) Supersaturation:

   The action agencies shall monitor temperature, turbidity, and TDG s in areas below the lowest WVS project dams (i.e., Big Cliff, Foster, Cougar, Fall Creek, and Dexter dams) and document the monitoring plan in the Flow and Water Quality Plan. In coordination with NMFS and relevant agencies or partners via the Adaptive Management Team, an associated biological impact monitoring program may be developed in areas below these projects, as deemed necessary, and documented in the Flow and Water Quality Plan. The monitoring plans will specify monitoring locations, sampling methodologies, calibration and maintenance of monitoring equipment, QA/QC, data collection and reporting, and archival storage in the Corps' online database. This information, and the results of biological monitoring, shall be shared with resource agencies on a schedule deemed appropriate by the Adaptive Management Team (or possibly in real-time for water quality parameters measured at gages) for effective use in in-season management decisions. This will reduce take by ensuring that incubating eggs and fry or migrating juvenile and adult salmon and steelhead are not exposed to temperature, turbidity, or TDG levels higher than anticipated and that the effects are not more severe for juvenile and adult migrants than expected. NMFS recognizes that proposed operations for dam passage and downstream temperature management may sometimes cause elevated levels of these water quality parameters downstream of the projects. It will be the work of the Adaptive Management Team to find the optimal combination of costs and benefits per operation, under various conditions, and the continued collection and reporting of this data will be critical to that work.

d. Identify, Review, and Prioritize Adult Fish Facility and Hatchery Maintenance Issues

When operating properly, adult fish facilities and hatchery facilities should provide sufficient attraction conditions for adult salmon and steelhead trying to migrate further upriver to spawn or return to the hatchery. These facilities should also provide safe and healthy conditions, that also minimize environmental stressors, for returning adult fish upon entering the facilities and prior to processing for upstream transport or for use as broodstock. Maintenance of these structures and systems is critical for their long-term reliability and the provision of safe and effective passage. To further reduce take associated with the maintenance of existing fish facilities and operations:

i. The action agencies shall annually review critical failures that have created attraction issues and interrupted safe and healthy conditions and make recommendations for the prioritized non-routine maintenance needs (per facility) to the Adaptive Management Team so that they may be considered prior to submitting the next annual request. If failures may be remedied in-season and in-season funding alternatives are available, these issues may be brought to the Adaptive Management Team at any point in the budget and prioritization cycle.

ii. The action agencies shall develop, in coordination with NMFS and WFPOM, a prioritized list of maintenance issues critical for the continued reliability of adult fish facilities in the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette River basins and use this list to consider how to prioritize the use of appropriate funds, to the extent possible.

3) The following terms and conditions implement reasonable and prudent measure 3.

Minimize incidental take from the operation of adult fish facilities, and handling, sampling, and transport activities associated with adult outplanting and reintroduction efforts by working with ODFW staff to: 1) adhere to the related methods and guidelines outlined in Section 5 of the WFOP (Willamette Fish Operations Plan) including new requirements for fish sampling and training; and 2) provide a report to NMFS on an annual basis (by January 31st of each year) for each of the adult fish facilities included in the proposed action. This report shall include the following information, unless the Adaptive Management Team determines that any of this information is no longer necessary or informative:

a. The number of adult mortalities that occurred at the facility, by date, species, sex, origin (hatchery vs. natural-origin), and a description of what factors led to the mortalities or could be improved to reduce mortalities in the future.

b. A summary of temperature and water-quality conditions at the facility during fish collection periods.

c. A summary of any conditions within or below the facility that may have led to attraction issues.

d. A general breakdown of the number of fish collected at the facility that year split-out between adults used for broodstock (or transported to another facility for broodstock collection) vs. adults transported to release sites by: species, sex, and origin (hatchery vs. natural-origin). Note this information in relation to hatchery broodstock collection and outplanting goals as identified in NMFS 2019a.

e. For adults transported to adult-release sites: number of fish transported by date, species, sex, origin (hatchery vs. natural origin), and separated by specific release location. Also, if there were any observed mortalities during transport, those must be noted along with whether there may have been a known cause (conditions in transport tank or handling or stream conditions during release).

f. For Chinook salmon adults transported to adult release sites: annually estimate prespawning mortality rates by release site and evaluate how timing of release and other factors can reduce prespawning mortality (PSM) rates. Compare results to the values reported in Table 7.1-1 (for “Adult Transport” which includes PSM) and report to NMFS.

