PROGRAMMATIC
DRAFT ENVIRONMENTAL IMPACT STATEMENT

Expenditure of Funds to Increase Prey Availability for Southern Resident Killer Whales

January 2024

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

Photo Credits:
San Juan Islands, WA – Matthew Connolly
Southern Resident Killer Whale – NOAA Fisheries
Adult Chinook Salmon – Lance Kruzic
Alaska salmon troller Bay of Pillars in Chatham Strait – NOAA Fisheries

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

January 26, 2024

Dear Recipient:

In accordance with provisions of the National Environmental Policy Act, we announce the availability for review of our draft Programmatic Environmental Impact Statement (PEIS) for the expenditure of funds to increase the prey availability for endangered Southern Resident Killer Whales (SRKWs).

The proposed action/preferred alternative for the National Marine Fisheries Service (NMFS) is to use federal funds for a hatchery prey increase program for SRKWs to mitigate the effects of U.S. salmon fisheries managed under the Pacific Salmon Treaty. The funding would be distributed to hatchery operators to produce juvenile hatchery salmon for release into the wild as prey (food) for SRKWs in marine waters.

The document is accessible electronically through the following website at:
https://www.fisheries.noaa.gov/action/prey-increase-program-southern-resident-killer-whales

Comments may be submitted to NMFS via electronic mail or physical mail to the contact addresses below during the public comment period. Comments must be received no later than Monday, March 11, 2024.

Comment Coordinator: Lance Kruzic
Project Coordinator
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Email: hatcheries.public.comment@noaa.gov

Thank you in advance for your input and assistance in finalizing this PEIS.

Sincerely,

Jennifer Quan
Regional Administrator

Title of Environmental Review: Programmatic Draft Environmental Impact Statement for the Expenditure of Funds to Increase Prey Availability for Southern Resident Killer Whales

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Location of Proposed Activities: Washington, Oregon, Idaho, Puget Sound, Columbia River

Abstract: NMFS evaluates a range of alternatives for the use of federal funding to increase the prey availability for Southern Resident Killer Whales (SRKWs), to offset reductions in prey resulting from regional declines in salmon abundances and fisheries managed under the Pacific Salmon Treaty. SRKWs are listed as endangered under the Endangered Species Act and the availability of prey (food) is currently one of several limiting factors inhibiting the recovery of this species. The proposed action/preferred alternative would be to use the funds for the production of juvenile hatchery salmon for release into the wild as prey (food) for SRKWs. Other alternative uses for the funding include: discontinuing the funding of the program (No Action), a habitat-based prey increase program to increase naturally produced salmon as prey, and use of the funds to compensate for a further fishery harvest reduction. The effects of these alternatives are evaluated on the specified resources. This EIS is responsive to a recent court order.

Executive Summary

Background

In 2005, the National Marine Fisheries Service (NMFS) listed the Southern Resident killer whale (SRKW) distinct population segment as endangered under the Endangered Species Act (ESA; 70 FR 69903, 11/18/05). The ESA recovery plan (NMFS 2008b) identifies the availability of prey, primarily Chinook salmon, as one of several limiting factors in the recovery of SRKW. Declines in the abundance of salmon, and other fish stocks, throughout the region (NMFS 2019) has resulted in fewer fish being available for SRKWs throughout their entire range. In addition to prey availability, other threats such as pollution and contaminants, and effects from vessels and sound are also affecting the recovery of SRKWs (NMFS 2008b). All of these threats are chronic, widespread issues facing SRKWs and difficult and complex to resolve in the short-term (NMFS 2021c).

In 2019, NMFS issued an ESA Biological Opinion (NMFS 2019) analyzing federal actions related to the southeast Alaska (SEAK) salmon fisheries, and a conservation funding program addressing SRKW and threatened Puget Sound Chinook impacted by the salmon fisheries managed under the Pacific Salmon Treaty (PST). The 2019 PST Agreement added to significant reductions associated with the 1999 PST Agreement and again in the 2009 Agreement to further reduce fishery impacts on ESA listed species. However, there was a practical limit to what could be achieved through the bilateral negotiation process. As a consequence, and in addition to the SEAK, Canadian, and southern United States fishery measures identified in the 2019 PST Agreement, the U.S. Section generally recognized that more would be required to mitigate the effects of harvest and other limiting factors that contributed to the reduced status of Puget Sound Chinook salmon and SRKWs that could be addressed through a targeted funding initiative. The funding initiative established a new “prey increase program” for SRKWs to help offset the effects of West Coast fisheries managed by the 2019 PST agreement. The goal of the prey increase program was to provide a meaningful increase in prey for SRKWs in the times and areas most beneficial to them (NMFS 2019).

In 2020, NMFS first received funding to implement this new prey increase program for SRKWs. Additional hatchery production began in 2020 using federal funds designated for the specific purpose of increasing prey availability for SRKWs in marine waters to offset fishery harvest effects. Specific criteria were used by NMFS to determine which hatchery programs received funding each year with available funding. NMFS has distributed funds for additional hatchery production according to the annual spend plans it submits to Congress regarding PST implementation funds for fiscal years 2020 through 2023.

In 2020, the Wild Fish Conservancy, a 501(c)3 nonprofit organization, filed a lawsuit in the U.S. District Court for the Western District of Washington alleging that the issuance of the 2019 opinion (NMFS 2019) violated the ESA and the National Environmental Policy Act (NEPA). On August 8, 2022, the district court found that NMFS violated both the ESA and NEPA. With respect to the ESA, the court determined that NMFS improperly relied on uncertain mitigation (prey increase program) to reach its conclusion that the federal actions related to the SEAK fisheries were not likely to jeopardize ESA listed Chinook salmon and SRKW, and that NMFS failed to evaluate whether the increased hatchery production funded through the prey increase program would jeopardize the continued existence of ESA-listed Chinook salmon. With respect to NEPA, the court concluded NMFS failed to conduct necessary NEPA analysis for the issuance of the incidental take statement (ITS) that exempted the take associated with the SEAK salmon fisheries from liability under the ESA section 9, and for the prey increase program. The court subsequently issued an order on remedy, in which it partially vacated the incidental take statement for the winter and summer southeast Alaska salmon fisheries, and remanded the NMFS (2019) ESA Biological Opinion to NMFS to remedy the flaws it had identified. The Court did not vacate the portions of the NMFS (2019) Biological Opinion regarding the SRKW prey increase program or enjoin that program. The district court's order partially vacating the ITS was stayed by the United States Court of Appeals for the Ninth Circuit on June 21, 2023.

NMFS is conducting this programmatic review under NEPA of the federal funding used to increase prey availability for SRKWs. This Programmatic Environmental Impact Statement (PEIS) analysis addresses this court order. The purpose and need for the action associated with this federal funding, a suite of alternative uses of the funding, and the effects of these alternatives on the specified resources are summarized below.

Proposed Action

NMFS proposes to continue to distribute appropriated funds consistent with the PST spend plan to hatchery operators for the production of additional hatchery salmon for release into the wild specifically for the benefit of SRKWs.

Purpose and Need

The purpose of the proposed action is to increase prey (food) availability for SRKWs to help mitigate the effects of declining Chinook salmon abundances and PST fisheries. The action is needed because prey availability is currently a factor limiting the recovery of SRKWs, and PST fisheries, while reduced from prior agreements, continue to remove Chinook salmon (harvest) that would otherwise potentially be available as prey (food) in times and areas important to SRKWs.

Project Area and Analysis Area

The project area is the geographic area where the proposed action would take place. NMFS potentially distributes funds to operators of hatcheries in Washington, Oregon, and Idaho, where hatchery salmon can be produced. This geographic area represents the best opportunity to produce and release juvenile hatchery Chinook salmon (from freshwater areas) that will migrate to marine habitats and be available in the times and areas that benefit SRKWs as these hatchery salmon grow and mature before returning back to freshwater where they were born.

The analysis area varies depending upon the resource being assessed. For SRKWs, it includes the marine habitats where the whales are found. For salmon, it covers both freshwater and marine habitats where both hatchery and natural salmon occur throughout their entire lifecycle. The fisheries analysis focuses on the areas where the tribal, commercial, and recreational fisheries occur in marine waters because this is where the prey available for SRKWs is affected by fishing under consideration here. Additional ESA and NEPA analyses for fisheries will be conducted separately to address the court order related to fishery impacts. A detailed description of each resource's analysis area is provided in Chapter 3, Affected Environment. In Chapter 4, Environmental Consequences, the direct and indirect effects on various resources are evaluated within the project and analysis areas.

Alternatives Including the Proposed Action

Three alternatives were identified as meeting the purpose and need for the action, and we also evaluate a no action alternative. These alternatives analyze different actions that could be funded by NMFS in the future to increase prey availability for SRKWs. Given this is a PEIS to evaluate our expenditure of funds to increase prey availability, a range of future funding levels for each alternative was considered. That range includes recent levels of federal funding (approximately $6.2 million annually), but we also considered and evaluated the potential funding level that could implement actions to attain a 4-5% increase in prey for SRKWs in the times and areas most beneficial to them (the prey increase program goals; Dygert et al. 2018; NMFS 2019). These alternatives are:

Alternative 1 (No Action): No Funding for Prey Increase Program – This alternative would discontinue the expenditure of federal funds to increase the prey availability for SRKWs beginning in fiscal year 2024 and thereafter; after completion of this PEIS and ROD. Prey availability for SRKWs would not be increased in the future from the use of this federal funding.

Alternative 2 (Proposed Action/Preferred Alternative): Hatchery Prey Increase Program – A portion of the federal funds appropriated on an annual basis to NMFS for activities related to PST implementation would be distributed to hatchery operators throughout the region to produce additional hatchery salmon for release into the wild for SRKWs. This alternative would continue the prey increase program implemented by NMFS in recent years going forward into the future.

Alternative 3: Habitat-based Prey Increase Program – This alternative assumes a portion of the federal funds appropriated on an annual basis to NMFS for activities related to PST implementation will be used for habitat restoration, enhancement, and protection projects that increase the abundance of naturally-produced Chinook salmon in the wild across the region. Under this alternative, none of the funds would be spent to produce hatchery fish for the benefit of SRKWs.

Alternative 4: Reduced Fishing to Increase Prey- In this alternative we assume a portion of the federal funds appropriated on an annual basis to NMFS for activities related to PST implementation will be used to compensate for a reduction in fishery harvest of Chinook salmon in marine waters. This would increase prey availability for SRKWs by reducing the harvest of Chinook salmon in marine waters. Fishery closures in select areas and times were modeled to determine the effects on identified resources.

Affected Environment

The affected environment is the current state of activities and effects as it relates to the specified resources. The affected environment represents past and present actions throughout the region affecting each of the specified resources below. This represents the best estimate of the current environmental baseline to which to compare the effects of the alternatives considered in this PEIS.

Initial scoping identified five resources in the Project Area that are potentially affected by the four alternatives:

- Chinook Salmon and Their Habitats
- Southern Resident Killer Whales
- Other Fish and Wildlife Species
- Socioeconomics

- Environmental Justice

Current conditions include effects of the past and current operation of hatchery programs. This includes hatchery Chinook salmon produced specifically for SRKWs (federal and non-federal funded) and hatchery production that occurs for other purposes. Current conditions also include the current status of species affected, including Chinook salmon and SRKWs and their habitats, and marine fisheries occurring in U.S. waters that impact affected resources.

Environmental Consequences

This PEIS provides a programmatic-level analysis of environmental impacts associated with different uses of NMFS' funding to increase prey availability for SRKWs as described in the alternatives. Each of the specified resources is evaluated for each of the alternatives to provide the expected range of effects (positive and negative) to the natural and human environment. This analysis provides a broad, region wide assessment of NMFS' funding to increase prey availability for SRKWs; applying different funding directives and assessing the effects over the short-term (<5 years) and longer time periods (>5 years).

The relative magnitude and direction of impacts is described using the following terms:

- Undetectable: The impact would not be detectable and not significant.
- Negligible: The impact would be at the lower levels of detection and not significant.
- Low: The impact would be slight, but detectable and not significant.
- Medium: The impact would be readily apparent and considered significant.
- High: The impact would be severe or greatly beneficial and considered significant

Our analysis of the four alternatives evaluates a wide range of impacts associated with the identified resources for the alternatives, with a concluding statement on significance. Table S-1 below provides a summary of the predicted resource effects under each of the four alternatives. The summary reflects the detailed resource discussions in Chapter 4, Environmental Consequences.

Table S-1. Summary of environmental consequences of PST federal funding to increase prey availability for SRKWs for each alternative in this PEIS. Short-term refers to the next 5 years or less and long-term refers to greater than 5 years in the future. "Current funding" refers to the average recent funding NMFS has received for the prey increase program. "Program goals for SRKWs" refers to an approximately 4-5% increase in prey in the times and areas most beneficial for SRKWs (Dygert et al. 2018; NMFS 2019).

Resource	Alternative 1 (No Action): No Funding to Increase Prey for SRKW)	Alternative 2 (Proposed Action/ Preferred Alternative): Hatchery Prey Increase Program)	Alternative 3: Habitat-based Prey Increase Program	Alternative 4: Reduced Fishing to Increase Prey
Chinook Salmon and Their Habitat	Range of effects depending upon the natural population. Low adverse impacts to low benefits over the short term from no prey increase program.	Low to medium adverse impacts from additional hatchery production in existing hatchery facilities at current funding and at program goals for SRKWs (short and long terms).	Low benefits over the short-term from habitat restoration. Greater benefits to salmon and their habitats over the long-term, for all funding assumptions.	Medium benefits from reduced harvest of Chinook salmon in marine waters (immediate, short, long terms), at current funding and at program goals for SRKWs.

Resource	Alternative 1 (No Action): No Funding to Increase Prey for SRKW)	Alternative 2 (Proposed Action/ Preferred Alternative): Hatchery Prey Increase Program)	Alternative 3: Habitat-based Prey Increase Program	Alternative 4: Reduced Fishing to Increase Prey
Southern Resident Killer Whales	Medium adverse impact in the near term from reduced Chinook salmon prey availability associated with no federal funding of the prey increase program.	Low to medium benefits of increased prey at current funding. Medium to high benefits at program goals for SRKWs (short and long terms).	Low benefits over the short-term, with more over the long term from habitat restoration that increases Chinook salmon as prey in marine waters, for all funding assumptions.	Medium to high benefits from reductions in fishery harvest of Chinook salmon to increase prey for SRKWS (immediate) at current funding and at program goals for SRKWs.
Other Fish and Wildlife Species	Low impact to low benefit depending upon the species over the short and long terms.	Low impact to low benefit depending upon the species over the short and long terms.	Low impact to low benefit depending upon the species over the long term.	Undetectable to low benefit depending upon the species (immediate).
Socio-economics	Negligible to low impacts over the short and long terms from no prey increase program funding.	Low to medium benefits over the short term from having production of additional hatchery salmon, at current funding and at program goals for SRKWs.	Negligible to low benefits from habitat restoration activities to increase natural production of Chinook salmon in freshwater, for all funding assumptions.	High negative impacts (immediate, short, and long terms) from reductions in fishery harvest of Chinook salmon, at current funding and at program goals for SRKWs.

Resource	Alternative 1 (No Action): No Funding to Increase Prey for SRKW)	Alternative 2 (Proposed Action/ Preferred Alternative): Hatchery Prey Increase Program)	Alternative 3: Habitat-based Prey Increase Program	Alternative 4: Reduced Fishing to Increase Prey
Environmental Justice	Negligible to low impacts over the short and long terms from no prey increase program funding.	Negligible to low benefits over the short and long terms from additional hatchery production at current funding and at program goals for SRKWs.	Negligible to low benefits over the long term, for all funding assumptions.	High negative impacts (immediate, short, and long terms) from reductions in fishery harvest of Chinook salmon, at current funding and at program goals for SRKWs.

ACRONYMS AND ABBREVIATIONS

EIS	Environmental impact statement
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
HGMP	Hatchery and genetic management plan
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
PEIS	Programmatic Environmental Impact Statement
pHOS	Proportion of hatchery-origin spawners on spawning grounds
PST	Pacific Salmon Treaty
SEAK	Southeast Alaska
SRKWs	Southern Resident Killer Whales
WDFW	Washington Department of Fish and Wildlife

GLOSSARY OF KEY TERMS[1]

Abundance: Generally, the number of fish in a defined area or unit. It is also one of four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

Adipose fin: A small fleshy fin with no rays, located between the dorsal and caudal fins of salmon and steelhead. The adipose fin is often "clipped" on hatchery-origin fish so they can be differentiated from natural-origin fish.

Anadromous: A term used to describe fish that hatch and rear in fresh water, migrate to the ocean to grow and mature, and return to freshwater to spawn.

Analysis area: Within this Environmental Impact Statement (EIS), the analysis area is the geographic extent that is being evaluated for each resource. For some resources (e.g., socioeconomics and environmental justice), the analysis area is larger than the project area. See also **Project area**.

Commercial harvest: The activity of catching fish for commercial profit.

Conservation: Used generally in the EIS as the act or instance of conserving or keeping fish resources from change, loss, or injury, and leading to their protection and preservation. This contrasts with the definition under the United States Endangered Species Act (ESA), which refers to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary.

Distinct Population Segment (DPS): Under the ESA, the term "species" includes any subspecies of fish or wildlife or plants, and any "Distinct Population Segment" of any species or vertebrate fish or wildlife that interbreeds when mature. The ESA thus considers a DPS of vertebrates to be a "species." The ESA does not however establish how distinctness should be determined. Under NMFS policy for Pacific salmon, a population or group of populations will be considered a DPS if it represents an Evolutionarily Significant Unit (ESU) of the biological species. In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) Policy for recognizing DPSs (DPS Policy: 61 Fed. Reg. 4722, February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies to a broader range of animals to include all vertebrates.

Emigration: The downstream migration of salmon and steelhead toward the ocean.

Endangered: The term endangered species means any species that is in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA): A United States law that provides for the conservation of endangered and threatened species of fish, wildlife, and plants.

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[1] This list of definitions is for informative purposes. To the extent terms are defined by statute or regulation, those definitions apply.

Environmental justice: The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Escapement: Adult salmon and steelhead that survive fisheries and natural mortality, and return to spawn.

Estuary: The area where fresh water of a river meets and mixes with the salt water of the ocean.

Evolutionarily Significant Unit (ESU): A concept NMFS uses to identify Distinct Population Segments of Pacific salmon (but not steelhead) under the ESA. An ESU is a population or group of populations of Pacific salmon that 1) is substantially reproductively isolated from other populations, and 2) contributes substantially to the evolutionary legacy of the biological species. See also **Distinct Population Segment** (pertaining to steelhead).

Federal Register: The United States government's daily publication of Federal agency regulations and documents, including executive orders and documents that must be published per acts of Congress.

Fishery: Harvest by a specific gear type in a specific geographical area during a specific period of time.

Habitat: The physical, biological, and chemical characteristics of a specific unit of the environment occupied by a specific plant or animal; the place where an organism naturally lives.

Hatchery and genetic management plan (HGMP): Technical documents that describe the composition and operation of individual hatchery programs. Under Limit 5 of the 4(d) rule, NMFS uses information in HGMPs to evaluate impacts on salmon and steelhead listed under the ESA.

Hatchery facility: A facility (e.g., hatchery, rearing pond, net pen) that supports one or more hatchery programs.

Hatchery operator: A Federal agency, state agency, or Native American tribe that operates a hatchery program.

Hatchery-origin fish: A fish that originated from a hatchery facility.

Hatchery-origin spawner: A hatchery-origin fish that spawns naturally.

Hatchery program: A program that artificially propagates fish. Most hatchery programs for salmon and steelhead spawn adults in captivity, raise the resulting progeny for a few months or longer, and then release the fish into the natural environment where they will mature.

Limiting factor: A physical, chemical, or biological feature that impedes species and their independent populations from reaching a viable status.

National Environmental Policy Act (NEPA): A United States environmental law that is intended to ensure Federal agencies consider the environmental impacts of their actions to support informed decision-making and established the President's Council on Environmental Quality (CEQ).

National Marine Fisheries Service (NMFS): A United States agency within the National Oceanic and Atmospheric Administration and under the Department of Commerce charged with the stewardship of living marine resources through science-based conservation and management, and the promotion of healthy ecosystems.

Natural-origin: A term used to describe fish that are offspring of parents that spawned in the natural environment rather than the hatchery environment, unless specifically explained otherwise in the text. "Naturally spawning" and similar terms refer to fish spawning in the natural environment.

Pacific Salmon Commission- body of members formed by the governments of Canada and the United States in 1985 to implement the Pacific Salmon Treaty.

Pacific Salmon Treaty- Treaty between the government of Canada and the government of the United States of America concerning Pacific Salmon.

Population: A group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group.

Preferred alternative: The alternative selected or developed from an evaluation of alternatives. Under NEPA, the preferred alternative is the alternative an agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors.

Programmatic Environmental Impact Statement (PEIS): An analysis document conducted under NEPA that assesses the environmental impacts of proposed policies, plans, programs, or projects for which subsequent actions will be implemented either based on the programmatic review, or based on subsequent NEPA reviews tiered to the programmatic review (e.g., a site- or project-specific document). In this case, the PEIS is evaluating a program where NMFS uses federal funds to increase the prey availability for SRKWs.

Project area: Geographic area where the Proposed Action will take place. See also **Proposed Action**.

Proportion of hatchery-origin spawners (pHOS): The proportion of naturally spawning salmon or steelhead that are hatchery-origin fish.

Proposed Action: For this PEIS, the proposed action is NMFS' continued use of federal funding specified for the prey increase program to be used for the production of hatchery salmon specifically to increase the prey availability for SRKWs in marine waters.

Record of Decision (ROD): The formal NEPA decision document that is recorded for the public. It is announced in a Notice of Availability in the Federal Register.

Recovery: Defined in the ESA as the process by which the decline of an endangered or threatened species is stopped or reversed, or threats to its survival neutralized so that its long-term survival in the wild can be ensured, and it can be removed from the list of threatened and endangered species.

Recovery plan: Under the ESA, a formal plan from NMFS (for listed species) outlining the goals and objectives, management actions, likely costs, and estimated timeline to recover the listed species.

Recreational harvest: The activity of catching fish for non-commercial reasons (e.g., sport or recreation).

Run: The migration of salmon or steelhead from the ocean to fresh water to spawn. Defined by the season they return as adults to the mouths of their home rivers.

Scoping: In NEPA, an early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.9).

Smolts: Juvenile salmon and steelhead that have left their natal streams, are out-migrating downstream, and are physiologically adapting to live in salt water.

Stock: A group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place in a different season.

Straying (of hatchery-origin fish): A term used to describe when hatchery-origin fish return to and/or spawn in areas where they are not intended to return/spawn.

Threat: A human action or natural event that causes or contributes to limiting factors; threats may be caused by past, present, or future actions or events.

Threatened species: As defined by section 4 of the ESA, any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Tributary: A stream or river that flows into a larger stream or river.

Watershed: An area of land where all of the water that is under it or drains off of it goes into the same place, e.g. Rogue River watershed or Umpqua River watershed.

Yearling: Juvenile salmon or steelhead that has reared at least one year in the hatchery.

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1. Purpose of and Need for the Proposed Action

1.1. Background

In 2005, NMFS listed the Southern Resident Killer Whale (SRKW) distinct population segment as endangered under the Endangered Species Act (ESA; 70 FR 69903; 11/18/05). The ESA recovery plan (NMFS 2008b) identifies the availability of prey, primarily Chinook salmon, as one of several limiting factors in the recovery of SRKW. Declines in the abundance of salmon, and other fish stocks, throughout the region (NMFS 2019) has resulted in fewer fish being available for SRKWs to eat throughout their entire range. In addition to prey availability, other threats such as pollution and contaminants, and effects from vessel and sound are also limiting factors affecting the recovery of SRKWs (NMFS 2008b). All of these problems are chronic, widespread issues facing SRKWs, acting synergistically, and difficult and complex to resolve in the short-term (NMFS 2021c).

In addition to the poor status of SRKWs, the abundance of most Chinook salmon stocks throughout SEAK, Canada, and the Pacific Northwest has also been trending downward over the last few decades (https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/report-card-recovery-reviews-assess-28-salmon-and). Many of these salmon stocks are protected under the federal ESA. Fisheries on all of these Chinook stocks are managed under appropriate U.S. and international fisheries laws and agreements (e.g. Magnuson-Stevens Fishery Conservation and Management Act (MSA), Pacific Salmon Treaty (PST)). In response to the decline in these stocks, all of the fisheries affecting these Chinook salmon stocks have also been reduced; with fishing effort and harvest exhibiting similar long-term declines over the last few decades (NMFS 2019; PFMC 2023).

In 2019, a new PST Agreement was reached between the U.S. and Canada. Included in this new agreement were revised fishing regimes for Chinook salmon stocks. This triggered a new ESA consultation and biological opinion (BiOp) by NMFS on two federal actions related to management of southeast Alaska salmon fisheries (NMFS 2019). The two federal actions for this ESA BiOp were the delegation of management authority of authorized fisheries in the Exclusive Economic Zone (EEZ) of southeast Alaska to the state of Alaska, and federal funding through grants to the State of Alaska for the State's management of commercial and sport salmon fisheries and transboundary river enhancement necessary to implement the 2019 PST Agreement.

The PST Agreement included fishery reductions beyond those in the prior 2009 agreement for Chinook salmon. To offset the impacts of the fisheries on ESA listed species in combination with these new reductions, further actions were funded to help restore critical Chinook salmon stocks in Puget Sound through habitat enhancement/restoration and conservation hatchery programs. These measures were intended to increase specific Puget Sound Chinook populations, which over the long term would be expected to increase prey availability for SRKWs. In addition, a hatchery prey increase program was implemented to produce additional hatchery Chinook salmon to provide more prey availability in the times and areas most beneficial for SRKWs to help offset the PST fisheries harvest effects in the short term (NMFS 2019). These funding actions were also analyzed in the 2019 BiOp.

Producing additional hatchery fish for SRKWs to help offset prey availability issues for SRKWs was deemed an appropriate mitigation measure because hatchery production has an existing record of producing salmon for stocks of importance as SRKW prey and the productions could be modified to increase prey abundance and availability in the times and areas most important to SRKWs. Throughout the states of Washington, Oregon, and Idaho hatchery salmon and steelhead are produced and released as juveniles to support a wide range of objectives throughout the region, including mitigation for habitat degradation and loss, enhancement of recreational and commercial fisheries, and aid in the conservation and enhancement of salmon and steelhead stocks in the wild. Over the last century, hatchery programs have increased the returns of salmon and steelhead throughout the region. Every year, hundreds of millions of juvenile hatchery salmon and steelhead are released throughout the region's rivers, and in many cases, the majority of adult salmon and steelhead that return originate from hatcheries. This long-established, proven practice has demonstrated producing additional fish via hatcheries result in more fish that thrive in the ocean, survive back to freshwater, and return to their original release areas. Considering the ongoing annual production of hatchery fish in the region's existing facilities, funding can, and has, been used to take immediate action to boost the production of hatchery salmon. This increase in hatchery salmon has provided more prey in the times and areas most beneficial for SRKWs in the short term; helping to reduce their current risk of extinction (NMFS 2019).

In 2020, NMFS received funding for PST implementation, which included an amount to implement the conservation funding measures described above. A portion of this funding was used by NMFS to fund hatchery operators throughout the region to produce hatchery Chinook salmon specifically for increasing the amount of prey available for SRKWs in the ocean to offset declining Chinook salmon abundances and the effects of PST fishery harvest of Chinook salmon. Congress has continued to appropriate increased funds for PST implementation in each subsequent year; a portion of which NMFS has allocated each year to fund the prey increase program. The funding amount for the prey increase program varied based on annual Congressional appropriations for activities related to implementation of the PST and NMFS' spend plan for these funds, which is developed in conjunction with the U.S. Pacific Salmon Commission commissioners. NMFS has distributed funds for the hatchery prey increase program according to the PST spend plan for fiscal years 2020 through 2023 in the amounts of $5.6, $7.3, $6.3, and $5.6 million, respectively. Funding for 2024 has not been specified as of the publishing of this PEIS document (January 2024).

In 2020, the Wild Fish Conservancy, a 501(c)3 nonprofit organization, filed a lawsuit in the U.S. District Court for the Western District of Washington alleging that the issuance of the 2019 BiOp violated the ESA and the National Environmental Policy Act (NEPA). On August 8, 2022, the district court found that NMFS violated both the ESA and NEPA. With respect to the ESA, the court determined that NMFS improperly relied on uncertain mitigation (the prey increase program) to reach its conclusion that the federal actions related to the SEAK fisheries were not likely to jeopardize ESA listed Chinook salmon and SRKW, and that NMFS failed to evaluate whether the increased hatchery production funded through the prey increase program would jeopardize the continued existence of ESA-listed Chinook salmon. With respect to NEPA, the court concluded NMFS failed to conduct necessary NEPA analysis for the issuance of the ITS, which exempted take associated with the SEAK salmon fisheries from ESA section 9, and for the prey increase program. The court subsequently issued an order on remedy, in which it partially vacated the incidental take statement for the southeast Alaska salmon fisheries, and remanded the 2019 BiOp to NMFS to remedy the flaws it had identified. The Court did not vacate the portions of the 2019 BiOp regarding the SRKW prey increase program or enjoin that program. The district court's order partially vacating the incidental take statement was stayed by the United States Court of Appeals for the Ninth Circuit on June 21, 2023.

In response to this recent District Court order, NMFS is concurrently conducting two reviews under NEPA: the Programmatic Environmental Impact Statement (PEIS) for the expenditure of funds to increase prey availability for SRKWs (this document), and an EIS titled "Environmental Impact Statement for the Issuance of an Incidental Take Statement under the Endangered Species Act for Salmon Fisheries in Southeast Alaska Subject to the Pacific Salmon Treaty and Funding to the State of Alaska to Implement the Pacific Salmon Treaty" (southeast Alaska fisheries website: https://www.fisheries.noaa.gov/resource/document/environmental-impact-statement-issuance-incidental-take-statement-salmon). These reviews are related because the actions considered in them were analyzed in the 2019 BiOp, and because the prey increase program was developed in connection with the 2019 PST Agreement. However, these reviews analyze separate federal actions and NMFS is conducting separate reviews under NEPA.

For this PEIS related to the prey increase program, "programmatic" reviews under NEPA are broad or high-level reviews that assess the environmental impacts of proposed policies, plans or programs under which subsequent actions may be implemented either based on the programmatic review itself, or based on subsequent NEPA reviews tiered to the programmatic review (e.g., a site- or project-specific review). Programmatic reviews often are undertaken when initiating a regional rulemaking, policy, plan, or program and/or assessing common elements or aspects of a series or suite of similar projects. The federal funding tied specifically to increasing prey availability for SRKWs fits within this programmatic context.

This PEIS assesses implementation of the prey increase funding program and alternative program-level uses of the funding, and the range of potential environmental impacts expected for activities associated with each alternative. The PEIS is based on currently available scientific information, as well as practical experience with existing projects. This PEIS may also inform other future NEPA reviews for individual project proposals that fall within the program, but it does not supplant those reviews.

It is important to highlight this PEIS pertains only to funds NMFS has designated for the prey increase program in PST spend plans for SRKWs. Appropriations for activities related to PST implementation overall are used for a variety of other purposes, including direct implementation of U.S. obligations under the PST, and conservation hatchery programs for at-risk Chinook salmon stocks in Puget Sound. These other actions are not addressed in this PEIS.

This PEIS does not evaluate site-specific issues and effects associated with site or project-specific implementation of the alternatives. As to the hatchery funding program, a variety of location-specific factors (e.g., specific hatchery facility and location, presence of threatened and endangered species, hatchery practices and capacity, and cultural resources) may vary considerably from site to site, especially over the entirety of the project area. In addition, site-specific details for each hatchery facility and the corresponding operation would greatly influence the magnitude of the environmental impacts from specific hatchery production being funded. A programmatic analysis cannot fully anticipate or address the effects of location specific and project-specific factors. Such effects are analyzed at the project level. Further details on the programmatic funding decision criteria and site-specific information is described in Chapter 2, the alternatives.

1.2. Description of the Proposed Action

As described above, Congress has appropriated annual funding for activities related to implementation of the PST and NMFS. In collaboration with the U.S. Pacific Salmon Commission Commissioners, spend plans have allocated a portion of PST funds to the prey increase program in 2020 through 2023. The goal of the additional hatchery production is to provide for an increase the abundance of Chinook salmon in marine waters by 4-5% to help mitigate the effects of the PST fisheries (loss of salmon) on SRKWs (NMFS 2019).

NMFS anticipates continued federal appropriations to increase prey availability for SRKWs, and is proposing to continue funding the prey increase program for SRKWs through at least the end of the current PST agreement (2028). To date, NMFS has funded the production of additional hatchery Chinook salmon in existing hatchery programs in Washington, Oregon, and Idaho. NMFS has focused on producing additional Chinook salmon for increased prey availability and not on other prey species because the best available information indicates that SRKWs strongly prefer Chinook salmon (as described in more detail in Section 3.3). Specific criteria were developed to guide these funding decisions (see section 2.2.1) to maximize the benefits to SRKWs, while mitigating potential adverse effects to salmon and steelhead listed under the ESA. NMFS conducted site-specific NEPA analyses for each funding decision or otherwise ensured that effects from funding specific hatcheries were evaluated in existing NEPA analyses.

1.3. Purpose of and Need for the Action

The need for the action is to enhance prey (food) availability for SRKWs in marine areas. Prey availability is a factor limiting the recovery of SRKWs. The purpose of the action is to increase prey availability for SRKWs, immediately, using funds directed through NMFS, for the production of additional hatchery fish for release into the wild to help mitigate the effects of declining salmon abundance and PST fisheries on SRKW prey availability.

1.4. Project Area and Analysis Area

The “project area” is the geographic area where the proposed action would take place. NMFS currently distributes funds to operators of hatcheries in Washington, Oregon, and Idaho, where additional hatchery salmon can be produced. The hatchery facilities are located primarily in the Columbia River and Puget Sound regions.

The "analysis area" varies depending upon the resource being assessed. For SRKWs, it includes the marine habitats where the whales are found. For salmon, it covers both freshwater and marine habitats where both hatchery and natural salmon occur. The fisheries analysis focuses on the areas where the tribal, commercial, and recreational fisheries occur in marine waters because these fisheries directly affect the prey available for SRKWs. A detailed description of each resource analysis area is provided in Chapter 3, Affected Environment. In Chapter 4, Environmental Consequences, the direct and indirect effects on various resources are evaluated within the project and analysis areas.

1.5. Scoping and Relevant Issues

This PEIS is a culmination of activities that included both internal, tribal, and public scoping that are described in the following paragraphs.

1.5.1. Tribal Government Scoping

NMFS provided advanced notification to affected tribes prior to the publication of the federal register notice of our intent to prepare an EIS for the expenditure of funds to increase prey availability for SRWKs. This notification was sent to potentially affected tribes in Oregon, Washington, Idaho, and southeast Alaska, asking for feedback on our plan to evaluate the expenditure of funding to increase prey availability for SRKWs. NMFS also held a tribal engagement webinar on October 30, 2023 to explain the proposed action, possible alternatives, and the EIS process for affected tribes. More than 25 tribal representatives from the Pacific Northwest and southeast Alaska participated in the webinar. A letter from Northwest Indian Fisheries Commission was received with comments on the development of the EIS.

1.5.2. Notices of Public Scoping and Public Review and Comment

Public scoping for this PEIS commenced with publication of a Notice of Intent in the Federal Register on August 10, 2023 (88 FR 54301). The comment period was open for 45 days to gather information on the scope of the issues and the range of alternatives to be analyzed in the PEIS. Two webinars were conducted (August 30-31, 2023) during the scoping public comment period to explain the proposed action, possible alternatives, and the EIS process. Many people from a variety of interests participated and asked questions.

NMFS developed a website for the prey increase program for SRKWs and includes our documents to provide information throughout the entire NEPA process at:

https://www.fisheries.noaa.gov/action/review-prey-increase-program-southern-resident-killer-whales

The website for the prey increase program for SRKWs began at the start of the scoping period and will be updated and available throughout the duration of this project.

1.5.3. Written Comments

Sixteen written comments were received by NMFS during the public scoping period. Comments were received from individuals, non-governmental organizations, a fish recovery board, and state and federal government agencies. There were many positions and interests shared through these comment letters with respect to SRKWs, hatchery fish, salmon fisheries, and salmon recovery in the Pacific Northwest and southeast Alaska. All of the comment letters received prior to the release of the PEIS are summarized in section 1.5.5 below.

1.5.4. Issues Identified During Scoping

Of the comments received during scoping, a wide range of issues were identified during the public scoping period and in the tribal engagement session:

- SRKWs – addressing prey availability for SRKWs is a key concern. In addition, addressing the other key limiting factors/threats for SRKWs (e.g. vessel noise, contaminants) is also a concern. All factors affecting the conservation and recovery of SRKWs, including the recovery of wild Chinook salmon, needs to be taken into account and not just prey availability in marine waters.

- Chinook salmon - the recovery of wild salmon and their habitats is a key issue of concern for most commenters. The effects of hatchery salmon on SRKWs as prey is important for the recovery of this species. The effects of hatchery salmon on the recovery of wild salmon is also a key issue of concern.

- Chinook Fisheries – changes to Chinook fisheries, and effects of those changes on all of the affected communities (tribal and non-tribal) is a key issue of concern. Chinook salmon harvest for all tribal and non-tribal fishers has been declining for decades; with current fisheries a small fraction of what existed historically. The abundance of hatchery and wild salmon, and their recovery, affects fishery harvest in southeast Alaska and the Pacific Northwest. These all are issues of concern for Chinook salmon fisheries and the affected communities.

1.5.5. Summary of Submitted Alternatives, Information, and Analyses

This section summarizes the alternatives, information, and analyses submitted by tribal, federal, state, and local governments and other public commenters during the scoping process for consideration by the NMFS in developing this PEIS (40 C.F.R. 1502.17).

NMFS invites public comments on this summary of submitted alternatives, information, and analyses during the public review period of the draft PEIS.

SRKW Comments

- provide a summary of NMFS SRKW Recovery Plan and how the proposed hatchery prey production fits within the overall federal efforts to recover this species.
- acknowledge that the U.S. Section of the Pacific Salmon Commission took three actions to address prey availability: a) negotiated harvest reductions; b) funded a Puget Sound salmon habitat restoration project; and c) funded increased hatchery production of Chinook salmon.
- the assessment criteria also should consider the certainty of deliverability of potential benefits, as well as overlap of the spatial/temporary distribution between prey and SRKWs.
- the slate of alternatives for increasing prey availability should not be limited to only those that seek to increase the overall abundance of Chinook salmon, but also include alternatives that seek to increase the abundance of prey availability for SRKWs. Examples include: a) funding of hatchery production of coho and chum salmon.
- an alternative should be added that addresses reduction of vessel effects on SRKWs, which also is an identified factor for decline. Reducing the physical and acoustical disturbance by vessels would increase SRKWs foraging success within Puget Sound and the Salish Sea.
- NMFS should conduct an EIS that considers NMFS's actions related to harvest levels for fisheries managed under the PST and the prey increase program together, so that NMFS can evaluate reasonable alternatives to harvests; reducing or eliminating the need for mitigation.
- encourage a multi-pronged approach that addresses these other factors of SRKW decline.
- request the analysis discuss the other factors that are limiting SRKW recovery, such as chemical pollution, noise pollution, vessel strikes and harassment by whale watchers.
- there are two, much more immediate factors, that have the potential to increase the local spatial-temporal availability of Chinook salmon to foraging SRKWs – reductions in fishing effort and interference/disturbance by vessels.

Chinook Salmon Comments

- NMFS should also propose a strategy to engage Russia and Japan in a joint program to reduce the total numbers of hatchery pink and chum released into the North Pacific with the purpose of reducing density-dependent mortality of wild salmon smolts in the North Pacific ocean.
- a cost-benefit analysis should be conducted that evaluates the opportunity cost of investing in increased hatchery production for a prey increase program against alternative investments in conservation action to benefit ESA-listed Chinook and SRKW, including changes in harvest management.
- NMFS must consider how it can avoid adverse impacts of the prey increase program, including through mitigation of the program, such as by requiring selective fishing gear in terminal fisheries on all hatchery fish from the program and by requiring recipients of the funding to close more harmful hatcheries.
- cumulative impacts of all hatchery programs being considered for expansion to provide prey for SRKWs need to be thoroughly and transparently evaluated.
- NMFS should consider a cost-benefit analysis for the fisheries and the prey increase program.
- for all alternatives developed, an economic analysis must include the cost of all necessary monitoring and evaluation of the prey increase program.
- propose that the following alternatives should be seriously considered in the EIS: 1) No prey increase program and reconfigured harvest management of Chinook in the Southeast Alaska PST abundance-based management regime (AABM) fisheries, 2) Should also evaluate an expanded version of Alternative 1 above including reconfigurations in all three AABM fisheries necessary to achieve no jeopardy to SRKWs. A combination of reduced hatchery Chinook production for a prey increase program that meets population-specific pHOS limits, plus reductions to the Southeast Alaska PST Chinook harvest that together will increase SRKW encounters with Chinook in key spring to fall foraging areas so as to meet minimal proportions of SRKW daily and seasonal energetic requirements.
- do not believe that re-allocation of the $5.6 million allotted to the prey increase program to habitat restoration activities will yield commensurate benefits to SRKW as hatchery production.
- evaluate adverse impacts of the existing NOAA hatchery increase program on ESA-listed salmon population viability, including whether the program increased the number of hatchery origin fish on the spawning grounds.
- it is important to include alternatives in the EIS that would provide funding to increase hatchery production and spawning habitat restoration, especially of the high priority stocks for SRKWs.

Chinook Salmon Fishery Comments

- for all alternatives developed, the take of juvenile, sub-adult, and adult Chinook salmon as bycatch in fisheries throughout their range should be quantified and analyzed.
- the purpose and need must be revised to answer the fundamental question at issue: Under what circumstances, if at all, can NOAA approve salmon harvests under the PST in a manner that is not going to result in jeopardizing ESA-listed species?
- NMFS description of the affected environment and the no action alternative should not include ongoing harvest for fisheries managed under the PST levels.
- NMFS must consider the long-term environmental consequences of its actions. In considering environmental impacts, NMFS must assess the impacts of all PST fisheries, combined with all other fisheries, hatcheries, dams, vessel traffic, climate change, and all other actions that adversely affect SRKWs, ESA-listed salmonids, and any other species affected by the proposed action.
- request that NOAA assess the effectiveness, in terms of benefit to SRKW, of decreasing U.S. harvest levels without agreement from Canada to take parallel reductions.
- recommend eliminating the alternative that proposes to reduce fishing impacts, instead of increased hatchery production.
- if NMFS proceeds with an alternative that affects fisheries, request that NMFS propose measures commensurate with impacts to prey availability in terms of when and where SRKWs forage for Chinook salmon.
- recommend eliminate any alternatives that would further restrict the numerous fisheries that have absorbed disproportionate socio-economic impacts for decades.
- if you proceed with a fishery management alternative, request that you include a social and economic impact analysis given the harm to coastal communities that would accrue from additional and pointless loss of access to Chinook fisheries.
- NMFS should evaluate fisheries impacts on the abundance of Chinook salmon and consider options to reduce those impacts.

2. Alternatives Including the Proposed Action

To warrant analysis in this document, an alternative must be reasonable and meet the purpose and need described in Section 1.3. If an alternative was considered but deemed to be 1) not reasonable or 2) not meet the purpose and need, or 3) to not be substantially different in the effects on affected resources among alternatives, it was not evaluated in detail in this document. Section 2.5 describes alternatives that were considered, but are not analyzed in detail.

Four alternatives were developed meeting the above criteria and are evaluated in this PEIS (Figure 1). The context for these four alternatives is the following:

- The United States and Canada have an agreement for the management of Chinook salmon and the fisheries that affect these stocks that is a part of the PST.
- This agreement was renewed in 2019 and is currently in effect through 2028. In association with the renewed agreement, the U.S. section of the Pacific Salmon Commission, the international body that implements the PST, agreed to seek federal funding for activities to conserve certain species listed under the ESA that are affected by fisheries managed under the PST.
- The goal of the prey increase program is to provide for a meaningful increase the abundance of Chinook salmon in marine waters to increase prey availability in the times and areas most beneficial to SRKWs (Dygert et al. 2018). NMFS (2019), in an analysis prepared in conjunction with the negotiation of the 2019 PST agreement, described a meaningful increase as a 4-5% increase in hatchery Chinook salmon being available for SRKWs, which was estimated at that time to be achieved through the production of an additional 20 million smolts released throughout a broad geographic area to target prey increases in times and areas of greatest benefit to SRKWs.
- NMFS has funded hatchery production in 2020-2023 specifically for SRKWs, and expects to continue to receive and allocate funding at similar levels in the future to increase prey availability for SRKWs.
- For the alternatives in this PEIS, each alternative considers actions that could be implemented using expected funding moving forward into the future (assumed to be on average approximately $6.2 million), and 2) actions that would likely provide for meeting SRKW prey increase program goals of 4-5% in at least some times and areas, and our expectations on the likely funding levels needed for these actions to be implemented.
- Further details on why this context is guiding the four alternatives included in this PEIS is described below.

Congress has appropriated annual funding for activities related to implementation of the PST. NMFS' spend plans for 2020-23 have allocated a portion of these funds to the prey increase program for SRKWs. NMFS' spend plans for fiscal years 2020 through 2023 have allocated $5.6, $7.3, $6.3, and $5.6 million dollars (average $6.2 million) annually to increase prey availability for SRKWs, respectively. Based on this history, and the fact that Congress has continued to appropriate similar funding levels and has received NMFS' spend plans each year describing the distribution of funds for the purpose of increasing prey for SRKWs, NMFS anticipates that funding for the remainder of the PST Agreement term will continue at levels similar to past years, and that funds will continue to be available to increase prey availability for SRKW at approximately $6.2 million per year – the average funding from 2020-2023. This level of funding is evaluated for each alternative and the expected outcomes for the specified resources. An additional level of funding that may allow for the implementation of actions estimated to increase prey availability by approximately 4-5% in the times and areas most beneficial for SRKWs (prey increase program goals; Dygert et al. 2019; NMFS 2019) for each alternative is also evaluated on the specified resources.

Dygert et al. (2018) estimated that 20 million smolts could be produced with approximately $5 million in funding. Due to the cost of production, hatchery capacity, and other factors, this estimate of the cost of production has proven to be low. In 2023, federal funding of $5.6 million has resulted in the production of approximately 11 million smolts. Future funding, at similar levels as in the recent past, may increase hatchery production above 11 million smolts as infrastructure projects are completed and efficiencies in implementation are gained. However, with current funding levels in the future, production is not likely to attain 20 million smolts due to rising costs of production. Figure 2 provides an overview of past federal funding of hatchery production. The state of Washington is currently expending funds to increase prey availability for SRKWs through hatchery production. The Washington Legislature has been including funding for this purpose in its biennial budget since 2019 (current biennium is 2023-2025). Production funded by Washington has exceeded 10 million smolts in recent years. In combination with Washington State funding to increase prey availability for SRKW, total increased production for this purpose has approximated 20 million smolts recently (the release originally projected to meet prey increase program goals).

In light of this background, NMFS has developed four alternatives specified below that evaluate different uses of federal funding to increase prey available for SRKWs, as well as a no action alternative. These four alternatives include:

- Alternative 1 is a no action alternative, in which no funding would be used to increase prey availability for SRKWs.
- Alternative 2, which is NMFS' preferred alternative, would use the available funding to increase prey abundance for SRKWs through the release of salmon from hatcheries.
- Alternatives 3 and 4 would apply the funds to different activities that could increase the prey available for SRKWs. NMFS is analyzing these alternatives in order to evaluate a full range of alternatives and environmental consequences of potential different uses of the federal funding to the increase prey abundance for SRKWs.
- These four alternatives allow for a range of effects to be evaluated on the identified resources, for comparative purposes, in Chapter 4, Environmental Consequences.

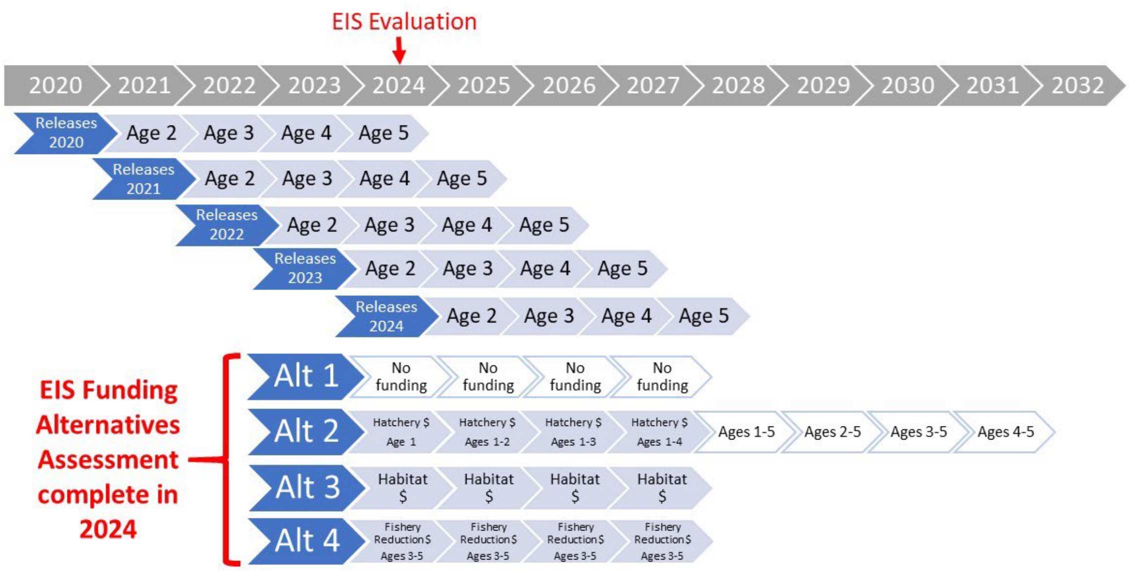

Figure 1. Timeline of the past hatchery prey increase program releases, the new PEIS assessment in 2024, and how each alternative would be implemented in 2024 through at least fiscal year 2028 (the end of current PST agreement). Releases in 2024 are funded by fiscal year funding 2023 and prior.

2.1. Alternative 1 (No Action): No Funding for Prey Increase Program

Under Alternative 1, federal funding to increase prey availability for SRKWs would be discontinued beginning in 2024. Funds have been distributed for fiscal year (FY) 2023, but under this alternative, no funds would be distributed after FY 2023. This alternative is considered the No Action alternative.