4) The following terms and conditions implement reasonable and prudent measure 4:

The action agencies (or their designated contractors conducting the research) shall implement the following to minimize the impact of take associated with the proposed action and the RPA:

a. The action agencies shall continue to support monitoring and coordination forums and other efforts that the region's tribes, state agencies, other federal agencies, NGOs, and other entities participate in to coordinate monitoring actions to the extent allowable by law.

b. In addition to new, proposed efforts to prioritize and evaluate annual monitoring projects via the Adaptive Management Team, the action agencies (or their contractors) must then obtain NMFS' review and concurrence for monitoring and evaluation plans via the annual ESA "take" authorization process before initiating any research-related activities. This take authorization process will continue to be conducted as outlined in T&C #5 (below). These plans must identify annual anticipated take levels. NMFS may amend a take authorization or adjust specific take levels accompanied by reasonable communication and notice to the applicable researcher.

c. Each researcher, in carrying out activities authorized by this incidental take statement and through NMFS' Take Determination letters, must comply with the terms and conditions of this incidental take statement and any additional conditions included in NMFS' Take Determination letters.

d. Each researcher is responsible for the actions of any individual operating under the authority of the researcher's designated take authorization.

e. Each researcher, staff member, or designated agent acting on the researcher's behalf must possess a copy of the incidental take statement in this opinion and the NMFS authorizing take determination letter.

f. Researchers may not transfer or assign incidental take within this determination to any other person(s). The take exemption ceases to be in force or effective if transferred or assigned to any other person without prior authorization from NMFS.

g. Each researcher is responsible for biological samples collected from ESA-listed species as long as they are useful for research purposes. The terms and conditions concerning any samples collected remain in effect as long as the researcher maintains authority over and responsibility for the material taken. A researcher may not transfer biological samples to anyone not listed in the research proposal without obtaining prior written approval from NMFS. Any such transfer will be subject to such conditions as NMFS deems appropriate.

h. The action agencies shall minimize the impact of take by making the following terms and conditions part of any contractual arrangement or other agreement made with other parties regarding the conduct of research, monitoring, and evaluation studies approved for implementation by NMFS pursuant to this ITS:

i. Fish listed under the ESA must be handled with extreme care and kept in water to the maximum extent possible during sampling and processing. Adequate circulation and replenishment of water in holding units is required. When using gear that captures a mix of species, ESA-listed fish must be processed first, to the extent possible, to minimize the duration of handling stress. ESA-listed fish must be transferred using a sanctuary net (which holds water during transfer) whenever practical to prevent the added stress of being out of water. Should NMFS determine that a researcher's procedure is no longer acceptable; the researcher must immediately cease such activity until an acceptable alternative procedure can be developed with NMFS.
Researchers / field personnel / hatchery technicians etc.:

1. Must not intentionally kill or cause to be killed any listed species unless a specific monitoring or evaluation proposal, approved by NMFS, specifically allows intentional lethal take.
2. Must ensure that the ESA-listed species are taken only by the means, in the areas, and for the purposes set forth in the research proposal, as limited by the terms and conditions.
3. Must allow anesthetized fish to recover (e.g., in a recovery tank) before being released. Fish that are simply counted, but not handled, must remain in water but do not have to be anesthetized. Whenever possible, unintentional mortalities of ESA-listed fish that occur during scientific research and monitoring activities shall be used in place of intentional lethal take.
4. Must use the most up-to-date standards and methods for PIT tag and active tag injection (or other tagging methods), which maximally reduce handling stress, handling time, and post-tagging mortality rates.
5. Must stop handling listed juvenile and adult fish if the water temperature exceeds 68°F at the capture site. Under these conditions, listed fish may only be visually identified and counted. Additionally, electrofishing is not permitted if the instantaneous water temperature exceeds 64°F.
6. When any ESA-listed adult fish is captured while sampling only for juveniles, the adult fish must be released without further handling and such take must be reported.
7. Must comply with NMFS' Guidelines for Electrofishing (NMFS 2000), if backpack electrofishing methods are used, available at: https://media.fisheries.noaa.gov/dam-migration/electro2000.pdf
8. Backpack and boat electrofishing is not permitted if listed adult salmon or steelhead are known to be present, unless a specific RME project and associated take authorization receives an exemption to do so. Any listed adult salmon or steelhead encountered while electrofishing are considered take, even if it is

allowed to swim away without any further interaction or handling, and must be reported as such in the annual report.

9. Must obtain approval from NMFS before changing sampling locations or research protocols.
10. Must implement the following measures when implementing escapement/redd surveys:

    - Except for escapement (redd) surveys, no in-water work will occur within 300 feet of spawning areas during anadromous fish spawning and incubation times.
    - Persons conducting redd surveys will be trained in redd identification, likely redd locations, and methods to minimize the likelihood of stepping on redds.
    - Workers will avoid redds and listed spawning fish while walking within or near stream channels to the extent possible. Avoidance will be accomplished by examining pool tail outs and low gradient riffles for clean gravel and characteristic shapes and flows prior to walking or snorkeling through these areas.
    - If redds or listed spawning fish are observed at any time, workers will step out of the channel and walk around the habitat unit on the bank at a distance from the active channel.

j. The action agencies (or their contractors) must notify NMFS as soon as possible but no later than 2 days after any authorized level of take is exceeded or if such an event is likely. The action agencies (or their contractors) must submit a concise description of the causative event (if known), a description of any resultant corrective actions taken (if any) to reduce the likelihood of future mortalities or injuries, and why the authorized take level was exceeded or is likely to be exceeded.

k. For the purposes of fulfilling term and condition 5b below, the action agencies (or their contractors) must keep accurate records for the end-of-the-year annual take report, including the number of listed fish taken and the location, the type of take, the number of fish intentionally killed and unintentionally killed, and a brief summary of the monitoring results (see 5b below). Falsifying annual reports or permit records is inconsistent with the terms of this ITS.

5) <u>The following terms and conditions implement reasonable and prudent measure 5:</u>

a. The Corps must provide implementation plans and study reports on schedule as outlined in the Adaptive Management Plan. The implementation plans and study reports required in each year, and the schedule for delivery, will be determined by the Adaptive Management Team and annual process. Study reports are essential for information critical to inform what operational changes are most appropriate for improving species survival. Failure to submit reports could also indicate that more incidental take is occurring than expected in our analysis of the RPA. Please Refer to Table 7.4-1 below for a full list of Reports and Plans required by the Reasonable and Prudent Alternative and the Incidental Take Statement in this Biological Opinion.

b. Annual ESA take authorization applications and annual ESA take monitoring reports and for all RME programs identified in the proposed action, the RPA, and this ITS shall be submitted using the Authorization and Permits for Protected Species (APPS) online reporting system (https//apps.nmfs.noaa.gov) or other reporting system as designated by NMFS. Submission and approval of an ESA take authorization application using the APPS system is required before any RME project or program may begin work in the field. A project or program's ESA take monitoring report is to be completed within 6 months from when fieldwork has been completed, or by December 15th (whichever is earliest); a take monitoring report is also a requirement for renewal of the project's or program's take authorization the following year.

The online ESA take authorization application will request the following information:

- Project purpose and relatedness to objectives of this opinion.
- Project sampling design and analysis methods.
- Project dates and location(s).
- The total number of ESA-listed fish estimated to be taken (with separate handling and mortality estimates) at each location and by ESU/DPS, life stage, origin (hatchery or natural-origin), and the manner of take (capture method and sampling methods).
- Names and affiliations of authorized researchers.
- Project contact information.
- Signed authorization letter.

The online ESA take reports will request the following information:

- A detailed description of scientific-research and monitoring activities, including the total number of ESA-listed fish taken at each location (with separate total handled and total mortality counts) and by ESU/DPS, life stage, origin (hatchery or natural-origin), and the manner of take (capture method and sampling methods).
- Measures taken to minimize disturbances to ESA-listed fish and the effectiveness of these measures, the condition of ESA-listed fish taken and used for research and monitoring, a description of the effects of research and monitoring activities on the subject species, the disposition of ESA-listed fish in the event of mortality, and a brief narrative of the circumstances surrounding fish injuries or mortalities to ESA-listed fish.
- Any problems that arose during research and monitoring activities and a statement as to whether the activities had any unforeseen effects.
- Steps that have been, and will be taken, to coordinate research and monitoring activities with those of other researchers.

Table 7.4-1 Comprehensive list of reports and plans required by the Reasonable and Prudent Alternative and the Incidental Take Statement in this Biological Opinion.