Alternative 1 assumes no federal funds for activities related to implementation of the PST would be used specifically to increase prey availability for SRKWs.

2.2. Alternative 2 (Proposed Action/Preferred Alternative): Hatchery Prey Increase Program

For Alternative 2, NMFS would continue to distribute federal funds to hatchery operators for the production of additional hatchery salmon specifically to increase the prey availability for SRKWs in marine areas through at least FY 2028 (the end of the term of the current PST agreement). This alternative evaluates NMFS' distribution of funding on an annual basis to increase the prey available for SRKWs up to the stated goals of the prey increase program in the project area (Dygert et al. 2018; NMFS 2019). In order to accomplish this, we evaluated a range of funding from current funding up to a funding level that is likely to meet SRKW goals, and the anticipated hatchery fish production associated with these funding levels.

The likely level of funding, which we would expect to continue based on 2020-2023 funding levels, is approximately $6.2 million per year. We expect that this level of funding would result in hatchery production levels and locations similar to those federally funded in FY 2023. We also evaluate a possible high level of funding, of approximately $12 million per year, which would likely achieve a production level that would result in approximately 4-5% increase in prey availability to SRKWs based on our analysis. At this level of funding, we anticipate that federal funding could provide for a similar level of hatchery production as was provided by the combined federal and Washington State funding in 2023. However, all funded programs under this scenario would still need to meet the six funding criteria described in Section 1.2.1 below.

Since this PEIS evaluates the expenditure of funds associated with increasing the prey availability for SRKWs at a program level, considering a range of funding and associated hatchery production is necessary. There is a possibility that additional federal funding may become available for the purpose of increasing prey availability for SRKWs. It is possible that in the future Washington may reduce or eliminate its funding, and that in response, the federal funding for this purpose may be increased. To account for this possibility, this alternative assesses the full range of effects up to prey increase program goals (which are defined for the purposes of this PEIS as an increase in prey of 4-5% in the times and areas most beneficial for SRKWs (Dygert et al. 2018; NMFS 2019)). In 2023, federal and state funded hatchery production produced approximately 20 million smolts, with approximately $12 million dollars (providing a real-life cost scenario for evaluating increased prey availability meeting SRKW program goals). This type of adaptive management is appropriate for a programmatic NEPA analysis, and considers the potential for varying funding levels in the future.

2.2.1. Proposed Funding Decision Criteria

For Alternative 2, the following criteria are used by NMFS when making funding decisions for hatchery production associated with funding to increase prey availability for SRKWs for each specific hatchery program:

• **Criteria 1**: Increased hatchery production should be for Chinook stocks that are a high priority for SRKW (NMFS and WDFW 2018; Ad-hoc SRKW Workgroup 2020).
• **Criteria 2**: Increased production should be focused on stocks that are a high priority for SRKW (NOAA and WDFW 2018), but funding should be distributed so that hatchery production is increased across an array of Chinook stocks from different geographic areas and run timings (i.e., a portfolio).
• **Criteria 3**: Increased production cannot jeopardize the survival and recovery of any Endangered Species Act (ESA)-listed species, including salmon and steelhead.
• **Criteria 4**: Because of funding and timing constraints, increased production proposals should not require major capital upgrades to hatchery facilities.
• **Criteria 5**: All proposals should have co-manager agreement (agreement among relevant tribal, state, and federal hatchery managers), as applicable.
• **Criteria 6**: All increased production must have been reviewed under the ESA and NEPA, as applicable, before NMFS funding can be used.

2.2.2. Stepwise Approach for Funding Decisions

The process for making funding decisions in this alternative would be as described in Figure 1, and as follows:

- Hatchery operators would submit to NMFS a description of their proposal for additional production of hatchery salmon to benefit SRKWs.
- NMFS would determine whether any particular funding proposal satisfied apply the six criteria described above. This would ensure funding is distributed to that hatchery production is increased across an array of high priority Chinook stocks from different geographic areas and run timings. Criteria 6 states all hatchery production must be reviewed under the ESA and NEPA before funding can be issued. For programs that received federal funds in 2020-2023, NMFS ensured

that the release of fish from these programs were covered by analysis under the ESA (in many cases through NMFS' approval of HGMPs under its 4(d) rule for threatened salmon and steelhead, and/or ESA analysis of NMFS' Mitchell Act funding program) and had been analyzed under NEPA. This coverage and these NEPA analyses, occurred at the site or program-specific, or regional level. NMFS will ensure this pre-existing analysis is still applicable before making its annual funding decisions. For programs that have not previously received federal funding, NMFS would ensure that any required ESA and NEPA analyses were completed and that the funded production would not jeopardize ESA-listed species prior to allowing the use of funding. If the site-specific evaluation concluded the hatchery production was appropriately analyzed consistent with the ESA and NEPA under existing and/or newly approved authorization documents, then these criteria would be met.

- If all of the six funding criteria are met for a hatchery production proposal, then NMFS would fund the operator to produce additional hatchery salmon to increase prey availability for SRKWs.

2.2.3. Hatchery Production Funded Using This Criteria

Since NMFS has distributed federal funding to increase the prey availability for SRKWs in FY 2020 through 2023, the six funding criteria have been applied to make funding decisions resulting in the total hatchery production shown in Figure 2. Production increases by individual programs from FY 2020 through FY 2023 are described in section 3.2 below and in Appendix A.

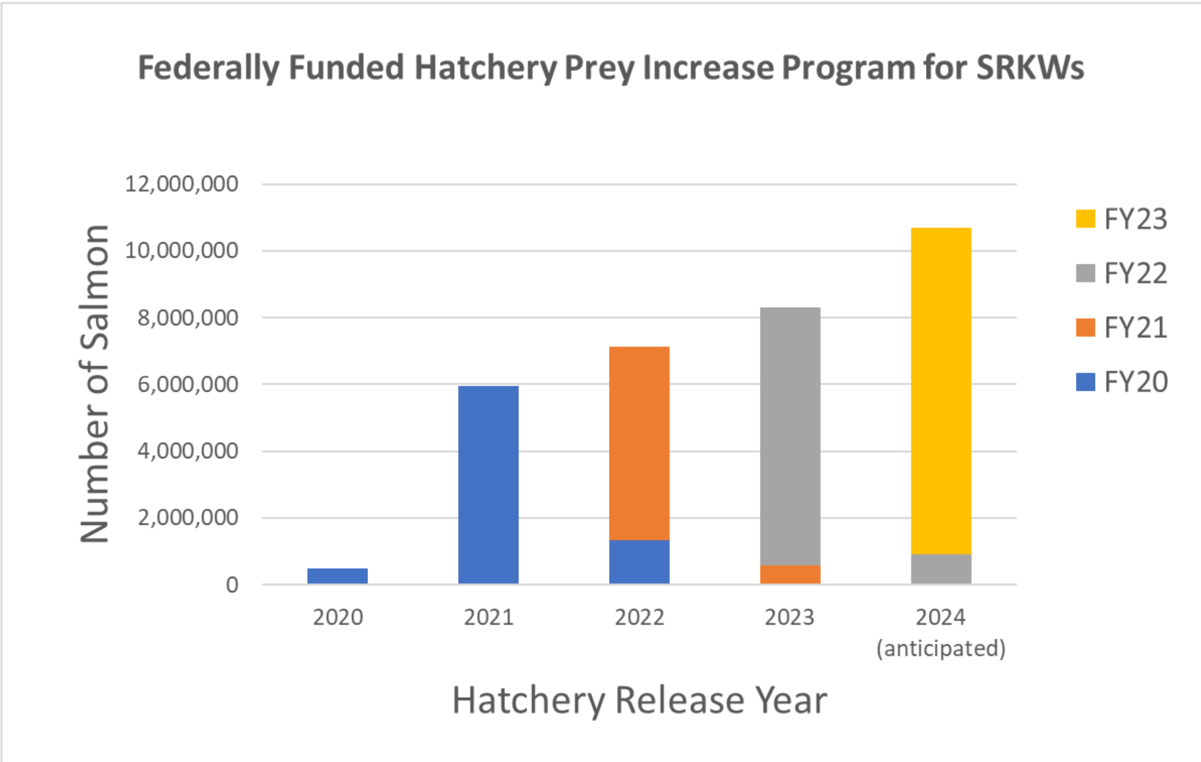

Figure 2. Production and release of juvenile hatchery Chinook salmon federally funded (PST) to increase prey availability for SRKWs.

Table 1. Hatchery production funded in FY2023 by NMFS, and site-specific NEPA and ESA authorizations. Note: depending upon the species, releases could occur in 2024 and/or 2025.

Facility	Region	Species	Entity	Increased Production Proposal	NEPA Coverage	ESA Coverage
Issaquah Hatchery	Puget Sound	Fall Chinook	WDFW	1,000,000	Lake Washington EA	Lake Washington BiOp (WCRO-2021-02104)
Soos Creek-Palmer Pond Hatchery Chinook	Puget Sound	Fall Chinook	WDFW	2,000,000	Duwamish Green River EIS	Duwamish Green BiOp (WCR-2016-00014)
Tulalip Bernie Gobin Hatchery	Puget Sound	Summer Chinook	Tulalip Tribe	2,000,000	Snohomish SEA	Snohomish Reinitiated BiOp 2021 (WCR-2020-02561)
University of Washington Hatchery	Puget Sound	Fall Chinook	Muckleshoot Indian Tribe	180,000	Lake Washington EA	Lake Washington BiOp (WCRO-2021-02104)
Spring Creek NFH	Columbia River	Fall Chinook	USFWS	2,000,000	Mitchell Act EIS	NWR-2004-02625
Little White Salmon NFH	Columbia River	Spring Chinook	USFWS	300,000	Mitchell Act EIS	Memo to file & NWR-2004-02625
Carson NFH	Columbia River	Spring Chinook	USFWS	100,000	Mitchell Act EIS	NWR-2004-02625 Carson SCS is covered in the 2007 Biop.
Wells Hatchery	Columbia River	Summer Chinook	WDFW/DPUD	1,000,000	Mitchell Act EIS	Wells Summer Chinook BiOp (WCRO-2020-00825)
East Bank and Marion Drain Hatcheries	Columbia River	Summer Chinook	Yakama Nation	100,000	Mitchell Act EIS	Yakima spring Chinook/summer Fall Chinook & Coho BiOp (NWR-2011-06509)
Dworshak NFH	Columbia River	Spring Chinook	Nez Perce Tribe	200,000	Mitchell Act EIS	WCR-2017-7303.

SAFE	Columbia River	Spring Chinook	ODFW	1,500,000	Mitchell Act EIS	SAFE BiOp (WCR-2020-02145)
Bonneville Hatchery	Columbia River	Fall Chinook	ODFW	250,000	Mitchell Act EIS	Mitchell Act WCR-2014-697
Umatilla and Bonneville Hatcheries	Columbia River	Fall Chinook	ODFW	120,000	Mitchell Act EIS	WCRO-2010-06511
Total				11,750,000		

2.3. Alternative 3: Habitat-based Prey Increase Program

Under Alternative 3, the habitat-based prey increase program alternative, NMFS would use funds available for the prey increase program to implement habitat-related projects that would increase the natural production of salmon in the wild. As with Alternative 2, we evaluate this alternative with expected current funding levels moving forward into the future (assumed to be on average $6.2 million annually). However, due to the nature of the action in this alternative, it is not possible to calculate a funding level that would be needed for habitat restoration in the analysis area to provide for a 4-5% increase in Chinook salmon abundance in marine waters for SRKWs. There are no modeling scenarios we could use to derive the level of funding needed (with any precision) for habitat restoration to increase the capacity and productivity in freshwater habitats across the analysis area that would result in abundance increases of adult Chinook salmon in marine waters of 4-5% that provide for meeting SRKW prey increase program goals. This calculation is extremely complex, involves numerous assumptions, and the modeling tools necessary to perform this are not presently available. Deriving an upper funding level for Alternative 2 is possible because of the recent past federal and Washington hatchery funding in 2023, but not for Alternative 3; given the scale and magnitude of habitat improvement needed to increase salmon abundance in the wild at program goals. Therefore, for purposes of this alternative analysis, we assume the higher program funding level for Alternative 3 to be the same as Alternative 2 ($12 million annually). We consider this range of funding in order to evaluate the program-level effects of this alternative on specified resources in Chapter 4.

Under Alternative 3, the funding levels specified above would be assessed in terms of the on-the-ground habitat restoration projects that could be funded annually. Habitat restoration projects would be selected and designed to benefit Chinook salmon; the preferred prey species for SRKWs. Habitat projects would be funded throughout Washington, Oregon, and Idaho, and focused on priority prey stocks for SRKW, as in criteria 1 for Alternative 2.

We used previously funded projects to estimate the extent of habitat restoration work that could be achieved with the available prey increase program funds. In order to determine the type, extent, and benefit of habitat restoration projects that could be implemented with the specified level of funding evaluated for this alternative, the data for NOAA’s Pacific Coastal Salmon Recovery Fund (PCSRF) was queried (https://www.webapps.nwfsc.noaa.gov/apex/f?p=309:15::::::). The PCSRF funds habitat restoration projects throughout the region and provides specific funding amounts for individual projects. The type of habitat restoration project, the amount of funding used, and anticipated wild fish production benefits were assessed for this alternative, using the same funding amounts as described in Alternative 2 (a recent average of $6.2 million dollars annually, and assumed $12 million dollars meeting prey increase program goals).

The following criteria were used to identify previously funded habitat restoration projects that could inform our evaluation of the potential effects of this alternative in Chapter 4, Environmental Consequences:

- **Criteria 1**: The most up-to-date funding year in the PCSRF database was 2023, so only projects funded in this fiscal year were queried and used in the analysis.
- **Criteria 2**: Funded projects used in this analysis were from the category "Salmonid Habitat Restoration and Acquisition" with the subcategories "Fish Passage Improvement, Instream Habitat, Riparian Habitat." Projects not categorized as these were not used in the analysis.
- **Criteria 3**: The project had to be implemented in the project area. The database catalogs projects in the project area according the following recovery domains in the Columbia Basin and Puget Sound: Interior Columbia, Willamette/Lower Columbia, and/or Puget Sound.
- **Criteria 4**: The cost of implementing the habitat project was the total cost of the project specified in the database, including PCSRF funds, state funds, other funds, and in-kind contributions.

Applying the above criteria provided an extensive list of previously funded habitat restoration projects that are used to inform our assessment of this alternative using the available federal funds to increase prey for SRKWs annually. The full description of habitat restoration projects included in our assessment scenario for this alternative is provided in Appendix C.

2.4. Alternative 4: Reduced Fishing to Increase Prey

Alternative 4 would use available funds specified for the prey increase program to reduce the harvest of Chinook salmon in U.S. marine area fisheries with the purpose of increasing the abundance of Chinook salmon available as prey for SRKWs. There is currently no legal mechanism available to use funding to reduce fishing effort and catch for the purpose of increasing prey availability for SRKWs, and programs that might inform an analysis of the amount of fishery reduction achievable with funding levels anticipated are not directly comparable. [2]However, we are analyzing this alternative in order to provide a

[2] The MSA provides for two methods of using funding to address reductions in fishing capacity and or opportunity. First, the MSA provides for fishery disaster relief, where a fishery resource disaster exists, defined as "is an unexpected large decrease in fish stock biomass or other change

comprehensive evaluation of alternative uses of available funds to increase SRKW prey, that is responsive to the court's order in *Wild Fish Conservancy v. Quan* and to public comments on scoping. The administration of buyback and disaster relief funding is extremely complex and fact-specific. Because there is no existing statutory authority or detailed program for using funds to reduce fishing to increase prey for SRKWs, and thus a great deal of uncertainty around how such a program would be administered, we used two indirect methods to inform our description and analysis of Alternative 4.

First, we developed fishery reduction scenarios in which $6.2 million annually (the recent average federal funding level) could be used to directly offset the loss of economic values in different U.S. salmon fisheries managed under the PST. As noted above, there is currently no legal framework under which NMFS could administer such a program, thus we developed these scenarios for analytical purposes.

Secondly, to help inform the comparison between Alternative 4 and Alternative 2, we modeled fishery reductions that would likely achieve a 4-5% increase in prey in the times and areas most beneficial to SRKW. To obtain the same level of benefits through fishery reductions to meet SRKW prey increase goals, an estimated $25 million dollars annually (minimum) would be needed to help implement these actions. See further explanation of our assumptions and context of this in the following paragraphs.

Both of the fishery reduction scenarios described above provide for an effects analysis on specified resources using expected federal funding in the future and for a scenario that likely meets prey increase goals for SRKWs (Dygert et al. 2018; NMFS 2019). These scenarios are also directly comparable to Alternative 2, the hatchery prey increase program, in terms of using current federal funding to implement actions, and using additional funding to help attain prey increase program goals for SRKWs.

There are numerous approaches that could be taken to evaluate the extent of fishery harvest reductions throughout the analysis area that could be achieved with the range of funding being considered for this alternative in this PEIS. For the current funding level of the prey program analysis, we assume Chinook salmon harvest could be reduced through funding equivalent to the socioeconomic value of the salmon harvest in current fishery markets (PFMC 2023; NMFS 2024). We considered the recent ex-vessel value

that results in significant loss of access to the fishery resource, which may include loss of fishing vessels and gear for a substantial period of time and results in significant revenue loss or negative subsistence impact due to an allowable cause; and
(ii) does not include—
(I) reasonably predictable, foreseeable, and recurrent fishery cyclical variations in species distribution or stock abundance; or
(II) reductions in fishing opportunities resulting from conservation and management measures taken pursuant to this chapter."

Second, the MSA provides for fishery capacity reduction through buyback programs. These programs may be initiated by NMFS at the request of a fishery management council, a state, or a majority of permit holders in a fishery. 16 USC section 1861a.

and community level value of Chinook salmon fisheries in the analysis area, (PFMC 2023; NMFS 2024), and identified example scenarios in which $6.2 million could be distributed to at least somewhat mitigate for the lost value of fishing seasons in various U.S. salmon fisheries.

For the analysis that reduces Chinook salmon fishery harvest to provide an additional 4-5% Chinook in times and areas important to SRKW, we modeled a series of fishery harvest closures that attained such increases. The value of the fisheries closed in this scenario equates to a minimum of $25 million dollars annually in current fishery markets (see section 4.5.4 for further details). In this scenario we modeled a Chinook fishing closure throughout all the winter and spring fishing periods and areas (i.e., a total harvest closure in winter and spring). The total closure of Chinook salmon harvest in the winter and spring periods was not sufficient to reach a 4-5% increase in prey availability. We determined that in order to reach the desired goals for prey increase, an additional 15% harvest reduction across all U.S. Chinook fisheries during the summer was necessary each year. This combination of closures and fishery reduction provided a level of prey increase similar to program goals, depending upon the time and area considered. Benefits in prey increase are not uniform across the analysis area. We determined this level of fishery reduction to be sufficient for analysis purposes to compare among other alternatives; in particular Alternative 2, the hatchery alternative. Further details of this scenario are discussed below and in Appendix F.

Again, there are numerous scenarios that could be implemented using the available and assumed funding to reduce Chinook salmon harvest across the commercial, sport, and tribal fisheries in the analysis area. NMFS has reduced fishing using funding mechanisms in the past; in particular through fishery disaster relief and buy-back programs. However, the cost of fishery reductions is a fact- and context-specific inquiry and thus choices had to be made on fishery reductions with the limited available funding for these types of actions. [3]

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[3] For context, fishery reduction costs that have occurred in the recent past include the following instances. The Pacific Salmon Treaty monies for the Southeast Alaska Chinook salmon fishery mitigation program, which provided $22.4 million dollars to the state of Alaska to alleviate the economic impacts from the required annual 7.5% fishery reduction prescribed in the 2019 Agreement (https://www.adfg.alaska.gov/index.cfm?adfg=fisherymitigation.main). The Washington Department of Fish and Wildlife's Columbia River commercial salmon fishery provided funding of $14.4 million to reduce the number of permits from 240 to 67 (https://wdfw.wa.gov/licenses/commercial/columbia-river-license-reduction). Canada has announced $123 million dollars to retire commercial salmon fishery licenses from a potential pool of 1,300 license holders (https://www.cbc.ca/news/canada/british-columbia/federal-fishing-license-purchases-1.6686192). In Southeast Alaska, $13.1 million was available to retirer 64 permits to reduce fleet capacity (https://www.federalregister.gov/documents/2023/06/01/2023-11638/fishing-capacity-reduction-program-for-the-southeast-alaska-purse-seine-salmon-fishery). Under Alternative 4, the assumed annual funding of $6.2

The results of these fishery scenarios (current funding level and prey increase program goals) on affected resources are evaluated in Chapter 4, Environmental Consequences. Additional analysis related to this alternative can be found in Appendix F.

2.5. Alternatives Considered But Not Analyzed in Detail

There are many alternative actions or combinations of actions that could be taken, and therefore analyzed in this PEIS, but these actions 1) do not meet the purpose and need for the action, 2) are beyond the control of NMFS authorities (non-federal), or decision making (not NMFS discretion), and/or under the authority of existing government to government agreements and treaties (PST), or 3) would not provide information helpful to this analysis and the decision making process. Congress appropriates federal funds for the implementation of the PST to NMFS, who then distributes funds for a prey increase program for SRKWs. That is the responsibility of NMFS and the purpose and need of the action evaluated in this PEIS.

The following alternatives were considered but will not be evaluated in detail:

- Of the federal funds NMFS receives for implementing the PST, use varying proportions of the funds for hatchery production, habitat restoration, and/or fishery harvest reductions. This alternative would essentially combine aspects of the existing alternatives into another alternative, but assumes the same amount of federal funding. This type of alternative was dismissed from further analyses because the benefits/effects of this type of alternative in meeting the goals of the prey increase program would be within the range of effects analyzed in the existing four alternatives. Therefore, this type of alternative does not provide any new information that NMFS deems useful for the decision-making process.
- Of the federal funds NMFS receives for implementing the PST, use these funds to enhance existing efforts by governmental and non-governmental entities to reduce predation of salmon by fish, birds, and marine mammals. Some potential examples of these efforts are tern and cormorant depredation of juvenile salmonids in the Lower Columbia River, the northern pikeminnow removal bounty program in the Columbia River, and marine mammal depredation/removal efforts at Bonneville dam and Willamette falls. Some of these predation

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million in the future (based upon the recent prey program average) could in fact be used to implement fishery reductions.

efforts would certainly provide benefits to juvenile salmon survival, which would in turn, increase the prey availability for SRKWs in marine waters. Other efforts would focus on adult salmon and not provide direct benefits to SRKWs in marine waters. This alternative was dismissed and will not be further evaluated because the four alternatives described above provide an adequate range of uses for the available funding. The potential benefits of reducing predation on salmon is within the scope of potential benefits to salmon production as in alternatives 2 and 3.

- Of the federal funds NMFS receives for implementing the PST, an alternative should be considered to fund the production of other salmon species besides Chinook salmon to increase the prey availability for SRKWs. Coho salmon and chum salmon are preyed upon by SRKWs in specific areas and during certain times that could potentially provide enhanced benefits to SRKWs. This alternative could meet the purpose and need for the action. However, NMFS will not be analyzing another alternative that specifically produces other salmon species. The hatchery prey increase program alternative, using solely Chinook salmon, meets the purpose and need for the action and provides opportunity to produce additional hatchery Chinook salmon meeting the overall goals of the program. Since this is the case, evaluating another alternative using other salmon species was not necessary to fulfil the goals of the prey increase program (as evaluated herein for 2023 Chinook salmon releases). Another alternative evaluated in the PEIS that focuses on the natural production of salmon will provide additional benefits for Chinook salmon, and other salmon species, that naturally reproduce in the wild from habitat restoration and enhancement.
- Of the federal funds NMFS receives for implementing the PST, use these funds to reduce the effects of vessels on SRKWs feeding in critical areas of the Salish Sea during critical time periods, and/or use these funds towards monitoring and enforcing the existing vessel regulations. While vessel measures may increase the ability of SRKWs to locate and capture prey, such an alternative would not increase the amount of prey available to SRKWs in any given area. Washington State recently passed more restrictive vessel distance regulations (1000 yards) to go into effect in 2025, and the Washington Commercial Whale Watch Licensing Program also reduces vessel effects from the whale watching industry. The Quiet Sound (US waters) and ECHO (Canada waters) programs have implemented large commercial vessel slowdowns in recent years to reduce impacts of noise around SRKWs. Both initiatives have robust monitoring to evaluate the reduction in noise associated with the slowdown measures. NMFS also supports vessel monitoring through the Soundwatch program. This alternative use of the federal funding for vessel impacts was eliminated from further consideration because there would be no expected

benefit to prey quantity, and the expected benefit to prey availability is not comparable to the other alternatives, and as such it doesn't meet the purpose and need for the action.

- An additional alternative was considered that essentially combines Alternative 2 (the hatchery prey increase program) and Alternative 4 (the fishery harvest reduction) together. We modeled the cumulative effects of these actions and the results are reported in Appendix F. The effects of this scenario are within the range of effects considered in alternative 2 and alternative 4 in the PEIS and thus were dismissed from further analysis.

3. Affected Environment

3.1. Introduction

Chapter 3, Affected Environment, describes current conditions for five resources that may be affected by implementation of the alternatives:

- Chinook Salmon and Their Habitat (Section 3.2)
- Southern Resident Killer Whales (Section 3.3)
- Other Fish and Wildlife Species (Section 3.4)
- Socioeconomics (Section 3.5)
- Environmental Justice (Section 3.6)

Current conditions, depending on the resource, include effects of the past operation of Chinook salmon hatchery programs, fisheries, and habitat conditions and restoration projects in the analysis area. It is important to note the hatchery prey increase program has been funded by NMFS in FY2020 through FY2023 and therefore fish produced with funds distributed in those years are currently a part of the affected environment.

3.2. Chinook Salmon and Their Habitat

Chinook salmon have a complex life cycle that involves a freshwater rearing period (typically 1 year or less) followed by two to four years of ocean feeding and growth prior to their spawning migration. The behavior of Chinook salmon differs substantially, with freshwater rearing going from stream residence to schooling behavior as emigration occurs in mainstem rivers to the marine environments. Chinook salmon considered herein range from the Columbia River and coastal Oregon rivers to as far north as the ocean waters off British Columbia (BC), specifically North/Central British Columbia (NCBC) and SEAK. Other stocks migrate in a less distant but still significantly northerly direction, while still others remain in local waters or range to the south of their natal streams. While there is great diversity in the range and migratory habits among different stock groups of Chinook salmon, there also is a remarkable consistency in the migratory habits within stock groups, which greatly facilitates stock-specific fishery planning (Figure 3).

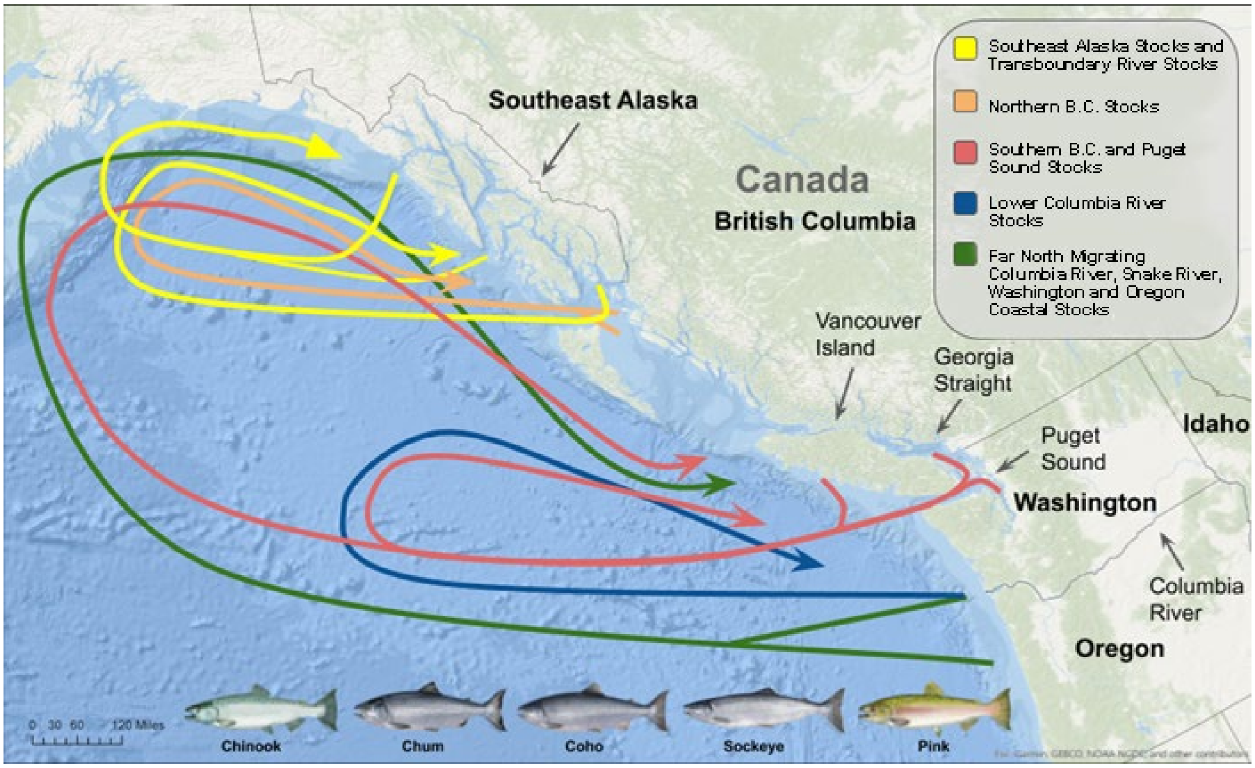


Figure 3. Migratory patterns of major Chinook salmon stock groups. Figure taken from the Pacific Salmon Commission.

Chinook salmon considered in this PEIS include all of the stocks potentially affected by the alternatives described herein. These stocks represent Chinook salmon from the Oregon Coast, Columbia River Basin, Washington Coast, and Puget Sound regions. These stocks represent both ESA-listed and non-listed stocks. A summary of the most recent stock status can be found at the following websites:

- NOAA Fisheries: https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/report-card-recovery-reviews-assess-28-salmon-and
- Pacific Fishery Management Council: https://www.pcouncil.org/salmon-management-documents/

In general, Chinook salmon stocks throughout the analysis area are currently experiencing short-term and long-term declines in abundance (NWIFC 2023). Recent abundances of nearly every stock of Chinook salmon is less than the most recent 10 year averages and far less than long-term averages (Ford 2022). Recent survivals and productivity in freshwater and marine areas for Chinook salmon are continuing to suffer from droughts, high temperatures, and the warm water blob in the ocean in the recent past, which represented unfavorable ocean conditions for salmon, continues to have effects on the returns of Chinook salmon throughout the region. Natural-origin stocks and hatchery-origin fish are similarly experiencing lower than average returns in recent years.

3.2.1. Chinook Salmon Habitat

Chinook salmon are found in freshwater streams and rivers, where clean, cool, and well-oxygenated waters with gravel or rocky bottoms are essential for successful spawning. After hatching, juvenile Chinook salmon seek shelter in freshwater habitats with submerged vegetation or woody debris to avoid predators. Downstream migration occurs at age-0 and age-1, with ocean entry commonly in the spring, summer, and fall time periods. In the ocean, Chinook salmon typically spend two to five years before migrating back into freshwater and spawning in their natal habitats. The key habitat requirements for Chinook salmon are described by life stage in Table 2.

Table 2. Primary constituent elements for the habitats of Chinook salmon.

Physical and biological Features		Species Life History Event
Site Type	**Site Attribute**	
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

Across the analysis area, the current habitat capacity and productivity for Chinook salmon is much reduced from historic levels due to a suite of anthropogenic effects (NWIFC 2023). Much habitat has been eliminated and/or reduced and the remaining habitat is controlled by many factors that affect the physical habitat of streams and rivers, including water quality and quantity, for Chinook salmon populations. Many populations of Chinook salmon throughout the region are at or near historically low abundances.

Restoration efforts are being implemented to help recover Chinook salmon throughout the region including habitat restoration, improvements in juvenile and adult survivals, and other actions. However, there is also continued pressures on habitat from development, continued use of the watersheds in which the salmon live, and worsening environmental conditions including warmer water temperatures, reduced rainfall, and other adverse conditions in recent years.

3.2.2. Hatchery Production

Hatchery Chinook salmon production in Oregon, Washington, and Idaho is a crucial part of fisheries management in the Pacific Northwest. Within these states, a variety of federal, state, tribal, and other entities fund and operate hatcheries to rear young Chinook salmon, which are released into rivers and streams to support recreational and commercial fishing, and in some cases essential conservation and recovery objectives. This practice helps offset the decline in natural salmon populations due to factors like habitat loss and degradation. However, it also raises concerns about potential genetic and ecological effects on wild salmon and the need for careful management to maintain healthy populations. Overall, with such careful management hatchery Chinook salmon production plays a vital role in balancing the conservation of wild salmon while still providing for fishing opportunities in the region (including treaty reserved tribal rights).

Hatchery production of salmonids in the Pacific Northwest has occurred for over 100 years. Currently, there are hundreds of hatchery programs in Oregon, Washington, and Idaho that produce juvenile salmon that migrate through the analysis area. Hatcheries can provide benefits by reducing demographic risks and preserving genetic traits for populations at low abundance in degraded habitats. In addition, hatchery production can help to provide harvest opportunity upholding the meaningful exercise of treaty rights for the Northwest tribes (NWIFC 2023). Hatchery-origin fish may also pose risk through genetic, ecological, or harvest effects. For example, hatchery programs can affect ESA-listed salmon and steelhead through competition with natural-origin fish for spawning sites and food, outbreeding depression, and hatchery-influenced selection.

Figure 4 and Figure 5 show existing hatchery facilities located throughout the analysis area. These facilities are funded and operated by state, tribal, and federal organizations for a variety of hatchery purposes. Within the existing hatchery production facilities throughout the region, a few of these facilities (shown as black dots in the figures) have received PST-related prey increase funds in the FY 2020-2023 time period to produce some additional hatchery Chinook salmon. Overall, these facilities have been producing Chinook salmon for decades and the hatchery prey increase program funding has been distributed for production at these existing facilities, as described in the sections below.

Because most hatchery programs are ongoing, the effects of each program are reflected in the most recent status of the species (see weblinks and summary above). Nearly all of the existing hatchery programs have also undergone the necessary site-specific evaluations under NEPA and the ESA to determine the effects of this hatchery production.

The history and evolution of hatcheries are important factors in analyzing their past and present effects. From their origin more than 100 years ago, hatchery programs have been tasked to compensate for factors that limit anadromous salmonid viability. The first hatcheries, beginning in the late 19th century, provided fish to supplement harvest levels, as human development and harvest impacted naturally produced salmon and steelhead populations. As development in freshwater systems continued (e.g., in the Columbia River Basin dam construction between 1939 and 1975), hatcheries were used to mitigate for lost salmon and steelhead harvest attributable to reduced salmon and steelhead survival and habitat degradation. Since that time, most hatchery programs have been tasked to maintain fishable returns of adult salmon and steelhead, usually for cultural, social, recreational, or economic purposes, as the capacity of natural habitat to produce salmon and steelhead has been reduced.

A new role for hatcheries emerged during the 1980s and 1990s after naturally produced salmon and steelhead populations declined to unprecedented low levels. Because genetic resources that represent the ecological and genetic diversity of a species can reside in fish spawned in a hatchery, as well as in fish that spawn in the wild, hatcheries began to be used for conservation purposes to conserve genetic resources, reintroduce salmon back into historic habitats, and reduce demographic risks. Such hatchery programs are designed to preserve the salmonid genetic resources until the factors limiting salmon and steelhead viability are addressed. In this role, hatchery programs reduce the risk of extinction (NMFS 2005; Ford 2011). However, hatchery programs that conserve vital genetic resources are not without risk to the natural salmonid populations because the manner in which these programs are implemented can affect the genetic structure and evolutionary trajectory of the target population (i.e., natural population that the hatchery program aims to conserve) by reducing genetic and phenotypic variability and patterns of local adaptation (HSRG 2014; NMFS 2014).

Population viability and reductions in threats are key measures for salmon and steelhead recovery (NMFS 2013). Beside their role in conserving genetic resources, hatchery programs also are a tool that can be used to help improve viability (i.e., supplementation of natural population abundance through hatchery production). In general, these hatchery programs increase the number and spatial distribution of naturally spawning fish by increasing the natural production with returning hatchery adults. Across the affected environment, there is a range of hatchery programs affecting Chinook salmon. Some hatchery programs are providing a net benefit to natural populations. Other hatchery programs continue to pose varying levels of risk to natural populations from genetic and ecological effects.

Available knowledge and information on the effects of hatchery fish releases on density dependent interactions affecting the growth and survival of other juvenile salmon in the ocean is limited and highly variable in complex physical and biological environments. The preponderance of scientific literature shows the early marine phase when salmon first enter saltwater is the most critical in determining the overall survival rate to adulthood. The conditions affecting this early marine phase for salmon are highly variable and change dramatically both seasonally and annually (Beamish and Neville 2021). The mechanisms driving survivals of salmon in this life stage is very limited and not clearly understood (Beamish 2022).

There is no way to predict what the future conditions in the early marine phase may be in advance of a few months. These conditions are important in understanding how hatchery production, and the fish released, will eventually affect all salmon survival in this critical early marine phase when first entering saltwater. Hatchery production is initiated one to two years before the juvenile hatchery fish will enter saltwater, so there is no way to predict what marine conditions may be in advance of production.

High releases of hatchery fish entering the marine environment may affect survival conditions for co-occurring natural-origin salmon. Ruggerone et al. (2022) described the increased abundance of hatchery and natural pink salmon in recent decades being able to change the trophic dynamics in the marine environment and thus potentially affect the survival of other salmon. In the analysis area, hatchery fish may also pose similar risks depending upon the abundances entering marine areas, current environmental conditions, and limitations. It is likely there may be adverse effects at a local level over a period of time depending upon the productivity of the marine environment in the California current of the eastern Pacific ocean within the analysis area. See https://ecowatch.noaa.gov/regions/california-current for further information on the current state of marine waters off the western US and annual fluctuations.

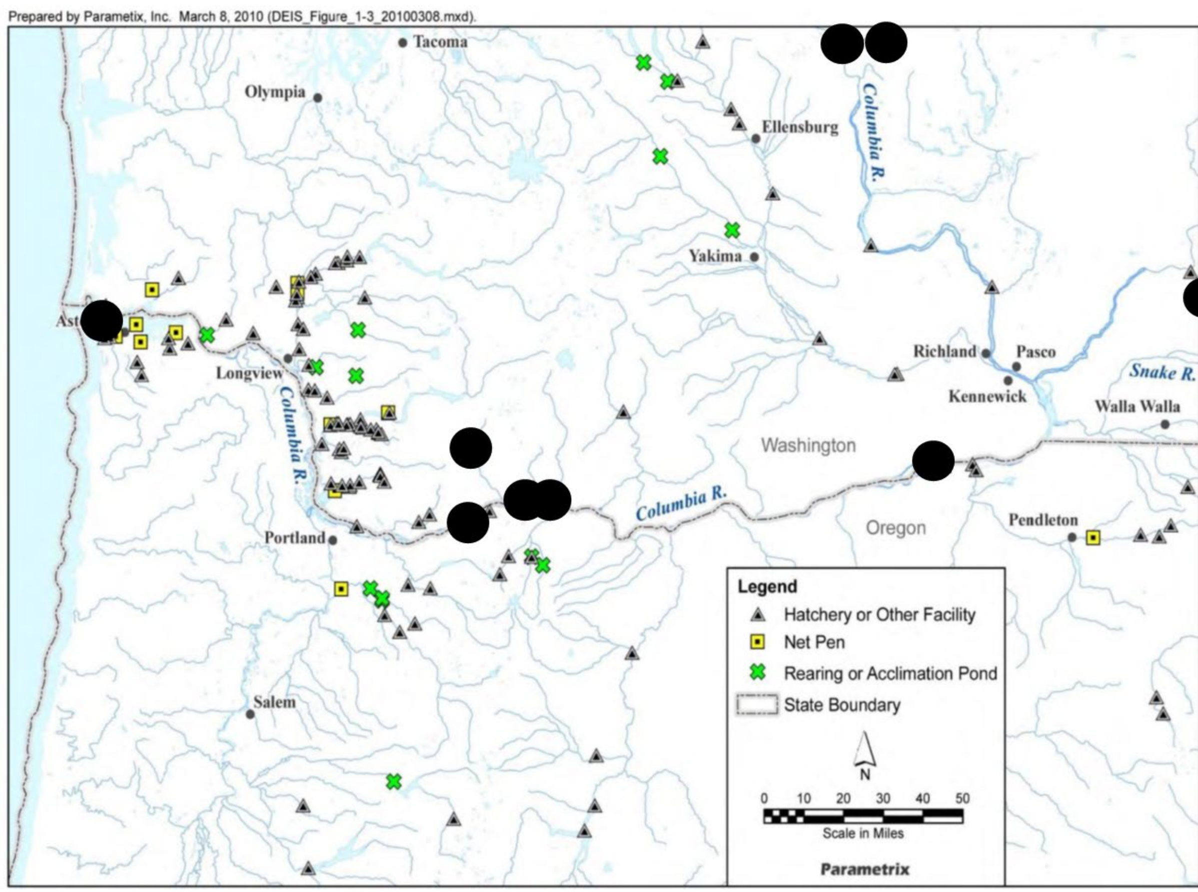


Figure 4. Hatchery facilities in the project area of the Columbia River Basin. The black circles show the general location of facilities used for the hatchery prey increase program production funded by NMFS in 2023. Figure adapted from NMFS (2014).

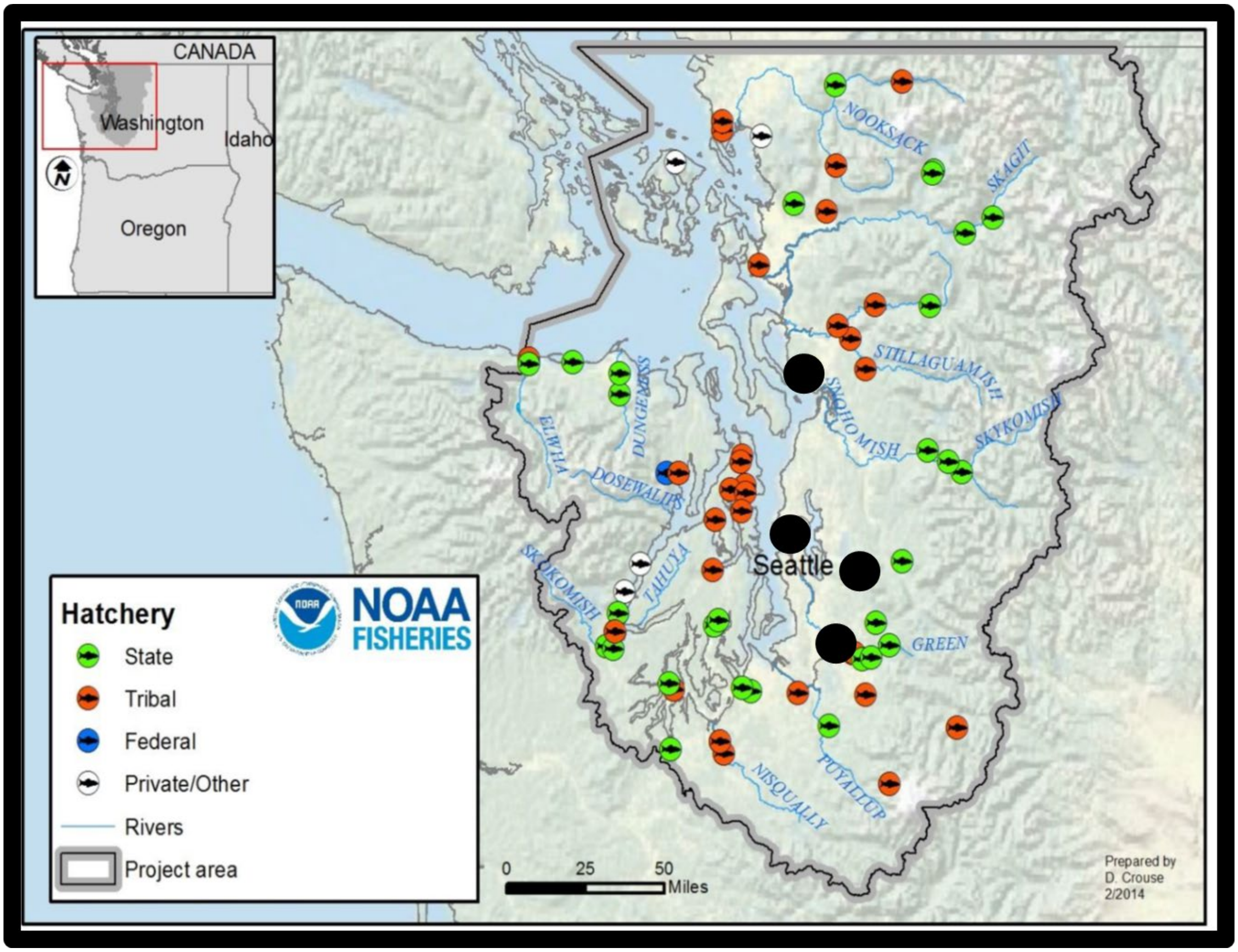


Figure 5. Hatchery facilities in the project area of the Puget Sound region. The black circles show the general location of hatchery prey increase program production funded by NMFS in 2023. Figure adapted from NMFS (2014).

3.2.2.1.Existing Hatchery Production

Regional Hatchery Releases

In the recent past, an average of 158 million juvenile Chinook salmon annually have been released throughout the analysis area over the years of 2008 through 2023 (Table 3). The total number released into each sub-region of the analysis area varies substantially from year to year. In the U.S. Salish Sea, in the 2008-2023 time period, annual releases of hatchery Chinook salmon ranged from 40.6 million in 2021 to a high of 52 million in 2023. In the Columbia River, annual Chinook hatchery releases ranged from 80.0 million in 2023 to 107.8 million in 2010. Across the analysis area, 62% of the Chinook releases occurred in the Columbia River; 28% in the U.S. portion of the Salish Sea. From a longer-term perspective, total release of hatchery Chinook salmon in the analysis area were typically more than 200 million fish prior to the mid-1990's (Figure 7).

Table 3. Total regional hatchery juvenile Chinook salmon releases from 2008 through 2023. Data from Regional Mark Information System (https://www.rmpc.org/).

Release Year	Salish Sea	Washington Coast	Oregon Coast	Columbia River
2008	44,930,915	10,125,788	6,176,199	94,901,003
2009	43,336,852	10,330,852	5,629,442	103,057,567
2010	41,836,569	9,202,126	6,675,993	107,783,568
2011	43,863,472	11,197,030	5,983,922	102,170,533
2012	41,907,618	11,248,489	6,312,472	103,798,265
2013	41,006,628	9,872,485	6,079,183	103,748,801
2014	41,275,967	11,422,843	7,252,409	101,376,847
2015	42,486,682	11,311,230	5,987,165	99,083,861
2016	41,392,329	8,842,142	5,878,639	93,116,623
2017	41,502,620	10,059,269	5,461,163	95,083,272
2018	46,089,539	9,696,522	5,895,970	97,087,901
2019	49,758,060	11,044,692	4,067,665	92,635,747
2020	50,178,052	8,791,100	5,920,781	91,357,510
2021	40,609,889	12,506,266	5,662,594	97,874,041
2022	50,256,589	13,033,163	4,597,875	87,761,462
2023	52,147,431	9,042,426	4,597,875*	76,963,674
Average by Area	**44,536,201**	**10,482,901**	**5,761,209**	**96,737,542**
Total Average Releases			**157,517,854**	

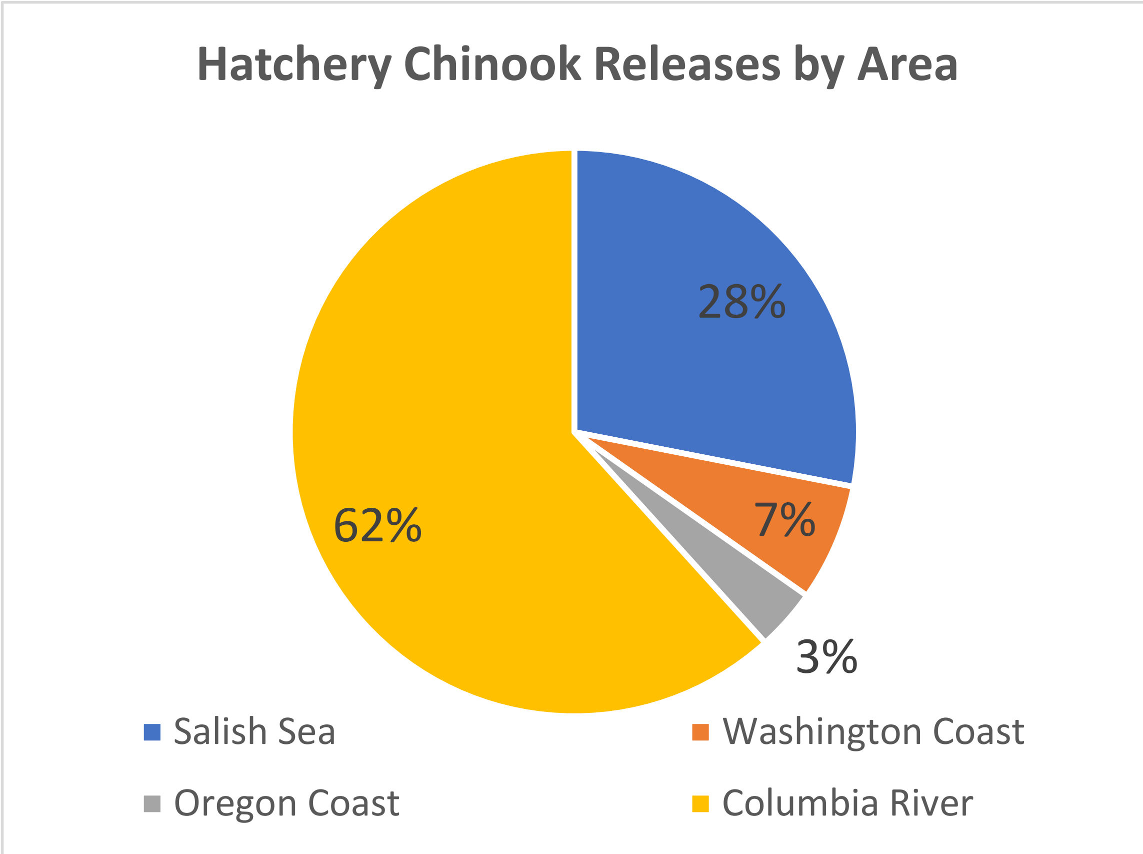


Figure 6. Average proportion of hatchery Chinook salmon releases (2008-2023) by area. Data from Table 3.