	Subject	RPA Required Plan or Report	ITS Required Plan or Report	FREQUENCY / DEADLINE
PLANS	Reintroduction Plans	1.1 Modify the proposed AM Plan and annual WFOP to include ongoing plans for retintroduction. NMFS will work with ODFW and USACE to develop modifications and criteria.		End of year 3 - 2028
	AM Plan - Plan identifying triggers for corrective actions.	1.3 For each basin and project or operation/ identify triggers for poor performance of interim measures, corrective actions / next steps, and dates by which corrective action will be taken.		Within one year - Early 2026
	Design or feasibility studies	1.4 Provide early designs or draft feasibility studies to NMFS for review, before decisions are made.		Ongoing, before decisions are made.
	Joint Flow Management Plan	2.1 USACE, BOR and NMFS will develop a join Flow Management Plan, and concurrently with upcoming WBR Section 7 consultation process.		Within one year - Early 2026

	Subject	RPA Required Plan or Report	ITS Required Plan or Report	FREQUENCY / DEADLINE
	Alternatives Analysis for Sorting South Santiam Adult Returns	4.6.2 Assess ways to sort returning adults at Foster AFF in the future, especially for separating NORs between release sites in South Santiam reach vs. above Green Peter - and costs / benefits of proposed AFF below GPR.		Once, prior to moving forward with GPR adult fish facility design process.
	Annual RME Plan	Not required by RPA or ITS but will be part of the Adaptive Management process as outlined under the Proposed Action.		Annual
	Plan for future McKenzie Hatchery Chinook Management	RPA 5.2 - self-explanatory - work with NMFS and ODFW on future hatchery fish management options and plan for McKenzie Chinook production.		Within 2 years of EWEB finalizing plan for Leaburg Decommissioning.
	Plan to meet adult holding needs at Willamette Hatchery	5.3 - Coordinate with ODFW to develop a plan that ensures success of broodstock collection needs at Willamette Hatchery and for the Middle Fork Willamette.		Once, end of year 3 (end of 2027)
	Prioritized list of Adult Fish Facility Maintenance Issues		T&C 2d - Review any critical failures or potential issues that can create ladder attraction issues or unsuitable raceway conditions, etc. at the facilities with AM Team, and	Annually

	Subject	RPA Required Plan or Report	ITS Required Plan or Report	FREQUENCY / DEADLINE
			develop, in coordination with NMFS and WFPOM, a prioritized list for funding decisions.	
REPORTS	Draft Study Results (General)	1.4 Draft study results to NMFS for review and input, before decisions are made.		Ongoing, before decisions are made.
	ESA Take Reports for RME Studies		T&C 4 and T&C 5b - Take authorization applications and annual final reports via the APPS system as currently carried out by contractors conducting RME studies.	Annually, per project
	Assessment of potential North Santiam temperature management models.	3.5 This assessment will include differences between modeled results of temperatures below Detroit and Big Cliff and in the Willamette with a 1) SWS structure vs. 2) using current operational alternatives (for downstream temperature management in potential future hot / dry years).		December of Year 2027

	Subject	RPA Required Plan or Report	ITS Required Plan or Report	FREQUENCY / DEADLINE
	Basic annual turbidity assessment	3.7 Report on how the year's operations affected turbidity		Annually to WFPOM / FWQMT
	Basin-Wide Monitoring Program - Annual Reports	4.2 Annual reports summarizing juvenile tagging efforts, and juvenile and adult detection data (including travel times, migration, etc.) from PTAGIS in reference to flow, water quality, etc. as specified in RPA 4.2 and as modified through adaptive management.	T&C 2a - Evaluate Dam and Reach Survival Rates for Juveniles; T&C 2c. Monitor Effects of Temperature, Turbidity, and DO Supersaturation.	Annually, once PIT detection capabilities are installed in at least one sub-basin and/or at Willamette Falls
	Basin-Wide Monitoring Program - 3-Year Evaluations	4.2 These reports will synthesize the results of the annual reports in all previous years and note what has been learned about operational effects under various water years / environmental conditions using among - year and among - basin comparisons.	T&C 2a - Evaluate Dam and Reach Survival Rates for Juveniles; T&C 2c. Monitor Effects of Temperature, Turbidity, and DO Supersaturation.	Every three years, after PIT detection installed in at least one sub-basin and/or at Willamette Falls.
	Spawning Survey Reports	4.3.3 Spawning survey results - alternating between two sub-basins each year. Can be combined with 4.3.6 reports on release site juvenile outmigration.	T&C 2b - Evaluate Adult Chinook Pre-Spawning Mortality Rates Below Dams.	Annually, by March 1st of each year.
	Adult Fish Facility and Adult Release Data Reporting	4.3.4 Update template for how these reports are organized and in a format in which annual totals and summaries may be compared among years.	T&C 3 - Provide a report to NMFS on an annual basis for each of the adult fish facilities included in the proposed action including	Bi-weekly or Monthly Updates to the Online Reports (RPA) and also annual reports by Jan. 31st (T&C).

	Subject	RPA Required Plan or Report	ITS Required Plan or Report	FREQUENCY / DEADLINE
			information outlined in T&C 3.	
	Adult Release Site Assessment	4.3.5 Building on similar assessments in the past and looking to optimize release locations / explore new ones in future and in coordination with new adult reintroduction planning.		By 2031
	Adult Release Site Productivity Results	4.3.6 Brief monthly adult release site productivity reports (numbers passed through RSTs), for one site per sub-basin each year, plus one end-of year summary.		Monthly and annually, and continuation (and site location changes) determined by AM Team.
	Ongoing Genetic Pedigree Analysis and Reporting	4.3.7 Setting up a more consistent an annual process, for contracting analyzing and reporting this ongoing effort. Finalize results of backlog by 2027.		End of 2027 - reports for backlog catch up and then annual thereafter.
	Spring / Summer Operations Effects on Temperatures	4.6.1 Report to NMFS and AM Team on how modified operations at GPR and FOS in recent years has affected river temperatures below Foster and at Foster AFF.		Sometime in 2026

	Subject	RPA Required Plan or Report	ITS Required Plan or Report	FREQUENCY / DEADLINE
	Assessment of Interim Operations on Juvenile Passage	4.8.1 Report synthesizing data collected during interim operations, operation effectiveness in improving juvenile fish passage and where data gaps may still exist.		End of FY 2028
	Evaluate Alternatives for Improving Passage Conditions through LOP and DEX	4.9.2 - Determine whether spill and drawdown passage conditions are acceptable and also look at methods for optimizing passage conditions through turbines and spillway at Dexter. Compare these alternatives and related passage metrics to those using a FSS / FSC at LOP.		End of 2029
	Evaluation of Hills Creek Dam Passage Conditions and Optimization	4.9.3 -Evaluate downstream passage at Hills Creek through different operations and by route and report back to NMFS, so that potential modifications can be proposed.		Once, by 2030
	Assessment of Cougar downstream passage metrics	4.10.1 - assess RO opening data for optimization to improve injury and survival rates, find best times to limit turbine use, and report to AM / WATER Teams.		Once before 2027.
	Final Assessment of South Santiam Interim Measures & FIRO	4.11.1 - Final report evaluating all data relevant to downstream fish passage and WQ for interim operational measures at GPR and FOS, including feasibility of using FIRO to improve GPR refill timing.		Once in 2028.

	Subject	RPA Required Plan or Report	ITS Required Plan or Report	FREQUENCY / DEADLINE
	Report on Habitat Restoration Potential for Future Adult Release Locations	6.2 - Identify and evaluate potential habitat restoration projects near adult release sites above reservoirs. This RPA is related to other measures regarding reintroduction planning: RPA 1.1 and RPA 4.3.5.		December of 2035
	New WRBBPP Feasibility Assessment	6.3 - The Action Agencies will assess the current revetment structures. In addition to the efforts described in the proposed action under "Maintain Revetments Using Nature-based Engineering /Alter for Ecosystem Restoration", the revetments will be considered for potential habitat values if modified.		December of 2030

7.5 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 the threatened and endangered species. Specifically, "conservation recommendations" are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). NMFS provides the following conservation recommendations:

1. Work with Willamette Basin partners such as tribes, state agencies, NGO's, and landowners to plan for and implement stream temperature mitigation through habitat restoration and floodplain reconnection downstream of WVS projects (in lower tributaries and the mainstem Willamette River).

2. Use the USACE's most recent accomplishments in their Engineering with Nature program to inform and serve as a model for improving the USACE WVS revetments. Make a concerted effort to collaborate with landowners associated with or affected by (positively or negatively) current revetments made of rocky, hardened structure (rip-rap) and find any and all opportunities to either: 1) replace these hardened revetments with softer materials; or 2) reconnect the river with the floodplain through partial to full revetment removal.