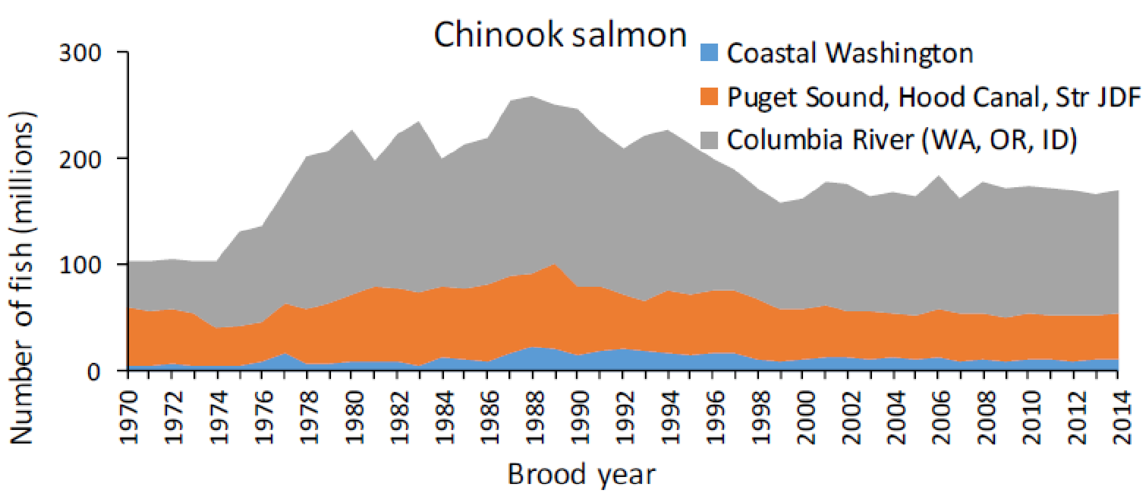


Figure 7. Long-term dataset of hatchery Chinook salmon releases throughout the region. Taken from WDFW (2020).

Hatchery Chinook Spawning in the Wild

Hatchery Chinook salmon returning to freshwater areas that are not harvested in fisheries, collected at hatchery facilities, and survive may spawn in the wild. A common metric measuring the extent of hatchery Chinook salmon spawning in the wild is the proportion of hatchery origin salmon (pHOS) spawning in the wild (pHOS; NMFS 2019). pHOS is a function of the number of hatchery-produced and naturally-produced salmon spawning together in a particular area and has been used as a surrogate to help inform potential genetic interactions between hatchery and natural salmon. pHOS would be 100% if no natural-origin salmon are spawning in the specified area; or conversely 0% if no hatchery fish are spawning in the wild.

Some available data on recent pHOS throughout the analysis is summarized in Appendix B. Depending upon the specific location, status of wild Chinook natural population, escapement of hatchery salmon, and the adjacent hatchery facilities, pHOS ranges from near zero to near 100% (Ford 2022). This is the baseline data in the affected environment prior to the return of hatchery production from releases associated with the prey increase program (see next section). This is an extremely important point that affects our evaluation of Alternative 2, the hatchery prey increase program. See Table 7 for a timeline of adult returns from hatchery releases.

In many geographic locations, such as the lower Columbia River, pHOS in certain natural population areas are high as a result of baseline hatchery releases, without the additional hatchery production associated with the prey increase program. Current (Appendix B) pHOS estimates are based on returns through 2023, prior to returns of any fish produced using prey increase funds (returns of all age classes beginning in 2023 for fall Chinook and 2024 for spring Chinook (see Table 7)). It is important to separate existing hatchery production (in this subsection of the affected environment) from the relatively new, additional hatchery production associated with the prey increase program for SRKWs (next subsection). Otherwise it is easy to assume high pHOS in certain areas is associated with hatchery fish produced specifically for SRKW prey (federal or non-federally funded), and this simply is not the case in most natural populations throughout the analysis area (as explained below).

Returns of hatchery Chinook salmon to freshwater areas is highly variable depending upon survival of salmon in freshwater and marine areas. The variability occurs annually as fluctuations in the survival of salmon at all life stages occurs. Freshwater survival rates of juvenile salmon varies greatly from year to year depending upon environmental factors and other stressors. Survival during freshwater emigration and early marine survival of juvenile salmon fluctuates tremendously. Ocean survivals vary dramatically depending upon seasonal productivity affecting all trophic levels. Returns of hatchery salmon modeled in this assessment can vary as much as twice the mean value within a short amount of time (<10 years; Figure 8). For the most abundant stock in the analysis area (Columbia River upriver brights), the variability in returns over 10 years has been as much as an order of magnitude difference (~34,000 to ~356,000; Appendix F). This variability must be taken into account when assessing the effects of hatchery salmon on pHOS in natural populations.

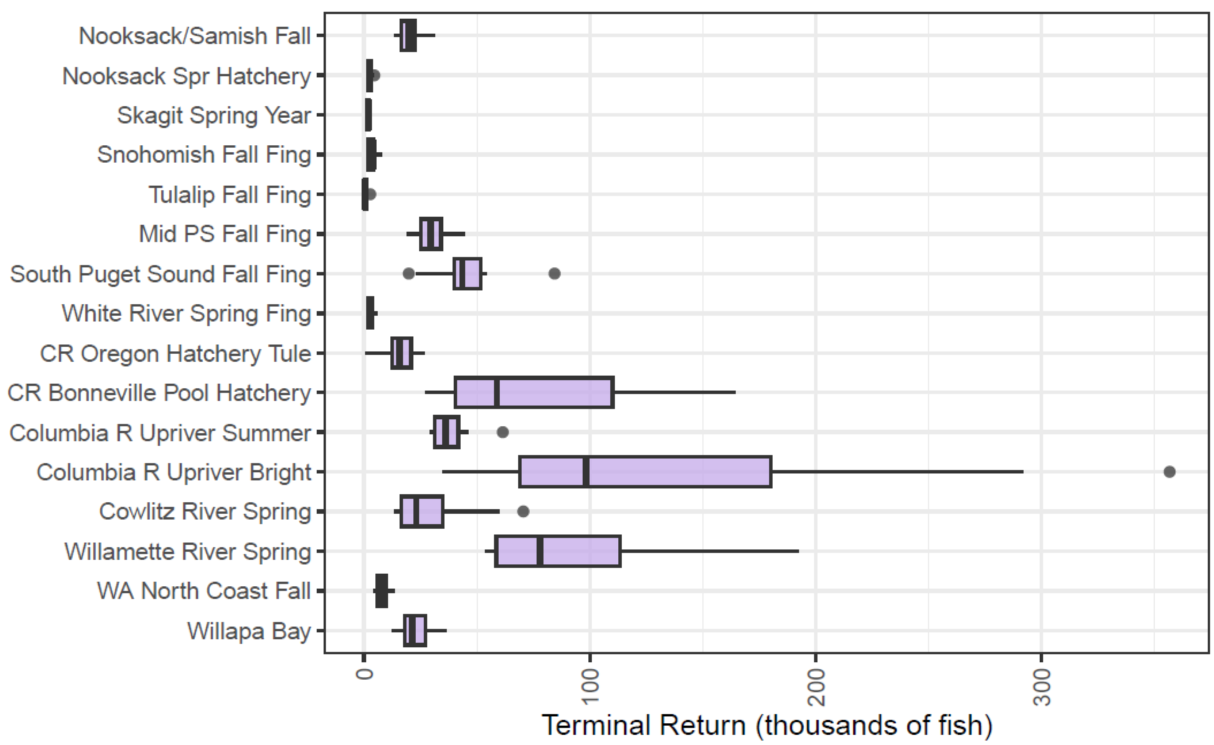


Figure 8. Variability of hatchery Chinook salmon returns to the river for Fishery Regulation Assessment Model (FRAM) stocks associated with the prey increase program (see next section for details). See Appendix F for further details.

3.2.2.2. Hatchery Prey Increase Program Funding

Regional Hatchery Releases

Currently, hatchery production is a significant component of the salmon prey base within the range of SRKWs and very important to meeting the nutritional needs of these whales (Barnett-Johnson et al.

2007). Prey availability has been identified as a threat to SRKW recovery, and so hatchery salmon will continue to provide a significant prey base for SRKWs.

In recent years, hatchery production has been funded by federal and state agencies specifically to provide more prey availability for SRKWs. NMFS has been allocating approximately $6.2 million (average) of the federal appropriation for PST implementation annually from FY 2020-2023 to increase prey availability for SRKW through hatchery production. For example, 7.2 million Chinook salmon were released in 2022 funded by these appropriations (Table 4). Table 4 shows the releases increasing from 2020 through 2023. For 2023, a total of 8.3 million Chinook salmon were released (Table 4).

Also, in response to recommendations from the Washington State Southern Resident Orca Task Force (2018), the Washington State Legislature provided $12.5 million of funding "prioritized to increase prey abundance for southern resident orcas" (Engrossed Substitute House Bill 1109) for the 2021-2023 biennium (July 2021 through June 2023). This Washington State funding has resulted in approximately 11.6 million additional Chinook salmon released in 2023 (Table 5). In 2023, the Legislature provided $12.5 million for the 2023-2025 biennium (July 2023 through June 2025).

These initiatives have produced fish that are currently increasing prey availability of Chinook salmon for SRKWs (Table 6), as fish released from 2019 and 2020, depending on life history, are currently reaching adult age in the ocean (in 2023). Fish funded by these programs through FY 2023 and planned for release as smolts in 2024 are expected to contribute to the prey base through 2028.; as these fish will take a few years to reach maturity in the ocean (within 3-5 years of release based on their type of release and life history; subyearling fall Chinook salmon, for instance, generally return to freshwater after four years of ocean residency (Groot and Margolis 1991)). As these fish exit the ocean after reaching maturity they may contribute to spawning and overall Chinook salmon abundance within the vicinity of their natal release. This will occur at varying intervals, given the various life histories and types of releases listed in Table 4, but as described here, this will continue to occur 3-5 years after FY 2023 funding. Funding for FY 2024 will be determined after this PEIS evaluation and the ROD is signed.

Table 4. Number of released fish (release years 2020 through 2023) from Federally funded hatchery programs in FY2020 through FY2023 intended to increase prey availability for SRKWs throughout areas where PST fisheries occur.

Facility	Region	Operating Agency	Life History/ Adjacent Natural Population	Type of Release	2020 Release	2021 Release	2022 Release	2023 Release
Issaquah Hatchery	Puget Sound	WDFW	Fall Chinook/ Cedar, Sammamish	Sub-yearling	-	-	707,026	1,000,000
Tulalip Bernie Gobin Hatchery	Puget Sound	Tulalip Tribe	Summer Chinook/Tulalip, Skykomish	Sub-yearling	-	-	958,415	1,808,692
Soos Creek Hatchery	Puget Sound	WDFW	Fall Chinook/ Green	Sub-yearling	-	2,003,244	2,077,000	2,137,191
East Bank and Marion Drain Hatcheries	Columbia River	Yakama Nation	Fall Chinook/ Toppenish	Yearling	-	-	19,755	109,876
Marion Drain Hatchery	Columbia River	Yakama Nation	Summer Chinook/ Toppenish	Sub-yearling	-	279,594	-	-
Select-Area Fishery Enhancement (SAFE)	Columbia River	ODFW	Spring Chinook/ NA	Yearling	-	1,345,310	1,507,467	1,430,813
Umatilla Hatchery	Columbia River	ODFW	Fall Chinook/ Umatilla	Sub-yearling	-	-	127,931	-
Round Butte Hatchery	Columbia River	ODFW	Spring Chinook/ Deschutes	Sub-yearling	-	167,000	-	-

Facility	Region	Operating Agency	Life History/ Adjacent Natural Population	Type of Release	2020 Release	2021 Release	2022 Release	2023 Release
Bonneville Hatchery	Columbia River	ODFW	Fall Chinook/ Tanner	Sub-yearling	-	344,122	250,000	234,871
Wells Hatchery	Columbia River	Douglas PUD/ WDFW	Summer Chinook/ NA	Sub-yearling	-	482,734	520,239	514,076
Little White/Willard NFH	Columbia River	USFWS	Fall Chinook/Little White Salmon	Sub-yearling	479,694	649,356	-	-
Little White/Willard NFH	Columbia River	USFWS	Spring Chinook/ Little White Salmon	Yearling	-	-	380,578	497,692
Dworshak NFH	Columbia River	Nez Perce Tribe	Spring Chinook/ Clearwater	Yearling	-	-	508,985	493,858
Spring Creek NFH	Columbia River	USFWS	Fall Chinook/ White Salmon	Sub-yearling	-	688,509	66,294	-
Carson NFH	Columbia River	USFWS	Spring Chinook/ Wind	Yearling	-	-	-	74,123
TOTAL					**479,694**	**5,959,869**	**7,124,258**	**8,301,192**

Table 5. Washington State funded hatchery production for 2019 through 2023 releases (2019-2021 biennium funding) to increase prey for SRKWs (excludes base production).

Facility	Region	Life History/ Adjacent Natural Population	Type of Release	2019 Release	2020 Release	2021 Release	2022 Release	2023 Release
Kendall	Puget Sound	Spring Chinook/ NF Nooksack	Sub-yearling	704,170	449,199	381,725	635,697	532,756
Whatcom Cr.	Puget Sound	Fall Chinook/ Whatcom*	Sub-yearling	200,000	670,000	491,747	543,181	520,964
Hupp Springs	Puget Sound	Spring Chinook/ Minter*	Sub-yearling	259,873	388,909	543,034	515,642	476,501
Samish	Puget Sound	Fall Chinook/ Samish*	Sub-yearling	1,089,148	1,217,867	0	906,459	1,042,500
Wallace River	Puget Sound	Summer Chinook/ Skykomish	Sub-yearling	-	260,745	183,901	1,049,421	1,151,558
Wallace River	Puget Sound	Summer Chinook/ Skykomish	Yearling	-	34,938	44,158	0	79,315
Soos/Palmer	Puget Sound	Fall Chinook/ Green	Sub-yearling	282,638	1,210,986	-		

Facility	Region	Life History/ Adjacent Natural Population	Type of Release	2019 Release	2020 Release	2021 Release	2022 Release	2023 Release
Marblemount	Puget Sound	Spring Chinook/ Cascade	Sub-yearling	0	246,479	159,534	128,022	204,190
Marblemount	Puget Sound	Spring Chinook/ Cascade	Yearling	86,500	405,000	414,874	0	499,293
Sol Duc	WA Coast	Summer Chinook/ Sol Duc	Sub-yearling	500,143	582,479	480,291	558,969	553,736
Sol Duc	WA Coast	Summer Chinook/ Sol Duc	Yearling	-	-	67,787	28,588	64,982
Minter	Puget Sound	Fall Chinook/ Minter*	Sub-yearling	763,333	321,497	332,672	291,083	419,058
Naselle	WA Coast	Fall Chinook/ Naselle	Sub-yearling	-	-	1,472,258	2,577,982	1,826,352
Forks Creek	WA Coast	Fall Chinook/ Willapa	Sub-yearling	567,560	2,278,497	257,338	108,072	84,308
Wells Hatchery	Col River	Summer Chinook/ Yakima	Sub-yearling	0	541,299	482,734	520,239	514,075

Facility	Region	Life History/ Adjacent Natural Population	Type of Release	2019 Release	2020 Release	2021 Release	2022 Release	2023 Release
Quinault Lake	WA Coast	Fall Chinook/ Quinault	Sub-yearling	-	-	500,000	446,651	500,000
Sol Duc/Bear Springs	WA Coast	Summer Chinook/ Sol Duc	Sub-yearling	-	-	147,913	115,179	73,122
Sol Duc/Bear Springs	WA Coast	Summer Chinook/ Sol Duc	Yearling	-	70,000	70,758	72,651	20,170
Wilkeson Creek	Puget Sound	Fall Chinook/ Puyallup	Sub-yearling	-	404,000	175,614	400,000	386,049
Clarks Creek	Puget Sound	Fall Chinook/ Puyallup	Sub-yearling	-	376,480	196,035	611,685	675,200
White River	Puget Sound	Spring Chinook/ White	Sub-yearling	-	-	167,557	238,335	273,385
Lummi Bay Hatchery	Puget Sound	Spring Chinook/ NF, MF Nooksack	Sub-yearling	-	50,000	222,168	499,193	504,080
Skookum Creek	Puget Sound	Spring Chinook/	Sub-yearling	-	870,000	794,626	0	762,084

Facility	Region	Life History/ Adjacent Natural Population	Type of Release	2019 Release	2020 Release	2021 Release	2022 Release	2023 Release
Klickitat Hatchery	Col River	SF Nooksack Fall Chinook/ Klickitat	Sub-yearling	-	1,000,000	-	574,715	154,835
Lewis River	Col River	Spring Chinook/ Lewis	Sub-yearling	944,425		389,959	268,950	290,165
TOTAL				**5,397,790**	**11,378,375**	**7,976,683**	**11,090,714**	**11,608,678**

*Only the productions that have already been released at the time of this Opinion's signing are included in this table.

Table 6. Summary of federal and state funded 2020 through 2023 Chinook salmon releases to increase prey availability for SRKWs.

Funding Source	Release Years				
	2019	2020	2021	2022	2023
PST FY20		479,694	5,959,869	1,338,993	-
PST FY21	-	-	-	5,785,265	571,815
PST FY22	-	-	-	-	7,729,377
Washington State Legislature ('19-'21)	5,397,790	11,378,375	7,976,683	-	-
Washington State Legislature ('21-'23)	-	-	-	11,098,233	11,608,870
TOTAL	**5,397,790**	**11,858,069**	**13,936,552**	**18,222,491**	**19,910,062**

The percentage of total regional releases funded by federal and state sources to increase prey availability for SRKWs for release years 2020 through 2023 are shown in Figure 9. Over these four years (releases completed for the year), the hatchery releases for SRKWs have averaged 10.85% of the total regional releases for those particular years. For 2023 releases, approximately 14% or less of the regional releases of Chinook salmon in the analysis area were funded by dollars specified for SRKWs (approximately 20 million prey increase program fish out of a total of 157 million throughout the region).

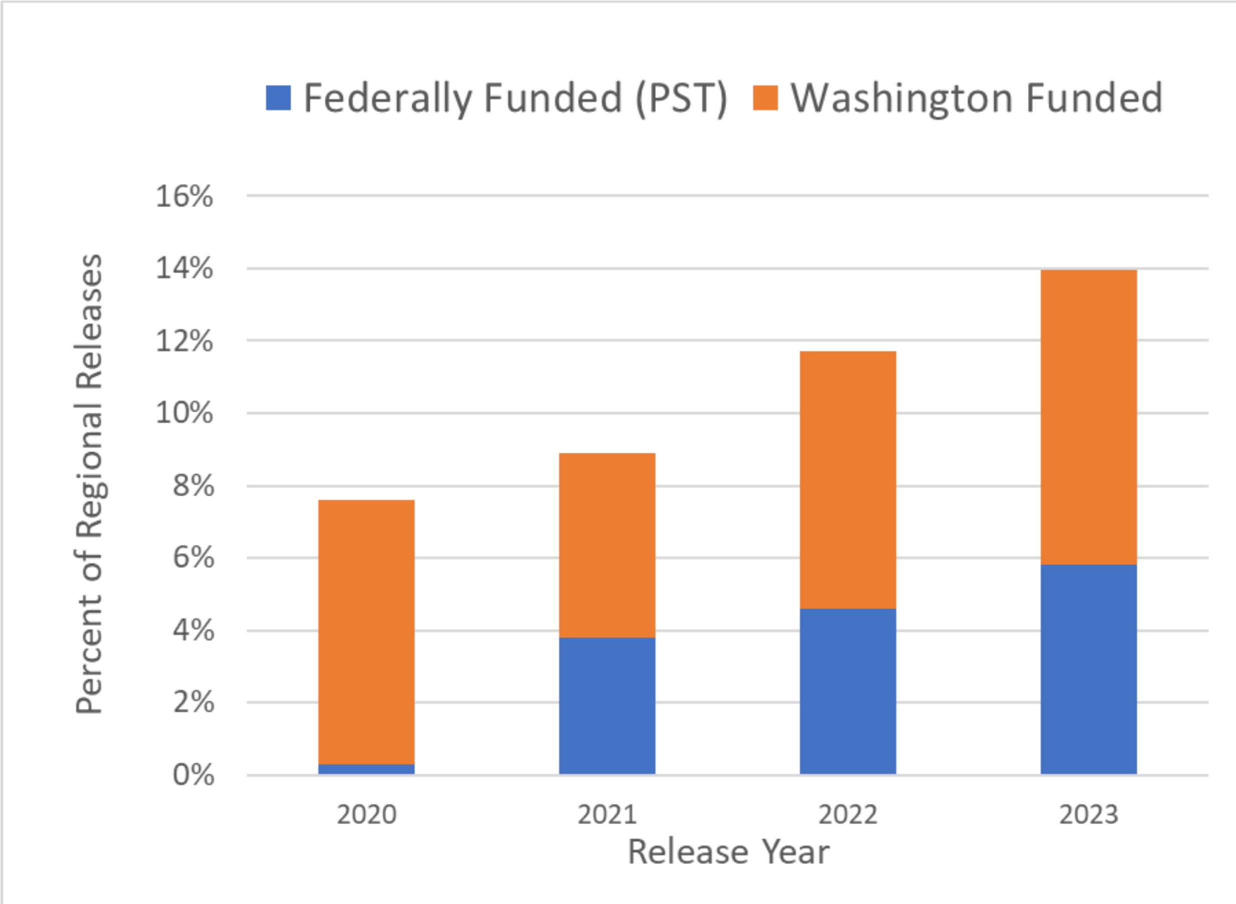


Figure 9. Percent of regional hatchery Chinook salmon juvenile releases funded by federal and state of Washington specifically to increase prey availability for SRKWs. Values calculated from data in previous tables.

Hatchery Chinook Spawning in the Wild

The potential for hatchery Chinook salmon straying into natural spawning areas from the combined federal and state prey increase funding is just beginning as jack and adult life stages mature and return to freshwater. Table 7 shows the returns to freshwater for each age class of hatchery Chinook salmon. 2023 is the first year where all age classes from fall Chinook salmon releases will begin to return, and 2024 for spring Chinook salmon releases.

The incidence of hatchery salmon straying into natural population areas is predominately near the hatchery facilities where the fish were reared and released as juveniles (Appendix B; NMFS 2014). Straying can occur in other natural population areas distant from the point of release, but this level is nearly always very low due to the homing instincts of Chinook salmon (NMFS 2014). Therefore, the highest degree of straying from hatchery salmon produced as part of the prey increase funding is expected to be the greatest in the adjacent natural population areas where these salmon are produced. For hatchery Chinook production associated with the prey increase funding, the natural population areas are identified in Table 4 and Table 5, respectively for federal and state funded production. For all of these areas, the prey increase funded production is only a small proportion of the total release of hatchery salmon since existing facilities use space to produce salmon for SRKWs. On average in 2020-2023, 14% or less of the regional hatchery Chinook releases were from production intended to increase prey for SRKWs. The highest proportion occurred with 2023 releases, as production continued to increase.

There are no estimates for pHOS available yet for the years that would include prey increase program funded salmon because 2023 and 2024 are the first years when all age classes of fall Chinook and spring Chinook salmon are returning from these releases, respectively (Table 7). This is an important consideration because commonly half of the spawning cohort of salmon in any given year are comprised of age 5 fish. Earlier years, without all age classes returning, would not provide an accurate assessment of what prey increase program funded fish would be contributing to pHOS. It is expected the increase in returns to freshwater will be essentially proportional to the increase in smolt releases (assuming freshwater harvest and collection efficiency at the hatchery remain constant). However, given natural variability in the survival of salmon from juvenile release to adult return (Figure 8), the magnitude of change can be significant. The expected increase in pHOS from the prey increase program funded hatchery production is assessed under Alternative 2 in Chapter 4, Environmental Consequences, because spawning ground data for the fall of 2023 is not yet available (as of January, 2024), and not all age classes of Chinook salmon have returned from the first brood year (in 2019) for prey increase program hatchery fish (Table 7).

Table 7. Return of hatchery salmon to freshwater by brood year of release as juveniles, for fall Chinook and spring Chinook life histories, from hatchery production for SRKWs.

FALL CHINOOK

	Smolt Release by Brood Year				
	2019	2020	2021	2022	2023
Return Freshwater, by Year					
2021	jack				
2022	age 4	jack			
2023	age 5	age 4	jack	first year all age classes return freshwater	
2024		age 5	age 4	jack	
2025			age 5	age 4	jack
2026				age 5	age 4
2027					age 5
2028					

SPRING CHINOOK

	Smolt Release by Brood Year				
	2019	2020	2021	2022	2023
Return Freshwater, by Year					
2022	jack				
2023	age 4	jack			
2024	age 5	age 4	jack	first year all age classes return freshwater	
2025		age 5	age 4	jack	
2026			age 5	age 4	jack
2027				age 5	age 4
2028					age 5

3.2.3. Fisheries

Chinook salmon fisheries occur in freshwater and marine waters throughout the entire project area. For purposes of this PEIS, fisheries in marine waters off the coasts of Oregon, Washington, Salish Sea, Puget Sound, and southeast Alaska for Chinook salmon occur in the affected environment and are relevant to the alternatives assessed in this document. Subsequent fisheries also occur on returning salmon to freshwater areas as the salmon migrate upstream back to spawning areas but these fisheries are not applicable to the alternatives assessment. Marine fisheries affect prey availability in marine areas for

SRKWs, and freshwater fisheries have bearing on the return of hatchery salmon back to hatchery facilities and pHOS (hatchery fish spawning in the wild).

All Chinook salmon fisheries (and other fisheries potentially harvesting Chinook salmon) are governed by management plans and agreements that prescribe allowable exploitation rates for specific stocks and ESUs in the US and Canada (e.g. Pacific Salmon Treaty, North Pacific Fishery Management Council's Fishery Management Plan for the Salmon Fisheries in the EEZ off Alaska, PFMC Salmon Fishery Management Plan for southern US, US v. Washington, US v. Oregon). The purposes of these management plans are to ensure the protection and conservation of stocks at risk, sustainably manage fisheries on all stocks, provide fishing opportunities both recreationally and commercially, provide for the exercise of tribal fishing rights, and provide economic benefits to local communities from conducting fisheries. Some of these management plans, including PFMC plans, are implemented annually by the federal government, state agencies, and/or tribes depending upon the stock statuses every season and fishery impact limitations.

A summary of these fisheries management regimes for Chinook salmon can be found at:

- Pacific Fishery Management Council https://www.pcouncil.org/managed_fishery/salmon/
- North Pacific Fishery Management Council https://www.npfmc.org/wp-content/PDFdocuments/fmp/Salmon/SalmonFMP.pdf
- Alaska Department of Fish and Game https://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareasoutheast.salmon_managementplans
- Pacific Salmon Commission https://www.psc.org/about-us/history-purpose/pacific-salmon-treaty/
- United States v. Washington https://www.fisheries.noaa.gov/west-coast/sustainable-fisheries/salmon-and-steelhead-fisheries-west-coast-united-states-v-washington
- United States v. Oregon https://www.fisheries.noaa.gov/west-coast/sustainable-fisheries/salmon-and-steelhead-fisheries-west-coast-united-states-v-oregon

In general, SEAK Chinook fisheries are managed primarily to stay within catch limits set under the PST Agreement, though they may in some years be reduced below these levels. PFMC salmon fisheries off Washington and northern Oregon are managed consistent with the PST Agreement, but are in most years managed to limit impacts to ESA listed species such that the resulting catch is substantially below what the PST Agreement would allow. Puget Sound salmon fisheries are managed through agreements between the State of Washington and Treaty Tribes, and are constrained to limit impacts to specific populations or groups of populations of threatened Puget Sound Chinook. Fisheries in the Columbia River and tributaries are managed under the U.S. v. Oregon Management Agreement, which is designed to limit impacts to ESA listed Columbia River stocks and to provide for the exercise of treaty rights by Columbia River tribes. Puget Sound and Columbia River fisheries are managed consistent with the PST Agreement, but normally more conservatively in order to protect ESA listed stocks. Generally, fisheries in the southern U.S. (Washington, Oregon, California, Idaho) are managed to keep impacts within certain exploitation rate levels, and/or to ensure that a certain number of a given stock escape the fisheries and return to hatcheries or spawning grounds. Fisheries have been reduced significantly from historic levels and are currently managed to ensure that they do not jeopardize listed salmon and that sufficient numbers fish escape the fisheries to maximize future generations given existing habitat conditions and other limiting factors.

A variety of fish and wildlife species inhabit the marine waters where Chinook salmon fisheries can occur. Other salmon species, non-salmonid species, and many wildlife species live in the marine waters either all, or a significant portion, of their life. SRKWs and other marine mammals such as grey whales, humpback whales, sea lions, and seals are typically found in the waters where Chinook fishing occurs throughout the analysis area.

Implementation of Chinook salmon fisheries can affect the natural environment including many species that may be directly or indirectly affected by fishing. The effects of fisheries on Chinook salmon, other salmon, and other species, varies depending on timing and allowed catch levels. Since there are a variety of fishing methods used to catch Chinook salmon throughout the large analysis area, the interaction with other species also depends upon the gear used in the specific fishery. NMFS (2019), NMFS (2021), and NMFS (2023) provide an overview of the effects of Chinook salmon fishing on ESA-listed fish and wildlife species under the jurisdiction of NMFS. Commercial troll and recreational fisheries use specific gear that limits interactions with other species, and the prominent catch is salmon with little interception of non-targeted species. Net fisheries conducted throughout the region vary in scope and interaction depending upon the location and season, but overall current management regimes are highly effective in managing unintended catch with all gear used.

3.3. Southern Resident Killer Whales

The SRKW population inhabits inland and coastal waters of the analysis area year-round. The 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). As of the 2023 census, the population numbers 75 individuals (CWR 2023), as compared to 88 individuals when the DPS was listed in 2005, indicating a consistent downward trend.

SRKWs occur throughout the coastal waters off Washington, Oregon, northern California, and Vancouver Island, Canada and are known to travel as far south as central California and as far north as SEAK (Figure 10) (NMFS 2008b; Hanson et al. 2013; Carretta et al. 2023), though there has only been one sighting of a SRKW in SEAK. SRKWs are highly mobile and can travel up to 86 miles (160 km) in a single day (Erickson 1978; Baird 2000), with seasonal movements likely tied to the migration of their primary prey, salmon. During the spring, summer, and fall months, the whales spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Ford et al. 2000; Hauser et al. 2007 (Bigg 1982; Krahn et al. 2002; Olson et al. 2018; NMFS 2021b; Ettinger et al. 2022; Thornton et al. 2022)) with Chinook salmon as their preferred prey year-round (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016; Hanson et al. 2021). During fall and early winter, SRKWs, and J pod in particular, expand their routine movements into Puget Sound, likely to take advantage of chum, coho, and Chinook salmon runs (Osborne 1999; Hanson et al. 2010; Ford et al. 2016; Olson et al. 2018). SRKW are known to focus their foraging efforts along the west side of San Juan Island during the summer months, and along the west side of Vancouver Island at Swiftsure Bank in the spring/early summer months (Thornton et al. 2022). Although seasonal movements are somewhat predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall (Olson et al. 2018; NMFS 2021b), with late arrivals and fewer days present in recent years (NMFS 2021b; Ettinger et al. 2022).

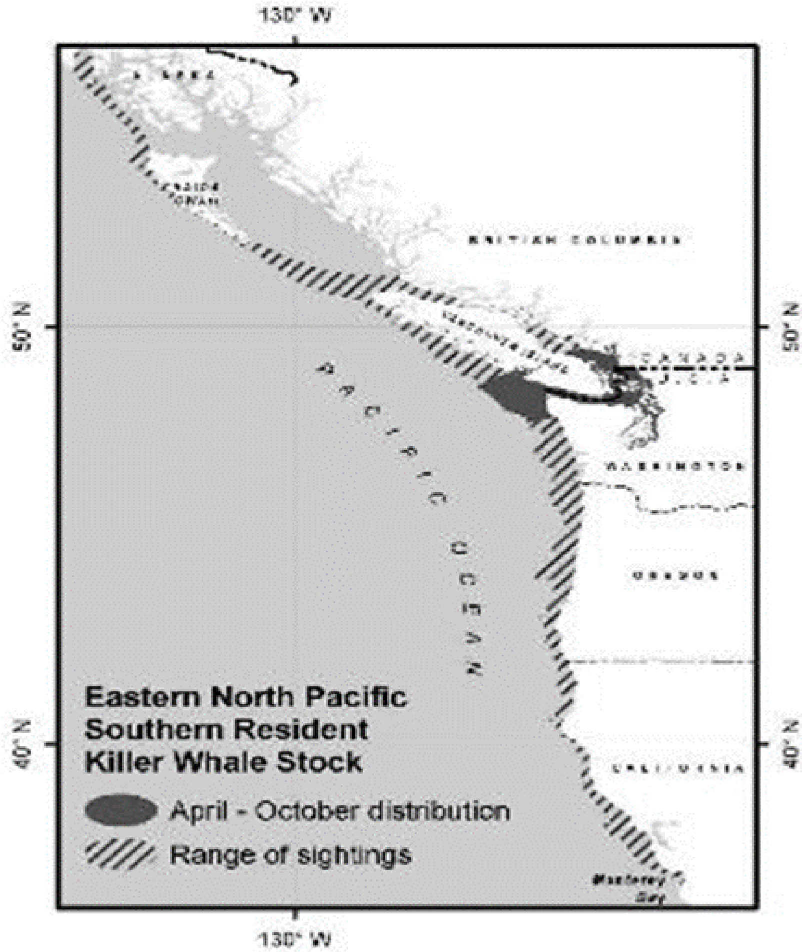


Figure 10. Geographic range of SRKWs (reprinted from Carretta et al. (2023).

Critical habitat for the SRKW DPS was first designated on November 29, 2006 (71 FR 69054) in inland waters of Washington State and was expanded in 2021 to include six additional coastal critical habitat areas off the coast of Washington, Oregon, and California (additional approximately 15,910 sq. miles) (86 FR 41668, August 2, 2021). Based on the natural history of SRKWs and their habitat needs, NMFS identified the following physical or biological features essential to the conservation of the listed species: (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. See NMFS (2021) for a detailed description of the coastal critical habitat areas. The factors limiting SRKW recovery as described in the final recovery plan and 2021 5-Year Review include reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008b); NMFS 2021). Oil spills, disease, and the small population size/inbreeding 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 2008b; Murray et al. 2021); NMFS 2021).

Many factors are currently contributing to the problem of insufficient prey availability for SRKWs. Long-term declines in the survival and productivity of Chinook salmon throughout the entire region have led to fewer adult salmon being available as prey for SRKWs in critical times and areas. Concomitant with a historical decline in salmon abundance, current activities continue to affect salmon, its habitat, and ultimately prey availability for the whales. Directed and non-directed salmon fisheries catch Chinook salmon (e.g. NMFS 2023), which reduce the available prey to SRKW, along with hydropower operations (e.g. NMFS 2019) and nearshore development (e.g. NMFS 2022). Predation on Chinook salmon by other marine mammals, such as sea lions and seals, may also be a contributing factor in the decline of prey available to SRKWs (Chasco et al. 2017a; Chasco et al. 2017b). Along the West Coast, there has been a reduction in fishery exploitation rates on key ESA-listed and/or overfished stocks through recent fisheries management plans (e.g. NMFS 2019; 2021; 2023). Hatchery production of salmon provides additional prey for SRKW while also supporting declining salmon stocks and ESUs, and has been used as a tool to mitigate for actions that reduce the amount of prey available to SRKW (e.g. NMFS (2019)).

In an effort to prioritize salmon recovery efforts for increasing prey availability for SRKWs, NMFS and WDFW developed a priority stock report identifying the important Chinook salmon stocks along the West Coast (NOAA Fisheries and WDFW 2018).[4] The list was created using information on (1) Chinook salmon stocks found in SRKW diet through fecal and prey scale/tissue samples, (2) SRKW body condition over time through aerial photographs, and (3) SRKW spatial and temporal overlap with Chinook salmon stocks ranging from SEAK to California. Extra weight was given to the salmon runs that support SRKWs during times of the year when the whales' body condition is more likely reduced and when Chinook salmon may be less available, i.e., winter months. This priority stock report will be updated over time as new data become available. The report was designed only to prioritize recovery actions for SRKW; currently, stock-specific abundance estimates have not been factored into the report, therefore it is not intended to assess fisheries actions or prey availability by area. The first 15 salmon stocks on the priority list include fall, spring, and summer Chinook salmon runs in rivers spanning from British Columbia to California, including the Fraser, Columbia, Snake, and Sacramento Rivers, as well as

[4] https://media.fisheries.noaa.gov/dam-migration/srkw_priority_chinook_stocks_conceptual_model_report___list_22june2018.pdf

several rivers in Puget Sound watersheds (NOAA Fisheries and WDFW (2018), also see Table 11 replicated in NMFS (2021)).

As described in Section 3.2.2.2 above, funding through NMFS and the State of Washington has been used to increase regional hatchery production with the goal to enhance prey availability for SRKWs. One of the domestic actions associated with the 2019-2028 PST Agreement was to provide federal funding annually for increased hatchery production of SRKW prey (NMFS 2019). Thus far, the federal prey increase program, in fiscal years 2020 through 2023, has been $5.6, $7.3, $6.3, and $5.6 million dollars, respectively (averaging $6.2 million per year). Additionally, the Washington State Legislature provided approximately $13 million "prioritized to increase prey abundance for southern resident orcas" (Engrossed Substitute House Bill 1109) for the 2019-2021 biennium (July 2019 through June 2021) and $12.5 million for the 2021-2023 biennium (July 2021 through June 2023). These funds have resulted in an additional 36.3 million Chinook salmon smolts released to date. In 2023, the Legislature provided $12.5 million for the 2023-2025 biennium (July 2023 through June 2025). Combined, the federal and state prey increase program funding has resulted in the release of an additional >50 million Chinook salmon smolts. The increase in adult salmon from these hatchery releases are assessed in Chapter 4, Environmental Consequences.

NMFS considers SRKWs to be currently among nine species at high risk of extinction as part of NMFS's Species in the Spotlight initiative[5] 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[6].

[5] https://www.fisheries.noaa.gov/feature-story/recovering-threatened-and-endangered-species-report-congress-2019-2020

[6] https://www.fisheries.noaa.gov/resource/document/species-spotlight-priority-actions-2021-2025-southern-resident-killer-whale

3.4. Other Fish and Wildlife Species

Chinook salmon and SRKWs are the focal species in the proposed action due to the nature of the action. However, other fish and wildlife species may also be affected by the alternatives. Many aquatic and terrestrial species occur in the analysis area and may be potentially affected (beneficial and adverse) by hatchery salmon as prey, predators, or competitors. The most common species identified in the analysis area and considered in the analysis are described in Appendix D and Appendix E . Generally, interactions among these species and hatchery fish would occur (1) through competition for space or food used by hatchery fish, or (2) predation if hatchery fish are prey for other fish species, or vice-versa. These interactions with hatchery fish may differ depending upon the salmon life stage and time of year. Below we describe the species in the analysis area that may be impacted and those expected to interact with hatchery salmon as part of the proposed action.

3.4.1. Marine Mammals

Of all the marine mammals listed and considered in Appendix D, only the Steller sea lion, California sea lion, and harbor seal would be expected to be impacted by the proposed action and other alternatives. Steller sea lions, California sea lions, and harbor seals are predators of natural- and hatchery-origin salmon, and as such we consider them further in this analysis.

Steller sea lion are present in the analysis area. The western DPS is listed under the ESA. The eastern DPS was delisted in 2013. California sea lion and harbor seal are very common in all marine areas and many freshwater areas throughout the entire analysis area. These two species are healthy and near carrying capacity. All of these species are protected under the MMPA.

3.4.2. Fish

Many fish species listed and considered in Appendix D occupy marine and freshwater habitats throughout the analysis area. Many ESUs and DPSs of salmon and steelhead are listed under the federal ESA. Specific species delineations of eulachon, bull trout, green sturgeon, yelloweye rockfish, and bocaccio rockfish are also listed under the federal ESA. Nearly all of these fish species rely upon, or opportunistically prey upon, salmon as food during their life stages. Smaller fish species and early larval life stages may interact with natural- and hatchery-origin salmon during select periods of the year. Ecological interactions, such as competition and predation, may occur between select fish species and hatchery salmon, primarily at the juvenile life stage of salmon. Due to differences in the behavior, habitat use, and migratory characteristics of salmon at the sub-adult and adult life stages, interactions with other fish species is minimal. The effects of the alternatives on ESA listed rockfish and eulachon are further assessed in Chapter 4.

3.4.3. Birds

There are several species of birds that feed on juvenile salmon, including Caspian terns and cormorants. During the spring when juvenile salmon out-migrate to the Pacific Ocean, salmon may be a major food source for these bird populations within the analysis area, especially more so once the fish enter the lower Columbia River and estuary. Hatchery-produced fish appear to be more vulnerable to bird predation than natural-origin fish (Collis et al. 2001).

Other bird species may feed on salmon during select time periods or life stages in marine areas when Chinook salmon are abundant and available. Marbled murrelet, gulls, and other sea birds feed opportunistically on baitfish in the ocean and this may include juvenile salmon during certain periods of the year.

Bird species that are primarily terrestrial for feeding and rearing are not affected by the alternatives to any meaningful degree.

3.4.4. Terrestrial Animals

Terrestrial animals that spend the majority of their time on land for food and rearing are not affected by the action to any meaningful degree for analysis (Appendix E). Other select species of small mammals, reptiles, and amphibians may interact with the aquatic environment but do not interact with juvenile and/or adult salmon more than opportunistically. The differences in the alternatives analysis for these species is not discernable.

3.5. Socioeconomics

Socioeconomics is defined as the study of the relationship between economics and social interactions with affected regions, communities, and user groups. Additional socioeconomic and demographic information for western U.S. coast fishing communities can be found on the NMFS Northwest Fisheries Science Center website at: http://www.nwfsc.noaa.gov/research/divisions/sd/communityprofiles/index.cfm. Tourism and recreation are included in socioeconomics because fisheries (commercial, tribal, and recreational) are important socioeconomic resources and can be affected by the proposed action and the alternatives analyzed in this PEIS.

Native peoples of the Pacific Northwest and SEAK use salmon as an important food for sustenance and salmon are a strong spiritual symbol and central to their traditions and culture. Salmon are also an iconic species of great cultural importance, in addition to economically. Salmon and tribal fisheries form an important part of Native American tribal culture and have been since time immemorial. Salmon provide cultural, ceremonial, and subsistence benefits to tribal communities on the West Coast and in SEAK. There are 151 and 228 Federally-recognized tribes in the Pacific Northwest and Alaska regions, and many other non-Federally-recognized tribes, many of which utilize salmon for occasions including but not limited to ceremonies, celebrations, funerals and as part of their cultural identity.

3.5.1. Southern US Fisheries

The socioeconomic benefits of Chinook salmon fisheries occur from harvest in ocean, Salish Sea, Puget Sound, nearshore estuaries, and in freshwater by both tribal and non-tribal people. The economic value of southern US non-treaty commercial and recreational ocean salmon fisheries off the coasts of Washington, Oregon, and California in recent years has averaged approximately $70 million (PFMC 2023). Treaty Indian commercial ocean fisheries off the coast of Washington is around $1 million in economic benefits and additionally have very strong cultural importance to the tribes. Approximately 99% of the economic value of commercial non-Indian salmon harvest comes from Chinook salmon. Additional salmon harvest occurs in non-ocean fisheries and provide substantial commercial, tribal, and recreational economic benefits to fishers and affected communities.

For southern US commercial fisheries, the number of limited entry salmon permits issued by the three states in 2022 was 2,011, and decreased by 51 from the prior year (2,062). This is the lowest number of coastwide salmon permits on record, with declines over the prior year (which had previously been the lowest number) occurring in all three states: California (-20), Oregon (-30) and Washington (-1). For participation in the commercial salmon fishery in 2022, a total of 563 harvesting vessels participated in the non-Indian commercial troll salmon fishery in 2022 (PFMC 2023). In Oregon and Washington, 180 and 79 vessels participated in the commercial salmon fishery.

PFMC (2023) reported commercial landings were made on 36 percent of all permits coastwide in 2022. This was lower than the 10-year (2012-2021) average share of 42 percent. From 1982 to 1993, an average of 5,193 of 7,942 total permits (65 percent) harvested on an annual basis. Harvest opportunity began declining substantially after that time, and some permits were subsequently removed in a buyback program.

PFMC (2023) reported 264,200 recreational angler trips taken on the West Coast in 2022 was 264,200, an increase of six percent from 248,100 taken the prior year, and 75 percent above the 150,600 trips in 2020. The number of recreational angler trips in 2022 was also 26 percent above the 2017-2021 average of 209,100. The community level value of this recreational fishing for salmon exceeded $21 million dollars in 2022 (based upon the average trip expenditures of $83 per day; PFMC 2023).

The total socioeconomic impacts associated with commercial and recreational ocean salmon fisheries in 2022 for Washington, Oregon, and California combined were an estimated $77.5 million (PFMC 2023). This was two percent below the prior year's total of $79.1 million, 38 percent above the 2020 total of $56.3 million, and 21 percent above the 2017-2021 average of $70.1 million (all dollar values adjusted for inflation; PFMC 2023).

3.5.2. Southeast Alaska Fisheries

Chinook salmon fisheries also occur in US waters of southeast Alaska. Tribal and non-tribal fisheries occur for ceremonial and subsistence, commercial, and recreational purposes and provide substantial socioeconomic benefits. NMFS (2024) provides a comprehensive review of SEAK fisheries, but some key figures are included here. In 2018, the southeast Alaska commercial troll fishery accounted for a harvest of 13.4 million pounds of salmon (all species) with a total ex-vessel value of $28.4 million, with 70% of all permits held fished that year. Commercial troll harvest volume and value varies significantly year-to-year. Over the 10-year period from 2009 to 2018, harvest volume ranged from a low of 14.8 million pounds (2016) to a high of 26.3 million pounds (2013). Harvest value ranged from $21.5 million (2009) to $44.1 million (2014) (McDowell 2019). Alaska resident power troll permit holders accounted for 85% of the harvest value in 2018. Residents of Washington State accounted for 8% of the 2018 harvest value. Just under 10 percent of active permit holders (62 permit holders) generated 25% of total gross earnings, averaging $114,233 in 2018, compared to the fleet average of $42,448. More than half of active trollers were in the bottom quartile, averaging $18,941 in gross earnings (McDowell 2019).

Chinook salmon accounted for an annual average of 46% of the troll fleet's total ex-vessel earnings from 2014 through 2018. Longer-term (2000 to 2018) Chinook accounted for an average of 44% of annual average ex-vessel value. The lowest year was in 2013 when Chinook accounted for only 27% of trollers'

total ex-vessel earnings. The highest year was in 2015, at 58%. Over the 2000 to 2018 period, Chinook accounted for highest percentage of ex-vessel earnings in six of 19 years, among all species.
The ex-vessel value of the Chinook harvest averaged $14.8 million over the 2014 to 2018 period, ranging between $11.7 million and $18.0 million. The 2000 to 2018 annual average was $11.7 million (in nominal dollars), ranging from $5.2 million (2001) to $19.5 million (2014). Chinook salmon accounted for 44% of the commercial troll fleet's total ex-vessel value over the 2014 to 2018 period.

Approximately 1,450 fishermen earn income directly from the fishery, including skippers (permit holders) and crew. Total labor income is estimated at $20.4 million. Total direct, indirect, and induced labor income is estimated at $28.5 million. Total annual output is estimated at $44 million. Processing troll-caught salmon generates approximately $12 million in annual labor income for plant workers. Annualized troll-related processing employment is estimated at 250 jobs, though the number of processing workers is actually much higher, as most of the processing activity occurs in the summer.

The troll fleet has a total economic impact in southeast Alaska of approximately $85 million annually, as measured in terms of total output, including fishing, processing, and all related multiplier effects. With Chinook accounting for about 44% of the power troll fleet's total ex-vessel value over the 2014 to 2018 period, with all other factors held equal, Chinook also account for about the same percentage of the total economic impact of the troll fleet, or approximately $37 million annually in total output.

3.6. Environmental Justice

This section was prepared in compliance with Presidential Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (EO 12898), dated February 11, 1994, and Title VI of the Civil Rights Act of 1964. The EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." See the following website for more information on environmental justice: (http://www.epa.gov/compliance/basics/ejbackground.html).

In Executive Order 12898 (59 FR 7629), Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, the President directed that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." While there are many economic, social, and cultural elements that influence the viability and location of such populations and their communities, the development, implementation and enforcement of environmental laws, regulations and policies can have impacts. Therefore, Federal agencies, including NMFS, must ensure fair treatment, equal protection, and meaningful involvement for minority populations and low-income populations as they develop and apply the laws under their jurisdiction.

Both EO 12898 and Title VI address persons belonging to the following target populations:

- Minority – all people of the following origins: Black, Asian, American Indian and Alaskan Native, Native Hawaiian or Other Pacific Islander, and Hispanic
- Low income – persons whose household income is at or below the U.S. Department of Health and Human Services poverty guidelines.

Definitions of minority and low income areas were established on the basis of the Council on Environmental Quality's (CEQ's) Environmental Justice Guidance under the National Environmental Policy Act of December 10, 1997. CEQ's Guidance states that "minority populations should be identified where either (a) the minority population of the affected area exceeds 50 percent or (b) the population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis." The CEQ further adds that "[t]he selection of the appropriate unit of geographical analysis may be a governing body's jurisdiction, a neighborhood, a census tract, or other similar unit that is chosen so as not to artificially dilute or inflate the affected minority population."