3. Establish an annual acreage goal for habitat restoration to include, but not be limited to, project types such as floodplain reconnection, side-channel access/restoration, large-wood placement, and stage zero projects.

4. The Corps should support, in coordination with NMFS, the formation of a Willamette Basin Collaborative. which should include representatives from conservation organizations, agricultural and other industries, private landowners, state agencies, tribes, federal agencies and other affected communities. The purpose of the Willamette Basin Collaborative, similar to the Columbia Basin Partnership, would be to bring together diverse representatives from across the Willamette Basin to establish a common vision and goals for protecting and propelling the recovery of UWR Chinook and UWR steelhead. The Collaborative's work should utilize the Columbia Basin Partnership Task Force's "Goals to Restore Thriving Salmon and Steelhead to the Columbia Basin: Phase 1 and Phase 2 Reports", while developing a range of scenarios and strategies that address different cultural, social, economic and ecological considerations specific to the Willamette Basin, the first being formulation of the Flow Management Plan. The vision and goals developed by the Collaborative should be considered by the WATER group and its technical teams when making management decisions.

5. Create a list of studies that need to be completed to improve or verify current estimates and assumptions about passage in the Fish Benefit Workbook, beginning with improved estimates for Detroit, Hills Creek, and Lookout Point Dams. Prioritize the list and create a study schedule with all representatives on the WATER Team, and plan budgets for contracts accordingly. Conducting the studies will allow for the establishment of a

completer and more accurate baseline and help in the prioritization of future passage improvements.

6. If deauthorization of Cougar Dam for hydropower production occurs, USACE should re-establish natural run-of-the river flow through the tunnel once passage conditions are optimized. If flood risk reduction requires shutting the tunnel gate, reopen the gate to bring the reservoir back to the optimal fish passage level as soon as possible.

7. Analyze current genetic pedigree results and determine what information is needed to fully assess current Chinook salmon outplanting methods including NOR/HOR ratios, locations (including habitat quality), and timing. Consider winter steelhead outplanting above Green Peter Dam.

8. If Hills Creek and Lookout Point passage efficiency and survival objectives can be achieved, increase adult Chinook salmon outplanting efforts in tributaries to Lookout Point Reservoir and/or above Hills Creek Reservoir.

9. Work with ODFW and NMFS to implement improvements to fish counting abilities (and NOR vs HOR identification) at Bennett and Lebanon dams.

7.6 Reinitiation of Consultation

This concludes formal consultation for maintenance and operation of the WVS. Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the federal agency, where discretionary federal involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

7.7 Not Likely to Adversely Affect Determinations

When evaluating whether the proposed action is not likely to adversely affect listed species or critical habitat, NMFS considers whether the effects are expected to be completely beneficial, insignificant, or discountable. Completely beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Effects are considered discountable if they are extremely unlikely to occur.

7.7.1 Eulachon

The 2010 status review concluded that the southern DPS of eulachon experienced an abrupt decline in abundance throughout its range, beginning in the mid-1990s. Although eulachon abundance in monitored rivers improved in the 2013–2015 return years, sharp declines in eulachon abundance occurred in monitored rivers in 2016–2018. Recent improvements in ocean conditions in the northern California Current, beginning in 2020, suggest that eulachon may rebound in numbers in the near future. The 2016 ESA five-year review concluded that the DPS's threatened designation remained appropriate. An updated five-year review is in preparation.

Eulachon may be impacted by the proposed action by modified flows and water temperature changes in their freshwater life stage. However, these effects are likely to be insignificant given the species occurs closest to the project area during the time of year when water is coolest and water quantity is highest. Eulachon do not use Willamette River or any of its tributaries for spawning.

7.7.2 Eulachon critical Habitat

NMFS designated 16 specific areas as eulachon critical habitat within the states of California, Oregon, and Washington. The designated areas are a combination of freshwater creeks and rivers and their associated estuaries, comprising approximately 539 km (335 mi) of habitat. The Tribal lands of four Indian Tribes are excluded from designation after evaluating the impacts of designation and benefits of exclusion associated with Tribal land ownership and management by the Tribes. In the portion of the species' range that lies south of the U.S.–Canada border, most eulachon production originates in the Columbia River Basin. Within the Columbia River Basin, the major and most consistent spawning runs return to the mainstem of the Columbia River and the Cowlitz River (Gustafson et al. 2010). Spawning also occurs in other tributaries to the Columbia River, including the Grays, Elochoman, Kalama, Lewis, and Sandy rivers (WDFW and ODFW 2001).