The CEQ guidelines do not specifically state the percentage considered meaningful in the case of low-income populations. For this environmental impact statement, the assumptions set forth in the CEQ guidelines for identifying and evaluating impacts on minority populations are used to identify and evaluate impacts on low-income populations. EPA guidance regarding environmental justice extends beyond statistical threshold analyses to consider explicit environmental justice effects on Native American tribes (EPA 1998). Federal duties under the Environmental Justice Executive Order, the presidential directive on government-to-government relations, and the trust responsibility to Indian tribes may merge when the action proposed by another federal agency or the EPA potentially affects the natural or physical environment of a tribe. The natural or physical environment of a tribe may include resources reserved by treaty or lands held in trust; sites of special cultural, religious, or archaeological importance, such as sites protected under the National Historic Preservation Act or the Native American Graves Protection and Repatriation Act; and other areas reserved for hunting, fishing, and gathering (usual and accustomed, which may include "ceded" lands that are not within reservation boundaries). Potential effects of concern may include ecological, cultural, human health, economic, or social impacts when those impacts are interrelated to impacts on the natural or physical environment (EPA 1998).

The United States and Native Americans have committed to and sustained a special trust relationship, which obligates the federal government to promote tribal self-government, support the general well-being of Native American tribes and villages, and to protect their lands and resources. In exchange for the surrender and reduction of tribal lands and removal and resettlement of approximately one-fifth of Native American tribes from their original lands, the United States signed treaties, passed laws, and instituted policies that shape and define the special government-to-government relationship between federal and tribal governments. These responsibilities and obligations are important aspects in environmental justice issues.

For the project area of this PEIS, nearly all of the affected communities in southern US and SEAK waters are rural communities with lower than average income levels. Some communities have a substantial number of people in poverty. All of the tribes in the project area are affected by salmon, SRKWs, and the alternatives in the PEIS.

For areas in southern US waters, many tribes live, fish, and experience the waters of Puget Sound, the Salish Sea, the Columbia River, and off the coast of Washington and Oregon. Salmon and SRKW are interconnected and are an important part of Native American tribal culture and have been since time immemorial. Billy Frank Jr said: "As the salmon disappear, so do our tribal cultures and treaty rights. We are at a crossroads, and we are running out of time." (NWIFC 2023). Salmon provide cultural, spiritual, ceremonial, and subsistence benefits to tribal communities on the West Coast. There are 151 Federally-recognized tribes and many other non-Federally-recognized tribes in the analysis area; many of which utilize salmon for occasions including but not limited to ceremonies, celebrations, funerals and as part of their cultural identity. Several tribes in the analysis area are party to treaties with the US that reserve to those tribes fishing rights. These tribal treaty-reserved rights have been held by the courts to include the right to half of the harvestable salmon returning to these waters every year.

The tribes in Western Washington have reduced their Chinook salmon harvest by 60-95% since the 1980s as the harvestable numbers of Chinook have declined (NWIFC 2023). The remaining fisheries to this day are just a small fraction of what occurred historically. All fishery opportunities presently are essential and vital to the well-being of all tribes in southern US waters. Fishing is still the essential livelihood for many tribal members throughout the Pacific Northwest.

In Oregon, the major port towns include Astoria, Tillamook, Newport, Coos Bay, Brookings. In recent years Newport, Coos highest landings of Chinook salmon in recent years (PFMC 2023). The communities where these ports are located are in lower than average income level counties. In 2021, per capital average personal income for the state of Oregon was $61,596. All of the affected coastal communities have average income levels less than $55,000, with exception of Coos County which was less than $60,000. As shown in Table 8, landings of Chinook salmon have declined significantly over the last few decades, but the ex-vessel value of the remaining catch is a substantial proportion of the per capita average income in each community.

Table 8. Commercial landings of Chinook salmon in Oregon coastal ports and ex-vessel value per individual fisher. Table from PFMC (2023).

Year	Dressed Pounds Landed (thousands)	Nominal Exvessel Value ($ thousands)	Vessels Landing Salmon	Vessels with Permits	Nominal Average Exvessel Value/Vessel (dollars)	Real Average Exvessel Value/Vessel (2022 dollars)
1974	-	7,937	2,253	-	3,523	16,464
1975	-	5,808	2,304	-	2,521	10,782
1976-1980[b/]	6,679	8,185	3,875	4,314	2,112	6,379
1981-1985[c/d/]	2,969	5,774	2,050	2,993	2,817	6,589
1986-1990	5,688	6,641	1,557	2,528	4,265	8,552
1991-1995[e/]	1,265	3,294	476	1,465	6,920	12,293
1996-2000	1,428	3,063	399	1,062	7,677	12,553
2001[f/]	2,949	4,721	449	1,175	10,515	16,815
2002[f/]	3,498	5,391	468	1,175	11,519	18,139
2003[f/]	3,681	7,222	494	1,178	14,620	22,576
2004[f/]	2,920	9,919	595	1,181	16,670	25,069
2005[f/]	2,691	8,503	565	1,168	15,050	21,944
2006[f/]	499	2,701	357	1,127	7,565	10,700
2007	565	2,822	436	1,009	6,473	8,915
2008	70	494	138	1,092	3,579	4,836
2009	146	345	225	1,062	1,531	2,056
2010	513	2,791	370	1,021	7,543	10,007
2011	404	2,401	304	1,003	7,899	10,267
2012	745	4,271	369	990	11,576	14,769
2013	1,293	7,611	399	977	19,075	23,919
2014	2,639	14,760	493	977	29,938	36,851
2015	1,200	7,334	488	980	15,028	18,315
2016	518	4,261	313	972	13,613	16,426
2017	267	2,129	176	956	12,099	14,327
2018	289	2,442	230	945	10,618	12,278
2019	320	2,103	218	925	9,645	10,957
2020	183	1,524	174	907	8,756	9,818
2021	232	2,249	187	883	12,026	12,914
2022[g/]	375	3,201	180	853	17,784	17,784

In Washington, the major coastal port towns include Neah Bay, La Push, Westport, and Ilwaco. Westport has the highest landings of Chinook salmon in recent years (PFMC 2023). In 2021, the Washington state per capita personal income was $73,775. Pacific county (where Ilwaco is located) had less than $47,000 income per capita. Grays Harbor county (where Westport is located) had less than $50,000. Jefferson and Clallam counties has less than $61,000. All of these communities are below the average income level, and many families are living in poverty. As shown in Table 9 landings of Chinook salmon have declined significantly over the last few decades in Washington, but the ex-vessel value of the remaining catch is a substantial proportion of the per capita average income.

Table 9. Commercial landings of Chinook salmon in Washington coastal ports and ex-vessel value per individual fisher. Table from PFMC (2023).

Year	Dressed Pounds Landed (thousands)	Nominal Exvessel Value ($ thousands)	Vessels Landing Salmon	Vessels with Permits	Nominal Average Exvessel Value/Vessel (dollars)	Real Average Exvessel Value/Vessel (2022 dollars)
1978	4,746	10,025	3,041	3,291	3,297	11,756
1979	5,262	15,091	2,778	3,068	5,432	17,888
1980	3,398	7,114	2,626	2,797	2,709	8,182
1981-1985[b/c/]	1,433	3,225	1,675	2,233	1,696	4,365
1986-1990	752	1,670	913	1,349	1,997	4,295
1991-1995[d/e/f/g/]	345	834	397	586	1,607	3,008
1996-2000[h/i/j/]	126	197	54	270	4,188	7,025
2001	290	383	57	169	6,718	10,743
2002	679	758	75	165	10,102	15,907
2003	875	991	82	163	12,087	18,664
2004	594	1,185	86	160	13,779	20,720
2005	481	1,290	91	158	14,170	20,662
2006	231	1,045	84	158	12,440	17,596
2007	217	953	79	158	12,062	16,612
2008	114	709	86	158	8,244	11,140
2009	291	1,169	97	158	12,051	16,181
2010	537	3,115	116	158	26,856	35,631
2011	339	1,687	112	158	15,066	19,582
2012	452	2,358	105	158	22,457	28,652
2013	481	2,838	108	157	26,275	32,946
2014	551	2,709	116	156	23,351	28,743
2015	640	3,448	122	153	28,266	34,449
2016	201	1,606	107	151	15,009	18,110
2017	343	2,919	108	155	27,031	32,008
2018	263	2,350	108	155	21,759	25,161
2019	322	1,925	88	155	21,878	24,852
2020	168	1,173	60	153	19,555	22,213
2021	233	2,043	76	153	26,882	28,866
2022	291	1,849	79	152	23,402	23,402

For areas in SEAK, there are many small, isolated, rural communities where the troll fishery is crucial to environmental justice target populations and the local economy. Communities such as Craig, Elfin Cove, Hoonah, Meyers Chuck, Pelican, Point Baker, Port Alexander, Tenakee, and Yakutat heavily rely on the troll fishery as a pillar of the local economy as many fishermen stop there weekly to refuel, order groceries, and deliver fish. In a given fishing season, trollers follow the location of fishing openers set by ADF&G and stop in multiple communities. These communities have substantial portions of their populations that rely on trolling as a primary source of income, in many cases, their only source. Shown in Table 10, many of these rural communities report median household incomes below the national median household income of $70,784. The larger communities (e.g., Juneau, Petersburg, Ketchikan, and

Sitka) have more diverse economies and resources; however the troll fishery still brings in substantial revenue. For example, only 7% of Sitka residents are directly involved in the troll fishery. Nonetheless, Sitka permit holders brought in $8.2 million in ex-vessel value to their community in 2021 as well as fish landing taxes that support community infrastructure and basic services.

Table 10. Selected demographic indicators in Southeast Alaska communities. See Conrad and Thynes (2022) and NMFS (2024) for further information.

	Total Salmon Permits	Population Estimates	Pct. Of Population Identifying as Alaska Native or American Indian*	Persons Below Poverty	Median Household Income
ANGOON	9	340	61.0%	85	$44,167
CRAIG	125	992	15.0%	130	$61,875
EDNA BAY	4	42	0.0%	26	$38,500
ELFIN COVE	11	38	0.0%	0	$194,063
GUSTAVUS	22	657	3.1%	26	$38,500
HAINES	88	2575	6.7%	347	$63,355
HOONAH	81	917	47.9%	75	$64,432
HYDABURG	12	347	69.0%	85	$45,938
HYDER	1	46	-	-	-
JUNEAU	279	32202	10.1%	2293	$90,126
KAKE	21	530	56.6%	83	$64,000
KASAAN	2	49	-	17	$75,417
KETCHIKAN	258	13762	18.0%	1289	$77,820
KLAWOCK	28	694	41.6%	182	$53,750
METLAKATLA	28	1444	81.0%	-	-
MEYERS CHUCK	8	21	-	-	-
NAUKATI BAY	1	131	-	42	-
PELICAN	25	83	31.6%	4	-
PETERSBURG	327	3357	7.8%	160	$71,696
PORT ALEXANDER	14	57	0.0%	9	$45,625
SITKA	444	8350	10.3%	573	$82,083
SKAGWAY	5	1146	-	64	$75,000
TENAKEE	10	126	0.0%	9	$45,865
THORNE BAY	18	449	2.8%	67	$49,583
WRANGELL	176	2084	22.9%	258	$54,891
YAKUTAT	183	673	31.3%	41	$72,083

Source: CFEC Permits Database 2023, DOLWD Alaska Population Estimates 2023, DCCED DCRA 2023. Note: table does not include non-resident permit holders.

The commercial troll fishery is significant for Alaska Native communities. Lingít (Tlingit), Xaadas (Haida), and Ts'msyen (Tsimshian) peoples have called Southeast Alaska home since time immemorial, and salmon has been a cultural mainstay for the entirety of that time. Lingít, Xaadas, and Ts'msyen peoples have fished the waters of Southeast for 10,000 years and continue to do so as commercial troll fisherman. The tradition of "trolling" pre-dates western contact: Lingít, Xaadas, and Ts'msyen peoples used a hook-and-line (bone hooks) from their canoes when fishing for Chinook salmon. In some cases, four generations of one family have supported their household and the Southeast economy through a hook-and-line fishery. Now, many citizens of the tribe depend on the commercial troll fishery for their livelihood, with some Alaska Natives earning 60% to 70% of their income from the commercial troll fishery. Of the 1,820 hand-troll and power troll permits active in Alaska, 85% are held by Southeast Alaska residents, 14% of which are held in our most rural communities with the highest percentages of Alaska Natives. Fishing remains deeply tied to a traditional way of life for Alaska Natives in Southeast, and fishermen rely on the commercial and sport fishery to secure salmon for personal use to feed their families and revenues from fishery taxes to keep schools operating and basic infrastructure up to date. Every fisherman matters in a small community and the stewardship of traditional lands and waters is crucial to maintaining Alaska Native ways of life and is an expression of their sovereignty.

All of SEAK's major fisheries are "limited entry," meaning an interested participant must purchase a permit. Many troll vessels are smaller, highly specialized, and not easily convertible to a fishery that requires a larger boat or different gear type such as pots or equipment needed to haul a net. The sale of a troll business will not support investment in another fishery, as the value of a troll business is contingent on the ability to fish for Chinook salmon.

Overall, the environmental justice target populations of minorities and lower than average income populations throughout the project area in southern US and SEAK waters depend and rely upon Chinook salmon, SRKWs, and fisheries as a way of life, for ceremonial and subsistence, and other important cultural and economic aspects.

4. ENVIRONMENTAL CONSEQUENCES

4.1. Introduction

This section evaluates the potential impacts of the four alternatives on the natural and human environment including the biological, physical, and human resources described in Chapter 3, Affected Environment. Under Alternative 1 the funding to increase prey availability for SRKW would not continue in FY 2024 and beyond. Alternative 2 (Proposed Action/Preferred Alternative) is NMFS' continued funding of hatchery production to increase the prey availability for SRKWs. Alternative 3 is NMFS' funding of habitat restoration/enhancement to increase the natural production of Chinook salmon in the wild to increase the prey availability for SRKWs. Alternative 4 is reducing Chinook salmon fishery harvest in marine areas to increase prey availability for SRKWs.

Where applicable, the relative magnitude of impacts is described using the following terms:

Undetectable:	The impact would not be detectable and not significant
Negligible:	The impact would be at the lower levels of detection and not significant
Low:	The impact would be slight, but detectable and not significant
Medium:	The impact would be readily apparent and considered significant.
High:	The impact would be severe or greatly beneficial and considered significant.

The summary of effects of each alternative on the specified resources concludes with a statement of the level of significance in time and space.

4.2. Effects on Chinook Salmon and Their Habitat

The environmental consequences of the four alternatives on Chinook salmon and their habitat is evaluated below according to three distinct life stages: juvenile life stage in freshwater, marine life stage, and the returning adult life stage in freshwater. This provides a complete evaluation of effects throughout the entire life cycle of Chinook salmon and their habitats. This is important given the focus of the alternatives (i.e. hatchery production, natural production, and marine fisheries).

4.2.1. Alternative 1 (No Action): No Funding for Prey Increase Program

4.2.1.1. Juvenile Freshwater Life Stage

Under this alternative, NMFS would not allocate designated PST funds to increase prey availability for SRKWs beginning in 2024 and thereafter. The program that has been operating since 2020, as described in the Affected Environment and Table 4, would be discontinued. No additional funds would be spent to increase SRKW prey availability. The change to the affected environment on juvenile Chinook salmon and their habitat in Alternative 1 (No Funding for Prey Increase Program) would be of the cessation of hatchery Chinook salmon releases that are funded by NMFS using PST-related funds. This would equate to approximately 14% or less total smolt releases of hatchery Chinook salmon throughout the analysis area (~20/157 million fish; Table 3; Table 6) compared to the affected environment (recent past).

The effects of hatchery releases funded through sources other than the PST-related prey increase funding would continue under this alternative. This includes ecological interactions among natural and hatchery Chinook salmon, that would occur during the period of time as hatchery salmon emigrate downstream through mainstem river and estuaries to marine areas during the smolt life stage. The period of interaction is typically in the range of one to two weeks depending upon where the hatchery fish are released in the watershed. The area of interaction depends upon the river reaches where hatchery and natural fish co-occur. In the Columbia River, the mainstem river is the primary area of co-occurrence as hatchery fish emigrate downstream to the ocean. Most studies on the ecological effects of hatchery Chinook salmon on natural Chinook salmon have observed overlap in space and time during discrete time periods, but have not demonstrated a competitive interaction based upon limited resources (SIWG 1984; Pearsons et al. 1994). Predation by hatchery Chinook salmon on natural Chinook salmon is possible, but by primarily older aged hatchery salmon on young of the year natural salmon over discrete periods of time when these different life stages co-occur in space and time (Pearsons and Fritts 1999).

Existing hatchery fish releases throughout the analysis area not specifically funded by NMFS or Washington to increase prey availability for SRKWs have incorporated best management practices to minimize the adverse effects of ecological interactions among hatchery and natural fish in the wild. These practices include releasing hatchery fish that are ready to emigrate downstream to marine areas as smolts so that interactions in freshwater are minimized, releasing smolts at the proper size for the specific life stage to minimize predation risks, and not releasing hatchery fish that show residual behaviors that will not likely emigrate in a timely manner. Most hatchery programs have undergone ESA consultations on the effects of the program on listed salmon and steelhead and incorporate these practices into the respective management plans.

4.2.1.2.Marine Life Stage

The effects of Alternative 1 (No Funding of Prey Increase Program) on Chinook salmon in the marine areas would be that fewer hatchery Chinook salmon would reach the marine environment compared to hatchery releases that occurred from 2020-2023 and in Alternative 2. The estimates of the reduction in the number of Chinook salmon under this alternative are shown in Table 14 and Figure 14 (i.e. if the prey program was discontinued, the additional hatchery salmon prey in the affected environment would go away). Cessation of the federal prey increase program beginning in 2024 would mean from a zero to approximately 6% (assuming maximum prey increase program goals) fewer Chinook salmon adults in certain marine areas and times, on average, beginning in 2026 and thereafter. See Table 7 for the schematic of salmon age classes.

The discontinuation of the funding to increase prey availability in Alternative 1 and the benefits to natural-origin Chinook salmon of fewer hatchery fish during the marine life stage are expected to be low and are not considered to be significant. The reductions in hatchery Chinook salmon are estimated to be 6% or less in marine areas, and given interannual variability in marine productivity, the abundances of salmon (orders of magnitude change over a salmon generation; see Figure 8), and the need for salmon to school for protection equates to an overall low effect from this alternative.

4.2.1.3.Adult Freshwater Life Stage

Under the assumption of no federal funding of the prey increase program beginning in 2024 and beyond, Alternative 1 would result in fewer adult hatchery Chinook salmon returning back to freshwater areas in 2027 and beyond compared to the current affected environment. Under this alternative adult hatchery returns once fish produced using PST-related funds for FY 2020-2023 have all returned, would be similar to conditions before additional prey production for SRKW began. The difference would be dependent upon the specific hatchery stock and, on average, would range from a 1% to 64% fewer hatchery salmon returns under this alternative (Table 12). These estimates are for returns to the primary freshwater area (i.e. river mouths) and subsequent commercial and recreational fisheries would occur. Hatchery facilities would continue to collect returning hatchery adults from existing hatchery releases of other programs. After these activities, any remaining hatchery fish could spawn naturally in the wild. For natural populations, pHOS would be expected to continue as reported in Appendix B (current affected environment) for Chinook salmon throughout the region under Alternative 1. The discontinuation of the prey increase program in Alternative 1 and benefits to natural-origin Chinook salmon in relation to impacts from pHOS is expected to be similar to the current affected environment.

4.2.2. Alternative 2 (Proposed Action/Preferred Alternative): Hatchery Prey Increase Program

NMFS has a long history of evaluating the effects of hatchery programs on Chinook salmon throughout the project area. Extensive analysis of the hatchery operations and production of hatchery fish associated with these facilities has been evaluated by NMFS previously (e.g. NMFS 2014; NMFS 2019). A more detailed discussion of the general effects of hatchery programs on salmonids can be found in the Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs (NMFS 2014).

Six factors may pose *positive*, *negligible*, or *negative* effects to population viability of naturally-produced salmon and steelhead. These factors are:

(1) the hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock,
(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities,
(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, the migration corridor, estuary, and ocean,
(4) research, monitoring, and evaluation that exists because of the hatchery program,
(5) the operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program, and
6) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

The principal mechanisms upon which hatchery programs can affect Chinook salmon are found in Table 11. To summarize, hatchery programs can affect the genetics of natural populations from straying and interbreeding in the wild. Hatchery programs can increase the number of salmon spawning in historical habitats, which may increase the abundance and productivity (in some cases) of the natural population (reintroduction). Hatchery fish can compete and predate upon co-occurring natural-origin fish; particularly at the juvenile life stages. Hatchery fish can transfer diseases and pathogens to natural-origin fish after release from the hatchery. In some circumstances, hatchery programs can benefit salmonid viability by supplementing natural spawning and thereby increasing natural-origin fish abundance and spatial distribution, by serving as a source population for re-populating unoccupied habitat, and by conserving genetic resources.

Table 11. General mechanisms through which hatchery programs can affect natural-origin salmon populations.

Effect Category	Description of Effect
Genetics	• Hatchery-origin salmon and steelhead interbreeding with natural-origin fish in the wild can change the genetics of the affected natural population(s). • Hatchery-origin fish can alter the genetic integrity and/or genetic diversity of the affected natural population(s) depending upon the magnitude of interaction. • If natural-origin fish abundance is critically low, the hatchery stock may contain genetic resources valuable for population conservation and recovery.
Competition and predation	• Hatchery-origin fish can increase competition for food and space. • Hatchery-origin fish can increase predation on natural-origin salmon and steelhead.
Pathogen transfer	• Hatchery fish can have elevated levels of pathogens and bacteria from rearing in the hatchery that can be transferred to the natural-origin population from hatchery fish and/or release of hatchery effluent.

Effect Category	Description of Effect
Hatchery facilities	• Hatchery facilities can reduce water quantity or quality in adjacent streams through water withdrawal and discharge of effluent. • Hatchery facilities at weirs and dams to collect broodstock and/or control hatchery fish on the spawning grounds can have the following unintentional consequences: o Isolation of formerly connected populations o Limiting or slowing movement of migrating fish species, which may enable poaching, increase predation, and/or alter spawn timing and distribution o Alteration of stream flow o Alteration of streambed and riparian habitat o Alteration of the distribution of spawning within a population o Increased mortality or stress due to capture and handling o Impingement of downstream migrating fish
Natural population masking	• Hatchery-origin fish spawning naturally can mask the true status of the natural-origin population from hatchery supplementation.
Fishing	• Fisheries targeting hatchery-origin fish can have incidental impacts on co-occurring natural-origin fish.

Effect Category	Description of Effect
Population viability benefits	• Depending upon the objective of the specific hatchery program, hatchery fish can potentially: o Increase the abundance of natural-origin fish from additional natural spawning in the wild. o Increase the productivity of the natural population from hatchery fish spawning and nutrient enhancement, particularly if abundance of natural-origin fish is low. o Preserve and/or increase the genetic and phenotypic diversity of the affected natural population, particularly for severely depressed populations.
Nutrient cycling benefits	• Returning hatchery-origin adults can increase the amount of marine-derived nutrients in freshwater systems from natural spawning and/or outplanting of carcasses from the hatchery.

Short- and long-term risks associated with competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer continuing into the future under Alternative 2 would be similar to the effects from federal and Washington state hatchery releases to increase prey availability for SRKWs in 2023 (see Table 6; Figure 9). Releases of hatchery Chinook salmon in 2023 produced with federal and state funds specifically for SRKW prey was approximately 20 million smolts and is expected to meet the program goals of a 4-5% increase in prey availability for SRKWs in marine areas (see section 4.3.2 for details; Appendix F). The specific effects of this alternative are assessed below by each specific life stage.

Since this PEIS evaluation is programmatic, as described in section 2.2 we assess a range of hatchery production scenarios including 1) the hatchery production that is currently being federally funded (PST in Table 6), and 2) total hatchery production that is estimated to meet prey increase program goals (any combination of federal (PST) and Washington state funded in Table 6). The current federal production using FY 2023 funds is approximately 10.5 million fish (Figure 2), with a maximum program goal of 20 million fish for SRKWs.

The hatchery programs would continue to pose short- and long-term adverse risks associated with genetic effects, competition and predation, facility effects, masking of natural population status from hatchery fish spawning, incidental fishing effects, and transfer of pathogens from hatchery fish and/or the hatchery facility to the adjacent river or stream. The hatchery programs would continue to provide some benefits to salmon and steelhead from hatchery fish carcasses and nutrient cycling in the ecosystem under Alternative 2. Should federal funding and production levels reach the specified program goals for Alternative 2, this would equate to the maximum impact levels described below. The effects at the federal program goal level would be similar in scope to the releases of federal and state SRWK prey hatchery fish released in 2023 in the current affected environment (Table 6).

4.2.2.1.Juvenile Freshwater Life Stage

Alternative 2 would result in using available funding for FY 2024 and beyond of hatchery Chinook salmon releases ranging from current funding levels up to prey increase program goals (with consideration given to Washington state funded SRKW production). At the current funding level of production, hatchery releases into the future would be similar in scope as the releases that occurred in 2023 (see Chapter 3, Affected Environment). At funding levels that attain program goals, we would expect effects similar to those that occur from combined federal and state funded production released in 2023. For the level of federal production meeting program goals, hatchery Chinook salmon releases would be approximately 14% higher than for Alternative 1 (No Funding of Prey Increase Program). The hatchery programs receiving federal funding under this alternative would continue to be implemented according to the six funding decision criteria (see section 2.2.1) using existing hatchery facilities and locations similar in scope as described in Table 4 and Table 5.

The areas where ecological interaction between natural Chinook salmon and hatchery releases occurs is predominately in the larger mainstem river reaches and estuaries, because released hatchery fish quickly emigrate downstream from the release sites. Smolt releases from the hatcheries occur as age-0 and age-1 Chinook salmon, which are different age classes with different lengths and behaviors (see Table 4 and Table 5 for age classes of hatchery production). Age-1 hatchery Chinook salmon emigrate through freshwater areas rapidly as they are physiologically transforming and adapting for ocean entry. The time of interaction between the hatchery fish and natural fish is short in duration and in most cases less than two weeks until ocean entry. The hatchery releases from all the funded programs do not occur at the same time, but are dispersed throughout the region depending upon the race of fish propagated and the life stage when the fish are released. The net effect is that releases funded by the prey increase program are separated in space and time, so that ecological interactions with natural fish are minimized and are never intense.

One of the largest releases of Chinook salmon (SAFE; Table 4) occurs in the estuary and these fish do not interact at all with natural fish in freshwater. Given the low proportion of prey program releases (2.6%) relative to baseline production levels, and these measures taken to minimize the overlap of fish produced through the prey program with natural fish, the effects of the prey program on juvenile Chinook salmon in fresh water is likely low and not considered to be significant.

Ecological interactions between hatchery and natural Chinook salmon in the form of predation and competition are difficult to quantify. Predation from age-1 hatchery Chinook salmon on age-0 natural Chinook salmon is possible, but unlikely given the timing of hatchery releases relative to natural fish presence, and differences in microhabitat habitat use (NMFS 2014). Competition occurs when a specific resource is limited, and this aspect of interaction is negligible to very low effect because hatchery fish are released as smolts (age 0 and age 1) and are actively emigrating downstream to the ocean. The interaction space is changing continuously, and little if any competition is expected to occur above a minimal level.

In summary, under current federal funding levels, Alternative 2 would increase hatchery Chinook salmon releases in the analysis area by approximately 7% compared to Alternative 1, the No Action alternative. Under federal funding levels that likely attain prey increase program goals for SRKWs, hatchery Chinook salmon releases would be approximately 14% higher than Alternative 1. The negative ecological impacts from Alternative 2 on juvenile Chinook salmon is expected to be low given the widespread distribution of hatchery releases in space and time (Figure 4; Figure 5). Due to these factors, these effects are not considered to be significant compared to Alternative 1 (No Funding of Prey Increase Program).

4.2.2.2.Marine Life Stage

Ecological Interactions Between Hatchery and Natural Chinook Salmon

For Chinook salmon, the early rearing period when salmon first enter marine areas such as Puget Sound and the Columbia River plume is one of the most critical periods impacting their fitness and survival (Greene et al. 2005; Pearsall et al. 2021; Sobocinski et al. 2021). However, assessment of the effects of hatchery fish on natural-origin Chinook salmon in marine areas such as Puget Sound is difficult due to the nature of these ecological conditions and because relevant scientific knowledge is incomplete and rapidly evolving (Pearsall et al. 2021). Based on a comprehensive review of recent science, the Salish Sea Marine Survival Project (SCSSMPS) https://marinesurvivalproject.com/) concluded hatcheries contributed a medium effect on the number of Chinook salmon entering the Salish Sea (Figure 11). Figure 11 shows the complex ecological dynamics affecting salmon survival in the early marine phase of rearing for Chinook salmon and all the factors affecting their abundance. Even though this data is reported for marine areas specific to Puget Sound and the Salish Sea, the ecological dynamics and factors affecting salmon survival are also applicable to marine conditions for the Columbia River plume.

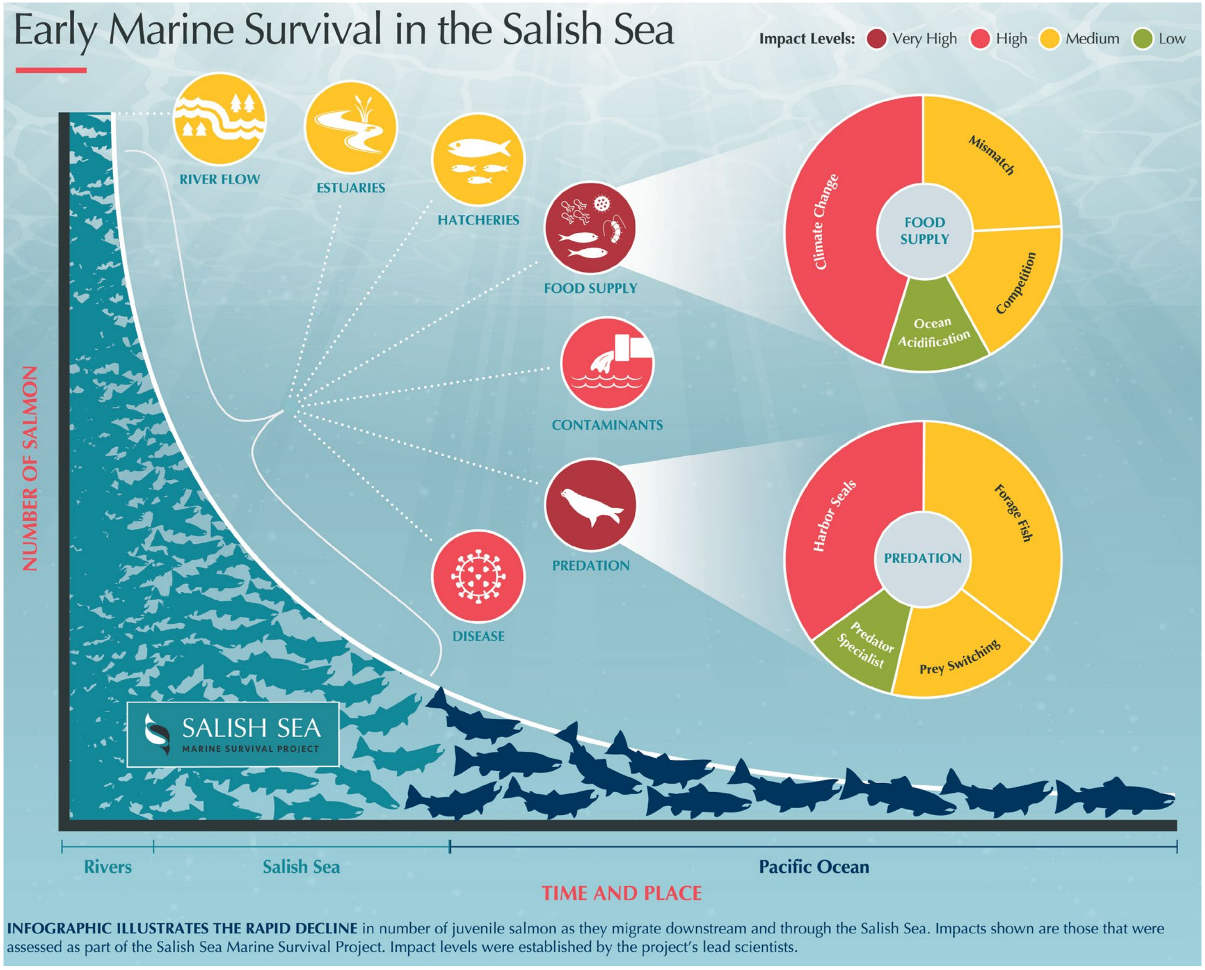


Figure 11. Infographic describing the effects of hatcheries and other factors in the early marine survival in the Salish Sea (figure taken from https://marinesurvivalproject.com/research-findings/).

With regards to effects from hatchery fish, competitive interactions that negatively affect natural Chinook salmon (e.g., depleting prey resources and negatively impacting growth) are of particular concern. The SCSSMPS concluded that: 1) there is some evidence that intra- and inter-specific competition during some time periods and in some places of the Salish Sea impacts Chinook salmon marine survival; 2) study results are mixed; and, 3) if competition does occur, it is most likely dictated by factors other than Chinook salmon abundance that deplete or limit prey availability or habitat (e.g., dynamic environmental variables, ecosystem productivity, and food web interactions involving natural-origin species such as pink salmon, herring, and crab) (Pearsall et al. 2021). Therefore, hatchery releases could exacerbate density-dependent effects during years of low ocean productivity.

Kendall et al. (2020) found effects to marine survival from hatchery Chinook release abundances, but only evaluated survival of hatchery-origin fish themselves, not natural-origin Chinook salmon. In contrast, (Nelson et al. 2019) found no statistically-significant negative relationships between region-wide hatchery Chinook release abundances and natural-origin productivity for 16 of the 17 Salish Sea Chinook salmon stocks evaluated. One stock (Stillaguamish) showed a positive relationship between hatchery release abundance and natural stock productivity, perhaps due to predator swamping effects, where predators do not affect salmon as much due to their high abundances. Hatchery Chinook releases into Puget Sound occur over a condensed time period, at a larger fish size, and with less fish size variability relative to natural-origin Chinook salmon (Nelson et al. 2019). Thus, intra-specific competitive effects to survival may be more acute among hatchery-origin fish themselves. Sobocinski et al. (2021) observed that release date of hatchery coho and Chinook salmon may influence survival of hatchery-origin Chinook salmon, though the mechanisms for these effects were not clear, and the extent to which these observations apply to natural-origin Chinook salmon are speculative. Hatchery Chinook salmon release abundances were not found to affect marine survival of hatchery Chinook salmon.

While rearing in Puget Sound, juvenile hatchery-origin Chinook salmon are large enough to eat natural-origin salmonid fry and small parr-sized subyearlings (e.g., Keeley and Grant (2001); Duffy et al. (2010)). Juvenile Chinook salmon are opportunistic predators that prey on a wide variety of taxa, including a wide variety of fish species, in the Salish Sea and other marine waters (Beamish 2018). However, based on studies and surveys to date, juvenile salmonids appear to be a very minor dietary component in the Salish Sea. When they eat fish, juvenile Chinook salmon in offshore areas of the Salish Sea eat primarily forage fishes, especially Pacific herring (Duffy et al. 2010; Davis et al. 2020); Sweeting et al. 2007; Riddell et al. 2018, and references therein). There is no evidence that juvenile hatchery-origin Chinook salmon select for natural-origin Chinook salmon in the Salish Sea, or eat quantities that would have a detectable effect at the population or ESU scale.

Hatchery-origin Chinook salmon that remain in Puget Sound as residents (or transients) may prey upon juvenile natural-origin Chinook salmon. However, recent sampling efforts have found that resident Chinook salmon prey largely on forage fish (especially herring and to some extent sand lance), amphipods, and larval crab (Beauchamp et al. 2020; Chamberlin 2021/unpublished data). No evidence of cannibalism by resident Chinook salmon on their younger, smaller conspecifics was found. Beauchamp et al. (2020) found no juvenile Chinook salmon in the stomachs of resident Chinook salmon (n=232) sampled in Puget Sound during May–September, 2018–2019. Similarly, Chamberlin (2021/unpublished data) found no juvenile Chinook salmon in the stomachs of resident Chinook salmon (n=419) sampled in Puget Sound during November–April, 2015–2019. Conversely, previous sampling efforts (Duffy et al. 2010; Beauchamp and Duffy 2011) found some instances of cannibalism by resident Chinook salmon in Puget Sound. These researchers initially estimated that predation rates on juvenile Chinook salmon could be quite high based on these data. However, the later work (i.e., Beauchamp et al. 2020) noted that "…the limited sample sizes, suboptimal timing and temporal resolution of sampling the predators' diets infused considerable uncertainty into the [2011] predation estimates." The Beauchamp et al. (2020) study was performed in a more rigorous manner to address these deficiencies. Together, these results suggest that resident hatchery-origin Chinook salmon present a minor predation risk to listed natural-origin juvenile Chinook salmon at the population and ESU scale.

Based on the information summarized above, Alternative 2 would likely contribute an additional 14% across the analysis area of hatchery Chinook salmon smolts (assuming maximum prey increase program goals are met). As noted previously, the abundance of hatchery Chinook salmon entering the marine areas would be far less than released from the hatcheries due to substantial mortality as the fish emigrate into marine areas (Figure 11). However, assuming all things are held constant, there would still be an expected increase of 14% entering marine areas compared to Alternative 1 (No Action). Since the releases of hatchery Chinook salmon at different age classes occurs at different time periods (spring, summer, fall), interactions with hatchery fish would be dispersed across seasons throughout the year. Impacts on natural Chinook salmon in marine areas overall would be expected to be low and are not considered to be significant compared to Alternative 1 (No Funding of Prey Increase Program).

4.2.2.3. Adult Freshwater Life Stage

The effects of Alternative 2, the hatchery prey increase program, on Chinook salmon at the adult life stage are primarily related to genetic, demographic, and nutrient cycling effects. The returns of adult salmon from hatchery releases are summarized in Table 7. The full life cycle of adult salmon is typically completed five years after the federal funding is distributed. For this analysis of the effects, we analyze federal funding beginning in 2024 and thereafter up to the maximum prey increase program goals for SRKWs (provided by the scenario for 2023 hatchery releases funded by NMFS and Washington).

All of the hatchery facilities, operations, and existing programs that would receive federal funding under Alternative 2 exist presently and are part of the Affected Environment in Chapter 3. Under Alternative 2, federal funding for production specifically to increase prey for SRKW would continue in 2024 and beyond, and could occur from a range of current production levels to production levels necessary to attain prey increase program goals. Therefore, it is necessary to evaluate what effects the hatchery prey program may have in addition to the pre-existing levels of production throughout the analysis area.

There are two indices that are used to assess the effects of this alternative at the adult return life stage to freshwater: 1) the expected increase in adult salmon to the rivers compared to the current affected environment (see section 3.2.2), and 2) the increase in the number of juvenile hatchery salmon released compared to the current affected environment. Both of these metrics provide the best available information to assess what the expected increase in adult salmon returns may be to freshwater after accounting for marine survival, marine fisheries, and predation by SRKWs.

The expected increase in adult hatchery Chinook salmon to the rivers are shown in Table 12 for stocks associated with the hatchery prey increase program. The percent increase in returns for the federally funded SRKW hatchery salmon ranges from 0% to 64% depending upon the salmon stock and river of return. It is important to note that these additional returns do not automatically equate to similar increases in pHOS on natural spawning grounds. In freshwater, additional mortality of salmon occurs from commercial and recreational fisheries, natural predation, natural mortality, and collection of salmon returning to hatchery facilities.

The specific details of each hatchery stock are evaluated at the site-specific level (according to the descriptions in section 2.2) to determine the precise effects on pHOS and other hatchery-related effects. The site-specific evaluations under the ESA and NEPA before federal funding is distributed to the operators for additional hatchery production assess the specific situation and determine the effects on pHOS after accounting for fisheries, natural mortality, and hatchery collection efficiency. For example, the largest expected return of hatchery salmon from the federal program is for Willamette spring Chinook salmon (18,892 fish; Table 12). However, this additional production occurs in the lower Columbia River's Select Area Fishery Enhancement (SAFE) program near Astoria, Oregon. This program is located to provide off-channel commercial fisheries in the estuary while minimizing effects to other ESA-listed stocks. Nearly all of the returns to these SAFE areas in the estuary are harvested (NMFS 2021); and thus the effects to pHOS in lower Columbia River populations are minimal. In addition, no natural stocks of spring Chinook salmon occur in the adjacent areas, further limiting the likelihood of hatchery fish presence on spawning grounds. Therefore, the largest increase in abundance from the federal program, in this example, is not expected to effect pHOS for natural populations from this additional prey production. NMFS (2021) evaluated the site-specific effects of this additional prey production in accordance with the funding criteria described in section 2.2.1.

Table 12. Mean annual nominal and percent increase in returns to the river mouth by FRAM stock resulting from the hatchery prey increase funding. Table taken from Appendix F. The total mean nominal increase is 91,494 Chinook salmon from the table.

FRAM STOCK	MEAN NOMINAL INCREASE			MEAN PERCENT INCREASE		
	FEDERAL	WA STATE	TOTAL	FEDERAL	WA STATE	TOTAL
Nooksack/Samish Fall	0	6,716	6,719	0%	33%	33%
Nooksack Spr Hatchery	0	6,860	6,861	0%	265%	265%
Skagit Spring Year	0	3,786	3,787	0%	203%	203%
Snohomish Fall Fing	0	4,179	4,181	0%	126%	126%
Tulalip Fall Fing	983	0	983	120%	0%	120%
Mid PS Fall Fing	11,769	3,988	15,760	38%	13%	50%
South Puget Sound Fall Fing	0	1,996	2,007	0%	4%	4%
White River Spring Fing	0	1,565	1,566	0%	54%	54%
CR Oregon Hatchery Tule	546	0	548	7%	0%	7%
CR Bonneville Pool Hatchery	0	0	3	0%	0%	0%
Columbia R Upriver Summer	9,066	7,472	16,540	24%	20%	43%
Columbia R Upriver Bright	0	1,567	1,576	0%	1%	1%
Cowlitz River Spring	0	2,849	2,849	0%	10%	10%
Willamette River Spring	17,931	0	17,933	19%	0%	19%
WA North Coast Fall	0	2,896	2,898	0%	39%	39%
Willapa Bay	0	7,283	7,286	0%	33%	33%

Another index for evaluating the effects of this alternative on returns of salmon to freshwater at the programmatic level is to assess the increase in hatchery releases throughout the region. If it is assumed fisheries in marine and freshwater areas will continue in accordance with management plans and agreements (a safe assumption), and other mortality factors occur in similar intensity and variability, the percent increase in hatchery Chinook salmon releases can be measured to determine the likely increases in pHOS at the regional scale. Again, a 10% increase in hatchery production does not automatically translate into an additional 10% increase in pHOS, due to hatchery collection efficiency and many other factors.

Figure 9 shows the additional production of hatchery salmon funded by federal and state sources. For the federal program at recent funding levels, an additional release of less than 14% has occurred at the regional scale through past prey increase funding. Under stated goals for the prey increase program, the total increase in hatchery releases in the future could be as high as 14% at the regional scale (Figure 9; section 3.2.2). If the maximum prey increase program of 14% additional hatchery Chinook salmon are released, and it is assumed hatchery fish straying of returning adult salmon also increases by 14%, the expected increases in pHOS are shown in Figure 12. The effect of additional hatchery fish returning from the SRKW funded production on pHOS depends upon the conditions in the current affected environment.

Additional available data for pHOS throughout the region is shown in Table 13, with further supporting data in Appendix B. The effects of the SRKW funded hatchery production pHOS in a particular area depends upon the hatchery facility releasing fish and the adjacent natural population near the hatchery (Figure 4; Figure 5). At the regional scale, the SRKW hatchery production does not affect the current affected environment in most natural populations because only a low percentage of natural populations are potentially affected by SRKW hatchery returns. Most natural populations are not affected at all by Alternative 2 because hatchery fish are not released in these populations and do not return as adults to these area (Table 13). The affected natural populations are specified in Table 4, Table 5, and Table 13. All age classes of adult fall Chinook salmon will begin returning in 2023 and spring Chinook salmon in 2024 (Table 7).

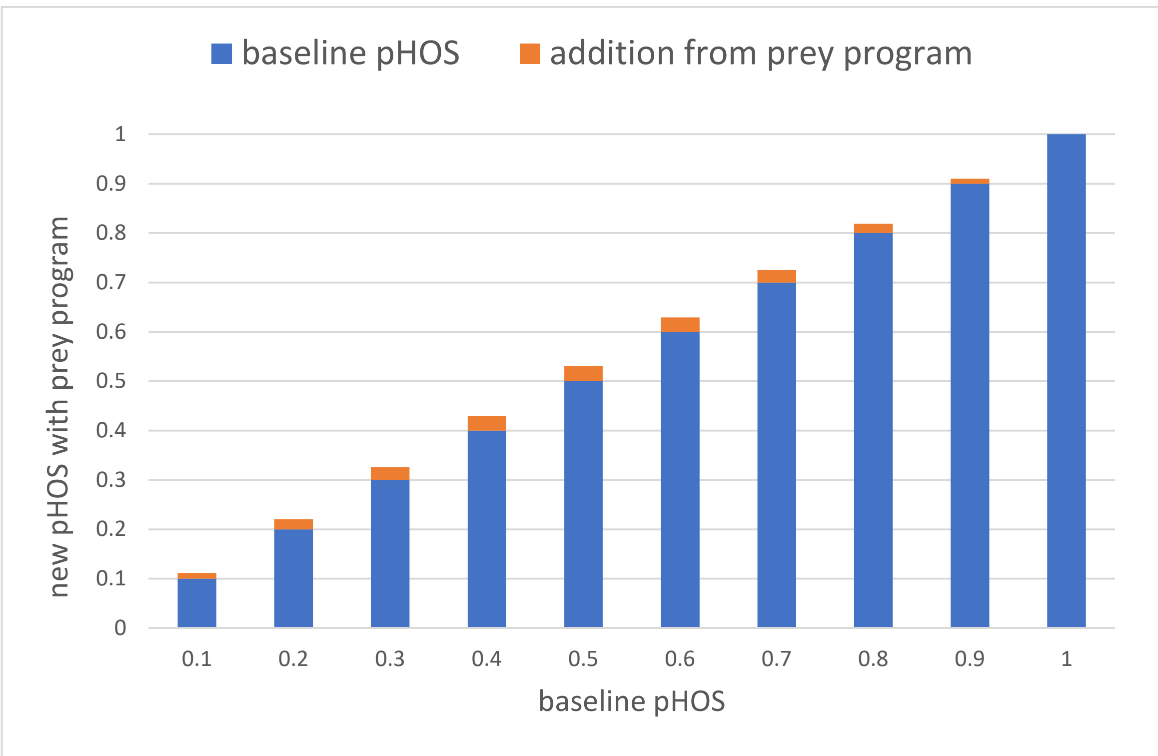


Figure 12. pHOS increases from hatchery production meeting SRKW program goals. This assumes a 14% increase in hatchery strays to the affected natural population. See Appendix B for additional information on baseline pHOS conditions of affected natural populations.

Alternative 2 will increase the return of adult hatchery salmon to freshwater areas and hatchery collection facilities that release these salmon for SRKWs. The increases to pHOS will depend upon the site-specific conditions of the individual hatchery program and natural population and are analyzed in site specific NEPA and ESA analyses. A hypothetical scenario, assuming a 14% increase in pHOS of affected natural populations is included in Table 13.

Alternative 2 will likely result in some level of increase in pHOS for select natural populations throughout the analysis area affected by the release of hatchery salmon for SRKW. Modeling of programmatic assumptions shows pHOS increases ranging from negligible to medium impact depending upon the site-specific circumstances (Figure 12; Table 13). Alternative 2 compared to Alternative 1 (No Funding for Prey Increase Program) will result in impacts that could be considered significant for some natural populations; particularly those populations having low returns of natural-origin salmon and high pHOS levels in the current affected environment.

Table 13. Modeled pHOS increase of 14% for ESA-listed Chinook salmon populations directly affected by Alternative 2 compared to baseline pHOS values in the affected environment (from Ford 2022). "Negligible" indicates natural populations where Alternative 2 is not likely to affect pHOS (based upon the location of hatchery releases).

Domain	ESA-Listed Chinook Salmon Population	pHOS in Affected Environment (most recent baseline conditions)	Modeled pHOS in Alternative 2 (assuming a 14% increase from prey program production)
Puget Sound	NF Nooksack R. spring	0.87	0.88
	SF Nooksack R. spring	0.55	0.58
	Low. Skagit R. fall	0.16	negligible
	Up. Skagit R. summer	0.09	negligible
	Cascade R. spring	0.14	0.16
	Low. Sauk R. summer	0.02	negligible
	Up. Sauk R. spring	0.01	negligible
	Suiattle R. spring	0.03	negligible
	NF Stillaguamish R. su/fall	0.55	negligible
	SF Stillaguamish R. su/fall	0.54	negligible
	Skykomish R. summer	0.38	0.41

Domain	ESA-Listed Chinook Salmon Population	pHOS in Affected Environment	Modeled pHOS in Alternative 2
		(most recent baseline conditions)	(assuming a 14% increase from prey program production)
	Snoqualmie R. fall	0.25	0.28
	Sammamish R. fall	0.84	0.86
	Cedar R. fall	0.29	0.32
	Green R. fall	0.7	0.73
	White R. spring	0.85	0.87
	Puyallup R. fall	0.68	0.71
	Nisqually R. fall	0.53	negligible
	Skokomish R. fall	0.84	negligible
	Mid-Hood Canal fall	0.11	negligible
	Dungeness R. summer	0.75	negligible
	Elwha R. fall*	0.95	negligible
Lower Columbia & Willamette	Upper Cowlitz/Cispus Rivers spring	0.94	negligible
	Kalama River spring	0	negligible
	North Fork Lewis River spring	-	14% increase of baseline
	Sandy River spring	0.08	negligible
	Big White Salmon River spring	0.82	negligible
	Grays River Tule fall	0.57	negligible
	Youngs Bay fall	0.86	negligible
	Big Creek fall	0.96	negligible
	Elochoman River/ Skamokawa Tule fall	0.55	negligible
	Clatskanie River fall	0.95	negligible
	Mill/Abernathy/Germany Creeks Tule fall	0.78	negligible

Domain	ESA-Listed Chinook Salmon Population	pHOS in Affected Environment	Modeled pHOS in Alternative 2
		(most recent baseline conditions)	(assuming a 14% increase from prey program production)
	Lower Cowlitz River Tule fall	0.23	negligible
	Coweeman River Tule fall	0.09	negligible
	Toutle River Tule fall	0.45	negligible
	Upper Cowlitz River Tule fall	0.18	negligible
	Kalama River Tule fall	0.43	negligible
	Lewis River Tule fall	0.44	negligible
	Clackamas River fall	0.32	negligible
	Sandy River fall	-	negligible
	Washougal River Tule fall	0.42	negligible
	Lower Gorge Trib Tule fall	0.04	0.05
	Upper Gorge Trib Tule fall	0.42	0.45
	Big White Salmon R Tule fall	0.43	0.46
	Lewis River Bright fall	0	negligible
	Sandy River Bright fall	-	negligible
	Clackamas River spring	0.03	negligible
	North Santiam River spring	0.74	negligible
	South Santiam River spring	0.79	negligible
	McKenzie River spring	0.43	negligible
	MF Willamette River spring	0.93	negligible
Snake	Tucannon River sp/su	0.73	negligible
	Wenaha River sp/su	0.26	negligible
	Lostine River sp/su	0.58	negligible
	Minam River sp/su	0.06	negligible
	Catherine Creek sp/su	0.62	negligible
	Grande Ronde River Upper Mainstem sp/su	0.76	negligible

Domain	ESA-Listed Chinook Salmon Population	pHOS in Affected Environment (most recent baseline conditions)	Modeled pHOS in Alternative 2 (assuming a 14% increase from prey program production)
	Imnaha River Mainstem sp/su	0.59	negligible
	South Fork Salmon River Mainstem sp/su	0.68	negligible
	Secesh River sp/su	0.04	negligible
	East Fork South Fork Salmon River sp/su	0.42	negligible
	Chamberlain Creek sp/su	0	negligible
	MF Salmon River Lower Mainstem sp/su	0	negligible
	Big Creek sp/su	0	negligible
	Camas Creek sp/su	0	negligible
	Loon Creek sp/su	0	negligible
	MF Salmon River Upper Mainstem sp/su	0	negligible
	Sulphur Creek sp/su	0	negligible
	Marsh Creek sp/su	0	negligible
	Bear Valley Creek sp/su	0	negligible
	Lower Snake River fall	0.67	negligible
Upper Columbia	Wenatchee River spring	0.57	negligible
	Entiat River spring	0.3	negligible
	Methow River spring	0.63	negligible

4.2.3. Alternative 3: Habitat-based Prey Increase Program

Alternative 3, the habitat-based prey increase program alternative, directs funding to habitat restoration projects throughout the analysis area to increase the production of Chinook salmon in the wild; instead of hatchery production (Alternative 2). This alternative relies upon improvements in natural conditions in freshwater to bolster the production of juvenile Chinook salmon and therefore available prey for SRKWs.

Survival at the juvenile life stage for salmonids (e.g., egg, alevin, fry, and parr life stages) is highly variable and mortality can be significant due to natural environmental conditions. There are no formal methods established to estimate Chinook salmon production increases in freshwater from actual, site-specific habitat restoration projects implemented on the ground. The best available information indicates there could be two different approaches for evaluating the potential effects of habitat restoration on Chinook salmon abundance and productivity: 1) evaluate total habitat restoration expenditures and trends in salmonid abundances to see if the funding actions made a difference (Jaeger and Scheuerell 2023) and 2) modeling the benefits of largescale habitat restoration on salmon population lifecycle parameters (Honea et al. 2009); Beechie et al. 2021; Jorgensen et al. 2021; Fogel et al. 2022). For the analyses of effects for this alternative, we applied both of these approaches within the scale of funding available annually for habitat restoration projects included for this alternative beginning in 2024 (the funding assumption in this alternative is the same as alternative 2). Refer to section 2.3 above for more details. A full description of the habitat restoration projects included in this analysis is in Appendix C.

The two scenarios are described below, and then inferences are made to each life stage of Chinook salmon, as it relates to meeting the purpose and need for the alternative on Chinook salmon for SRKWs.

4.2.3.1.Scenario 1: Habitat Restoration Funding Across the Project Area

Appendix C provides the habitat restoration projects evaluated for this alternative scenario at an equivalent funding amount and range as for Alternative 2, the hatchery prey increase program. The types of projects funded in this scenario are targeted to improve stream complexity to enhance survival and habitat capacity, fish passage improvements to access habitat, riparian and floodplain habitat restoration to improve survival condition, and others. The projects are scattered across the project area in many different populations of Chinook salmon. Given the complexities of natural survival of Chinook salmon, the influence of environmental conditions, the cost and scale of habitat improvement projects, there is no way to quantify the benefits to Chinook salmon population increase from this habitat restoration spread across the entire project area.

Jaeger and Scheuerell (2023) conducted an extensive analysis of the expenditure of funds towards salmonid restoration in the Columbia River Basin; asking the question “is there evidence of an overall increase in wild fish abundance associated with the totality of these recovery efforts?" They analyzed more than $9 billion in restoration spending efforts by federal and state agencies, including a substantial amount of habitat restoration projects implemented on the ground in Chinook salmon populations over several decades. Jaeger and Scheuerell (2023) was unable to conclude there was a significant benefit to wild fish from the restoration spending that was above and beyond what was calculated for hatchery fish returns in combination with restoration spending at the very large scale of the Columbia River over many decades. This could be due in part to not implementing habitat restoration projects that benefitted the species, continued habitat degradation co-occurring with habitat restoration, recent dramatic climate change impacts, and other survival challenges salmon face that is outpacing the benefits of localized habitat restoration efforts.

Given the widespread area the funding of the habitat restoration projects included in Alternative 3 (scenario 1), across specific areas of Puget Sound, Washington coast, and the entire Columbia River Basin, similar results are expected from this alternative, the habitat-based prey increase program, as in Jaeger and Scheuerell (2023). There are certainly benefits of habitat restoration to Chinook salmon, but it is impossible to quantify what the benefits are in terms of meeting the purpose and need of increasing the prey availability of Chinook salmon in marine waters for SRKWs. There is not likely a significant increase in Chinook salmon abundance over the short-term (<5 years), with greater benefits accruing over the long-term as habitat restoration continues and salmon respond to improved survival conditions.

In conclusion, scenario 1 will not likely provide significant increases to natural Chinook salmon abundance throughout the project area.

4.2.3.2.Scenario 2: Habitat Restoration Funding Directed Towards One Chinook Salmon Population/Watershed

Another approach supported by the best available information for habitat restoration project funding to enhance the abundance and productivity of salmonids is to direct all funding to one specific population area in order to better address key limiting factors/threats for habitat (e.g. Jorgensen et al. 2021). For scenario 2 in Alternative 3, instead of spreading habitat restoration project across the entire region, all funding is focused within a high priority Chinook salmon population area so that the likely benefits to natural production may be enhanced compared to scenario 1 above. This scenario provides another measure of increasing natural production in the most meaningful way to help increase Chinook salmon and be available as prey in marine waters for SRKWs.

Jorgensen et al. (2021) modeled potential benefits to Chinook salmon abundance and productivity in the Chehalis River watershed from significant habitat improvements at a scale that would influence habitat capacity and productivity at each life stage of salmon. For Chinook salmon, the model results differed depending upon the adult run timing and the focus of the habitat restoration in the watershed (Figure 13). For spring Chinook production, focused restoration affecting fine sediment, wood, shade, and floodplain issues with habitat capacity and productivity provides the greatest increases in abundance. For fall Chinook salmon, the increases in abundance were not as pronounced, with restoration focused on fine sediment providing the greatest benefits.

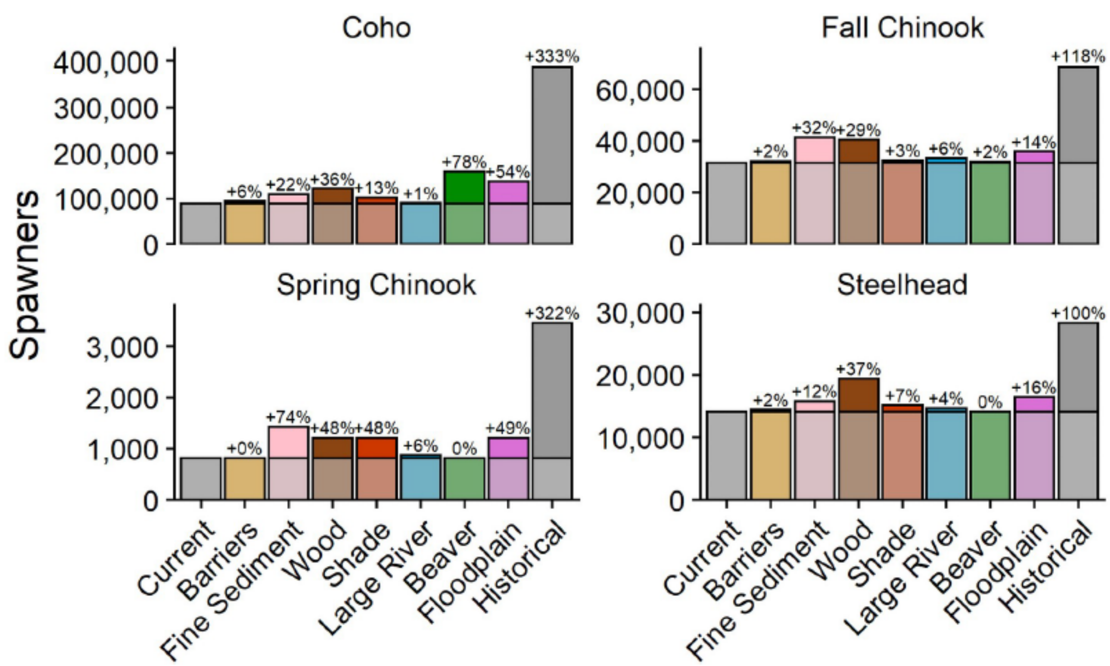


Figure 13. The potential increase in spawner abundances modeled for diagnostic habitat restoration scenarios in freshwater. Figure taken from Jorgensen et al. (2021).

The percent increase in abundance of Chinook salmon ranged from a high of 74% increase for spring Chinook to no increase in abundance from habitat improvements compared to current status (Figure 13). The amount of funding needed to accomplish the modeled diagnostic habitat improvements was not reported in Jorgensen et al. (2021) and is not presently available (personal communication, J. Jorgensen), but it is likely to be a very substantial amount of funding. The habitat restoration projects reported in Appendix C show the types of projects that could be implemented annually with an average of $6.2 million from the prey increase federal funding. Twice as many projects are assumed to be implemented with $12 million (the prey increase program goal funding level in Alternative 2). For the scenario modeling reported by Jorgensen et al. (2021) the potential increases in abundance are considerable (i.e. 74% increase), and at a likely order of magnitude greater in scale and benefit than the habitat projects reported in Appendix C. In terms of the number of additional Chinook salmon produced by these scenarios, the highest possible increases are in the range of 10,000-20,000 more salmon.

An unknown is if the amount of annual funding in this Alternative 3 (~$6.2 million each year currently; $12 million assumed maximum) is at the scale to accomplish the abundance increases reported in Jorgensen et al. (2021). The best available information suggests it cannot (Appendix B). Therefore, it is reasonable to project the benefits of this scenario would be less than 10,000 additional Chinook salmon; which is a significant increase at the local population scale, but is a much lower than the near-term abundance increase than Alternative 2, the hatchery prey increase program (for reference to the scale of Chinook salmon abundance in marine areas, refer to Appendices F and H). Additionally, the focus of the prey increase program was to increase abundance in both coastal and inland marine waters, and by only focusing on one population this would only increase abundance in marine areas where this particular population migrated, which may be limited in overlap with SRKW migration and feeding areas. This would likely not accomplish the stated goal for the prey increase program; which is to provide an increase in prey availability in the times and areas most beneficial for SRKWs (e.g. the portfolio effect of a diversity of Chinook stocks needed to accomplish the stated goals).

4.2.3.3.Juvenile Freshwater Life Stage

As explained in the two habitat restoration scenarios above, there would be some increases in the short-term in juvenile production of Chinook salmon from Alternative 3 under either scenario. However, under both scenarios in Alternative 3, the increase in juveniles emigrating to marine areas as smolts would be more than Alternative 1 (No Funding for Prey Increase Program) but less than expected in Alternative 2 (Hatchery Prey Increase Program). Alternative 3 does not provide the same level of survival benefits from egg to smolt in the wild compared to Alternative 2, which relies upon the high survival from egg to smolt in a hatchery. The expected benefits to natural Chinook salmon from Alternative 3 are likely to be low, under the assumptions used, and are not considered to be significant. More benefits to natural production would accrue over the long-term as more federal funding is put towards continued habitat restoration of Chinook salmon throughout the analysis area.

4.2.3.4.Marine Life Stage

The benefits of Alternative 3 to Chinook salmon and their habitat occurs primarily by producing more juvenile Chinook salmon that emigrate to marine areas. Since the production of juveniles under the assumptions applied in Alternative 3 are expected to be low in the short-term, the corresponding benefits in marine areas is also expected to be low. Alternative 3 results in higher benefits compared to Alternative 1 but lower benefits compared to Alternative 2. For reference, prey increases in the range of 3-5% in certain time and areas is of the magnitude of hundreds of thousands (100,000's) of adult Chinook salmon in marine areas (Appendix F). Most of the benefits from habitat restoration would occur over the long-term as habitat for Chinook salmon improves and more natural production occurs in time.

4.2.3.5.Adult Freshwater Life Stage

Alternative 3 focuses on increasing the natural production of Chinook salmon. As described in the previous section on expected juvenile Chinook salmon increases, the corresponding adult increases will also be low over the short-term. This alternative has no effects on pHOS, since all of the production occurs in the wild producing natural-origin fish. Alternative 3 would provide more natural Chinook salmon compared to Alternative 1 (No Funding for Prey Increase Program) but would be expected to result in lower total abundances of Chinook salmon in freshwater compared to Alternative 2. Over the long-term, more benefits to adult Chinook salmon would be expected as habitat restoration continues to be implemented across the analysis area.

4.2.4. Alternative 4: Reduced Fishing to Increase Prey

Alternative 4 focuses on using the available federal funds in 2024 and thereafter to reduce the harvest of Chinook salmon in marine waters to increase the prey availability for SRKWs. To inform our analysis of this alternative, we estimated the fishery reductions that would occur with current funding of the prey increase program ($6.2 million) and further fishery reductions that would help meet the prey increase program goals of 4-5% for SRKWs in marine areas. Further details on this can be found in Appendix F.

4.2.4.1.Juvenile Freshwater Life Stage

Alternative 4 would not affect salmon at the juvenile life stage, because it would involve the reduction of fishery effects to the adult life stage in marine waters. This alternative only affects the adult life stages described below. Subsequent benefits to juvenile salmon production would occur after additional adult spawning at that life stage.

4.2.4.2.Marine Life Stage

Alternative 4 assessed two fishery management scenarios: current funding and prey increase program goals. The program goal scenario provides the greatest benefits to Chinook salmon abundance and is summarized there. First a total harvest closure for Chinook salmon fisheries occurring October through June in all US waters (southeast Alaska and southern US), and then an additional 15% harvest reduction in all Chinook salmon fisheries occurring in the summer period. This scenario provides harvest reductions of Chinook salmon to provide for meeting the stated prey increase goals for SRKWs (see section 2.4 above for further explanation). Alternative 4 would provide benefits to Chinook salmon in the marine life stage by not being harvested. For the winter and spring closures, an additional 0.39% to 2.98% Chinook salmon would remain in marine waters throughout this life stage (Appendix F). For the additional 15% harvest reduction in the summer coupled with the winter and spring period closures, an additional 0.51% to 3.81% Chinook salmon would reside in marine waters depending upon the region and season. The greatest abundance increases from these management actions occur in the north of Falcon region in the summer period (Appendix F).

The benefits of Alternative 4 would be more adult Chinook salmon surviving in marine waters. There would be potential advantages for Chinook salmon by having more salmon in schools to help avoid predators and reduce predation by marine mammals such as SRKWs, harbor seals, and sea lions. Most of the other benefits to Chinook salmon are described in the next section.

Alternative 4 would reduce fishery harvest of Chinook salmon and not increase the release of hatchery fish to increase prey availability for SRKWs. In comparison to Alternative 2 (the hatchery prey increase program), Alternative 4 would equate to similar abundances in marine waters without the risks associated with hatchery fish. The benefits of this alternative to Chinook salmon at these large scales is in the range of zero to 5% (Appendix F), which is a relatively small increase in the abundance of Chinook stocks at the regional level overall, and not considered to be significant. See Figure 8 for an example of the magnitude of change in the abundance of Chinook salmon from year to year.

4.2.4.3.Adult Freshwater Life Stage

Alternative 4 would result in additional returns of Chinook salmon to freshwater from reduced harvest in marine fisheries. For the prey increase program goal scenario, the expected increases in marine waters range from 0.39% to 3.81% depending upon the region and time period (Appendix F). The increases of Chinook salmon returns to freshwater would likely be within this range for all populations throughout the analysis area. After return to freshwater, Chinook salmon would be subject to additional in-river fisheries, but at these relatively small increases, river fisheries would likely be about the same as the No Action alternative. Alternative 4 would result in lower pHOS values on the spawning grounds from additional natural Chinook salmon returning to freshwater compared to Alternative 2; albeit at low levels because hatchery Chinook salmon abundance would also continue from other hatchery fish releases in the current affected environment and not associated with the prey increase program (see Figure 12 for comparative purposes).

4.3. Effects on Southern Resident Killer Whales

The effects of each alternative on SRKW are described below in terms of the effects to Chinook salmon, the primary prey of SRKWs, and the goals of the prey increase program. None of the alternatives are expected to have contaminant exposure impacts beyond that of the status quo in the affected environment. Only Alternative 4 is expected to have effects to vessel, physical, and noise disturbance in the analysis area. We describe the relative impacts (beneficial or negative) that each alternative has on the SRKW population and its habitat. The focus of the SRKW alternatives analysis is for Chinook salmon at the adult life stage (ages 3+) in marine waters where SRKWs reside.

4.3.1. Alternative 1 (No Action): No Funding for Prey Increase Program

Under Alternative 1, there would not be federal funding for the prey increase program for SRKWs (Section 2.1 above). Chinook salmon prey availability for SRKWs would decrease at the levels shown in Figure 14 for the federal hatchery production. Compared to the affected environment, prey availability under Alternative 1 (No Funding for Prey Increase Program) would decrease from zero to over 6%, on average, depending upon the specific area and time (Figure 16).

Given the current status of SRKWs and the PST prey increase program goal for SRKWs of providing an increase in prey availability in the range of 4-5% (NMFS 2019), the negative effects of Alternative 1 on SRKWs are a medium impact and considered significant.

4.3.2. Alternative 2 (Proposed Action/Preferred Alternative): Hatchery Prey Increase Program

Under Alternative 2, NMFS would continue to fund the production of hatchery Chinook salmon specifically for the purpose of increasing prey availability for SRKWs in marine waters. See Table 4 and Appendices A and F for a summary of federally funded hatchery Chinook salmon released to date by hatchery stock. Future federal funding is expected to produce a similar, or greater, amount of hatchery fish, potentially up to the goals specified for the prey increase program (assuming reduced or eliminated state funding).

We assessed the impacts of Alternative 2 on SRKW using the following three steps: (1) we assessed the total Chinook salmon abundance in the analysis area by referring to the FRAM-Shelton approach described in the PFMC SRKW Ad Hoc Workgroup Report (PFMC 2020), the Biological Opinion on PFMC-area fisheries (NMFS 2021), and most recently in the 2023 Puget Sound Chinook Salmon Fisheries Biological Opinion (NMFS 2023), (2) we assessed the likely annual total number of adult (age 3+) hatchery Chinook salmon produced and released under Alternative 2 under two scenarios: a) the hatchery production that is currently being federally funded (see PST in Table 6), and b) the total hatchery production that is estimated to meet prey program goals (any combination of federal and Washington state funded production in Table 6), and (3) using the two values derived in steps (1) and (2) we calculated the percent increase in Chinook salmon in the analysis area due to the federally funded program under Alternative 2. This analysis was done assuming baseline Chinook salmon abundances that occurred over a 10-year time frame (2009-2018[7]) to represent a range of prey abundances in the analysis area and to assess the expected impact to SRKW under different environmental conditions. Please see Appendix F for a detailed description of these methods.

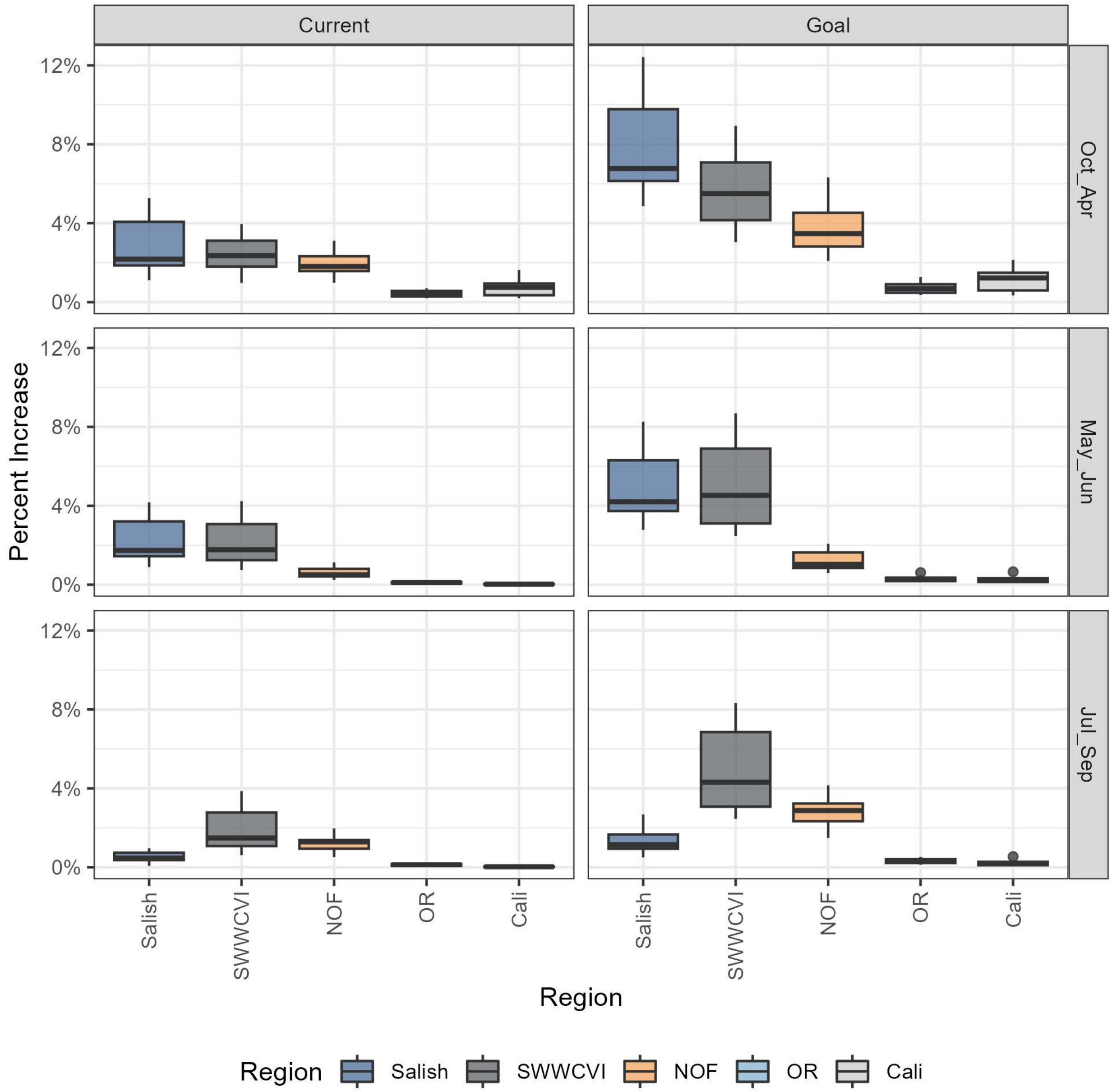
We focused our analysis on specific spatiotemporal strata that are known to be important for SRKW and foraging. As described in Section 3.3, SRKW are found in the Salish Sea primarily during the summer and fall months and in coastal waters (mostly Washington and Oregon, and northern California less often) primarily during the winter months. Additionally, SRKW are known to focus their foraging efforts along the west side of San Juan Island during the summer months, and along the west side of Vancouver Island

[7] Just prior to publishing this draft PEIS, Chinook salmon abundance data through 2020 became available. See Appendix H for the pre-fishing starting abundances through 2020 for each region. As we complete NEPA and ESA reviews we will incorporate new abundance information into our analysis where feasible.

at Swiftsure Bank in the spring/early summer months (Thornton et al. 2022). As such, we focused especially on the Salish region during the Jul-Sep time period, NOF during the Oct-Apr time period, and the SWWCVI region during the May-June and Jul-Sept time periods. Chinook fisheries south of Cape Falcon are typically closed through April, and thus have negligible effects.

As seen in Figure 14 (also see Table 14), under Alternative 2 (currently federally funded), during the October-April time step, SRKW prey is expected to increase by approximately 1.9%, on average, in the NOF region. During the May-June time step, SRKW prey is expected to increase by over 2%, on average, in the SWWCVI region, and in the July-September time step, prey is expected to increase by 1.9% in the SWWCVI region and 0.5% in the Salish Sea, on average. The ranges of increases presented in Figure 14 and are estimates based on the production that has occurred in 2023 as a representation of the current implementation of the program. However, the prey increases depend on the level of Chinook salmon observed in that year. For example, variable ocean conditions are a major driver of ocean salmon abundances, which can vary widely from year to year (see Table 12). As such, percent prey increases due to the hatchery program may be smaller in years where ocean abundance is high (i.e., marine survival is high for salmon across all stocks).

When considering hatchery production that would likely meet prey increase program goals for increased prey availability for SRKWs (i.e., a 4-5% increase in prey in marine waters estimated to be produced by a release of 20 million smolts), the results are shown in Figure 14 and Table 14. For this scenario of 20 million smolts released, on average, SRKW prey is expected to increase annually by 3.6% in the NOF region during the October-April time step. In the May-June time step, SRKW prey is expected to increase annually, on average, by approximately 4.8% in the SWWCVI region. In the July-September time step, SRKW prey is expected to increase annually, on average, by 4.6% in the SWWCVI region and 1.2% in the Salish Sea.



Note: box-and-whisker plots display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles).

Figure 14. Expected annual impact of the federal funding of Alternative 2, the hatchery prey increase program (for the current federal funding (Current) and funding that would meet prey increase program goals (Goal) as represented by the expected percent increase of the SRKW prey base (age 3+ Chinook salmon) by spatial region (x-axis) and time step (rows) based on a range of abundances. See Appendix F for further details.

Table 14. Expected annual impact of Alternative 2, the hatchery prey increase program funding under the Current (a) and Goal (b) scenarios) as represented by the average expected percent increase of the SRKW prey base (age 3+ Chinook salmon) by spatial region and time step. Table derived from Appendix F. Asterisks indicate the key times and areas of focus for SRKW.

a)

Alternative 2: Hatchery Prey Program - Current
Expected prey increase under current (2023) releases

	Oct-Apr			May-Jun			Jul-Sep		
	Region		*	*			*	*	
Year	SWWCVI	Salish	NOF	SWWCVI	Salish	NOF	SWWCVI	Salish	NOF
2009	2.76%	2.39%	1.79%	2.12%	1.92%	0.62%	1.77%	0.48%	1.97%
2010	2.60%	1.86%	2.18%	1.66%	1.44%	0.52%	1.47%	0.46%	1.66%
2011	2.11%	1.86%	1.83%	1.52%	1.45%	0.47%	1.27%	0.07%	1.26%
2012	2.10%	2.74%	1.66%	1.89%	2.27%	0.48%	1.51%	0.77%	0.86%
2013	1.06%	1.65%	1.03%	0.89%	1.36%	0.31%	0.78%	0.34%	0.79%
2014	0.97%	1.11%	0.98%	0.75%	0.89%	0.24%	0.62%	0.21%	0.52%
2015	1.70%	1.97%	1.54%	1.15%	1.56%	0.40%	1.01%	0.43%	1.35%
2016	3.23%	5.21%	2.37%	3.39%	3.98%	0.87%	3.11%	0.97%	1.20%
2017	3.96%	5.28%	3.11%	4.24%	4.17%	1.13%	3.86%	0.77%	1.40%
2018	3.68%	4.51%	2.71%	4.01%	3.52%	1.03%	3.60%	0.66%	1.32%

b)

Alternative 2: Hatchery Prey Program - Goal
Expected prey increase under target releases

	Oct-Apr			May-Jun			Jul-Sep		
	Region		*	*			*	*	
Year	SWWCVI	Salish	NOF	SWWCVI	Salish	NOF	SWWCVI	Salish	NOF
2009	6.70%	7.29%	3.70%	5.31%	4.61%	1.30%	5.03%	1.03%	4.16%
2010	5.75%	6.25%	3.68%	4.18%	3.67%	1.02%	4.01%	0.96%	3.29%
2011	5.11%	6.11%	3.27%	3.94%	3.72%	0.98%	3.81%	0.50%	2.83%
2012	5.25%	8.21%	3.24%	4.88%	5.54%	1.04%	4.61%	1.50%	1.99%
2013	3.21%	6.23%	2.40%	2.72%	3.80%	0.78%	2.75%	0.93%	2.21%
2014	3.04%	4.86%	2.08%	2.47%	2.78%	0.59%	2.45%	0.82%	1.49%
2015	3.84%	5.82%	2.68%	2.82%	3.77%	0.81%	2.83%	1.24%	2.92%
2016	7.21%	12.42%	4.81%	7.43%	8.26%	1.75%	7.47%	2.68%	2.73%
2017	8.94%	12.34%	6.32%	8.69%	7.72%	2.07%	8.33%	1.83%	3.43%
2018	8.12%	10.30%	5.34%	8.14%	6.56%	1.87%	7.76%	1.72%	3.07%

Alternative 2 provides a meaningful increase in prey availability for SRKWs. Compared to Alternative 1 (No Funding for Prey Increase Program), Alternative 2 provides more prey availability for SRKWs in the times and areas described in Figure 14. The maximum increase in prey availability could be as high as 7.3% for Chinook salmon in the Salish Sea, and 5.4% in the SWWCVI region, in the October through April time period under the "goal" level of funding and production. However, we note that SRKWs would experience the increase in prey availability resulting from production under this alternative 3-5 years following hatchery production funding, according to the time it takes for salmon to age into the preferred prey base for SRKWs (age 3+). In the meantime, fish produced with federal and state funds prior to 2024 would continue to return as adults and contribute to the SRKW prey base.

In total, the percent increases in prey due to Alternative 2 translate to an increase of 40,295 to 91,494 Chinook salmon annually (Table 15). For further description, please see Table 3 in Appendix F.

Table 15. Estimated mean annual nominal increase in returns to the river mouth by FRAM stock resulting from Alternative 2 based on 2023 releases.

	Mean Nominal Increase		
FRAM Stock	**Federal**	**WA State**	**Total**
Nooksack/Samish Fall	0	6,716	6,716
Nooksack Spr Hatchery	0	6,860	6,861
Skagit Spring Year	0	3,786	3,787
Snohomish Fall Fing	0	4,179	4,181
Tulalip Fall Fing	983	0	983
Mid PS Fall Fing	11,769	3,988	15,760
South Puget Sound Fall Fing	0	1,996	2,007
White River Spring Fing	0	1,565	1,566
CR Oregon Hatchery Tule	546	0	548
CR Bonneville Pool Hatchery	0	0	3
Columbia R Upriver Summer	9,066	7,472	16,540
Columbia R Upriver Bright	0	1,567	1,576
Cowlitz River Spring	0	2,849	2,849
Willamette River Spring	17,931	0	17,933
WA North Coast Fall	0	2,896	2,898
Willapa Bay	0	7,283	7,286
TOAL	**40,295**	**51,157**	**91,494**

Given the current status of SRKWs and the PST mitigation goal of providing an increase in prey availability for SRKWs in the range of 4-5% (NMFS 2019), the benefits of the currently funded federal hatchery production under Alternative 2 (current funding scenario) to SRKWs are medium and considered significant, but the benefits of the high end of the range considered under Alternative 2 (prey increase program goal scenario) are high and considered significant.

4.3.3. Alternative 3: Habitat-based Prey Increase Program

Under Alternative 3, federal funding would be directed towards activities to enhance and restore freshwater habitat specifically for Chinook salmon throughout the analysis area. Section 4.2.3 describes the anticipated increases in natural-origin Chinook salmon abundances that are used here to evaluate Alternative 3 on SRKWs in marine waters.

SRKWs are expected to benefit from habitat restoration activities that improve the production of natural Chinook salmon, as any such activities are expected to result in long-term benefits to natural Chinook salmon populations. For example, habitat restoration activities could include improving spawning and rearing areas in freshwater to increase habitat capacity and productivity for Chinook salmon, and thus provide benefits for SRKWs when these fish are in marine areas. Improvements to fish passage for upstream and downstream migrants of salmon can increase the spatial distribution, abundance, and productivity, of natural populations.

Habitat restoration priorities would be focused on Chinook salmon stocks and ESUs that are determined to be most important for SRKW prey (similar to Alternative 2). Benefits to natural production would be over the long-term, and not immediately, as the habitat improvements continue to improve the survival of salmon. There could also be compounding effects of habitat restoration benefits as improvements to habitat complexity continue to improve instream conditions from more large woody debris accumulation, improvement and growth of riparian areas, and improvements to water quality.

Any such benefit to Chinook salmon would be expected to occur no sooner than two to five years following restoration activities, as natural production increases and juvenile salmon emigrate to marine waters, grow into adult salmon, and become available as prey for SRKWs. Chinook salmon would continue to spawn and rear in improved habitat conditions. The benefits would continue to accrue each year afterwards.

The increases in natural Chinook salmon abundance from this alternative are expected to be low because current federal funding to implement habitat restoration projects (average of $6.2 million annually) is limited and not sufficient to support a meaningful increase in natural production, due to the nature of the action being considered here. Even with the assumption funding is doubled to be equivalent to the funding in Alternative 2 to meet prey increase program goals, the benefits are still expected to be low given the goals for increasing prey availability for SRKWs of 4-5% in marine waters. Funding could be used to support habitat restoration in a single watershed, thus focusing the limited funds to increase more prey in a single area. However, improving natural production of a single stock may have limited utility to SRKWs, who consume many different stocks with varied run timing. Alternatively, the limited funding could be spread across several watersheds, thus supporting natural production of a diverse range of stocks. However, the amount that each individual project could achieve would be low. See Appendix C for a possible scenario of habitat projects. The amount of funding does not equate to significant additional natural production across the analysis area. Given natural mortality of juvenile salmon in freshwater, which is typically very high, the overall increase in SRKW prey abundance from Alternative 3 in marine waters is expected to be very low.

The quantity of increased abundance of Chinook salmon for SRKWs from this alternative is unknown, but expected to be low (Section 4.2.3). The increases in prey for SRKWs from this alternative is likely an order of magnitude lower than for Alternative 2. Alternative 3 would result in greater benefits to SRKWs compared to Alternative 1 (No Funding for Prey Increase Program) because of habitat restoration actions that increase habitat capacity and productivity for Chinook salmon and their habitats.

4.3.4. Alternative 4: Reduced Fishing to Increase Prey

Under Alternative 4, U.S. Chinook salmon fisheries would be reduced as further described in Section 2.4 to increase prey availability for SRKWs. Two scenarios were modeled for fishery reductions to increase prey availability for SRWKs according to 1) the current federal funding level, and 2) attaining prey program goals. The first scenario used the current average federal funding of $6.2 million dollars for the prey increase program for fishery harvest reductions. The second scenario reduced fishery harvest needed to approximate the prey increase program goals of 4-5% additional prey availability for SRKWs (funding level minimum of $25 million; see section 2.4 for further details).

Current Federal Funding

Applying the current federal funding level of $6.2 million to compensate for reductions in fishery harvest could be used in a variety of seasons and time periods over the course of the fisheries annually. For this alternative, we modeled three hypothetical examples that reduce fishery harvest to an equivalent of $6.2 million in ex-vessel and community level economic costs (Table 18). The intent in all three examples was to reduce all fisheries equally to the extent possible. The reduction in fishery harvest under these three examples ranges from 42,000 to 83,000 Chinook salmon. The foregone harvest in SEAK salmon fisheries includes salmon stocks originating in Alaska and British Columbia, which would not be expected to migrate south and become prey for SRKW. As such, these estimates are considered a maximum estimate, and the benefit to SRKW is expected to be lower.

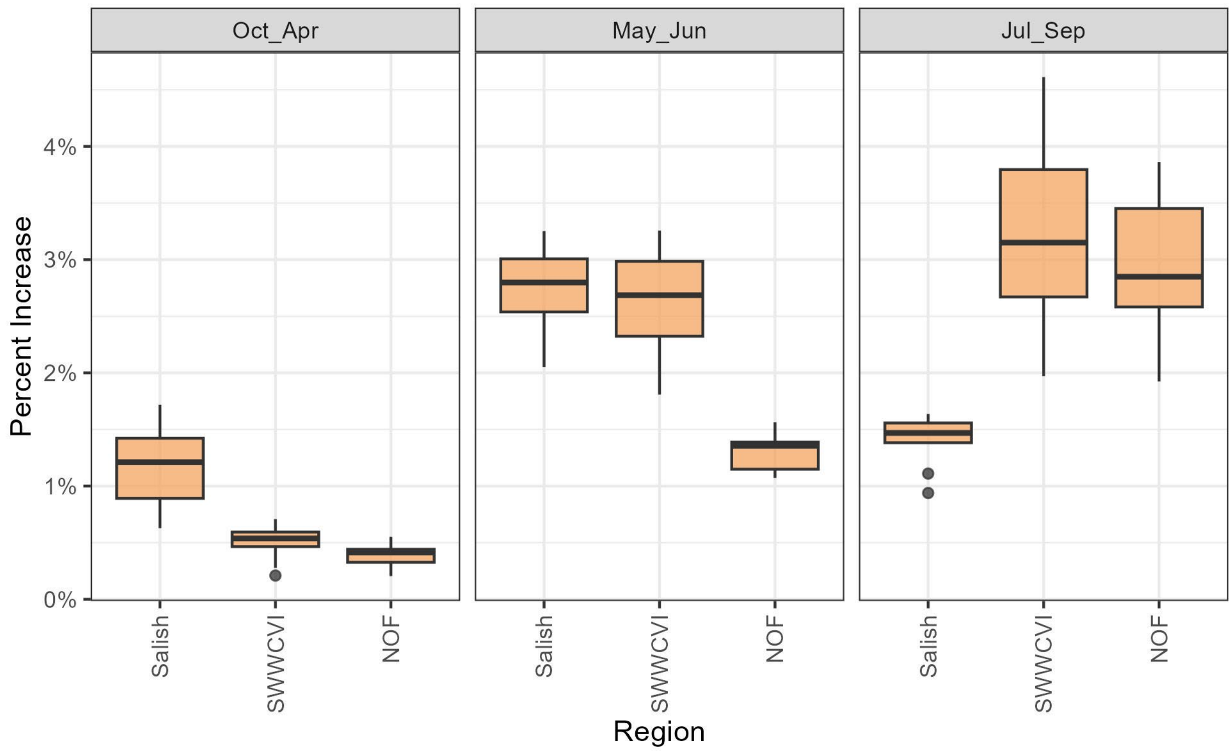
The fishery harvest reductions in Alternative 4 at the current funding level for the summer time period equates to 39% to 86% of the prey increase provided by Alternative 2 (current) in the regions of SWWCVI, Salish, and NOF.

Prey Increase Program Goals

For the second scenario to analyze the possible effects of Alternative 4, we also conducted a modeling exercise to determine what fishery reductions in U.S. fisheries managed under the PST would be needed to approximate the prey increase program goals of 4-5% additional prey availability for SRKWs. This is also a similar level of benefit to SRKW as in Alternative 2. To make this determination, a stepwise approach was taken to reduce salmon harvest first in the times and areas most beneficial to SRKWs. Additional reductions in fisheries were taken as needed in order to get to the same benefits as in Alternative 2, which is approximately 4-5% depending upon the time and area.

We focused on the same three spatiotemporal strata as Alternative 2 that are known to be important for SRKW and foraging: Salish Sea during the summer/fall, NOF during the winter, and SWWCVI during the spring and summer (Section 3.3). For the specific conditions modeled for this alternative, see Appendix F. As described in Appendix F, the fishery reductions were first closed in the winter/spring periods as this provides the most direct potential benefit to SRKWs during the critical winter/spring periods (Section 3.3). The average expected prey increase in NOF winter abundances from closing all marine U.S. winter and spring Chinook fisheries is 0.39% (Figure 16), as compared to the average expected winter increases in NOF under Alternative 2 (Current Funding) of 1.9% and Alternative 2 (Attain Goals) of 3.6%. The average expected prey increase in SWWCVI spring abundances from closing all marine U.S. winter and spring Chinook fisheries is 2.64% (Figure 16), as compared to the average expected spring increases in SWWCVI under Alternative 2 of 2.1% (Current Funding) or 4.8% (Attain Goals). Therefore, according to these estimates, it is apparent that a complete closure of U.S. winter and spring Chinook salmon fisheries under Alternative 4 would result in less than the prey abundance increases expected under Alternative 2 (Attain Goals), and close to or less than those expected under Alternative 2 (Current Funding), but more than Alternative 1, and more immediate abundance increases as compared to Alternative 3.

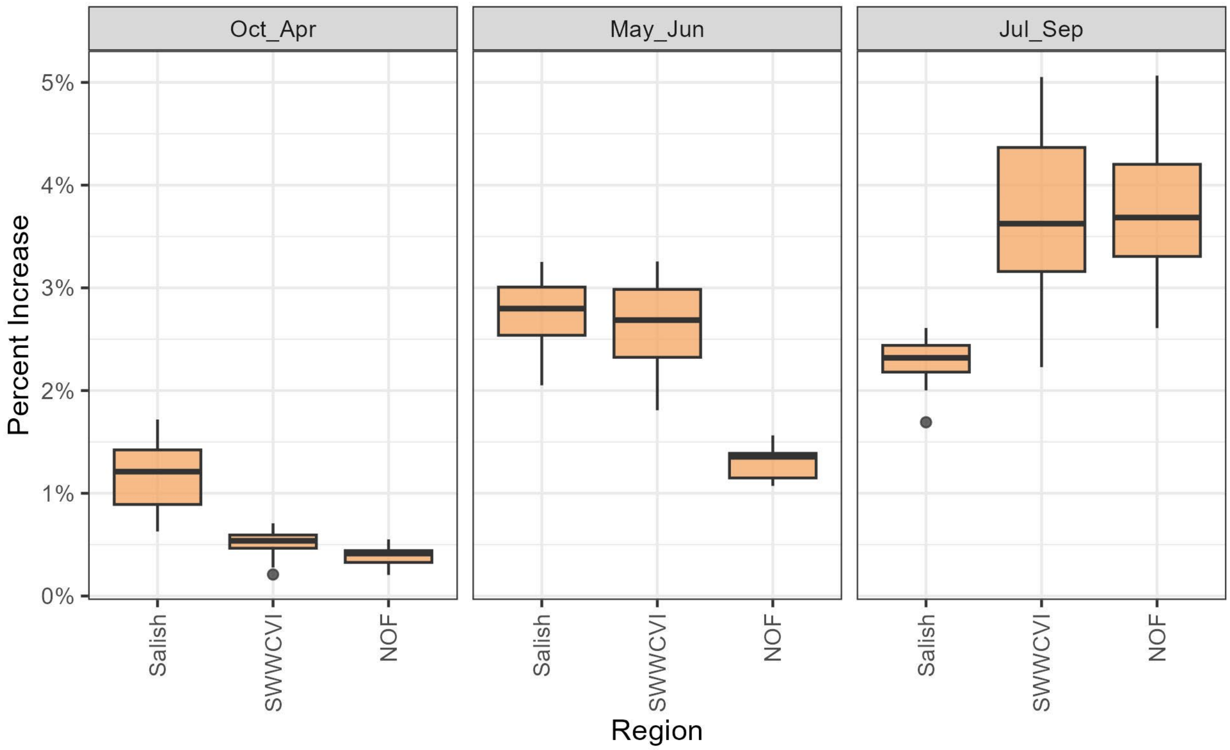
There is also a downstream effect from closing marine U.S. winter and spring Chinook salmon fisheries that affect the regional abundances in the summer time period (i.e., fish that would have been caught in a winter or spring fishery would survive and count towards summer abundances). For the Salish Sea region, this results in an average percent increase of approximately 1.4% during Jul-Sep (Figure 16), which is higher than the mean estimated increase of 0.5% under Alternative 2 (Current Funding), and similar to the estimate under Alternative 2 (Attain Goals) of 1.2%. For SWWCVI, this results in an average percent increase of approximately 3.2% during Jul-Sep (Figure 16), as compared to the estimated increase of 1.8% under Alternative 2 (Current Funding) or 4.6% under Alternative 2 (Attain Goals).



Note: box-and-whisker plots display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles).

Figure 15. Expected annual impact resulting from a full closure of all U.S. Chinook directed fisheries from October through June as represented by the expected percent increase of the SRKW prey base (age 3+ Chinook salmon) by spatial region (x-axis) and time step (columns). Figure taken from Appendix F.

To estimate what level of fishery reductions might approach the level of increased prey availability achievable under Alternative 2, we ran an additional modeling scenario that included the same closure of all marine U.S. winter and spring Chinook salmon fisheries as described in the step above, plus adding a fifteen percent reduction to all marine U.S. Chinook salmon fisheries that occurred during the summer time period that would be expected to affect SRKW prey availability. The results of including this fifteen percent reduction to marine U.S. Chinook fisheries in the summer time period are presented in Figure 17. The average percent increase to the Salish Sea abundance in the summer time period for this scenario is 2.3%, which is higher than the projected average increase of 0.5% under Alternative 2 (Current Funding) and the average of 1.3% under Alternative 2 (Attain Goals). The average percent increase to the SWWCVI abundance in the summer time period under Alternative 4 is 3.7%. Comparatively, the average percent increase to the SWWCVI abundance in the summer time period due to the hatchery prey increase program is 1.9% under Alternative 2 (Current Funding) or 4.9% under Alternative 2 (Attain Goals).



Note: box-and-whisker plots display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles).

Figure 16. Expected annual impact resulting from a full closure of all U.S. Chinook directed fisheries from October through June in addition to a fifteen percent reduction to all U.S. Chinook directed fisheries from July to September as represented by the expected percent increase of the SRKW prey base (age 3+ Chinook salmon) by spatial region (x-axis) and time step (columns). Figure taken from Appendix F.

As compared to Alternative 1 (No Prey Increase Program), Alternative 4 is expected to benefit SRKW by increasing the amount of prey available in their habitat. Alternative 4 is expected to provide more immediate benefits to SRKW as compared to Alternative 3, which has uncertain and future benefits. Alternative 4 (by design) would provide an increase in prey availability for SRKWs at a level similar to Alternative 2. As compared to Alternative 2, Alternative 4 is expected to provide fewer benefits to SRKW during the winter time period (low, insignificant), as fisheries are already so limited that reducing them further to a complete closure would not result in a prey increase comparable to that seen under Alternative

2. Alternative 4 has the potential for comparable benefits (medium, significant) to Alternative 2 during the spring and summer months. Additionally, Alternative 4 would be expected to reduce some impacts of vessels, including physical and noise disturbance, to SRKWs (e.g., fewer vessels fishing, or reduced time spent targeting Chinook salmon). However, Alternative 4 has the potential to increase prey to SRKWs immediately, while Alternative 2 would increase SRKW prey 3-5 years following initial production (see Section 4.3.2).

Table 16. Details of fishery reductions associated with Figure 16. Table derived from Appendix F. Asterisks indicate the key times and areas of focus for SRKW.

Alternative 4: Fisheries Reductions Oct-Jun Expected prey increase under closure of all marine U.S. winter and spring Chinook salmon fisheries									
	Oct-Apr			**May-Jun**			**Jul-Sep**		
	Region		*	*			*	*	
Year	**SWWCVI**	**Salish**	**NOF**	**SWWCVI**	**Salish**	**NOF**	**SWWCVI**	**Salish**	**NOF**
2009	0.45%	1.43%	0.31%	3.09%	3.14%	1.34%	3.79%	1.52%	2.78%
2010	0.53%	1.15%	0.43%	2.67%	2.90%	1.26%	2.79%	1.64%	2.53%
2011	0.57%	1.72%	0.44%	3.07%	3.25%	1.39%	3.80%	1.57%	2.92%
2012	0.55%	1.41%	0.40%	2.72%	2.89%	1.11%	3.51%	1.39%	2.48%
2013	0.21%	1.28%	0.20%	1.81%	2.47%	1.10%	1.97%	1.11%	2.73%
2014	0.60%	1.05%	0.43%	2.58%	2.50%	1.56%	2.72%	1.46%	3.86%
2015	0.52%	0.65%	0.38%	2.23%	2.71%	1.38%	2.27%	1.58%	3.47%
2016	0.71%	0.84%	0.52%	2.71%	2.66%	1.37%	3.80%	1.48%	3.70%
2017	0.67%	1.65%	0.55%	3.26%	3.04%	1.50%	4.61%	1.38%	3.39%
2018	0.28%	0.63%	0.23%	2.24%	2.05%	1.07%	2.65%	0.94%	1.92%

Table 17. Details of fishery reductions associated with Figure 17. Table derived from Appendix F.