Physical structures associated with dams and water diversions may impede or delay passage of eulachon. The operation of dams and water diversions may also affect water flow, water quality parameters, substrate quality, and depth, and further compromise the ability of adult eulachon to reproduce successfully. Optimum flow and temperature requirements for spawning and incubation are unclear, but effects on water flow and associated effects on water quality (e.g., water temperature) and substrate composition may affect adult spawning activity, egg viability, and larval growth, development, and survival. Eulachon are using freshwater streams, including those in the Columbia River basin for spawning when water temperatures are at their lowest and water quantity is at its highest (between December and Jun). Any effects from the proposed action on eulachon critical habitat will be insignificant.

7.7.3 Green Sturgeon

The southern DPS of green sturgeon successfully persisted throughout North America for 200 million years. They are thought to have experienced a precipitous decline in abundance during the past century, which is likely a result of anthropogenic harvest and destruction of spawning and rearing habitat. There are now regulations in effect prohibiting harvest, but the most significant threats to green sturgeon likely relate to the ongoing loss and inaccessibility of available spawning habitat in California. Much of this is driven by competing water resource needs between humans and fish. Dams and other impassible barriers, altered flows, and entrapment in water diversions can impede or inhibit their migration (NMFS 2021e).

Green sturgeon are rarely found in the lower Willamette and do not generally use the Upper Willamette portion of the basin; however, they may experience the effects of water temperature or flow fluctuations that could be propagated downstream into the Columbia River. Furthermore, green sturgeon do not use the Willamette Basin to spawn but rather spawn in the Kalamath, Eel River, Rogue River, Sacramento Rivery, Feather, River, and Yuba Rivers. Because the effects of the proposed action would dissipate the further downstream they are encountered, individual green sturgeon would experience only insignificant effects and would not be not expected to be harmed by the proposed action.

7.7.4 Green Sturgeon Critical Habitat

NMFS designated critical habitat for the southern DPS of green sturgeon in 2009. The designated critical habitat listing does not include the Lower Willamette River. As explained above, any effects of the proposed action would be highly attenuated by the time they reached rivermile 74 of the Columbia River. Therefore, all effects of the proposed action on green sturgeon critical habitat would be insignificant.

7.7.5 Humpback Whales

Humpback whales *(Megaptera novaeangliae*) are only recently utilizing the lower portion of the Columbia River estuary during summer and fall, and not much is known about this recent change. Humpback whales were observed in the immediate vicinity of West and East Sand Islands in late summer and fall of 2015 and 2016 (The Chinook Observer 2016). They were also observed in the area in 2017 and 2019, but their presence was not documented there in 2018 (The Daily Astorian 2019). Most recently they were again seen earlier in the season than ever, at the beginning of April in 2020 (The Chinook Observer 2020). There is no contemporary documentation of their presence in the Columbia River prior to the summer of 2015. Their presence is likely due to the highly concentrated shoals of coastal pelagic fish such as northern anchovy (*Engraulis mordax*), which presents an opportunity for foraging.

The Mexico humpback whale DPS is threatened. The abundance estimate for the Mexico DPS is 3,264 individuals, and the population trend is unknown. Estimates of population growth trends do not exist for the Mexico DPS by itself. Given evidence of population growth throughout most of the primary feeding areas of the Mexico DPS (California/Oregon – Calambokidis et al. 2008), Gulf of Alaska from the Shumagins to Kodiak (Zerbini et al. 2006a), it is unlikely this DPS was declining, but the BRT noted that a reliable, quantitative estimate of the population growth rate for this DPS was not available. The Central America DPS is composed of whales that breed along the Pacific coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras and Nicaragua. Whales from this breeding ground feed almost exclusively offshore of California and Oregon in the eastern Pacific, with only a few individuals identified at the northern Washington southern British Columbia feeding grounds. The trend of the Central America DPS is considered unknown. The abundance estimate of the Central America DPS is 411 individuals, with an unknown population trend.

There is no indication that the proposed action will cause any measurable effects to humpback whale prey. Because humpback whales typically prey on pelagic species such as sardines, effects of the proposed action will be insignificant.