Alternative 4: Fisheries Reductions Oct-Jun + 15% Summer Closure Expected prey increase under closure of all marine U.S. winter and spring Chinook salmon fisheries plus a 15% reduction of summer Chinook salmon fisheries									
	Oct-Apr			May-Jun			Jul-Sep		
	Region		*	*			*	*	
Year	SWWCVI	Salish	NOF	SWWCVI	Salish	NOF	SWWCVI	Salish	NOF
2009	0.45%	1.43%	0.31%	3.09%	3.14%	1.34%	4.38%	2.42%	3.65%
2010	0.53%	1.15%	0.43%	2.67%	2.90%	1.26%	3.20%	2.45%	3.18%
2011	0.57%	1.72%	0.44%	3.07%	3.25%	1.39%	4.35%	2.56%	3.72%
2012	0.55%	1.41%	0.40%	2.72%	2.89%	1.11%	4.02%	2.61%	3.26%
2013	0.21%	1.28%	0.20%	1.81%	2.47%	1.10%	2.23%	2.00%	3.45%
2014	0.60%	1.05%	0.43%	2.58%	2.50%	1.56%	3.23%	2.15%	5.07%
2015	0.52%	0.65%	0.38%	2.23%	2.71%	1.38%	2.61%	2.27%	4.23%
2016	0.71%	0.84%	0.52%	2.71%	2.66%	1.37%	4.37%	2.30%	4.82%
2017	0.67%	1.65%	0.55%	3.26%	3.04%	1.50%	5.05%	2.34%	4.12%
2018	0.28%	0.63%	0.23%	2.24%	2.05%	1.07%	3.15%	1.69%	2.61%

4.4. Effects on Other Fish and Wildlife Species

A complete list of the other fish and wildlife species considered for impacts of the four alternatives are listed in Appendix D. For species not included in this analysis in Section 4.4, we expect there to be no effect of any of the alternatives on the species beyond the current conditions. There would be negligible differences among the alternatives on the effects to these species.

For marine mammals in the analysis area, effects of the alternatives are expected for Steller sea lions, California sea lions, and harbor seals as they regularly feed on salmon in marine and freshwater areas. For fish in the analysis area, effects of the alternatives are expected for ESA-listed yelloweye rockfish and bocaccio rockfish in Puget Sound/Georgia Basin and the southern DPS of eulachon. The effects of the alternatives on these species are assessed below.

4.4.1. Alternative 1 (No Action): No Funding for Prey Increase Program

Alternative 1 would result in no funds being distributed to increase prey availability for SRKWs. Most of the fish and wildlife species in the affected environment could potentially benefit from Chinook salmon being present as prey during all of their life stages; as these species eat salmon when available, except as described below. This alternative would not increase the abundance of Chinook salmon available to these species at the level described in section 4.2.1. None of the species in this section rely upon salmon to the same degree as SRKWs, and thus effects of this lack of increase in prey availability for Stellar sea lions, California sea lions, and harbor seals, and ESA-listed rockfish in Puget Sound/Georgia Basin and southern DPS eulachon is expected to be low and not considered significant. These species are more opportunistic predators responding to local feeding conditions and availability with salmon representing a minor proportion of their dietary intake.

Under this alternative, potential predation of ESA-listed juvenile rockfish in the Puget Sound/Georgia Basin region and southern DPS of eulachon by juvenile hatchery Chinook salmon during the summer would not increase compared to the affected environment.

4.4.2. Alternative 2 (Proposed Action/Preferred Alternative): Hatchery Prey Increase Program

Alternative 2 would increase Chinook salmon abundance at the level described in section 4.2.2. The effects of Alternative 2 overall for these species is expected to be low and not considered significant. There may be certain times and areas where Chinook salmon prey is important for these species, because of the opportunity to prey upon salmon, but overall this increase is not significant to their overall dietary intake needs.

For yelloweye and bocaccio rockfish in Puget Sound/Georgia Basin, Alternative 2 will release additional hatchery Chinook salmon that may interact with these species as they enter and live in pelagic habitats of marine areas (NMFS 2020). Hatchery Chinook salmon smolts will enter marine waters during the spring and summer and potentially prey upon young of the year larval rockfish during the period when rockfish are small and co-occurring with juvenile salmon in pelagic waters. The duration of this effect will occur predominately from June through September as larval rockfish are present with hatchery salmon throughout Puget Sound/Salish Sea (Figure 17). After this period, larval rockfish grow larger and migrate to bottom habitats and juvenile salmon migrate to other marine waters, and therefore the interaction between these fish is minimal. NMFS (2020) concluded a small fraction of larval rockfish may be consumed by the total releases of all hatchery salmon and steelhead throughout Puget Sound (as descrbied in the Affected Environment). Alternative 2 may increase this interaction; albeit it will be at a very low level because proposed releases are relatively low in this alternative compared to the regionwide totals of hatchery fish.

As rockfish grow to a larger size, juvenile and sub-adult Chinook salmon may be prey for these rockfish species when available. The benefits of salmon to these rockfish species is estimated to be negligible (NMFS 2020).

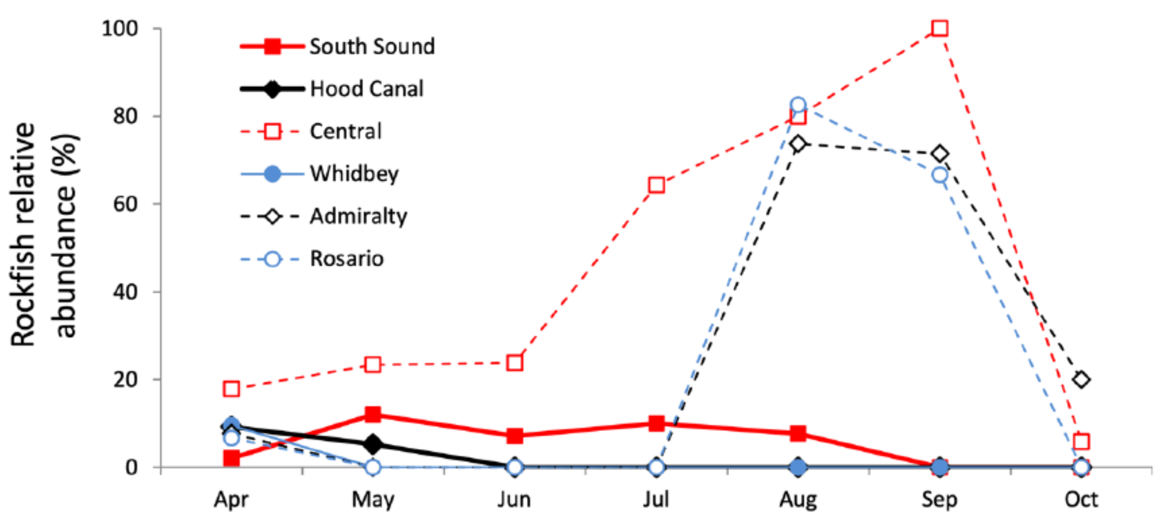


Figure 17. Relative abundance of rockfish at a subset of index sites from April through October. Image from Greene and Godersky (2012).

For the southern DPS of eulachon, there is the possibility of ecological interactions between eulachon and Chinook salmon. Interactions at the juvenile and adult life stages of eulachon is expected to be negligible with juvenile Chinook salmon. Predation by adult Chinook salmon may occur on all life stages of eulachon due to the size of prey salmon typically feed upon. The highest risk of predation currently known occurs in the Lower Columbia River during the winter period when early returning hatchery spring Chinook salmon (e.g. Willamette stock) are present with returning adult eulachon. The interaction is expected to be low as eulachon enter the tributaries to spawn. The magnitude of effect is negligible given the abundance of eulachon, the relatively low numbers of adult hatchery salmon co-occurring during this time, and the significant predation pressures by marine mammals on both of these fish species during this period (NMFS 2022).

4.4.3. Alternative 3: Habitat-based Prey Increase Program

Alternative 3 would result in an increase in the natural production of Chinook salmon from habitat restoration projects at the level described in section 4.2.3. The increase in Chinook salmon abundance for Alternative 3 is likely to be an order of magnitude lower than for Alternative 2. The overall benefit to these species (sealions, seals, and rockfish) for this alternative is likely to be negligible and not considered to be significant.

4.4.4. Alternative 4: Reduced Fishing to Increase Prey

Alternative 4 would reduce the harvest of Chinook salmon in marine fisheries during certain times and areas in US waters; providing an increase in Chinook abundance as described in section 4.2.4. The benefits in terms of prey availability for these species is low and not considered to be significant. Alternative 4 is equivalent to the low benefits in Alternative 2, but provides more benefits to these species (sealions, seals, and rockfish) than Alternatives 1 and 3.

4.5. Effects on Socioeconomics

Communities in the analysis area receive substantial income and employment activity from the commercial, tribal, and recreational salmon fisheries, and other economic inputs from federal funding. Many of these communities are located in rural settings where all economic inputs are essential to maintaining the viability of these human environments. Native American tribes throughout the entire analysis area use salmon as an important food for sustenance and commercial purposes, and salmon are a strong spiritual symbol and central to their traditions and culture. Salmon are also an iconic species of great cultural and ecological importance.

4.5.1. Alternative 1 (No Action): No Funding for Prey Increase Program

Alternative 1 would not provide funding for the prey increase program. Following this cessation in funding, additional Chinook salmon (hatchery- and/or natural-origin) would no longer be produced and/or released. The increase in adult Chinook abundance (resulting from the prey increase program ending in FY 204 and beyond) would diminish beginning 2026 and thereafter as adult salmon enter possible fisheries in marine and freshwaters after being available to SRKWs. This cessation for funding of hatchery Chinook salmon would affect the socioeconomics throughout the region by not distributing an average of $6.2 million dollars annually from the federal funding of the prey increase program. In addition, there is a multiplier effect of this funding to affect other local goods and services, and recreational and commercial fisheries in freshwater and marine areas.

Alternative 1 would result in no additional benefits from the prey increase program. The loss of the production of hatchery Chinook salmon, as in the current affected environment, and the benefits these salmon provide to affected communities would no longer occur beginning in 2024 and beyond.

4.5.2. Alternative 2 (Proposed Action/Preferred Alternative): Hatchery Prey Increase Program

The socioeconomic effects of Alternative 2 would be beneficial from the production of additional hatchery Chinook salmon. The annual funding of the prey increase program distributed to local communities (on average $6.2 million dollars annually under current funding, and up to $12 million for prey increase program goals) to produce additional hatchery fish would benefit state and tribal organizations as described in the Chapter 3, Affected Environment. The abundance of Chinook salmon would increase in commercial, tribal, and recreational fisheries throughout the analysis area (Table 14). Therefore, the impacts on socioeconomics under Alternative 2, related to an increase in potential catch in fisheries, especially in freshwater, after being available as prey for SRKWs in marine waters, would be medium beneficial impact and is considered significant. Alternative 2 would provide significantly greater socioeconomic benefits than Alternatives 1, 3, and 4.

4.5.3. Alternative 3: Habitat-based Prey Increase Program

The socioeconomic effects of Alternative 3 would benefit from the annual funding of the habitat restoration program to local communities that spend the money (on average $6.2 million dollars annually under current funding, and up to the assumed $12 million for prey increase program goals) to implement habitat restoration activities (and the multiplier effects of this federal funding) and the resultant increased natural production of Chinook salmon throughout the project area. Benefits of Alternative 3 would be greater than Alternatives 1 and 4, but much lower than Alternative 2. Therefore, the benefits of Alternative 3 on socioeconomics would be medium, but considered significant for the affected communities. Benefits to these local communities would be primarily over the long-term as habitat restoration and the associated benefits to the local community from watershed habitat improvements and natural salmon production occur.

4.5.4. Alternative 4: Reduced Fishing to Increase Prey

The socioeconomic effects of Alternative 4 are related to Chinook fishery closures and reductions in catch in US waters as described in section 2.4 for this alternative. Two scenarios were modeled for fishery reductions to increase prey availability for SRWKs according to current federal funding level and prey program goals. The first scenario used the current average federal funding of $6.2 million dollars for the prey increase program for fishery harvest reductions based upon socioeconomic impacts (ex-vessel value for commercial fisheries, and community level value for sport fisheries). The second scenario reduced fishery harvest needed to approximate the prey increase program goals of 4-5% additional prey availability for SRKWs (salmon not harvested), and then calculate the foregone socioeconomic value of those lost fishery harvest opportunities, which is estimated at a minimum of $25 million annually (see below).

Current Federal Funding

The minimum socioeconomic value of foregone harvest of Chinook salmon equating to $6.2 million in ex-vessel and community level economic impacts (PFMC 2023; NMFS 2024) is significant and ranges from a total of 42,000 to 83,000 Chinook salmon annually depending upon the assumptions of fishery season and specific fishery closed. Table 18 provides three examples of fishery closures, with the intent to reduce all fisheries equally to the extent possible, and foregone Chinook salmon harvest and associated socioeconomic impacts up to $6.2 million.

Table 18. Three hypothetical examples of fishery harvest reductions, each equating to an estimated $6.2 million in minimum socioeconomic costs. See text for details.

Example #1	Oct-April		May-June	
Fishery	Catch Reduction by 100%	Minimum Economic Value	NOF Only - 52% Catch Reduction	Minimum Economic Value
SEAK commercial	33,766	$2,141,237	no change	
SEAK sport	NA	NA	no change	
NOF commercial	NA	NA	21,040	$1,726,719
NOF sport	NA	NA	2,220	$184,922
SOF commercial	9,398	$771,284	no change	
SOF sport	7,951	$662,159	no change	
PS commercial	2,436	$199,920	no change	
PS sport	6,443	$536,573	no change	
Total:	59,994	$4,311,174	23,260	$1,911,640
Grand Total (catch, $):		**83,254**	**$6,222,814**	

Example #2	May-June	
Fishery	Catch Reduction by 76%	Minimum Economic Value
SEAK commercial	5,990	$379,845
SEAK sport	6,777	$3,415,789
NOF commercial	10,520	$863,359
NOF sport	1,110	$92,461
SOF commercial	14,305	$1,174,033
SOF sport	2,654	$221,038
PS commercial	261	$21,410
PS sport	272	$22,645
Total:	41,890	**$6,190,582**

Example #3	July-Sept	
Fishery	Catch Reduction by 31%	Minimum Economic Value
SEAK commercial	27,833	$1,765,027
SEAK sport	3,070	$1,547,381
NOF commercial	7,743	$635,436
NOF sport	6,390	$532,184
SOF commercial	8,698	$713,853
SOF sport	5,044	$420,081
PS commercial	1,535	$125,984
PS sport	5,303	$441,592
Total:	65,617	**$6,181,538**

Prey Increase Program Goals

Table 19 provides a summary of the average reduction in catch associated with closing U.S. Chinook salmon fisheries in the winter and spring time periods and reducing U.S. Chinook salmon fisheries in summer by 15%; in order to approximate the prey increase program goals of 4-5% additional prey availability for SRKWs (see section 2.4 for more details). We applied complete closures to the winter and spring time periods to show the maximum possible benefits to increasing prey availability for SRKWs, and the associated socioeconomic effects of doing this are evaluated here. Table 20 provides the same information but is also broken out by gear type to show the specific fishery sectors affected. An important consideration in interpreting these results is that fisheries were closed entirely or reduced equally without consideration for which specific fisheries might provide greater benefit to the abundances in the specific time/area strata being targeted. Again, this was to demonstrate the maximum benefits of fishery harvest reductions to increase prey availability for SRKWs (as described in section 4.3.4). It is likely that there are alternative scenarios that could provide similar benefits to abundances while requiring a smaller overall reduction to catches. However, this would involve more fine tuning and unequal treatment across fisheries, resulting in a disproportionate sharing of the burden across regions (see Appendix F).

Table 19. Reduction in catch by fishery region due to winter and spring closure (Oct-June) and a 15% reduction of summer (July-Sept) U.S. Fisheries. WAC is Washington coast net fishery in state waters (e.g. Willapa, Grays Harbor). Table taken from Appendix F.

FISHERY REGION	CATCH REDUCTION		
	OCT-APR	MAY-JUN	JUL-SEP
SEAK	33,766	53,197	14,717
PFMC_NOF	0	48,459	6,730
PFMC_SOF	17,349	70,665	6,544
WAC	0	0	1,490
PS	8,880	2,220	3,255

Table 20. Reduction in catch by fishery region and gear type due to winter and spring closure (Oct-June) and a 15% reduction of summer (July-Sept) U.S. Fisheries. Table taken from Appendix F.

FISHERY REGION	GEAR	CATCH REDUCTION		
		OCT-APR	MAY-JUN	JUL-SEP
SEAK	Net	0	4,266	757
SEAK	Sport	0	28,239	1,462
SEAK	Troll	33,766	20,692	12,497
PFMC_NOF	Sport	0	4,626	3,043
PFMC_NOF	Troll	0	43,833	3,687
PFMC_SOF	Sport	7,951	11,059	2,402
PFMC_SOF	Troll	9,398	59,606	4,142
WAC	Net	0	0	1,490
PS	Net	176	0	682
PS	Sport	6,443	1,133	2,525
PS	Troll	2,260	1,087	49

The reductions in catch under Alternative 4 are substantial. In SEAK, the total catch reduction is 101,679 Chinook salmon, which in some years would represent a reduction in at least half of the PST treaty catch limit for Chinook salmon in SEAK. In NOF region, the total catch reduction is 55,189 Chinook salmon.

In the SOF region, the total catch reduction is 94,558 Chinook salmon. In Puget Sound, the catch reduction is 14,355 Chinook salmon. The total Chinook salmon catch reduction under Alternative 4 is 267,271 salmon across all regions and times.

In order to quantify the socioeconomic costs to fishers, the industry, and local communities involved with Chinook salmon fisheries, the value of the foregone catch of Chinook salmon associated with Alternative 4 was estimated using fishery data from 2022 (PFMC 2023) for southern US fisheries and data from Conrad and Thynes (2022) and NMFS (2024) for SEAK fisheries.

The estimated foregone value of the Chinook salmon harvest associated with Alternative 4 totals $25.4 million dollars annually. The economic loss estimated for southern US recreational and commercial fisheries is $13.4 million dollars annually (Table 21). The economic loss estimated for southeast Alaska recreational and commercial fisheries is $12.0 million dollars annually (Table 22). These estimates should be considered minimum loss values because for commercial fisheries only ex-vessel values are used that do not consider other economic benefits throughout the community from fish processing, crew income, support services, and tax revenue. For the sport fishery in SEAK, the assumption on catch rates was high; resulting in minimal economic estimates for that fishery.

Table 21. Annual estimated value of foregone Chinook salmon harvest associated with Alternative 4 for southern US (S.U.S.) commercial and recreational fisheries. See text for details on the values reported in this table.

S.U.S. Commercial Troll Fishery	Chinook Harvest Reduction	Avg Weight per Chinook	Price/Pound
North of Falcon	47,520	10.7	7.67
South of Falcon	73,146		
Puget Sound	3,396		
Total Catch Reduction	124,062		
Total Exvessel Value	**$10,181,644**		
S.U.S. Recreational Fishery	**Chinook Harvest Reduction**	**Economic Impact per Salmon Harvested**	**Total Economic Impact**
North of Falcon	7,669	$83.28	**$3,263,577**
South of Falcon	21,418		
Puget Sound	10,101		
Total Catch Reduction	39,188		

Table 22. Annual estimated value of foregone Chinook salmon harvest associated with Alternative 4 for southeast Alaska (SEAK) commercial and recreational fisheries. See text for details on values reported in this table. These values are estimated to be minimum values because it was assumed two Chinook salmon harvested per day, which has not been allowed under recent regulations (i.e. if only one salmon can be harvested per day, the economic benefit would be substantially greater than presented here). See NMFS (2024) for further information on economic values used here.

SEAK Commercial Fishery	Chinook Harvest Reduction	Avg Weight per Chinook	Price/Pound
Troll	66,955	11.7	$5.42
Net	5,023		
Total Catch Reduction	71,978		
Total Exvessel Value	**$4,564,413**		
SEAK Recreational Fishery	**Chinook Harvest Reduction**	**Economic Impact per Day Saltwater Fishing**	**Total Economic Impact**
Sport	29,701	$504	**$7,484,652**
Total Catch Reduction	29,701	Assume 2 Chinook harvested per day	

Alternative 4 would substantially reduce Chinook salmon harvest beyond existing management agreements (e.g. PST) and further reduce fishing opportunities in an already depressed community suffering from the long-term decline of Chinook salmon. A foregone harvest of 267,271 Chinook salmon annually in US salmon fisheries would be devastating. The annual funding of $6.2 million dollars associated with the current federal prey increase program would only equate to 24% of the minimum annual economic losses ($25.4 million) of Chinook salmon fishery harvest in the affected communities under the scenario of meeting prey increase program goals.

Alternative 4 would have the highest adverse impacts on socioeconomics and is considered to be significant to the affected communities. Alternatives 1,2, and 3 all have significantly lower socioeconomics adverse effects because fishery harvest is not constrained beyond existing regulatory regimes; compared to Alternative 4.

4.6. Effects on Environmental Justice

As described in Chapter 3, Affected Environment, Native American tribes and other local communities throughout the project area may experience disproportionate effects from the alternatives as it relates to environmental justice concerns. These communities rely upon salmon, SRKWs, and other natural resources for their survival, livelihood, ceremonial and subsistence, nutrition, and fishery harvest activities to support their cultural, spiritual, and in general, their well-being and way of life.

4.6.1. Alternative 1 (No Action): No Funding for Prey Increase Program

Under Alternative 1, the following ecological, cultural, economic, and social effects on environmental justice communities would be expected in both the short and long term:

- The elimination of funding to increase prey availability for SRKWs is of significant importance and interest to Native American tribes throughout the analysis area who depend upon SRKWs for a variety of reasons.
- No increased abundance of Chinook salmon from the prey increase program (of either natural-origin or hatchery-origin) beginning in 2024 and beyond. This would result in a lower number of salmon which is important to Native American tribes for cultural, ceremonial, and subsistence interests as described in section 4.2.1. These salmon would be available to Native American tribes for potential harvest after being available for SRKWs in marine waters.
- No increased abundance of Chinook salmon from the prey increase program beginning in 2024 and beyond in rural and impoverished local communities throughout the analysis area for important cultural and economic interests. These additional salmon would have been available to affected communities after being available as prey to SRKWs in marine waters.
- A potential impact to environmental justice communities from the employment of full-time and seasonal employees associated with Chinook salmon hatcheries and the funding of the prey increase program salmon.

- No benefit to environmental justice communities from increased fisheries targeting Chinook salmon that increase the local purchase of supplies such as fishing gear, camping equipment, consumables, and fuel at local businesses; these increases would benefit environmental justice communities.
- Alternative 1 would no longer provide additional benefits from the prey increase program on environmental justice to the affected communities beginning in 2024 and thereafter. There would no longer be additional prey provided for SRKWs compared to the current affected environment.

4.6.2. Alternative 2 (Proposed Action/Preferred Alternative): Hatchery Prey Increase Program

Under Alternative 2, the following ecological, cultural, economic, and social effects on environmental justice communities would be expected in both the short and long term:

- An increase in the abundance of hatchery Chinook salmon available for SRKWs, which is of significance to Native American tribes for cultural and spiritual reasons.
- A potential increase in the amount of Chinook salmon potentially available to Native American tribes for cultural, ceremonial, and subsistence interests after the salmon are available as prey to SRKWs in marine waters.
- A potential benefit to the health and status of SRKWs from increased prey availability, which is important to Native American tribes for spiritual, ecological, and other reasons.
- A potential increase in beneficial impact to environmental justice communities from the purchase of goods and services to support Chinook salmon fisheries.
- A positive impact to environmental justice communities from the employment of full-time and seasonal employees associated with Chinook salmon fisheries.
- A potential increase in impact to environmental justice communities from fisheries targeting hatchery salmon that increase the local purchase of supplies such as fishing gear, camping equipment, consumables, and fuel at local businesses; these increases would benefit environmental justice communities from increased salmon abundance after being available as prey for SRKWs in marine waters.

Therefore, Alternative 2 would have medium positive impacts on environmental justice. Given the tribal and other community demographic parameters of concern for environmental justice, this would likely be a significant benefit (NWIFC 2023). Alternative 2 would provide substantially more benefits, with least amount of harm compared to alternatives 1, 3, and 4.

4.6.3. Alternative 3: Habitat-based Prey Increase Program

Under Alternative 3, the following ecological, cultural, economic, and social effects on environmental justice communities would be expected in both the short and long term:

- A potential increase in the amount of Chinook salmon potentially available to Native American tribes; albeit likely to be low over the short term compared to Alternative 2, with longer term benefits from restoration work, habitat improvement, and increased natural production of salmon.
- A potential increase in beneficial impact to other local communities over the longer term from the purchase of goods and services to support Chinook salmon fisheries, after the salmon are available as prey for SRKWs in marine waters.
- Some increase in impact to environmental justice communities from the employment of full-time and seasonal employees associated with Chinook salmon fisheries over the long term.
- A potential increase in impact to environmental justice communities from fisheries targeting natural salmon that increase the local purchase of supplies such as fishing gear, camping equipment, consumables, and fuel at local businesses; these increases would benefit environmental justice communities.

Therefore, Alternative 3 would have low potential benefits to environmental justice. Given the tribal and other community demographic parameters of concern for environmental justice, this would likely be a low but significant impact (NWIFC 2023).

4.6.4. Alternative 4: Reduced Fishing to Increase Prey

Under Alternative 4, two scenarios were modeled for fishery reductions to increase prey availability for SRWKs according to current federal funding level and prey program goals and have significantly different effects on environmental justice. The first scenario used the current average federal funding of $6.2 million dollars allocated for the prey increase program to help compensate for fishery harvest reductions. In our analysis, these reductions in fishery harvest ranged 42,000 to 83,000 Chinook salmon annually in commercial, tribal, and sport fisheries across the Pacific Northwest and SEAK (Table 18).

This would equate to a significant impact to tribal and rural communities dependent upon salmon fisheries (NWIFC 2023).

The second scenario reduced fishery harvest needed to approximate the prey increase program goals of 4-5% additional prey availability for SRKWs (salmon not harvested). These reductions averaged 267,000 salmon annually from commercial, tribal, and recreational fisheries in the Pacific Northwest and SEAK. The minimum economic loss of this scenario is at least $25 million annually (section 4.5.4). This scenario would result in major significant impacts to all affected tribal and rural communities throughout the analysis area.

Both of these scenarios represent significant impacts to Native American tribes in the SEAK and Pacific Northwest regions, who are already severely impacted from declines in regional Chinook salmon abundance and reduced fishing opportunities for ceremonial, subsistence, cultural, and commercial interests. In addition, the local communities throughout the analysis area rely upon Chinook salmon and the fisheries to the same extent. These environmental justice communities would be significantly impacted both of these fishery reduction scenarios.

Under Alternative 4, the following ecological, cultural, economic, and social effects on environmental justice communities would be expected in both the short and long term:

- An increase in the abundance of adult Chinook salmon available for SRKWs which is of importance to Native American tribes for cultural and spiritual reasons.
- A substantial decrease in the amount of Chinook salmon potentially available to Native American tribes for cultural, ceremonial, and subsistence fisheries interests from the fishery reductions in SEAK, NOF, WAC, and PS Chinook salmon fisheries (Table 18; Table 20.).
- A substantial decrease in beneficial impact to other local communities from the purchase of goods and services to support Chinook salmon fisheries.
- A substantial decrease in impact to environmental justice communities from the employment of full-time and seasonal employees associated with Chinook salmon fisheries.
- A substantial decrease in impact to environmental justice communities from fisheries targeting hatchery salmon that increase the local purchase of supplies such as fishing

gear, camping equipment, consumables, and fuel at local businesses; these increases would benefit environmental justice communities.

Therefore, Alternative 4 would have high adverse impacts on environmental justice tribal and non-tribal communities throughout the project area. Given the demographic parameters of concern for environmental justice, this would likely be a significant impact.

5. Cumulative Impacts

5.1. Introduction

As described in Chapter 3, Affected Environment, and Chapter 4, Environmental Consequences, ascertaining the effects of a prey increase program for SRKWs, whether via hatchery (Alternative 2) or natural (Alternative 3) is extremely complicated due to the life cycle of salmon in the wild, in a variety of habitats (freshwater and ocean), interacting with a host of aquatic and terrestrial species, under highly variable environmental conditions that can affect the salmon's survival by orders of magnitude at every life stage. The environments of a salmon are not static in space and time, and fluctuate greatly, making the effects of the actions also variable in space and time. All of these factors must be taken into account when describing the cumulative effects of the preferred alternative.

The central issue being analyzed in this PEIS is the insufficient amount of salmon prey currently available for endangered SRKWs and offsetting the effects of declining Chinook salmon abundances and PST fisheries. Prey availability for SRKWs is still a key limiting factor/threat impeding the recovery of this species. The insufficient production of salmon available in marine areas for SRKWs is the symptom of other problems currently affecting the production of salmon throughout all of their life stages. Salmon runs throughout the project area have declined significantly over the last 30 years in particular due to a whole host of factors (NWIFC 2023). The health of SRKWs is tied to the health of salmon runs. The health of salmon runs is tied to the health of their freshwater and marine habitats in which they need to survive and reproduce. This cumulative effects analysis describes this complicated situation from this perspective.

5.2. Past, Present, and Reasonably Foreseeable Future Actions

By definition, cumulative impacts analyses for NEPA documents must include a consideration of the reasonably foreseeable future activities, in addition to the impacts from NMFS' proposed action (Chapter 4) and all other actions taken within the affected environment (Chapter 3). The proposed action for hatchery production, as described above, is only a low proportion of the total hatchery fish releases funded through other sources that will occur into the foreseeable future. Other actions affecting SRKW and salmon survival and productivity will also occur across the region into the foreseeable future. The expected effects of human activities on the natural environment, which in turn affects SRKWs and salmon, is not likely to decrease into the foreseeable future throughout the region as a whole, as human population growth continues to increase, and the corresponding development and impacts on the natural environment continue to increase. Below is a list of reasonably foreseeable future actions that may contribute negatively or positively to a cumulative effect to the natural or human environment across the region:

- The analysis area has experienced unprecedented effects from climate change to the physical and biological processes over the last decade which in return affects salmon, SRKWs, and the ecosystems upon which they depend (Crozier et al. 2021). At a large, ecosystem scale, warming temperatures, lower precipitation, lower streamflows, and drought conditions have severely impacted terrestrial and aquatic environments. The abundance and productivity of salmon across the landscape has and will continue to be severely impacted by climate change into the foreseeable future. The marine environment will continue to be severely affected as well which has much bearing on salmon survival and SRKWs.
- Coastal development in the United States has increased steadily since the 1960s. There are only 254 counties (out of 3,142 total nationwide) situated on the coast, yet these counties contain almost a third of the U.S. population, and are home to intense concentrations of economic and social activity. Degradation or development of existing natural areas, or disruption of natural processes through increased human activity, all have the potential to impact the affected area and specifically project sites and resources during implementation of the preferred alternative or after restoration has been completed.
- Natural disasters and climate-related impacts could cause major devastation to coastal communities and natural resources. Wildfires throughout the region are widespread and impact the condition of freshwater habitats for salmon. Large-scale physical damage to the natural and human environment that can result, but of how government agencies (federal, state, and local) and citizens mobilize resources and shift priorities to address impacted areas. A shift in priorities, as well as the physical degradation or damage to natural resources, could have a meaningful impact on how the preferred alternative is implemented. Similarly, changes in weather patterns or other meteorological shifts may impact salmon survival and ultimately change where and when an alternative is implemented. For example, extended drought may nullify the efforts of watershed revegetation and in-stream habitat construction projects, and changes in ocean conditions may modify migratory fish behavior. Production of hatchery fish may have to be modified based upon water quality concerns at existing hatchery facilities that are not as favorable to fish survival as previously.

- Natural resource management regimes may shift to include greater or fewer species being proposed or listed under the Endangered Species Act (and subsequently their critical habitat designations) or within fishery management plans (and subsequently their essential fish habitat designations). The amount of salmon restoration funds for habitat projects may decrease in the future as budget and funding changes.
- Public and private funding availability that is normally used to implement restoration may expand or contract. Depending on how such changes come to pass could impact the hatchery facilities in which the preferred alternative is implemented.
- State environmental conservation programs that regularly conduct on-the-ground projects within the affected environments of the proposed action could contribute to a cumulative effect. Fish stocking, invasive species removal, land acquisition, and stormwater management actions performed by state programs may enhance the benefits of the restoration of salmon habitats.
- Ocean and freshwater tribal, commercial, and recreational fisheries will likely continue to be implemented according to applicable fishery management plans approved under the MSA or other authorities. The PST prescribes the allowable exploitation rates on various Chinook salmon stocks throughout the analysis area depending upon annual abundance estimates for the particular fishery, and each party of the PST must implement the fisheries management framework domestically, through the MSA or other authorities. These fisheries will continue into the future.

5.3. Climate Change

Climate change is exerting substantial and interconnected effects on salmon, SRKWs, and the ecosystems upon which they depend. The rise in global temperatures has led to warmer ocean waters, impacting the physiology, migration patterns, and reproduction of most salmon stocks and consequently SRKWs. Additionally, the absorption of excess carbon dioxide has caused ocean acidification, affecting the development of salmon, particularly during their early life stages, and influencing the availability of prey species. Disruptions in ocean currents due to climate change can alter the distribution of nutrients and prey crucial for salmon, while rising sea levels are transforming coastal habitats vital for salmon spawning and rearing. Changes in food availability, influenced by climate-induced shifts, further affect the survival and growth of salmon populations. Extreme weather events, such as storms and floods, are becoming more frequent and intense, posing direct and indirect threats to salmon habitats and migration routes. The melting of glaciers, a consequence of climate change, is impacting the cold, nutrient-rich environments that support salmon habitats. Additionally, habitat loss, driven by climate change, affects critical areas like wetlands and estuaries, limiting the available spaces for salmon to spawn and rear. Warmer waters also facilitate the spread of diseases and parasites, posing additional challenges to salmon populations. In essence, climate change is presenting a complex set of challenges that collectively jeopardize the life cycle, distribution, and overall abundance and productivity of salmon, and the availability of salmon as prey for SRKWs.

5.4. Cumulative Effects by Resource

5.4.1. Chinook Salmon and Their Habitats

Chapter 3, Section 3.2, Affected Environment, describes the baseline conditions for Chinook salmon. This includes the biological status of Chinook salmon and their habitats and current hatchery and harvest effects in the present baseline. These conditions are the result of many years of habitat loss and degradation, development, land management, fishery harvest, and hatcheries (Lackey et al. 2006). The expected direct and indirect effects of the alternatives on Chinook salmon are described in Chapter 4, Section 4.3, Effects on Chinook Salmon and Their Habitat. The expected future actions are described in Section 5.2 above. This section describes the cumulative effects of the proposed action on Chinook salmon and their habitats as it relates to the key aspect of increasing the prey availability for SRKWs.

Chinook salmon will continue to face significant challenges throughout the analysis area related to conservation and recovery of natural populations and their habitats. Continued habitat loss and degradation is likely to continue into the foreseeable future. Recovery actions aimed at mitigating and even slowing these declines will also occur into the future. Climate change impacts on summer stream temperatures, lower streamflow during critical life stages in freshwater, and warmer temperatures even through the winter will all impact Chinook salmon growth and survival while in freshwater. Hatchery salmon will even experience these conditions as hatchery facilities raise the salmon from natural water supplies from adjacent rivers and streams. Hatchery fish will also experience altered stream conditions after the fish are released from the hatcheries and emigrate through freshwater habitats to the ocean. Fishery harvest in marine and freshwater areas will continue to affect Chinook salmon with varying cumulative exploitation rates depending upon the stock. There will be continued pressures on both natural- and hatchery-origin Chinook salmon into the future throughout the analysis area.

Alternative 2, the hatchery prey increase program, is the preferred alternative in this EIS. The effects of this additional hatchery production is relatively minor, within the larger context of existing hatchery production for Chinook salmon throughout the analysis area. Chinook salmon natural populations and their habitats will continue to face challenges from a range of effects of pHOS and habitat degradation even in the absence of the hatchery prey increase program. Washington state also has produced hatchery Chinook salmon to increase Chinook prey availability for SRKW as described in Chapter 3, Affected Environment. The combined effects of both federal and state funding for hatchery production to increase prey for SRKWs is currently approaching the original goals established for this program by Dygert et al (2018); a meaningful increase in prey availability of 4-5% and the thought at that time was that this could be attained by additional 20 million hatchery smolts released. In recent years, 2022 and 2023, the combined effects of the federal and state funding for prey production is approaching this goal with releases at approximately 20 million in 2023 (Table 6; Figure 9). Alternative 2 considers a range of federal funding for production (from current funding to program goals), that would result in production of up to 20 million hatchery smolts at the high end of the range. We assume that because the combined federal and state funding as of 2023 is providing for the prey increase goal of 4-5% more adult Chinook, the high end of the Alternative 2 range would only occur if state funding were eliminated, thus higher federal funding would not increase combined production beyond 20 million smolts, but would make up for any reduction in state funding.

Hatchery effects on Chinook salmon will continue, regardless of the proposed action/preferred alternative/status quo. The additional hatchery production resulting from combined state and federal funding represents a maximum of 11-14% of the total regional releases of juvenile hatchery Chinook salmon (Figure 6; Figure 7; Figure 9). Depending upon the baseline conditions of pHOS in the natural population before the prey increase program was initiated, the percent increase in pHOS attributable to the cumulative prey increase funding (federal and state) is likely less than 14% for affected natural populations at the maximum prey increase program level. The greatest percent increases in pHOS from Alternative 2 is expected in populations with the lowest pHOS (Figure 12).

Our analysis discloses the effects of these releases at a programmatic level, and the overall effects on Chinook salmon and their habitats. The effects of the hatchery releases are additive to the existing baseline conditions of which hatchery effects are a part. Most of the natural populations throughout the analysis area have pHOS levels that are not affected by the hatchery prey increase program (federal and state) because these hatchery fish are not released in these areas (Table 13). Figure 4 and Figure 5 show the limited number of prey increase program hatchery facilities within the larger context of hatcheries throughout the region. The cumulative effects of the prey increase program (federal and state) on

Chinook salmon and their habitats, within the larger existing context of hatcheries, is not significant. Current challenges with Chinook salmon recovery will continue even without the hatchery prey increase program.

Alternatives 1, 3, and 4 do not rely upon hatchery production to the same degree as Alternative 2. Alternative 1 would not continue federal funding for the purpose of increasing prey for SRKW; but state funding through the Washington legislature could continue at their discretion. The other alternatives provide funding for natural recovery and fishery reduction. The cumulative effects of these potential actions could provide some help to Chinook salmon over the short- and long-terms, but it is not likely to be significant due to the scope of the limited funding over the larger landscape of Chinook salmon recovery throughout Washington, Idaho, and Oregon.

5.4.2. Southern Resident Killer Whales

This section describes the cumulative effects to SRKWs of other actions taken in the affected environment as they relate to all threats to SRKWs, including those that impact prey availability in marine and estuarine waters.

NMFS, in coordination with its multiple partners, has implemented targeted management actions identified in the SRKW recovery plan (NMFS 2008a) and informed by research. Transboundary efforts between the U.S. and Canada have occurred to address all the threats identified in the recovery plan. Since 2019, Canada has implemented annual conservation actions geared towards SRKWs including area-based fishery closures, interim sanctuary zones, and both voluntary initiatives and mandatory vessel regulations as part of interim orders to protect the whales. Interim measures have been released for 2023,[8] and are designed to reduce vessel- and prey-related threats for SRKWs when in the Salish Sea.

Harvest

Chinook salmon are the primary prey of SRKW throughout their geographic range, which includes the analysis area. The abundance, productivity, spatial structure, and diversity of Chinook salmon are affected by a number of natural and human actions, and these actions also affect prey availability for SRKWs. As discussed in Section 3.3, the abundance of Chinook salmon now is significantly less than historic

[8] https://www.pac.dfo-mpo.gc.ca/fm-gp/mammals-mammiferes/whales-baleines/srkw-measures-mesures-ers-eng.html

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. Details regarding current conditions of ESA-listed Chinook salmon in the analysis area are described above in Section 3.2.

Salmon fisheries that intercept fish that would otherwise pass through the analysis area and become available prey for SRKWs occur all along the Pacific Coast, from Alaska to California. Past, current, and future harvest actions, including Puget Sound salmon fisheries (NMFS 2019), PFMC-area salmon fisheries (PFMC 2023), the Pacific Salmon Treaty 2009 Agreement (NMFS 2008h), the southeast Alaska salmon fisheries (NMFS 2019), and the U.S. v. Oregon Management Agreements, have short-term and long-term effects on SRKWs via prey reduction from fishery operations. In conducting ESA Section 7 consultations on these actions, 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. Additionally, the PFMC groundfish fisheries catch Chinook salmon as bycatch, and the most recent Biological Opinion found the PFMC groundfish fishery is likely to adversely affect, but not jeopardize, ESA-listed Chinook salmon (NMFS 2017).

In 2021, the PFMC adopted Amendment 21 to address effects of PFMC-area ocean salmon fisheries on the Chinook salmon prey base of SRKWs. The Amendment established a threshold representing a low pre-fishing Chinook salmon abundance in the NOF area (including the EEZ and state ocean waters), below which the PFMC and States will implement specific management measures (NMFS 2023).

Hatcheries

Hatchery production of salmonids has occurred for over a hundred years. 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 analysis area. Many of these fish contribute to both fisheries and the SRKW prey base in coastal and inland waters of the analysis area.

NMFS has completed Section 7(a)(2) consultations on more than two hundred hatchery programs (Doremus and Friedman 2021); refer to Appendix C, Table C.1). A detailed description of the effects of these hatchery programs can be found in the site-specific Biological Opinions referenced in Appendix C, Table C.1). Additionally, a description of the effects of hatchery production receiving federal funds to increase SRKW prey is included in site specific ESA and NEPA documents for the funded programs (NMFS 2020, 2021, 2022). These effects are further described in Appendix C of NMFS (2018c), which is incorporated here by reference. Currently, hatchery production is a significant component of the salmon prey base within the range of SRKWs (Barnett-Johnson et al. 2007); NMFS 2019). As described in Section 3.3, the Washington State Legislature has provided approximately $13 million annually since 2019 for SRKW prey hatchery production, and has committed to continue until at least 2025.

Habitat

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 analysis area. Many of these activities have a federal nexus and have undergone Section 7(a)(2) consultation. Those actions have nearly all met the standard of not jeopardizing the continued existence of the listed salmonids or adversely modifying their critical habitat, and when they did not meet that standard, NMFS identified RPAs.

Activities that NMFS has consulted on that affect salmon habitat, and therefore also likely limit prey available to SRKWs, include hydropower projects (Mud Mountain Dam (NMFS 2014b), Howard Hanson Dam, Operation, and Maintenance (NMFS 2019c)), Klamath Project Operations (NMFS 2019) and decommissioning (NMFS 2021), the National Flood Insurance program (NMFS 2008b), marine construction (NMFS 2020a; 2021l; 2022c), and the Salish Sea Nearshore Programmatic (NMFS 2022i).

In 2020, 2021, and 2022, NMFS issued Opinions for 39 (NMFS 2020a), 11 (NMFS 2021l), and 15 (NMFS 2022c) habitat-modifying projects in the nearshore marine areas of Puget Sound. The Opinions concluded that the proposed action would jeopardize the continued existence of, and adversely modify critical habitat for, Puget Sound Chinook salmon and SRKWs. The expected improvements to Chinook salmon abundance resulting from implementation of the RPAs and conservation offsets as implemented under the Salish Sea Nearshore Programmatic Opinion (NMFS 2022i) for pending projects are expected to improve the amount of prey available for SRKWs and avoid jeopardy and adverse modification for SRKWs and their critical habitat.

In 2021, NMFS consulted on the removal of four dams on the mainstem Klamath and associated activities such as infrastructure modifications, removal, and reservoir drawdown, that impact Chinook salmon habitat (NMFS 2021). While temporary impacts to Chinook salmon are expected due to hatchery phase-out and short-term habitat degradation, long-term benefits to the SRKW prey base are expected due to increased natural-origin Chinook salmon production and survival.

The funding initiative for U.S. domestic actions associated with the 2019-2028 PST Agreement (Pacific Salmon Commission 2022) included funding for habitat restoration projects to improve habitat conditions for specified populations of Puget Sound Chinook salmon ($31.2 million over 3 years; FY 2020-2022). In FY20, FY21, and FY22, $8.9 million, $8.8 million, and $8.8 million, respectively, was directed at habitat restoration projects within the northern boundary watersheds of Nooksack, Skagit, Stillaguamish, Snohomish, Dungeness, and Mid-Hood Canal. Projects were selected according to a list of preferred criteria, one of which included projects that supported high priority Chinook salmon populations for SRKW. As a result of improving habitat conditions for these populations, we anticipate Puget Sound Chinook salmon abundance would increase and thereby benefit SRKWs in the long term.

Vessels

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.

The physical and noise disturbance due to vessels may interfere with the ability of SRKW to detect, locate, and capture prey in their environment, and as such have an effect on prey availability as experienced by the whales. This effect may be amplified when prey abundance is low, preventing SRKW from accessing the little prey that is available. There are currently federal and state regulations in place in Washington State waters of the Salish Sea. A Washington state law was signed in 2019 increasing vessel viewing distances from 200 to 300 yards to the side of the whales and limiting vessel speed within ½ nautical mile of the whales to seven knots over ground. This state law (Senate Bill 5577) also established a commercial whale watching license program and charged WDFW with administering the licensing program and developing rules for commercial whale watching by January 2021 for inland Washington waters (see RCW 77.65.615 and RCW 77.65.620). On December 18th, 2020, new commercial whale watching rules were adopted that took effect in 2021. These rules specify that commercial whale watching occur at distances of <0.5 nautical mile from July-September during two 2-hr time periods in the day for no greater than three vessels at once, make the no-go zone on the west side of San Juan island mandatory for commercial whale watching, and establish training, reporting, monitoring, and license procedures.[9] There is also an exclusion from approaching a group with a calf under one year old or an otherwise vulnerable, e.g., pregnant or malnourished, individual. Senate Bill 5918 amends RCW 79A.60.630 to require the state's boating safety education program to include information about the Be Whale Wise guidelines, as well as all regulatory measures related to whale watching, which is expected to decrease the effects of vessel activities to whales in state waters. WDFW submitted a report to the State Legislature in November 2022 about the effectiveness of state regulations for SRKW, including general vessel regulations and those associated with the commercial whale watching license program. That report summarized relevant information and results from public survey and focus group engagement. The analysis of all input resulted in WDFW recommending an expansion of the buffer distance for all vessels to 1000 yards from SRKWs. That recommendation became Senate Bill 5371, and was signed by Governor Jay Inslee in May 2023, to go into effect in 2025.

Contaminants and Oil Spills

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. Chinook salmon contain higher levels of some contaminants than other salmon species, however levels can vary considerably among populations. Mongillo et al. (2016) reported data for salmon populations along the west coast of North America, from Alaska to California, and found marine distribution was a large factor affecting persistent pollutant accumulation. They found higher concentrations of persistent pollutants in Chinook salmon populations that feed in close proximity to land-based sources of contaminants. There is some information available for contaminant levels of Chinook salmon in inland waters (i.e., Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016). Some

[9] https://wdfw.wa.gov/species-habitats/at-risk/species-recovery/orca/rule-making

of the highest levels of certain pollutants were observed in Chinook salmon from Puget Sound and the Harrison River (a tributary to the Fraser River in British Columbia, Canada) (Mongillo et al. 2016). These populations are primarily distributed within the urbanized waters of the Salish Sea and along the west coast of Vancouver Island (DFO Canada 1999; Weitkamp 2010). 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. 2023).

SRKWs are vulnerable to the risks imposed by an oil spill. There is some level of risk from serious spills in the analysis area because of the heavy volume of shipping traffic and proximity to petroleum refining centers. The total volume of oil spills in inland waters of Washington has increased since 2013 and inspections of high-risk vessels have declined since 2009 (WDOE 2017). The total volume of oil spills was less in 2017-2019 than in 2015-2017 but still higher than previous years (WDOE 2019).

In 2021, NMFS consulted on the reauthorization of the North Wing pier at the British Petroleum (BP) Cherry Point refinery (NMFS 2021a). This Opinion concluded that the action was likely to adversely affect but not likely to jeopardize the survival and recovery of SRKW or adversely modify their critical habitat. The action does result in an incremental increase in risk of large oil spills. However, the oil spills most likely to occur would be substantially smaller in magnitude than the size likely to be catastrophic to SRKW according to Lacy et al. (2017). Ongoing smaller spills are likely to continue but these are not expected to occur at a frequency or magnitude that would indirectly or directly expose SRKW to acute toxicity or significantly affect toxin accumulation through prey.

5.4.3. Other Fish and Wildlife Species

The primary fish and wildlife species of concern are Stellar sea lion, California sea lion, harbor seal, and Puget Sound/Georgia Basin yelloweye and bocaccio rockfish. With the exception of ESA-listed rockfish, the other species are near carrying capacity and considered healthy. All of the alternatives will have minimal effects on these species because Chinook salmon (hatchery or natural) are not the prey these marine mammals depend upon throughout their lives, and the larger environmental effects controlling marine productivity and predator-prey dynamics will be the key drivers for these species in the future. Given the opportunistic behavior of these marine mammals to take advantage of prey throughout their entire life, none of the alternatives are expected to drastically change the future outlook for these species.

Climate change, and the effects on ocean productivity off the west coast of the U.S., will continue to be the key determinant for the health of these species.

For ESA-listed rockfish in Puget Sound/Georgia Basin, none of the alternatives will result in a significant impact to these species because the expected impacts are short-lived and of low intensity. The larger environmental effects and key limiting factors/threats will continue into the foreseeable future for these species in the absence of the prey increase program.

5.4.4. Socioeconomics

The effects of the alternatives on socioeconomics are significantly different. Alternative 4 impacts affected communities significantly from the reduction of Chinook salmon harvest. The amount of fishery harvest reduction to reach a similar benefit as the hatchery prey increase program was substantial. Entire fishery seasons had to be closed, with an additional 15% reduction in all Chinook fisheries in the summer period. The affected communities in SEAK and off the coasts of Washington and Oregon have suffered from the decline in Chinook salmon abundances, and subsequent reductions in fisheries, for more than three decades. The PST agreement in 2019 further reduced these fisheries with additional socioeconomic impacts. Alternative 4 applies additional socioeconomic impacts to an already depressed fishery situation across the entire analysis area. The intent of the prey increase program was to mitigate for these fishery losses on affected communities and Alternative 2 provides substantial fishery mitigation while meeting the needs of SRKWs. Going into the foreseeable future, Chinook salmon will continue to face significant pressures, and the fisheries will have to be adjusted according to their abundances, which could mean that additional reductions will have even greater socioeconomic effects.

The socioeconomic impacts vary among the alternatives. Alternative 2 provides for attaining the biological goals of the prey increase program for SRKWs, while minimizing concurrent impacts to environmental justice communities. Alternative 4 reduces fishery harvest in already impoverished and affected communities from declines in Chinook salmon and would result in significant cumulative effects from decades of declining salmon runs, reduced commercial, tribal and recreational fisheries, and adding additional fishery harvest burdens into the future.

5.4.5. Environmental Justice

The effects of the alternatives on environmental justice are significantly different. Alternative 4 impacts affected communities significantly from the reduction of Chinook salmon harvest. Alternative 2 provides funding for many tribes throughout the analysis area and helps maintain important ceremonial, subsistence, and other uses for the tribes and other rural communities. Chinook salmon, and the tribal and non-tribal fisheries supported by these runs, have declined significantly over the last three decades in particular. Tribal fisheries are guaranteed by federal treaties with tribes and are a necessity of life both spiritually and physically. These concerns will continue into the foreseeable future as Chinook salmon runs continue to be in trouble. Long-term support for Chinook salmon recovery is still the most important aspect to guarantee tribal treaty rights and help support other rural communities depend upon natural resources for their way of life, health, and prosperity.

The environmental justice impacts vary among the alternatives. Alternative 2 provides for attaining the biological goals of the prey increase program for SRKWs, while minimizing concurrent impacts to environmental justice communities. Alternative 4 reduces fishery harvest in already impoverished and affected communities from declines in Chinook salmon and would result in significant cumulative effects from decades of declining salmon runs, reduced commercial, tribal and recreational fisheries, and adding additional fishery harvest burdens into the future.

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8. INDEX

9. APPENDIX A FEDERAL PRODUCTION PREY INCREASE PROGRAM 2020-2022

Copy of A. Purcell memo to file, dated September 1, 2022, status update on the hatchery production initiative for Southern Resident Killer Whale.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

September 1, 2022

To: Memo to File for Biological Opinion on the Delegation of Management Authority for Specified Salmon Fisheries to the State of Alaska

From: Allyson Purcell
Branch Chief, Hatcheries and Inland Fisheries
West Coast Region

PURCELL.ALLYSON.O.1365850964 Digitally signed by PURCELL.ALLYSON.O.1365850964 Date: 2022.09.30 17:27:29 -07'00'

Subject: Status Update on the Hatchery Production Initiative for Southern Resident Killer Whale[1]

Introduction

The Pacific Salmon Treaty (PST) provides a framework for the United States and Canada to cooperate on the management of Pacific salmon. A high degree of cooperation is required to prevent overfishing, provide optimum production, and ensure that each country receives benefits that are equivalent to the production of salmon in its waters. In 2019, the National Marine Fisheries Service (NMFS) completed a biological opinion on the effects of domestic actions associated with implementing the 2019-2028 PST Agreement (NMFS 2019). One of the domestic actions associated with implementation of the new PST agreement was the delegation of management authority for specified salmon fisheries to the state of Alaska. Another domestic action was to increase hatchery production to provide additional prey for endangered Southern Resident killer whales (SRKW). NMFS' 2019 biological opinion describes this latter action as follows:

> A preliminary design of the SRKW hatchery production program was developed, and is described below, in order to provide cost estimates and further definition for how the program should be designed and implemented to achieve the "meaningful increase" in prey availability that is intended. The preliminary design should be used as a benchmark for evaluating the program that will presumably be funded and implemented. However, there is flexibility to adjust the design to account for new information so long as the key objective of the program is met. By key objective we focus in particular on the intention to increase prey availability by 4-5 percent in areas that are most important to SRKWs as described below.
>
> The new production should be distributed broadly to supplement prey abundance in Puget Sound in the summer and offshore areas in the winter, times and areas that have been identified as most limiting. The hatchery production program would operate each year at a cost of no less than $5.6 million per year including an adjustment for administrative overhead. The goal of the hatchery production initiative for supplementing prey abundance is to provide a "meaningful" increase in the abundance of age 3-5 Chinook salmon in the times and areas most important to SRKWs. It would be prioritized to increase abundance in inside areas (Puget Sound) in the summer and

[1] The Hatchery Production Initiative for SRKW is also referred to as the prey increase program. These terms are used interchangeably by NMFS.

outside areas (coastal) during the winter where we believe prey abundance is most limiting (Dygert et al. 2018). For the estimated cost per year an additional 20 million Chinook salmon smolts could be expected. Five or six million smolts should come from facilities in Puget Sound with the remainder from the Washington coast and Columbia River. This disproportionate distribution results from the fact that the abundance of Chinook salmon in the ocean is about three times higher than it is in the Puget Sound. Increasing production by 20 million smolts with the above described distribution is expected to increase prey abundance by 4-5 percent in inside areas in the summer and coastal areas in the winter (Dygert et al. 2018).

For purposes of this analysis, we assume that funding for the conservation program for Puget Sound Chinook salmon and SRKW will be forthcoming largely as described and the program will be implemented during the duration of the new Chinook salmon regime as proposed. The benefits from reduction in harvest in SEAK and other fisheries resulting from the new PST Agreement will be effective immediately. However, it is important to note that the effects assumed in the analysis related to the funding initiative will not take place for at least four to five years into the future as funding is attained, fish from the conservation hatchery programs reach maturity in the oceans and productivity improvements are realized from the habitat mitigation. We recognize that there is a degree of uncertainty regarding whether Congress will provide the funding, in whole or in part, that was agreed to by the U.S. Section in a timely manner. In the event the required funding is not provided in time for actions to take effect during the agreement, or if the anticipated actions are not otherwise implemented through other means (e.g., non-fishing related restoration activities, other funding sources) this may constitute a modification to the proposed action that could result in effects on Puget Sound Chinook salmon and SRKW not considered in this opinion. If this was answered in the affirmative, reinitiation of consultation would therefore be required. See 50 CFR section 402.16(c). We expect this opinion and ITS to remain in place during the interim should reinitiation occur.

Washington State Funding for SRKW Prey

In response to recommendations from the Washington State Southern Resident Killer Whale Task Force (2018), the Washington State Legislature provided ~$13 million of funding "prioritized to increase prey abundance for southern resident orcas" (Engrossed Substitute House Bill 1109) for the 2019-2021 biennium (July 2019 through June 2021). Using these funds, over 10.8 million and 7.6 million additional hatchery-origin Chinook salmon were released to augment the SRKW prey base in 2020 and 2021, respectively from Washington Department of Fish and Wildlife Department, Douglas Public Utility District, and tribal facilities (Table 1). The Washington State Legislature also provided $12.5 million to increase prey abundance for SRKW in the 2021-2023 biennium (July 2021 through June 2023), and more than 11 million additional hatchery-origin Chinook salmon are estimated to be released in 2022 as a result of this funding (Table 2).

The Washington State funding was intended to and has been used to increase production of coho and chum salmon, which are consumed by SRKW in addition to Chinook. With these funds, an additional 1.67 million coho and 1.92 million chum salmon were released in 2020, an additional 3.28 million coho and 3.76 million chum salmon were released in 2021, and an additional 3.375 million coho and 8 million chum salmon are estimated to be released in 2022. Although increased production for coho and chum salmon was not included as part of the proposed action evaluated in the 2019 biological opinion on the delegation of management authority for specified salmon fisheries to the State of Alaska, a recent study (Hanson et al. 2021) found that coho and chum salmon are important prey to SRKW during certain periods of the year.

Federal funding for SRKW Prey: Selection Process and Criteria

In FY20, FY21, and FY22, NMFS solicited proposals for new hatchery production and associated infrastructure from the Treaty tribes of western Washington and the Columbia River Basin, U.S. Fish and

Wildlife Service, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, and other operators of hatchery programs in the region. The following criteria were used to prioritize funding for candidate programs:

- Criteria 1: Increased hatchery production should be for Chinook stocks that are a high priority for SRKW (NMFS and WDFW 2018; Ad-hoc SRKW Workgroup 2020)
- Criteria 2: Increased production should be focused on stocks that are a high priority for SRKW (NOAA and WDFW 2018), but funding should be distributed so that hatchery production is increased across an array of Chinook stocks from different geographic areas and run timings (i.e., a portfolio)
- Criteria 3: Increased production cannot jeopardize the survival and recovery of any Endangered Species Act (ESA)-listed species, including salmon and steelhead
- Criteria 4: Because of funding and timing constraints, increased production proposals should not require major capital upgrades to hatchery facilities
- Criteria 5: All proposals should have co-manager agreement, as applicable
- Criteria 6: All increased production must be reviewed under the ESA and National Environmental Policy Act (NEPA), as applicable, before NMFS funding can be used

FY20 PST Funding for SRKW Prey

For FY20, NMFS allocated $5.6 million of the PST federal appropriation for the Hatchery Production Initiative for SRKW. Of this $5.6 million, $738,509 was reserved by NMFS for administrative costs and the remainder was distributed to hatchery operators.

Table 3 describes the hatchery programs that were funded in FY20. This production is in addition to the hatchery production funded by the Washington State Legislature for the 2019-2021 biennium (Table 1). As a result of the FY20 funding, about 600,000 and over 6.1 million hatchery-origin Chinook salmon were released in 2020 and 2021, respectively. Additionally, over 3.3 million hatchery-origin Chinook salmon produced using the FY 2020 funds are estimated to be released in 2022[2].

FY21 PST Funding for SRKW Prey

For FY21, NMFS distributed almost $6.5 million[3] of the PST Federal appropriation (after overhead removed) for the Hatchery Production Initiative for SRKW.

Table 4 describes the hatchery programs that were funded in FY21 with PST funds. This production is in addition to the hatchery productions funded by the Washington State Legislature for the 2019-2021 and 2021-2023 biennia. As a result of the FY21 funds, about 167,000 and over 4.6 million hatchery-origin Chinook salmon are estimated to be released in 2021 and 2022[1] respectively. Additionally, over 2.3 million hatchery-origin Chinook salmon produced using FY 21 funds are expected to be released in 2023.

FY22 PST Funding for SRKW Prey

For FY22, NMFS distributed $5.4 million (after overhead removed) of the PST federal appropriation for the Hatchery Production Initiative for SRKW. Table 5 contains the final list of projects funded. These

[2] While the estimate number of fish for release in 2022 are the best estimate we have at this point, it is not feasible to count the exact number of individual fish for each release years.

[3] $5.6 million of the NMFS FY21 PST funds were allocated for the Hatchery Production Initiative for SRKW, with $4,723,845 to distribute after NMFS overhead was removed. Combined with $1,743,552 (after overhead is removed) from USFWS, this totals $6,467,397.

projects are expected to result in the release of an additional 11 million hatchery-origin Chinook salmon in the future years.

Conclusion

Table 6 summarizes the total release of hatchery-origin Chinook salmon in 2020, 2021, and 2022 funded via the PST federal appropriation as well as Washington State funds. In 2020, over 11.4 million hatchery-origin Chinook salmon were released as a result of the FY20 federal funding and 2019-2021 Washington State Legislature funding for the Hatchery Production Initiative for SRKW. In 2021, over 13.9 million additional hatchery-origin Chinook salmon were released as a result of the FY20 and FY21 PST funding and 2019-2021 Washington State Legislature funding. In 2022, over 19.3 million additional hatchery-origin Chinook salmon were released as a result of the FY20 and FY21 PST funding and 2021-2023 Washington State Legislature funding. These releases represent increases in production from the base period considered in NMFS' 2019 biological opinion (NMFS 2019; Table 1; Table 2). In addition, an additional 2.25 million coho and 2.42 million chum salmon were released in 2020, an additional 3.11 million coho and 5.43 million chum were released in 2021, and an additional 3.375 million coho and 8 million chum salmon are expected to be released in 2022. Although increased production for coho and chum salmon were not included as part of the proposed action evaluated in the 2019 biological opinion, these salmon are expected to provide additional prey to SRKW.

Overall, appropriated and obligated funding for the Hatchery Production Initiative for SRKW has been higher than what was anticipated in the 2019 biological opinion. In addition, a smaller proportion of the allocated federal funds are expected to be needed for infrastructure upgrades such as marking trailers and backup generators, in future years. Therefore, a higher proportion of the funds should directly support production of Chinook salmon in future years, as seen in the final list of projects for FY22 (Table 5). The 2019 biological opinion acknowledged that the benefits of the funding initiative would not take place for at least four to five years into the 2019-2029 PST Agreement as funding was attained and fish from the hatchery programs reached maturity in the oceans. Based on the numbers of hatchery Chinook produced using federal and state funds, released to date, and expected to be released in the next few years, NMFS concludes that the Hatchery Production Initiative for SRKW is on track to provide the benefits that were anticipated in the 2019 biological opinion.

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Table 1. Washington State Funding for SRKW Prey in the 2019-2021 biennium

Facility	Region	Species	Entity	Increased Proposal	Brood Source	Release Location	2019 Release	2020 Release	2021 Release
Kendall	Puget Sound	Sp. CK	WDFW	500,000	Kendall	Kendall	660,527	421,381	381,725
Whatcom Cr.	Puget Sound	F. CK	WDFW	500,000	Samish	Whatcom Cr.	200,000	670,000	491,747
Hupp Springs	Puget Sound	Sp. CK	WDFW	500,000	Minter	Hupp	259,873	388,909	543,034
Samish	Puget Sound	F. CK	WDFW	1,000,000	Samish	Samish	1,089,148	1,217,867	0
Wallace River	Puget Sound	Sum. CK	WDFW	400,000	Wallace River	Wallace River	-	260,745	0
Wallace River	Puget Sound	Sum. CK	WDFW	100,000	Wallace River	Wallace River	-	34,938	44,158
Soos/Palmer	Puget Sound	F. CK	WDFW	2,000,000	Green River	Palmer	282,638	1,210,986/[a]	-
Marblemount	Puget Sound	Sp. CK	WDFW	400,000	Marblemount	Marblemount	-	203,095	574,408
Sol Duc	WA Coast	Sum. CK	WDFW	500,000	Sol Duc	Sol Duc	500,143	582,479	480,291
Sol Duc	WA Coast	Sum. CK	WDFW	0	Sol Duc	Sol Duc	-	-	67,787
Humptulips *	WA Coast	F. CK	WDFW	500,000	Humptulips	Humptulips	-	-	-
Minter	Puget Sound	F. CK	WDFW	400,000	Minter	Minter	763,333	321,497	332,672
Naselle	WA Coast	F. CK	WDFW	2,500,000	Naselle	Naselle	-	-	1,472,258
Forks Creek	WA Coast	F. CK	WDFW	50,000	Forks Creek	Forks Creek	567,560	2,278,497	257,338
Wells Hatchery	Columbia River	Sum. CK	DPUD	500,000	Wells	Wells Hatchery	0	541,299	482,734
Quinault Lake	WA Coast	F. CK	Quinault Indian Nation	500,000	Quinault	Quinault Lake	-	-	500,000
Sol Duc/Bear Springs	WA Coast	Sum. CK	Quileute Tribe	150,000	Sol Duc	Bear Springs	-	-	147,913
Sol Duc/Bear Springs	WA Coast	Sum. CK	Quileute Tribe	75,000	Sol Duc	Bear Springs	-	70,000	70,758

Facility	Region	Species	Entity	Increased Proposal	Brood Source	Release Location	2019 Release	2020 Release	2021 Release
Wilkeson Creek	Puget Sound	F. CK	Puyallup Tribe of Indians	1,075,200	Voights	Wilkeson Creek	-	728,587	246,849
White River	Puget Sound	Sp. CK	Muckleshoot Indian Tribes	200,000	White River	White River	-	-	167,557
Squaxin/South Sound Net Pens	Puget Sound	F. CK	Squaxin Island Tribe	500,000	Deschutes / Green River	Squaxin/South Sound Net Pens	-	-	-
Lummi Bay Hatchery	Puget Sound	Sp. CK	Lummi Nation	500,000	Kendall	Lummi Bay	-	50,000	222,168
Skookum Creek	Puget Sound	Early CK	Lummi Nation	1,000,000	Skookum Creek	Skookum Cr.	-	870,000	794,626
Klickitat Hatchery	Columbia River	F. CK	Yakama Nation	1,000,000	Klickitat/Little White	Klickitat River	-	1,000,000	-
Lewis River	Columbia River	Sp. CK	WDFW	-	Lewis River	Lewis River	944,425		389,959
TOTAL							**4,323,222**	**10,850,280**	**7,667,982**

[a] Partially funded by PST with FY19 funds

SP CK = spring Chinook; F. CK = fall Chinook; WDFW = Washington Department of Fish and Wildlife

Table 2. Washington State Funding for SRKW Prey in the 2021-2023 biennium

Facility	**Region**	**Species**	**Entity**	**Increased Proposal**	**Brood Source**	**Release Location**	**Estimated 2022 Release**
Kendall	Puget Sound	Sp. CK	WDFW	500,000	Kendall	Kendall	550,000
Whatcom Cr.	Puget Sound	F. CK	WDFW	500,000	Samish	Whatcom Cr.	500,000
Hupp Springs	Puget Sound	Sp. CK	WDFW	500,000	Minter	Hupp	537,000
Samish	Puget Sound	F. CK	WDFW	1,000,000	Samish	Samish	900,000
Wallace River	Puget Sound	Sum. CK	WDFW	400,000	Wallace River	Wallace River	1,046,933
Wallace River	Puget Sound	Sum. CK	WDFW	100,000	Wallace River	Wallace River	0
Marblemount	Puget Sound	Sp. CK	WDFW	400,000	Marblemount	Marblemount	556,000
Sol Duc	WA Coast	Sum. CK	WDFW	500,000	Sol Duc	Sol Duc	585,000
Sol Duc	WA Coast	Sum. CK	WDFW	0	Sol Duc	Sol Duc	75,000
Minter	Puget Sound	F. CK	WDFW	400,000	Minter	Minter	500,000
Naselle	WA Coast	F. CK	WDFW	2,500,000	Naselle	Naselle	2,600,000
Forks Creek	WA Coast	F. CK	WDFW	50,000	Forks Creek	Forks Creek	110,000
Wells Hatchery	Columbia River	Sum. CK	DPUD	500,000	Wells	Wells Hatchery	520,440
Quinault Lake	WA Coast	F. CK	Quinault Indian Nation	500,000	Quinault	Quinault Lake	550,000
Sol Duc/Bear Springs	WA Coast	Sum. CK	Quileute Tribe	75,000	Sol Duc	Bear Springs	75,000
Wilkeson Creek	Puget Sound	F. CK	Puyallup Tribe of Indians	1,075,200	Voights	Wilkeson Creek	400,000
White River	Puget Sound	Sp. CK	Muckleshoot Indian Tribes	200,000	White River	White River	200,000
Squaxin/South Sound Net Pens	Puget Sound	F. CK	Squaxin Island Tribe	500,000	Deschutes / Green River	Squaxin/South Sound Net Pens	0
Lummi Bay Hatchery	Puget Sound	Sp. CK	Lummi Nation	500,000	Kendall	Lummi Bay	525,000
Skookum Creek	Puget Sound	Early CK	Lummi Nation	1,000,000	Skookum Creek	Skookum Cr.	545,000
Klickitat Hatchery	Columbia River	F. CK	Yakama Nation	1,000,000	Klickitat/Little White	Klickitat River	300,000
Lewis River	Columbia River	Sp. CK	WDFW	-	Lewis River	Lewis River	268,950
TOTAL							**11,344,323**

Table 3. Programs that received FY20 PST funding for the Hatchery Production Initiative for SRKW

Facility	Region	Species	Entity	Increased Proposal	Brood Source	Release Location	2020 Release	2021 Release/[a]	2022 Release/[a]	Operating Cost	Infrastructure Cost	Total Cost
Tulalip Bernie Gobin Hatchery	Puget Sound	Sum CK	Tulalip Tribe	1,000,000	Wallace	Tulalip Bay	-	-	1,500,000	$555,914	$783,414	$1,339328
Tulalip Bernie Gobin Hatchery	Puget Sound	Sum CK	RCO overhead	-	N/A	-	-	-	-	-	-	$55,180
Soos Creek Hatchery	Puget Sound	F. CK	WDFW	2,000,000	Green River	Green River	-	2,003,244/[c]	-	$245,559	-	$245,559
Soos Creek Hatchery	Puget Sound	F. CK	RCO overhead	-	N/A	-	-	-	-	-	-	$10,117
Partial funding for NWIFC marking trailer	Puget Sound	All	NWIFC	-	N/A	-	-	-	-	-	$500,000	$500,000
Partial funding for NWIFC marking trailer	Puget Sound	All	RCO overhead	-	N/A	-	-	-	-	-	-	$20,600
Marion Drain Hatchery	Columbia River	Sum. CK	Yakama Nation	500,000	Entiat/ Wells/ Chelan	Yakima River	-	279,594	-	$43,000	-	$43,000
Select-Area Fishery Enhancement (SAFE)	Columbia River	Sp. CK	ODFW	1,320,000/[a]	Willamette River	Youngs Bay or Tongue Point	-	1,657,580	-	$600,000	-	$600,000
SAFE	Columbia River	Sp. CK	ODFW	1,500,000	Willamette River	Youngs Bay or Tongue Point	-	-	1,507,467	$251,477 /[b]	-	$251,477
Umatilla Hatchery	Columbia River	F. CK (URB)	ODFW	120,000	Little White	Umatilla River	117,548	-	-	$30,000	_	$30,000
Parkdale Hatchery	Columbia River	Sp. CK	CTWSR	Not enough BS; Funds need to be reallocated	Hood River	N/A	-	-	-	$31,230	-	$31,230
Round Butte Hatchery	Columbia River	Sp. CK	ODFW	Not enough BS. Funds reallocated to	Deschutes River	N/A	-	-	-	$0	-	$0

Facility	Region	Species	Entity	Increased Proposal	Brood Source	Release Location	2020 Release	2021 Release/[a]	2022 Release/[a]	Operating Cost	Infrastructure Cost	Total Cost
				Bonneville tules								
Bonneville Hatchery	Columbia River	F. CK (tules)	ODFW	200,000	Bonneville Pool	Columbia River	-	344,122	-	$25,000	-	$25,000
Wells Hatchery	Columbia River	Sum. CK	DPUD	500,000	Wells	Columbia River	-	482,734	-	$170,000	-	$170,000
Little White/Willard National Fish Hatchery (NFH)	Columbia River	F. CK (URB)	USFWS	630,000	Little White	Little White River	479,694	-	-	$200,000	-	$200,000
Little White/Willard NFH	Columbia River	F. CK (URB)	USFWS	650,000	Little White	Little White River	-	649,356	-	$165,000	$140,000	$305,000
Little White/Willard NFH	Columbia River	Sp. CK	USFWS	400,000	Spring Chinook	Columbia River	-	-	380,578	$160,000	-	$160,000
Spring Creek NFH	Columbia River	F. CK (tules)	USFWS	2,000,000	Columbia River Gorge tules	Columbia River	-	688,509	-	$360,000	$515,000	$875,000
TOTAL							**597,242**	**6,105,139**	**3,388,045**	**$2,585,703**	**$1,938,414**	**$4,861,491**

[a] Tag codes will be available after the fish are tagged. [b] Additional funding will be needed in FY21 to complete rearing and release of these fish. [c] Partially funded by WDFW
RCO = WA's Recreation and Conservation Office; CTWSR = Confederated Tribes of the Warm Springs Reservation of Oregon; DPUD = Douglas Public Utility District; USFWS = United States Fish and Wildlife Service; ODFW = Oregon Fish and Wildlife Service; NWIFC = Northwest Indian Fisheries Commission; BS = broodstock; URB = Upriver Bright fall Chinook salmon; NFH = National Fish Hatchery; SP CK = spring Chinook; F. CK = fall Chinook

Table 4. Programs that received FY21 PST funding for the Hatchery Production Initiative for SRKW

Facility	Region	Species	Entity	Increased Proposal	Brood Source	Release Location	2021 Release	2022 Release	Anticipated 2023 Release	Operating Cost	Infrastructure Cost	Total Cost
Issaquah Hatchery	Puget Sound	F. CK	WDFW	1,000,000	Issaquah/ Soos Creek	Issaquah Creek	-	900,000	-	$135,000	-	$135,000
Issaquah Hatchery	Puget Sound	F. CK	RCO overhead	-	NA	-	-	-	-	-	-	$5,562
Soos Creek Hatchery	Puget Sound	F. CK	WDFW	2,000,000	Green River	Green River	-	2,000,000	-	$428,000	-	$428,000
Soos Creek Hatchery	Puget Sound	F. CK	RCO overhead	-	N/A	-	-	-	-	-	-	$17,634
Marking trailer	Puget Sound	All	WDFW	-	N/A	-	-	-	-	-	$1,500,000	$1,500,000
Marking trailer	Puget Sound	All	RCO overhead	-	N/A	-	-	-	-	-	-	$61,800
Clark Creek Hatchery upgrades	Puget Sound	N/A	Puyallup Tribe	These upgrades will create additional capacity to raise fish	N/A	-	-	-	-	-	$1,200,000	$1,200,000
Clark Creek Hatchery upgrades	Puget Sound	N/A	RCO overhead	-	N/A	-	-	-	-	-	-	$49,440
University of Washington Hatchery	Puget Sound	F. CK	Muckleshoot Indian Nation	180,000	N/A	-	-	-	-	-	$325,000	$325,000
University of Washington Hatchery	Puget Sound	F. CK	RCO overhead	-	N/A	-	-	-	-	-	-	$13,390
Marblemount Hatchery	Puget Sound	N/A	WDFW	These upgrades will create additional capacity to raise fish	N/A	-	-	-	-	-	$346,587.02	$346,587.02
Marblemount Hatchery	Puget Sound	N/A	RCO overhead	-	N/A	-	-	-	-	-	-	$14,892.82
Enhanced monitoring plan for	Puget Sound	All	WDFW	-	N/A	-	-	-	-	$5,000	-	$5,000

Facility	Region	Species	Entity	Increased Proposal	Brood Source	Release Location	2021 Release	2022 Release	Anticipated 2023 Release	Operating Cost	Infrastructure Cost	Total Cost
ecological effects												
Enhanced monitoring plan for ecological effects	Puget Sound	All	PSMFC overhead	-	N/A	-	-	-	-	$457		$457
East Bank and Marion Drain Hatcheries	Columbia River	Sum. CK	Yakama Nation	500,000	Entiat/ Wells/ Chelan	Yakima River	-	500,000	100,000	$137,707	-	$137,707
Klickitat Hatchery	Columbia River	F. CK	Yakama Nation	These upgrades will create additional capacity to raise an additional 1,000,000 F. CK (URB)	N/A	-	-	-	-	-	$55,000	$55,000
Select-Area Fishery Enhancement (SAFE)	Columbia River	Sp. CK	ODFW	1,500,000	Willamette River	Youngs Bay or Tongue Point	-	-	1,500,000	$851,476	-	$851,476
Umatilla Hatchery	Columbia River	F. CK (URB)	ODFW	120,000	Little White	Umatilla River	-	128,185	-	$30,000	_	$30,000
Bonneville Hatchery	Columbia River	F. CK (tules)	ODFW	250,000	Bonneville Pool	Columbia River	-	0	-	$56,430[b]	-	$56,430
Umatilla and Bonneville Hatchery	Columbia River	F. CK (URB)	ODFW	100,000	Little White	Umatilla River	167,010	-	-	$35,778	-	$35,778
Wells Hatchery	Columbia River	Sum. CK	DPUD/WDFW	500,000	Wells	Columbia River	-	550,000	-	$175,000	-	$175,000
Dworshak NFH	Columbia River	Sp. CK	Nez Perce Tribe	500,000	Clearwater River	Clearwater River	-	508,985	-	$81,000	$75,000	$156,000
Little White NFH	Columbia River	Sp. CK	USFWS	650,000	Little White	Little White River	-	-	650,000	$200,915	$98,050	$289,965

Facility	Region	Species	Entity	Increased Proposal	Brood Source	Release Location	2021 Release	2022 Release	Anticipated 2023 Release	Operating Cost	Infrastructure Cost	Total Cost
Spring Creek NFH	Columbia River	F. CK (tules)	USFWS	2,000,000	Columbia River Gorge tules	Columbia River	-	66,294	-	$317,989	$88,200	$406,189
Carson NFH	Columbia River	Sp. CK	USFWS	100,000	Carson	Wind River	-	-	100,000	$65,459	$96,600	$162,059
TOTAL							**167,010**	**4,653,464**	**2,350,000**	**$2,519,754**	**$3,784,437.02**	**$6,467,367**

Table 5. Programs that received FY22 PST funding for the Hatchery Production Initiative for SRKW

Facility	Region	Species	Entity	Increased Proposal	Operational Costs	Capital Costs	Total Cost
Issaquah Hatchery	Puget Sound	F. CK	WDFW	1,000,000	$135,000	-	$135,000
Automatic marking trailer	Puget Sound	N/A	WDFW	N/A	-	$1,500,000	$1,500,000
Soos Creek-Palmer Pond Hatchery Chinook	Puget Sound	F. CK	WDFW	2,000,000	$428,000	-	$428,000
Tulalip Bernie Gobin Hatchery	Puget Sound	Sum. CK	Tulalip Tribe	2,000,000	$555,914	-	$555,914
Tulalip Bernie Gobin Hatchery	Puget Sound	Sum. CK	RCO overhead	-	-	-	$22,904
University of Washington Hatchery	Puget Sound	F. CK	Muckleshoot Indian Tribe	180,000	$75,071	$315,261	$390,332
University of Washington Hatchery	Puget Sound	F. CK	RCO overhead	-	-	-	$16,082
Spring Creek NFH	Columbia River	F. CK (tule)	USFWS	2,000,000	$346,235	$156,993	$503,228
Little White Salmon NFH	Columbia River	Sp. CK	USFWS	650,000	$214,477	-	$214,477
Carson NFH	Columbia River	Sp. CK	USFWS	100,000	$89,281	$63,000	$152,281
Wells Hatchery	Columbia River	Sum. CK	WDFW/DPUD	500,000	$175,000	-	$175,000
East Bank and Marion Drain Hatcheries	Columbia River	Sum. CK	Yakama Nation	500,000	$148,212	-	$148,212
Dworshak NFH	Columbia River	Sp. CK	Nez Perce Tribe	500,000	$140,775	-	$140,775
SAFE	Columbia River	Sp. CK	ODFW	1,500,000	$876,956	-	$876,956
Bonneville Hatchery	Columbia River	F. CK (tule)	ODFW	250,000	$150,854	-	$150,854
Umatilla and Bonneville Hatcheries	Columbia River	F. CK (URB)	ODFW	100,000	$30,318	-	$30,318
TOTAL				**11,280,000**	**$3,366,093**	**$2,035,254**	**$5,440,333**

Table 6. Summary of 2020, 2021, and 2022 hatchery-origin Chinook salmon releases

Funding Source	**Release Years**		
	2020	**2021**	**2022**
PST FY20	597,242	6,105,139	3,388,045
PST FY21	-	167,010	4,653,464
Washington State Legislature ('19-'21)	10,850,280	7,667,982	-
Washington State Legislature ('21-'23)	-	-	11,344,323
TOTAL	**11,447,522**	**13,940,131**	**19,385,832**

10. Appendix B pHOS data for natural populations

Affected Environment Supplementary Data on pHOS. Data from WDFW (2020).

Table 4. A non-comprehensive summary of integrated Chinook hatchery programs operated by WDFW, showing the wild population Designations and Recovery Phases, and the hatchery Program Goals. For Run, Sp = Spring, Su = Summer, and F = Fall. For Designations (Design), P = Primary, C = Contributing, and S = Stabilizing. For Program Goals, C = Conservation, H = Harvest, and M = Mitigation. For the Recovery Phases, P = Preservation, R = Recolonization, LA = Local Adaptation, and FR = Fully restored. pNOB, pHOS, and PNI, Total Brood, and Escapement are for the Brood Year indicated. Total Brood is the total number of individuals spawned during that brood year. Meet HSRG – Now indicates if a hatchery program meets the HSRG target as established by HSRG (2015). Meet HSRG – Pre 2015 indicates if the hatchery program would have met the HSRG targets prior to HSRG eliminating target values for the Preservation and Recolonization Recovery Phases. Ratio B/E is the ratio of Total Brood per Escapement. Program size reflects the total number of brood year 2019 juveniles planned for release in 2020 or 2021. All data unpublished, WDFW HEAT Unit.

Hatchery	WDFW Region	Wild Population	Run	Design	Program Goal	Recovery Phase	pNOB	pHOS	PNI	Meet HSRG Now	Meet HSRG Pre 2015	Brood Year	Total Brood	Escape	Ratio B/E	Program Size
Methow-T.	2	Methow	Sp	P	C	P	0.55	0.21	0.72	Yes	Yes	2016	11	13,101	0.00	30,000
Chiwawa	2	Chiwawa	Sp	P	C	P	0.66	0.60	0.52	Yes	No	2015	109	1,836	0.06	144,000
Methow- M.	2	Methow	Sp	P	C	P	0.80	0.71	0.53	Yes	No	2015	96	1,353	0.07	133,249
Marblemount	4	Upper Skagit	Su	P	C	P	0.56	0.05	0.92	Yes	Yes	2015	90	10,706	0.01	200,000
Kendall Creek	4	NF Nooksack	Sp	P	C	P	0.00	0.77	0.00	Yes	No	2015	474	1,717	0.28	1,800,000[A]
Dungeness	6	Dungeness	Sp	P	C	P	0.25	0.75	0.25	Yes	No	2017	93	605	0.15	200,000
Elwha	6	Elwha	F	P	C	P	0.04	0.96	0.04	Yes	No	2017	1,016	1,892	0.54	2,700,000
Tucannon	1	Tucannon	Sp	P	C	R	0.79	0.67	0.54	Yes	No	2015	126	523	0.24	225,000
Lyons Ferry	1	Snake	F	P	M/C	R	0.36	0.74	0.33	Yes	No	2016	2,588	9,558	0.27	1,150,000
Dryden Pond	2	Wenatchee	Su	P	H	LA	1.00	0.06	0.94	Yes	Yes	2015	245	4,452	0.06	500,001
Washougal	5	Washougal	F	P	H	LA	0.28	0.57	0.33	No	No	2015	577	3,990	0.14	1,900,000
NF Toutle	5	Toutle	F	P	H	LA	0.17	0.70	0.20	No	No	2015	791	1,177	0.67	1,100,000
Naselle	6	Naselle	F	P[B]	H	LA	0.20	0.75	0.21	No	No	2016	1,076	2,383	0.45	2,500,000
Priest Rapids	3	Hanford Reach	F	P	H	FR	0.25	0.08	0.84	Yes	Yes	2017	5,668	73,759	0.08	7,299,543
Sol Duc	6	Sol Duc	Su	P	H	FR	0.12	0.10	0.54	No	No	2014	238	449	0.53	375,000[A]
Wallace	4	Skykomish	Su	C	H	R	0.08	0.36	0.19	Yes	No	2017	2,089	4,374	0.48	1,500,000
Lower Cowlitz	5	Cowlitz	F	C	H	LA	0.04	0.30	0.13	No	No	2015	1,691	6,060	0.28	2,400,000
Bingham Creek	6	Satsop	F	C	C	FR	0.30	0.15	0.67	Yes	Yes	2016	63	1,504	0.04	500,000
Forks Creek	6	Willapa	F	C[B]	H	LA	0.10	0.81	0.11	No	No	2016	2,306	2,995	0.77	350,000
Lake Aberdeen	6	Wynoochee	F	C	H	FR	0.18	0.00	1.00	Yes	Yes	2016	45	746	0.06	50,000
Soos Creek	4	Green/Duwamish	F	S	H	R	0.16	0.76	0.17	Yes	Yes	2017	3,250	8,357	0.39	5,500,000[A]
Issaquah	4	Sammamish	F	S	H	R	0.07	0.88	0.08	Yes	Yes	2016	1,336	1,247	1.07	3,000,000
Voights Creek	6	Puyallup	F	S	H	R	0.01	0.54	0.03	Yes	Yes	2017	1,685	2,012	0.84	1,600,000
George Adams	6	Skokomish	F	S	H	R	0.03	0.83	0.03	Yes	Yes	2016	3,483	1,342	2.60	3,900,000

[A] Includes recent increase in programs size to provide prey for Southern Resident Killer Whales (NF Nooksack: 500,000; Sol Duc: 55,000; Soos Creek: 2,000,000)

[B] Designations reflective of brood year 2016 data but Naselle recently redesignated as a Contributing population and Willapa recently redesignated as a Primary population

Table A1-1. Puget Sound Chinook demographics, Strait of Georgia and Whidbey basin MPGs. Unless otherwise noted, all values reflect arithmetic means for the years 2012-2016.

				Capacity			Adult naturally spawning abundance				Juvenile abundance	
Watershed	Management unit	Total harvest rate	Terminal Run Size (H + N)	Estimate	Ref	Natural population	Total abundance	pHOS	Natural-origin		Natural-origin	Hatchery releases
Strait of Georgia MPG												
Nooksack	Nooksack early	27 %	2,568	457	1	NF/Mid Nooksack	1,305	81 %	218		NA	1,170,079
			1,184			SF Nooksack	272	49 %	153			
	Nooksack & Samish fall	NA	36,661	NA	NA	NA	NA	NA	NA		NA	4,786,018
	San Juan Islands[A]	NA	NA	NA	NA	NA	NA	NA	NA		NA	594,567
Whidbey basin MPG												
Skagit	Skagit spring	20 %	4,865	1,683	2	Upper Sauk	1,215	2 %	1,188		3,679,258	823,530
						Suiattle	533	2 %	522			
						Cascade	301	NA	NA			
	Skagit summer/fall	40 %	14,646	22,366	2	Upper Skagit summer	10,606	4 %	10,180			
						Lower Skagit fall	2,335	5 %[B]	2,217[B]			
						Lower Sauk summer	612	8 %[C]	567[C]			
Stillaguamish	Stillaguamish	23 %	1,050	1,450	3	NF/summer	730	44 %	417		121,468	222,671
						SF/fall	98	22 %	78			
Snohomish	Snohomish	19 %	9,937	6,827	4	Skykomish summer	3,196	37 %	1,985		294,806	1,552,495
				3,588	4	Snoqualmie fall	1,061	22 %	813		61,659	0
	Tulalip Bay hatchery	NA	3,621	NA	NA	NA	NA	NA	NA		NA	2,281,362

[A] Glenwood Springs program
[B] pHOS only available in 2012, 2013 and 2015; natural-origin abundance 2014 and 2016 estimated pHOS averaged 2012, 2013 and 2015
[C] pHOS only available in 2012 and 2016; natural-origin abundance 2013 - 2015 estimated pHOS averaged 2012 and 2016

Table A1-2. Puget Sound Chinook salmon demographics, Central and South Sound, Hood Canal and Strait of Juan de Fuca MPGs. Unless otherwise noted, all values reflect arithmetic means for the years 2012-2016.

				Capacity			Adult naturally spawning abundance				Juvenile abundance	
Watershed	Management unit	Total harvest rate	Terminal Run Size (H + N)	Estimate	Ref	Natural population	Total abundance	pHOS	Natural-origin		Natural-origin	Hatchery releases
Central and South Puget Sound MPG												
Lake Washington	Lake Washington	26 %	6,779	NA[A]	NA	Sammamish	1,266	91 %	116		41,855[B]	1,691,097
				1,259	5	Cedar	1,250	30 %	913		915,091	0
Green	Green	26 %	14,295	8,971	6	Green	4,402	69 %	1,270		286,759	4,123,633
Puyallup	Puyallup fall	44 %	7,647	3,231	5	Puyallup	1,606	63 %	583		42,174	1,584,866
	White spring	19 %	3,739	954	1	White	2,180	72 %	565		7,793[C]	973,601
Nisqually	Nisqually	46 %	24,454	NA[D]	NA	Nisqually	1,585	51 %	726		103,437	3,760,382
	Mid-Sound hatchery[E]	NA	9,417	NA	NA	NA	NA	NA	NA		NA	2,117,802
	South Sound hatchery[F]	NA	16,798	NA	NA	NA	NA	NA	NA		NA	5,862,645
Hood Canal MPG												
Mid-Hood Canal	Mid-Hood Canal	23 %	358	NA[D]	NA	Mid-Hood Canal	342	NA	NA		2,886[G]	78,225[H]
Skokomish	Skokomish	58 %	30,465	NA[D]	NA	Skokomish	1,176	80%	205			4,086,004
	Hoodsport hatchery	NA	23,213	NA	NA	NA	NA	NA	NA		NA	2,753,818
Strait of Juan de Fuca MPG												
Dungeness	Dungeness	12 %		NA[D]	NA	Dungeness	291	71 %	96		54,513	194,655
Elwha	Elwha	13 %		NA[D]	NA	Elwha	2,163	95 %	112		54,200[I]	2,495,623[J]

[A] Sammamish population has never reached replacement, stock-recruit curve fitting thus unreliable (PSIT and WDFW 2017)
[B] Abundance estimate represents only Bear Creek, a tributary of the Sammamish River and only a portion of natural population
[C] White natural estimate only from 2016
[D] No stock-recruit curve fit to empirical data in PSIT and WDFW (2017) MUP
[E] Includes Grovers and Gorst hatchery programs
[F] Includes Minter, Chambers, McAllister, Deschutes and Coulter hatchery programs
[G] Abundance estimate represents only Duckabush River, one of three rivers in the Mid-Hood Canal population
[H] Hatchery releases only into Hamma Hamma River, one of three rivers in the Mid-Hood Canal population (terminated 2016)
[I] Elwha natural estimates only from 2014-2016
[J] Includes 0-372,646 annual releases into Morse Creek, an independent tributary of the Strait of Juan de Fuca (terminated 2016)

Table 23. Coded Wire Tag Recoveries 2004-2021 of Chinook salmon in tributaries to the Lower Columbia River including the Elochoman River, Mill/Abernathy/Germany Creek, Coweeman River, Lewis River, Kalama River, and Toutle River (Source RMIS)

Release Regions	CWT Recoveries	% of CWT Recoveries	Estimated CWTs	% of Estimated CWTs
Central California Coast Hatcheries	1	0.02%	2	0.02%
Central Columbia River Hatcheries (including Spring Creek, Little White/Willard, Bonneville, and Umatilla)	**6**	**0.10%**	**21**	**0.14%**
Columbia River General Location Hatcheries	1	0.02%	3	0.02%
Klamath River/Trinity River Hatcheries	1	0.02%	2	0.01%
Lower Columbia River Hatcheries	5737	99.27%	14279	98.17%
Northern Oregon Coast Hatcheries	1	0.02%	1	0.01%
Northern Washington Coast Hatcheries	5	0.09%	27	0.19%
San Joaquin River Hatcheries	2	0.03%	4	0.02%
Snake River Hatcheries	19	0.33%	181	1.24%
Upper Columbia Hatcheries	5	0.09%	22	0.15%
Willapa Bay Hatcheries	1	0.02%	5	0.03%
Totals	5779	-	14546	-

From Ford (2022). The following pNOS (1 – pNOS = pHOS) tables for ESA-listed Chinook salmon ESUs in the analysis area. Tables taken from Ford (2022).

Table 4. Five-year mean of fraction natural-origin (sum of all estimates divided by number of estimates).

Population	1995–99	2000–04	2005–09	2010–14	2015–19
Wenatchee River SP	0.56	0.42	0.23	0.40	0.43
Entiat River SP	0.70	0.56	0.47	0.77	0.70
Methow River SP	0.61	0.16	0.27	0.25	0.37

Table 13. Five-year mean of fraction natural-origin spawners (sum of all estimates divided by the number of estimates).

Population	MPG	1995–99	2000–04	2005–09	2010–14	2015–19
Tucannon River	Lower Snake	0.64	0.61	0.69	0.68	0.27
Wenaha River	Grande Ronde/Imnaha	0.89	0.96	0.97	0.73	0.74
Lostine River	Grande Ronde/Imnaha	0.97	0.61	0.39	0.40	0.42
Minam River	Grande Ronde/Imnaha	0.97	0.98	0.98	0.89	0.94
Catherine Creek	Grande Ronde/Imnaha	1.00	0.57	0.35	0.49	0.38
Grande Ronde River Upper Mainstem	Grande Ronde/Imnaha	1.00	0.76	0.33	0.22	0.24
Imnaha River Mainstem	Grande Ronde/Imnaha	0.53	0.44	0.23	0.34	0.41
South Fork Salmon River Mainstem	South Fork Salmon River	0.59	0.64	0.56	0.77	0.32
Secesh River	South Fork Salmon River	0.91	0.97	0.95	0.98	0.96
East Fork South Fork Salmon River	South Fork Salmon River	0.99	0.76	0.43	0.62	0.58
Chamberlain Creek	Middle Fork Salmon River	1.00	1.00	1.00	1.00	1.00
Middle Fork Salmon River Lower Mainstem	Middle Fork Salmon River	1.00	1.00	1.00	1.00	1.00
Big Creek	Middle Fork Salmon River	1.00	1.00	1.00	1.00	1.00
Camas Creek	Middle Fork Salmon River	1.00	1.00	1.00	1.00	1.00
Loon Creek	Middle Fork Salmon River	1.00	1.00	1.00	1.00	1.00
Middle Fork Salmon River Upper Mainstem	Middle Fork Salmon River	1.00	1.00	1.00	1.00	1.00
Sulphur Creek	Middle Fork Salmon River	1.00	1.00	1.00	1.00	1.00
Marsh Creek	Middle Fork Salmon River	1.00	1.00	1.00	1.00	1.00
Bear Valley Creek	Middle Fork Salmon River	1.00	1.00	1.00	1.00	1.00
North Fork Salmon River	Upper Salmon River	1.00	1.00	1.00	1.00	1.00
Lemhi River	Upper Salmon River	1.00	1.00	1.00	1.00	1.00
Salmon River Lower Mainstem	Upper Salmon River	1.00	1.00	1.00	1.00	1.00
Pahsimeroi River	Upper Salmon River	0.65	0.51	0.79	0.93	0.54
East Fork Salmon River	Upper Salmon River	0.77	1.00	1.00	1.00	1.00
Yankee Fork	Upper Salmon River	1.00	1.00	0.52	0.39	0.93
Salmon River Upper Mainstem	Upper Salmon River	0.80	0.62	0.58	0.71	0.36
Valley Creek	Upper Salmon River	1.00	1.00	1.00	1.00	1.00

Table 17. Five-year mean of fraction natural-origin fish in the population (sum of all estimates divided by the number of estimates).

Population	1995–99	2000–04	2005–09	2010–14	2015–19
Lower Snake River FA	0.58	0.34	0.37	0.31	0.33

Table 30. Five-year mean of fraction natural-origin spawners (sum of all estimates divided by the number of estimates) for Lower Columbia River Chinook salmon ESU populations. A value only in parentheses means that a total spawner count was available but no or only one estimate of natural spawners available. Blanks mean no estimate available in that 5-year range.

Population	MPG	1995–99	2000–04	2005–09	2010–14	2015–19
Upper Cowlitz/Cispus Rivers SP	Spring-run Cascade	—	—	—	0.08	0.06
Kalama River SP	Spring-run Cascade	—	—	—	1.00	1.00
North Fork Lewis River SP	Spring-run Cascade	—	—	—	—	—
Sandy River SP	Spring-run Cascade	—	—	—	0.89	0.92
Big White Salmon River SP	Spring-run Gorge	—	—	—	0.13	0.18
Grays River Tule FA	Fall-run Coastal	—	—	0.36	0.22	0.43
Youngs Bay FA	Fall-run Coastal	—	—	—	0.04	0.14
Big Creek FA	Fall-run Coastal	—			0.03	0.04
Elochoman River/ Skamokawa Tule FA	Fall-run Coastal	—	—	—	0.17	0.45
Clatskanie River FA	Fall-run Coastal	—	0.10	0.19	0.09	0.05
Mill/Abernathy/Germany Creeks Tule FA	Fall-run Coastal	—	—	—	0.11	0.22
Lower Cowlitz River Tule FA	Fall-run Cascade	—	—	—	0.70	0.77
Coweeman River Tule FA	Fall-run Cascade	—	—	—	0.82	0.91
Toutle River Tule FA	Fall-run Cascade	—	—	—	0.31	0.55
Upper Cowlitz River Tule FA	Fall-run Cascade	—	—	—	0.35	0.82
Kalama River Tule FA	Fall-run Cascade	—	—	—	0.08	0.57
Lewis River Tule FA	Fall-run Cascade	—	—	—	0.67	0.56
Clackamas River FA	Fall-run Cascade	—	—	—	0.60	0.68
Sandy River FA	Fall-run Cascade	—	—	—	—	—
Washougal River Tule FA	Fall-run Cascade	—	—	—	0.30	0.58
Lower Gorge Tributaries Tule FA	Fall-run Gorge	—	—	—	0.89	0.96
Upper Gorge Tributaries Tule FA	Fall-run Gorge	—	—	—	0.40	0.58
Big White Salmon River Tule FA	Fall-run Gorge	—	—	—	0.80	0.57
Lewis River Bright LFR	Late fall-run Cascade	—	—	—	1.00	1.00
Sandy River Bright LFR	Late fall-run Cascade	0.24	0.24	0.24	—	—

Table 46. Five-year mean of fraction natural-origin Chinook salmon spawning naturally in the Upper Willamette River Chinook salmon ESU (sum of all estimates divided by the number of estimates). Blanks (—) mean no estimate available in that 5-year range.

Population	MPG	1995–99	2000–04	2005–09	2010–14	2015–19
Willamette Falls SP	Willamette	—	0.24	0.30	0.24	0.22
Clackamas River SP	Willamette	0.33	0.58	0.79	0.94	0.97
North Santiam River SP	Willamette	—	—	0.33	0.26	0.26
South Santiam River SP	Willamette	—	—	0.39	0.40	0.21
McKenzie River SP	Willamette	—	—	0.64	0.55	0.57
Middle Fork Willamette River SP	Willamette	—	—	—	0.08	0.07

Table 52. Five-year mean of fraction natural-origin spawners (sum of all estimates divided by the number of estimates).