7.7.6 Humpback Whale Critical Habitat

NMFS designated critical habitat for the Central American DPS and Mexico DPS of humpback whales in 2021. Specific areas designated as critical habitat for the Central America DPS of humpback whales contain approximately 48,521 nautical mi^2 of marine habitat in the North Pacific Ocean within the portions of the California Current Ecosystem off the coasts of Washington, Oregon, and California. Specific areas designated as critical habitat for the Mexico DPS of humpback whales contain approximately 116,098 nautical mi^2 of marine habitat in the North Pacific Ocean, including areas within portions of the eastern Bering Sea, Gulf of Alaska, and California Current Ecosystem. The single humpback whale critical habitat PBF is prey abundance, though species conservation is also closely tied to climate change, fisheries interactions, noise pollution, marine pollution, and direct harvest. The proposed action would have no measurable effect on prey abundance for humpback whales. They are filter feeders and their prey items include pelagic schooling fish such as Pacific sardine, northern anchovy, and Pacific herring, which are not expected to be influenced by the dam operations or WVS maintenance activities. The chance of the proposed action affecting the humpback whale critical habitat PBF is discountable.

8 Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Section 305(b) of the MSA directs federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity," and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

This analysis is based, in part, on the EFH assessment provided by the USACE and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2005) and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

8.1 Essential Fish Habitat Affected by the Project

The Pacific Fishery Management Council (PFMC) described and identified EFH for groundfish (PFMC 2005) and Pacific Salmon (PFMC 1999). The proposed action and action area for this consultation are described in the Introduction to this document. Based on information provided by the action agency and the analysis of effects presented in the ESA portion of this document, NMFS concludes that the proposed actions will have the following adverse effects on EFH designated for Pacific Coast salmon and Groundfish.

8.2 Adverse Effects on Essential Fish Habitat

Based on the information provided in the BA and the analysis of effects presented in the ESA portion of this document, NMFS concludes that the proposed actions will have the following adverse effects on EFH designated for those species, including estuarine areas designated at habitat areas of critical concern in the Lower Columbia River and at other river mouths, bays, estuaries, and coastal waters that these projects will affect:

1. *Water quality* will be reduced due to increasing water temperatures during low water and hot years. Some operations may also cause increased TDG, and in water construction, or construction in riparian areas could result in inadvertent releases of hydraulic fluids, fuel, or other materials that could harm EFH.
2. *Natural cover for fish*, such as riparian vegetation, large wood, and boulders could be impacted due to reduced habitat forming processes that are inhibited by dam operations upstream.
3. *Forage availability and habitat access* will be temporarily reduced due to construction activities along revetments such as work area isolation and material movement/placement in-water. Some of these activities could result in some biological uplift in the form of improved rearing habitat, and refuge for rearing fish.
4. *Temporary loss of habitat function* would result from the proposed flow regime, which could cause less habitat to be available for spawning during low water years.

8.3 Essential Fish Habitat Conservation Recommendations

NMFS expects that fully implementing these conservation recommendations would protect EFH by avoiding or minimizing the adverse effects described in Section 3.2 above for Pacific coast salmon and Pacific coast groundfish:

1. The USACE, BPA, and BOR should implement the RPA fully.
2. The USACE should actively seek opportunities to engage landowners and agencies as necessary to implement floodplain reconnection projects intended to enhance flood storage and support habitat restoration for Pacific salmon species covered under this consultation and that occur in the action area.

Fully implementing these EFH conservation recommendations would avoid and/or minimize the adverse effects described in Section 3.2, above, for Pacific Coast salmon and Pacific Coast groundfish.

8.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, USACE must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the federal agency have agreed to use alternative time frames for the federal agency response. The response must include a description of the measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

8.5 Supplemental Consultation

The USACE must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

9 Data Quality Act Documentation and Pre-Dissemination Review

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

9.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the U.S. Army Corps of Engineers, Portland District, the Bureau of Reclamation, and Bonneville Power Administration. Other interested users could include permit or license applicants, citizens of affected areas, and others interested in the conservation of the affected ESUs/DPSs. Individual copies of this opinion were provided to USACE, BOR, and BPA. The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

9.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

9.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR part 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

10 References

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Ainslie, B.J., J.R. Post, and A.J. Paul. 1998. Effects of pulsed and continuous DC electrofishing on juvenile rainbow trout. *North American Journal of Fisheries Management* 18(4):905-918.

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11 Appendix A: USACE Appendix A to BA (Adaptive Management and Proposed action Implementation)

[see attachment]