Population	MPG	1995–99	2000–04	2005–09	2010–14	2015–19
North Fork Nooksack River SP	Strait of Georgia	0.28	0.11	0.19	0.14	0.13
South Fork Nooksack River SP	Strait of Georgia	0.26	0.55	0.57	0.42	0.45
Lower Skagit River FA	Whidbey Basin	0.94	0.91	0.86	0.92	0.84
Upper Skagit River SU	Whidbey Basin	0.91	0.87	0.84	0.95	0.91
Cascade River SP	Whidbey Basin	0.98	0.92	0.89	0.94	0.86
Lower Sauk River SU	Whidbey Basin	0.94	0.97	0.95	0.91	0.98
Upper Sauk River SP	Whidbey Basin	0.99	1.00	0.98	0.97	0.99
Suiattle River SP	Whidbey Basin	0.99	0.97	0.99	0.99	0.97
North Fork Stillaguamish River SU/FA	Whidbey Basin	0.59	0.70	0.40	0.43	0.45
South Fork Stillaguamish River SU/FA	Whidbey Basin	0.59	0.70	0.40	0.54	0.46
Skykomish River SU	Whidbey Basin	0.49	0.52	0.76	0.69	0.62
Snoqualmie River FA	Whidbey Basin	0.81	0.89	0.81	0.78	0.75
Sammamish River FA	Central/South Sound	0.29	0.36	0.16	0.07	0.16
Cedar River FA	Central/South Sound	0.61	0.59	0.82	0.78	0.71
Green River FA	Central/South Sound	0.55	0.47	0.43	0.39	0.30
White River SP	Central/South Sound	0.54	0.79	0.43	0.32	0.15
Puyallup River FA	Central/South Sound	0.88	0.79	0.52	0.41	0.32
Nisqually River FA	Central/South Sound	0.80	0.61	0.30	0.30	0.47
Skokomish River FA	Hood Canal	0.40	0.46	0.45	0.10	0.16
Mid-Hood Canal FA	Hood Canal	0.76	0.79	0.61	0.33	0.89
Dungeness River SU	Strait of Juan de Fuca	1.00	0.32	0.43	0.25	0.25
Elwha River FA	Strait of Juan de Fuca	0.41	0.53	0.35	0.06	0.05

11. Appendix C Habitat Restoration Projects

List of funded projects from the PCSRF database meeting the criteria specified for Alternative 3.

23-1099 R	WA RCO	2023	Deschutes Tribs Private Fish Barrier Replacement	Puget Sound	$445,901
23-1093 R	WA RCO	2023	Fennel Creek Restoration Phase 3 - Construction	Puget Sound	$542,000
23-1063 R	WA RCO	2023	Duckabush R Oxbow Final Design and Restoration	Puget Sound	$167,208
23-1018 R	WA RCO	2023	Lower Ohop Creek BDA and PALS Installation	Puget Sound	$259,035
23-1122 PR	WA RCO	2023	Lower Rutledge Johnson Floodplain Restoration Fina	Puget Sound	$140,520
23-1099 R	WA RCO	2023	Deschutes Tribs Private Fish Barrier Replacement	Puget Sound	$445,901
23-1093 R	WA RCO	2023	Fennel Creek Restoration Phase 3 - Construction	Puget Sound	$542,000
23-1154 R	WA RCO	2023	Schoolhouse Crk Barrier and Riparian Improvements	Lower Columbia River	$121,950

23-1155 R	WA RCO	2023	Upper Mason Ck Riparian and Floodplain Enhancement	Lower Columbia River	$272,346
23-1131 R	WA RCO	2023	Belfield Rock Creek Restoration	Lower Columbia River	$81,373
23-1129 R	WA RCO	2023	Thadbar Creek Restoration	Lower Columbia River	$199,500
23-1194 R	WA RCO	2023	Lower East Fork Grays Amendment	Lower Columbia River	$547,358
23-1157 R	WA RCO	2023	WRIA 26, 27,28 Nutrient and Riparian Enhancement	Lower Columbia River	$149,620
23-1155 R	WA RCO	2023	Upper Mason Ck Riparian and Floodplain Enhancement	Lower Columbia River	$272,346
23-1131 R	WA RCO	2023	Belfield Rock Creek Restoration	Lower Columbia River	$81,373
23-1129 R	WA RCO	2023	Thadbar Creek Restoration	Lower Columbia River	$199,500
23-1195 R	WA RCO	2023	Howard Lake Rd Upper Klick Floodplain	Middle Columbia River	$588,250
23-1029 R	WA RCO	2023	Walla Walla River B2B Phase 3A Restoration	Middle Columbia River	$434,262
23-1022 R	WA RCO	2023	Coppei Creek Project Area 07 Restoration	Middle Columbia River	$741,883

Total Funding of Projects	$6,232,326

12. Appendix D Complete List of Aquatic Species Considered

Species	Range within watersheds of the Pacific Northwest	Federal/State Listing Status	Type of Interaction with Hatchery Fish in Analysis Area
Coho Salmon, Chum Salmon, Sockeye Salmon, Pink Salmon, Steelhead	Freshwater and marine areas	Depends upon species. Federally listed spp listed below.	Significant overlap in space and time with hatchery Chinook salmon depending upon the specific location. In marine areas, potential beneficial interactions when schooling to avoid predators.
Lower Columbia River ESU, DPS (Chinook salmon, coho salmon, steelhead)		Threatened	
Upper Willamette ESU, DPS (Chinook salmon, winter steelhead)		Threatened	
Middle Columbia River DPS (steelhead)		Threatened	
Upper Columbia River ESU, DPS (spring Chinook salmon, summer steelhead)		Chinook endangered, steelhead threatened	

Snake River ESU, DPS (spring/summer Chinook salmon, fall Chinook salmon, sockeye salmon, summer steelhead)		Sockeye endangered, others threatened	
Columbia River chum salmon ESU		Threatened	
Puget Sound ESU, DPS (Chinook salmon, steelhead)		Threatened	
Hood Canal summer chum salmon ESU		Threatened	
Lake Ozette sockeye salmon ESU		Threatened	
Oregon Coast coho salmon ESU		Threatened	
Southern Oregon/Northern California Coast coho salmon ESU		Threatened	

California Coastal Chinook salmon ESU		Threatened	
Central Valley spring run Chinook salmon ESU		Threatened	
Sacramento River winter run Chinook salmon ESU		Endangered	
Central California Coast coho salmon ESU		endangered	
Northern California Coast steelhead DPS		Threatened	
California Central Valley steelhead DPS		Threatened	
Central California Coast steelhead		Threatened	

Southern California Coast steelhead DPS		endangered	
Green Sturgeon, White Sturgeon	Lower Columbia, marine areas, Puget Sound	Greens threatened	Predator of hatchery salmon.
Eulachon	Lower Columbia River, marine areas	Threatened	Juvenile life stages may compete with salmon and steelhead for food and space. Adult hatchery salmon may predate upon adult euchalon. Highest risk area is the Lower Columbia River when early returning adult spring Chinook salmon overlap in space and time with returning adult euchalon entering tributaries to spawn in the winter.
Bull trout	Specific reaches of watersheds in the Columbia and Puget Sound areas	Threatened	· Benefit from having juvenile salmon available as prey · May benefit from additional marine-derived nutrients provided by hatchery-origin fish

Sunflower Sea Star	Widespread distribution in marine areas from shallow intertidal areas to waters 1,400 deep.	Proposed Threatened (88 FR 16212)	Larvae are pelagic for a period of time commonly ranging from 6 to 12 weeks before settling to bottom marine habitats. There is the possibility juvenile hatchery Chinook salmon could eat larvae sea stars during this period. The magnitude of impact is negligible due to the size of sea star larvae (lower trophic levels than common prey of juvenile salmon).
Pacific, river, and brook lamprey	Common in main river channel, sloughs, and tributaries. Occasionally found in seasonal watercourses not far from permanent watercourses.	Not listed. Pacific lamprey and river lamprey are Federal species of concern. Pacific lamprey are Oregon sensitive species	· Potential prey item for adult salmon and steelhead · May compete with salmon and steelhead for food and space · May be a parasite on salmon and steelhead while in marine waters · May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Rainbow trout and Cutthroat trout	Common in the main river channel and in sloughs and tributaries. Mostly the juveniles of	Not listed	· Predator of salmon and steelhead eggs and fry. Potential prey item for adult salmon and steelhead. May compete with salmon and steelhead for food and space. May interbreed with steelhead. May benefit from

	this species are present in seasonal watercourses.		additional marine-derived nutrients provided by hatchery-origin fish
Speckled dace	Common in the main river channel and in sloughs, tributaries, and seasonal watercourses	Not listed	· Predator of salmon and steelhead eggs and fry · May compete with salmon and steelhead for food · May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Redside shiner	Common in the main river channel and in sloughs, tributaries, and seasonal watercourses	Not listed	· May compete with salmon and steelhead for food and space · May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Sculpin (genus *Cottus* and *Leptocottus spp.*)	Common in main river channel and in sloughs, tributaries, and seasonal watercourses	Not listed	· Predator of salmon and steelhead eggs and fry · May compete with salmon and steelhead for food · May benefit from additional marine-derived nutrients provided by hatchery-origin fish

Largescale sucker	Common in main river channel and in sloughs, tributaries, and seasonal watercourses	Not listed	· Predator of salmon and steelhead eggs and fry · May compete with salmon and steelhead for food · May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Northern pikeminnow	Common in the main river channel and in sloughs, tributaries, and seasonal watercourses	Not listed	· Freshwater predator on salmon and steelhead eggs and juveniles · May compete with salmon and steelhead for food · May benefit from additional marine-derived nutrients
Oregon Chub	Rare in sloughs and seasonal watercourses	Not listed. Recovered and delisted in 2015.	· May compete with salmon and steelhead for food · May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Centrarchid spp. And other non-natives (bass, bluegill, crappie, pumpkinseed)	Common in sloughs, tributaries, and seasonal watercourses	Non-native species	· Freshwater predator of salmon and steelhead · May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Lingcod	All marine areas	Not Listed	Predator of hatchery salmon

Rockfish (black, blue, canary, china, quillback, yelloweye, etc)	All marine areas	Not listed, except in Puget Sound/Georgia Basin bocaccio endangered and yelloweye threatened	Predator of hatchery salmon during certain life stages
Flatfish (halibut, sole, flounder, etc)	All marine areas	Not Listed	Predator of hatchery salmon
Marine mammals ESA-Listed: Southern Resident killer whale (SRKW) Humpback whale (2 listed DPSs) Sperm whale Fin whale Blue whale Sei whale Western North Pacific (WNP) gray whale North Pacific right whale Guadalupe fur seal Non-ESA Listed: West Coast transient killer whale Minke whale	All marine and estuarine areas	Endangered: SRKW, humpback whale (Central America DPS), sperm whale, fin whale, blue whale, sei whale, WNP gray whale, North Pacific right whale Threatened:	Predator of hatchery salmon: SRKW Steller sea lion California sea lion Harbor seal All other species minimal to no interactions

Eastern North Pacific gray whale California sea lion Steller sea lion Northern elephant seal Northern fur seal Harbor seal Harbor porpoise Dall's porpoise Northern sea otter Risso's dolphin Pacific white-sided dolphin Northern right-whale dolphin		Guadalupe fur seal Steller sea lion (Eastern DPS) delisted All others not listed	

Sources: Tinus and Beamesderfer (1994), NMFS (2013), ODFW (2005), USFWS (2013), Pribyl et al. (2005), and Williams et al. (2014).

13. Appendix E Complete List of Avian and Terrestrial Species Considered

Species	Range throughout the Pacific Northwest	Federal Listing Status	Type of Interaction with Salmon and Steelhead in Analysis Area
Northern spotted owl	Forest mountain habitat	Threatened	· No interaction
Marbled murrelet	Potential forest habitat primarily west of crest of Coast Range Mountains (in general)	Threatened	· Potential predator of juvenile salmon and steelhead in freshwater and saltwater areas · May consume similar prey items in the ocean
Yellow-billed cuckoo	Dense willow and cottonwood stands in river floodplains	Threatened	· No interaction
Streaked horned lark	Throughout the analysis area	Threatened	· No interaction
Other bird species dependent upon aquatic environment (osprey, heron, cormorant, bald eagle, dipper, gull, Caspian tern, duck, geese, and other sea birds)	Throughout the analysis area	Not listed	· Predators of juvenile and adult salmon and steelhead in freshwater and saltwater areas
Small mammals (river otter, mink, raccoon, weasel, fisher)	Throughout the analysis area. Typically, riparian areas	Not listed. Fisher is a	· Predators of juvenile and adult salmon and steelhead in freshwater areas

		candidate species	
Red tree vole	Potentially higher elevations	Candidate species	· No interaction
Grey wolf, Canada lynx	Throughout the analysis area	Wolf-endangered. Lynx-threatened	· Not applicable.
Other reptile species dependent upon aquatic environment (e.g.,snakes, lizards)	Throughout the analysis area	Not Federally listed, although California mountain kingsnake, Northern sagebrush lizard, common kingsnake are species of concern (USFWS 2013)	· Predators of juvenile and adult salmon and steelhead in freshwater areas
Amphibians (e.g.,tree frog, red-legged frog, western toad,	Throughout the analysis area	Not Federally listed, although many of	· Potential predator of eggs, fry, carcasses in freshwater areas

northwestern salamander)		these species are species of concern	

Sources: NMFS (2013), USFWS (2013), and http://pages.uoregon.edu/titus/herp/ (accessed January 17, 2024).

14. Appendix F Fishery Alternative Modeling Results

Copy of J. Carey, NMFS, 2023. Modeling for SRKW Hatchery Prey Program EIS.

Modeling for SRKW Hatchery Prey Program EIS

December 18, 2023

1. Modeling the Prey Program

Approach

To estimate effects on abundances from increased hatchery production associated with the prey program, we ran two separate scenarios: one that assumed the level of production that was released in 2022, and another that assumed the level of production that was released in 2023. Table 1 presents these releases summarized by Fishery Regulation Assessment Model (FRAM) stock, release year, and funding source. For more detail on these releases, see Appendices A1 & A2. Regional abundance increases resulting from this increased hatchery production were estimated by comparing the ending abundances between two sets of FRAM runs, one with and one without the increased hatchery production "turned on." Regional abundance estimates were derived using the approach developed by the Pacific Fishery Management Council's ad-hoc Southern Resident Killer Whale (SRKW) Workgroup (PFMC 2020) with modifications described in NMFS (2023). For all analyses in this document, we used distribution parameters from Shelton et al. (2021). The base model runs used in this assessment (i.e., without the prey program) used the FRAM Round 7.1.1 base period calibration and were from the "2019 PST" scenario completed for the [SEAK Biop].

Table 1: Number of Chinook released as part of the hatchery prey program, by release year, funding source, and FRAM stock.

	2022 RELEASES			2023 RELEASES		
FRAM STOCK	FEDERAL	WA STATE	TOTAL	FEDERAL	WA STATE	TOTAL
Cowlitz River Spring	NA	268,950	268,950	NA	290,165	290,165
CR Bonneville Pool Hatchery	66,294	NA	66,294	NA	NA	NA
CR Oregon Hatchery Tule	250,000	NA	250,000	234,871	NA	234,871
CR Upriver Bright	127,931	574,715	702,646	NA	154,835	154,835
CR Upriver Summer	564,734	520,239	1,084,973	623,952	514,075	1,138,027
Mid PS Fall Fing	2,784,026	1,011,685	3,795,711	3,137,191	1,061,249	4,198,440
NA	380,578	775,387	1,155,965	1,065,673	712,010	1,777,683
Nooksack Spr Hatchery	NA	1,134,890	1,134,890	NA	1,798,920	1,798,920
Nooksack/Samish Fall	NA	1,449,640	1,449,640	NA	1,563,464	1,563,464
Skagit Spring Year	NA	128,022	128,022	NA	703,483	703,483
Snohomish Fall Fing	NA	1,049,421	1,049,421	NA	1,151,558	1,151,558
South PS Fall Fing	NA	291,083	291,083	NA	419,058	419,058
Tulalip Fall Fing	958,415	NA	958,415	1,808,692	NA	1,808,692
WA North Coast Fall	NA	446,651	446,651	NA	500,000	500,000
White River Spring Fing	NA	753,977	753,977	NA	749,886	749,886
Willamette River Spring	1,507,467	NA	1,507,467	1,430,813	NA	1,430,813
Willapa Bay	NA	2,686,054	2,686,054	NA	1,910,660	1,910,660
Grand Total	6,639,445	11,090,714	17,730,159	8,301,192	11,608,678	19,909,870

To estimate abundances that might occur with the increased production, we developed a set of stock/brood year specific expansion factors to apply to the existing starting cohorts in the base model runs. To derive the expansion factors, we first needed to know the level of actual hatchery production that occurred for each stock. To determine this we conducted a series of queries of the Regional Mark Information System that returned the number of adipose fin-clipped (marked) Chinook released by brood year for each relevant FRAM stock (Appendix A3 & A4). These releases produced the subsequent age-specific cohorts contained in the postseason model runs; for example, the brood year 2010 marked releases of a given stock would produce the age 3 marked starting cohort in the 2013 postseason FRAM run and the age 4 marked starting cohort in the 2014 FRAM run. The stock and brood year-specific expansion factors were calculated by summing the actual production for a given stock/brood with the assumed increased production for that stock (from Table 1) and dividing by the actual production. These expansions were then applied to the respective stock/age-specific starting cohort sizes in each model run to simulate the proportional increases in abundance that would be expected with the increased hatchery production relative to the production that actually occurred. All fishery inputs were converted to effort scalars to allow for increased catches that would be expected to occur with higher abundances under the same levels of effort.

For this exercise we focused only on the marked components of each stock because we know the number of releases that produced the estimated starting cohorts, whereas the total production that produced the un-clipped cohorts is generally unknown due to uncertainty regarding the number of naturally-produced Chinook. Consequently, we limited this analysis to a time frame that began with return year 2009, as mass-marking became less consistent for brood years that contributed to prior return years. Once these models with the simulated increased hatchery production were run, we calculated the pre- and post-fishing abundances by region using the FRAM/Shelton approach outlined in PFMC (2020) with the modifications described in NMFS (2023). For each region/year combination we calculated percent increases due to the increased hatchery production by subtracting the post-fishing abundances in the original runs without the prey increases from the runs with the simulated prey program then dividing by the starting abundance of the original runs.

Effects on Abundance

A summary of the percent increases resulting from each modeling scenario (2022 releases & 2023 releases) by region, time period, and funding source is presented in Table 2, with additional detail provided in Appendices A5 and A6. Figures 1a and 1b show the effects of just the Federally funded production based on the 2022 and 2023 release levels, respectively. Figures 2a and 2b show the effects of both the Federal and the WA State funded production, individually and combined, based on the 2022 and 2023 release levels, respectively.

Table 2: Estimated mean 2009-2018 percent increases in adult (age 3-5) Chinook abundance from hatchery prey production releases that occurred in 2022 and 2023 by region, time step, and funding source.

		2022 RELEASES			2023 RELEASES		
REGION	TIME STEP	FEDERAL	WA STATE	TOTAL	FEDERAL	WA STATE	TOTAL
Salish	Oct_Apr	2.28%	3.77%	6.06%	2.86%	5.13%	7.98%
Salish	May_Jun	1.84%	2.31%	4.14%	2.26%	2.79%	5.04%
Salish	Jul_Sep	0.50%	0.78%	1.28%	0.52%	0.81%	1.32%
SWWCVI	Oct_Apr	2.16%	2.95%	5.11%	2.42%	3.30%	5.72%
SWWCVI	May_Jun	1.80%	2.42%	4.22%	2.16%	2.90%	5.06%
SWWCVI	Jul_Sep	1.52%	2.61%	4.13%	1.90%	3.00%	4.90%
NOF	Oct_Apr	1.84%	1.46%	3.29%	1.92%	1.83%	3.75%
NOF	May_Jun	0.55%	0.58%	1.13%	0.61%	0.61%	1.22%
NOF	Jul_Sep	1.22%	1.93%	3.15%	1.23%	1.58%	2.81%
OR	Oct_Apr	0.45%	0.23%	0.68%	0.44%	0.29%	0.73%
OR	May_Jun	0.11%	0.15%	0.26%	0.11%	0.19%	0.30%
OR	Jul_Sep	0.12%	0.17%	0.30%	0.12%	0.19%	0.32%
Cali	Oct_Apr	0.76%	0.30%	1.06%	0.72%	0.44%	1.16%
Cali	May_Jun	0.03%	0.13%	0.16%	0.03%	0.23%	0.26%
Cali	Jul_Sep	0.03%	0.10%	0.13%	0.03%	0.19%	0.22%

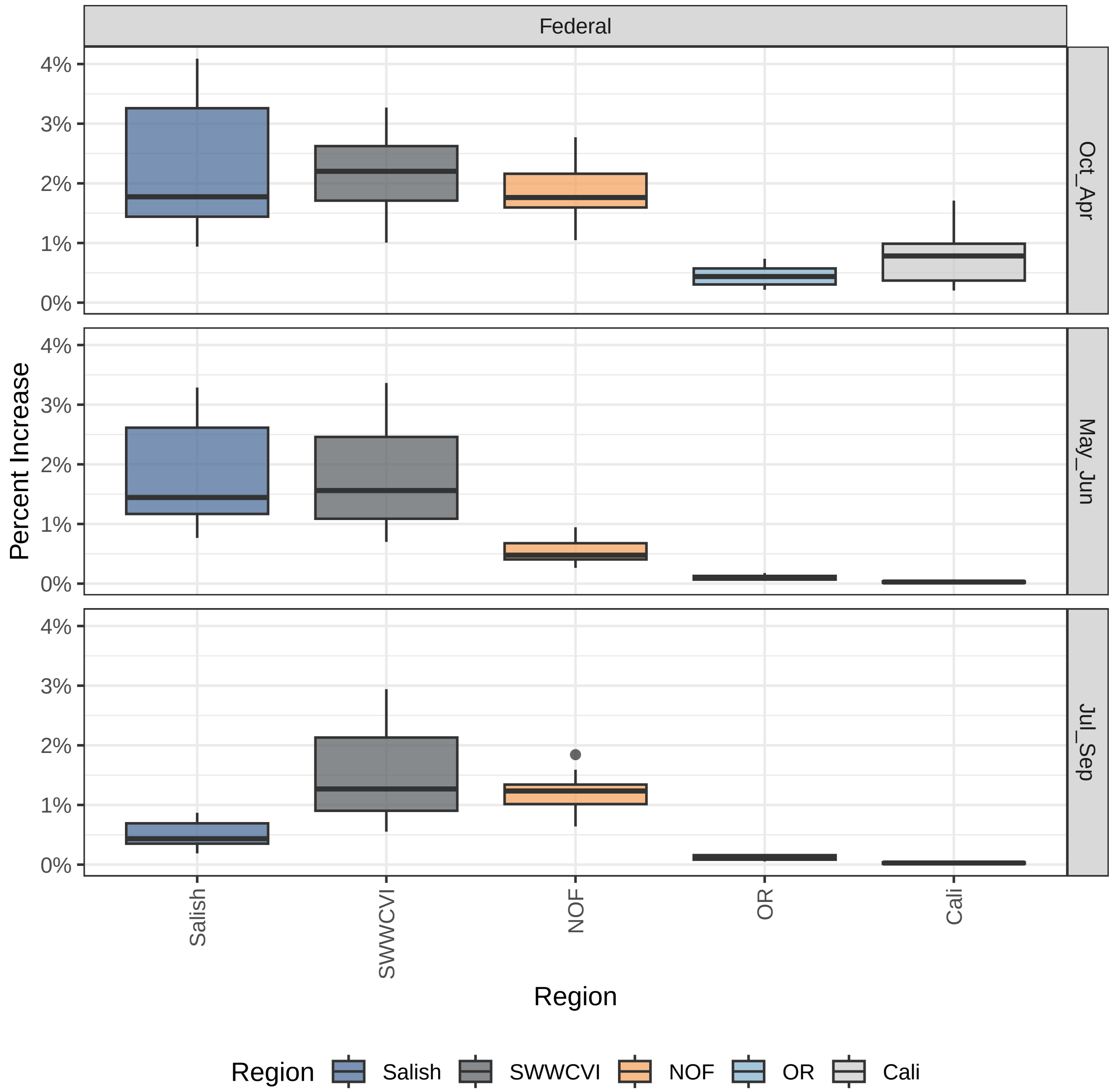

Figure 1a: Summary of estimated 2009-2018 percent increases in Chinook abundance due to 2022 release levels of the Federally funded hatchery prey program by region and time step.

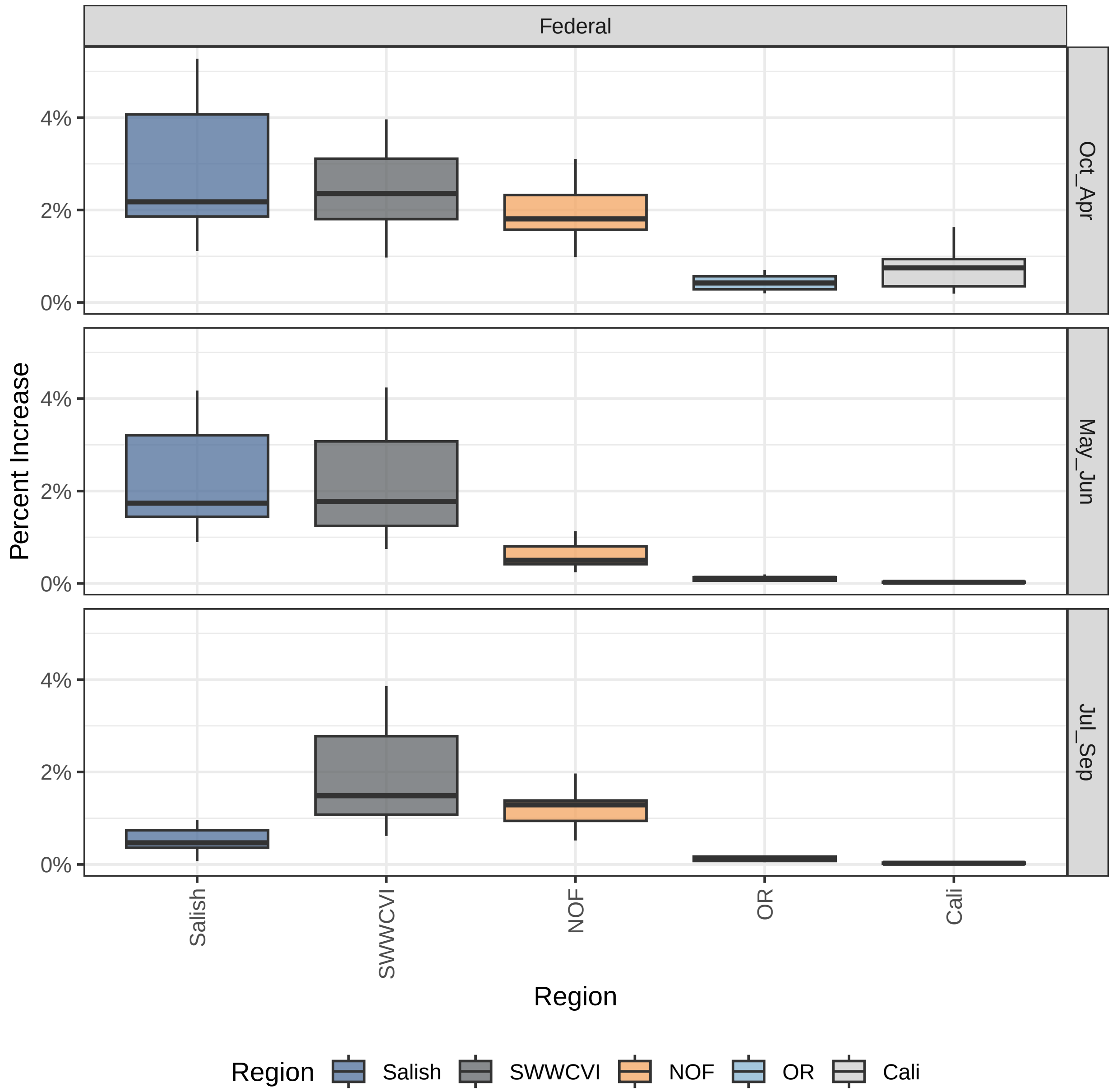

Figure 1b: Summary of estimated 2009-2018 percent increases in Chinook abundance due to 2023 release levels of the Federally funded hatchery prey program by region and time step.

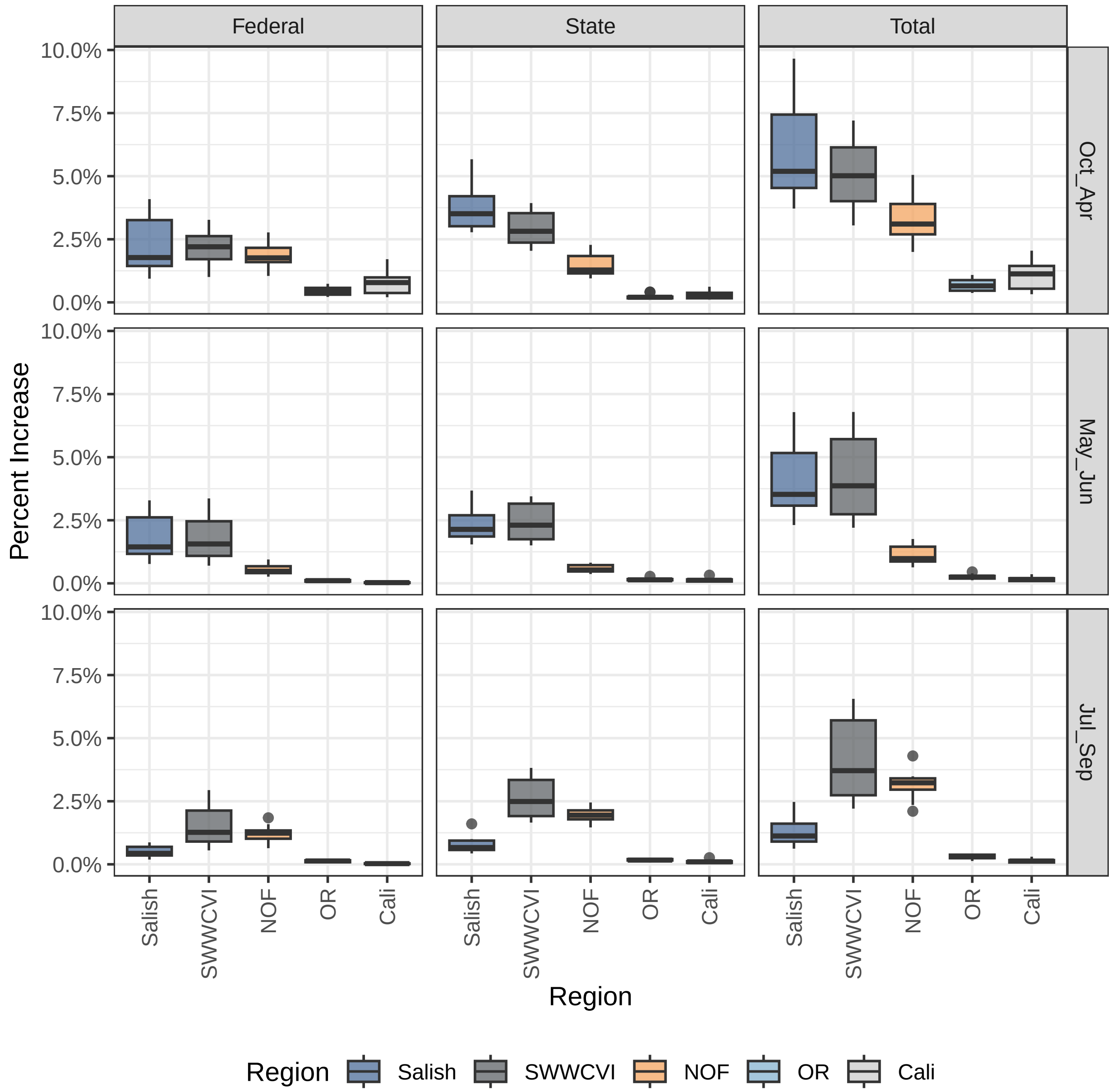

Figure 2a: Summary of estimated 2009-2018 percent increases in Chinook abundance due to 2022 release levels of the hatchery prey program by region, time step, and funding source.

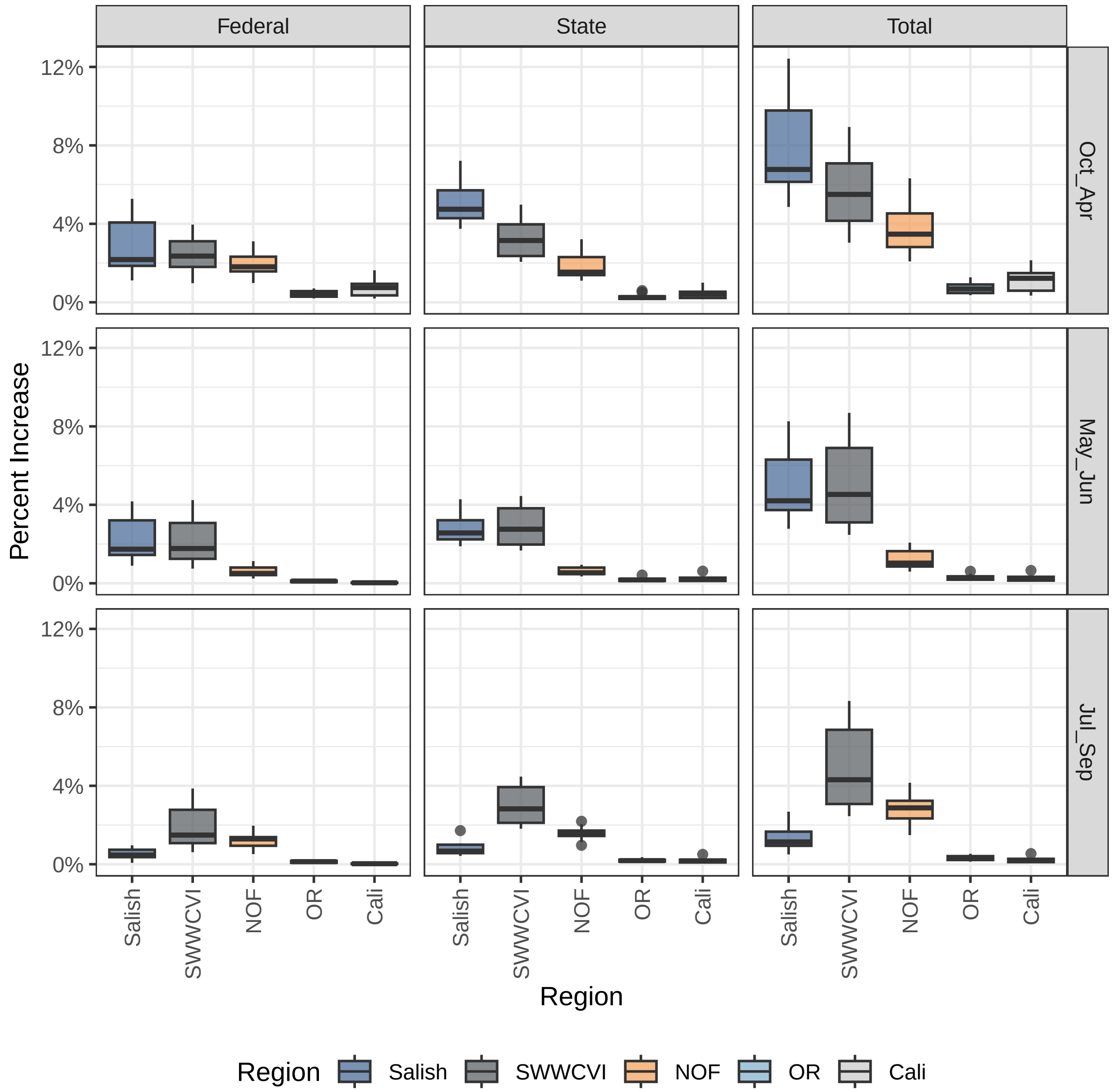

Figure 2b: Summary of estimated 2009-2018 percent increases in Chinook abundance due to 2023 release levels of the hatchery prey program by region, time step, and funding source.

Effects on Escapement

Table 3 shows the estimated mean annual increase in numbers of fish expected to return to the river under a prey program that maintains 2023 release levels and the percentage increase relative to the original abundances without the prey program. For all stocks with the exception of White River Spring, these are assumed to be 100% ad-clipped and the percentage increase is relative to only the ad-clipped component of the stock. It is important to note here that the numbers of fish reported represent returns to the river mouth, not fish on the spawning grounds. Of these additional fish returning to the river, some would be caught in freshwater fisheries and some would return to hatchery racks, while others would ultimately end up on the spawning grounds. All fisheries in the hatchery prey program Alternative were modeled to maintain the existing effort levels (i.e., if the abundance of a given stock doubled, then the fishery would catch twice as many of that stock). This is an important caveat to be aware of, and may not be a valid assumption in some cases, as the additional expected returns would likely be captured in annual forecasts, and certain fisheries, particularly those in more terminal areas, might be shaped differently as a result. Given this, it might be best to instead look at the percent increases and consider them as high bookends for the potential proportional increase in ad-clipped HOR spawners, acknowledging that fishery effort could be increased in some areas which would reduce the proportion of those additional fish that make it to escapement.

Table 3: Estimated mean annual nominal and percent increase in returns to the river mouth by FRAM stock resulting from the hatchery prey program based on 2023 releases.

	MEAN NOMINAL INCREASE			MEAN PERCENT INCREASE		
FRAM STOCK	FEDERAL	WA STATE	TOTAL	FEDERAL	WA STATE	TOTAL
Nooksack/Samish Fall	0	6,716	6,719	0%	33%	33%
Nooksack Spr Hatchery	0	6,860	6,861	0%	265%	265%
Skagit Spring Year	0	3,786	3,787	0%	203%	203%
Snohomish Fall Fing	0	4,179	4,181	0%	126%	126%
Tulalip Fall Fing	983	0	983	120%	0%	120%
Mid PS Fall Fing	11,769	3,988	15,760	38%	13%	50%
South Puget Sound Fall Fing	0	1,996	2,007	0%	4%	4%
White River Spring Fing	0	1,565	1,566	0%	54%	54%
CR Oregon Hatchery Tule	546	0	548	7%	0%	7%
CR Bonneville Pool Hatchery	0	0	3	0%	0%	0%
Columbia R Upriver Summer	9,066	7,472	16,540	24%	20%	43%
Columbia R Upriver Bright	0	1,567	1,576	0%	1%	1%
Cowlitz River Spring	0	2,849	2,849	0%	10%	10%
Willamette River Spring	17,931	0	17,933	19%	0%	19%
WA North Coast Fall	0	2,896	2,898	0%	39%	39%
Willapa Bay	0	7,283	7,286	0%	33%	33%

Figure 3 and Table 4 provide information on the amount of year-to-year variability in the number of fish returning to the river for the marked component of each FRAM stock that has a proposed increase under the prey program. Note that these values represent expected returns under the base model runs, not the model runs that include the additional production from the prey program.

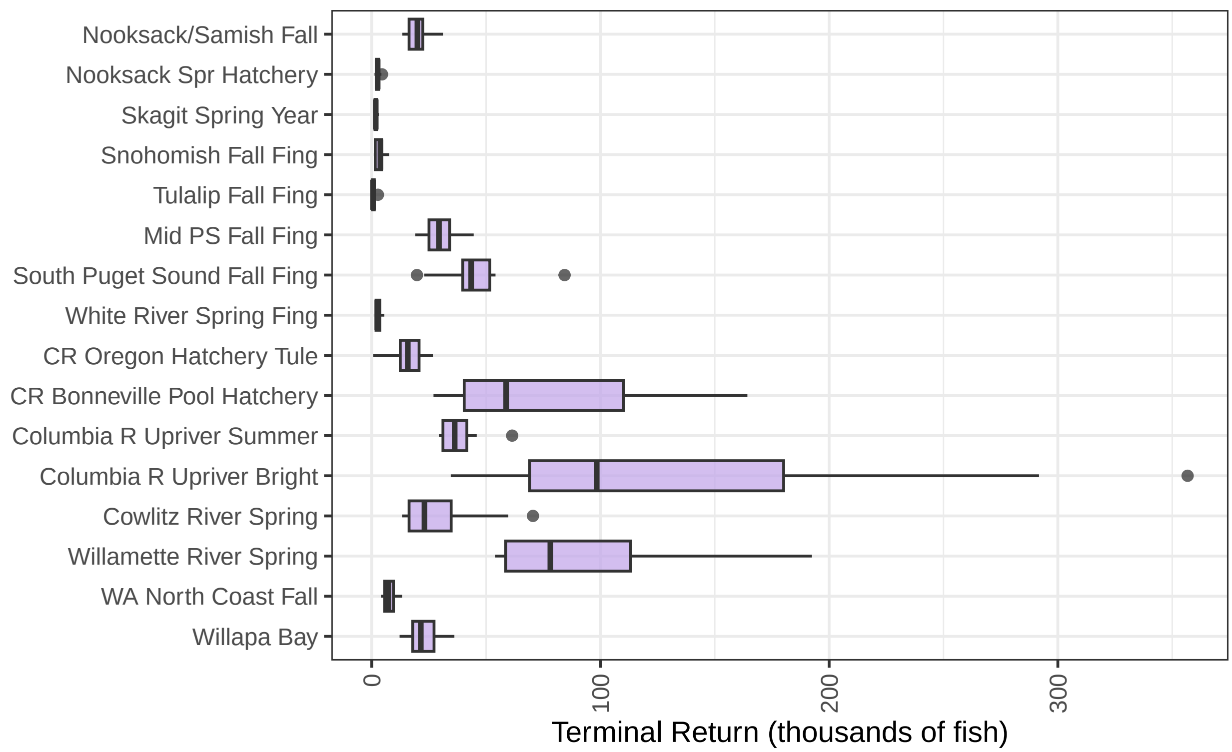

Figure 3: Summary of projected 2009-2018 returns to the river for FRAM stocks with proposed hatchery increases. These projections are from the base '2019 PST' model runs withouth increased hatchery production and, with the exception of White River spring, represent only the marked component of each stock.

Table 4: Minimum, maximum, mean, and standard deviation of projected returns to the river between 2009 and 2018 for FRAM stocks with proposed hatchery increases. These projections are from the base '2019 PST' model runs withouth increased hatchery production and, with the exception of White River spring, represent only the marked component of each stock.

	2009-2018 RETURNS TO THE RIVER MOUTH			
FRAM STOCK	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION
Nooksack/Samish Fall	13,401	31,149	20,603	5,631
Nooksack Spr Hatchery	1,239	4,497	2,697	1,041
Skagit Spring Year	1,303	3,122	1,906	580
Snohomish Fall Fing	1,042	7,578	3,411	2,063
Tulalip Fall Fing	188	2,723	904	815
Mid PS Fall Fing	19,035	44,589	30,637	8,227
South Puget Sound Fall Fing	19,785	84,339	45,262	17,897
White River Spring Fing	1,346	5,517	2,946	1,471
CR Oregon Hatchery Tule	641	26,744	15,727	7,689
CR Bonneville Pool Hatchery	27,018	164,256	75,744	46,701
Columbia R Upriver Summer	29,384	61,411	38,337	9,769
Columbia R Upriver Bright	34,562	356,733	139,309	108,550
Cowlitz River Spring	13,254	70,506	30,659	19,755
Willamette River Spring	53,924	192,467	94,142	45,529
WA North Coast Fall	4,067	13,275	7,623	2,867
Willapa Bay	12,202	36,153	23,297	7,656

2. Modeling the Reduced Fisheries Alternative

Effects on Abundance

For the reduced fisheries Alternative of the EIS, the intent was to develop a fishing scenario in the absence of any prey program production where instead fisheries were reduced by some level in order to provide an increase in Chinook abundance that was commensurate with the increases expected from the prey program. We focused on four key time/area strata as targets when developing the fishing scenario for this Alternative: the North of Falcon (NOF) region in the winter (Oct-Apr), the Southwest Vancouver Island (SWWCVI) region in the spring (May-Jun), and the SWWCVI and Salish regions in the summer (Jul-Sep) time period. These key area/time combinations were determined based on the tendency of SRKW to occur in these areas and times more often than others (Thornton et al. 2022). As seen in Table 2, the mean 2009-2018 percent increase of Chinook abundance in the NOF region in the winter ranged from 1.8% to 1.9% (depending on the production scenario) when considering only the Federally funded prey program releases, 1.5% to 1.8% when considering only the WA State funded prey program releases, and 3.3% to 3.8% when combining the two. For SWWCVI in the spring, the mean percent increases were 1.8%–2.2% for the Federally funded prey program releases, 2.4%–2.9% for the WA State funded prey program releases, and 4.2%–5.1% when combined. For SWWCVI in the summer, the mean percent increases were 1.5%–1.9% for the Federally funded prey program releases, 2.6%–3.0% for the WA State funded prey program releases, and 4.1%–4.9% when combined. Finally, for the Salish Sea region in the summer, the mean percent increases were similar between the 2022 and 2023 productions scenarios, at 0.5% for the Federally funded prey program releases, 0.8% for the WA State funded prey program releases, and 1.3% when combined.

We initially focused on the winter and spring abundances, acknowledging that these would only be affected by modifications to winter and spring fisheries; modifications to fisheries in the subsequent summer time period would not affect winter or spring abundances. Since the magnitude of Chinook catch in the winter and spring fisheries is generally lower compared to catch in the summer fisheries, we first ran a scenario where all U.S. Chinook fisheries in the Oct-Apr and May-Jun time periods were closed. In this scenario we modeled all individual stock-based management (ISBM) fisheries and Southeast Alaska (SEAK) aggregate abundance-based management (AABM) fisheries in subsequent time periods using the same fishing effort as in the original model runs in order to simulate the additional catch that might occur due to increased abundances resulting from the winter and spring U.S. fishery closures. For the Canadian AABM fisheries, however, we did not allow for this increased catch to occur, as they would still be subject to annual catch limits specified by the Pacific Salmon Treaty and we did not want potential additional catch to result in exceeding those catch limits.

The effects of Oct-Jun U.S. Chinook fisheries on regional abundances are presented in Figure 4, with additional detail provided in Appendix A7. In examining these results and focusing on the Oct-Apr NOF and May-Jun SWWCVI estimates, it quickly becomes apparent that even a complete closure of all U.S. winter and spring Chinook fisheries would not be able to achieve similar abundance increases as those expected from the hatchery prey program, particularly in the winter. The projected increases to the Oct-Apr NOF and May-Jun SWWCVI abundances from closing all winter and spring U.S. Chinook fisheries are 0.4% and 2.6%, respectively. Those compare to expected Oct-Apr NOF and May-Jun SWWVI increases from the hatchery prey program of 1.8%–1.9% and 1.8%–2.2%, respectively, if considering only the Federally funded prey program releases, or 3.3%–3.8% and 4.2%–5.1%, respectively, if considering both the Federally and WA State funded prey program releases.

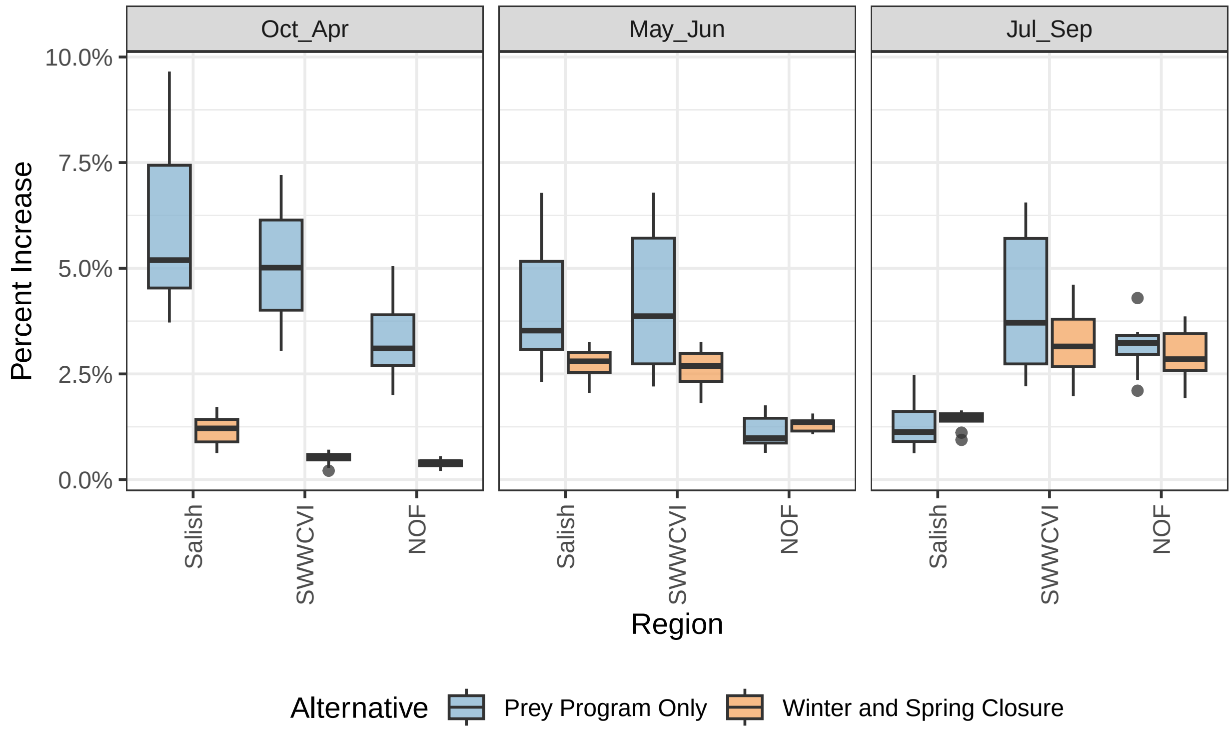

Figure 4: Summary of estimated 2009-2018 percent increases to regional Chinook abundances resulting from the full closure of all U.S. Chinook directed fisheries between October and June compared to expected increases from the prey program (based on 2022 releases).

There is also a downstream effect from closing winter Chinook fisheries that affects the regional abundances in the Jul-Sep time period. For the SWWCVI and Salish Sea regions, this results in average percent increases of approximately 3.2% and 1.4%, respectively. Overall, these values are similar to the percent increases expected from the combined Federal and WA State funded hatchery prey program of 4.1%–4.9% for SWWCVI and 1.3% for the Salish Sea, however, the percent increase in SWWCVI is not yet meeting the expected benefit from the hatchery prey program. To address this we ran an additional modeling scenario that included the same closure of all winter and spring U.S. Chinook fisheries as described above, in addition to a fifteen percent reduction to all Jul-Sep U.S. Chinook fisheries that would be expected to affect SRKW prey availability. There are some terminal fisheries within Puget Sound that are considered to only impact mature Chinook that are no longer vulnerable to SRKW as they make their way back to the rivers to spawn; these fisheries were not reduced in this modeling scenario (see NMFS (2023) for more detail on how these fisheries were identified). The results of including this fifteen percent reduction to U.S. Chinook fisheries in the Jul-Sep time period are presented in Figure 5 with additional detail provided in Appendix A8. The average percent increase to the SWWCVI abundance in the Jul-Sep time period for this scenario was 3.7%, which is now similar to the projected average increase of 4.1%–4.9% from the hatchery prey program when considering both the Federally and WA State funded production.

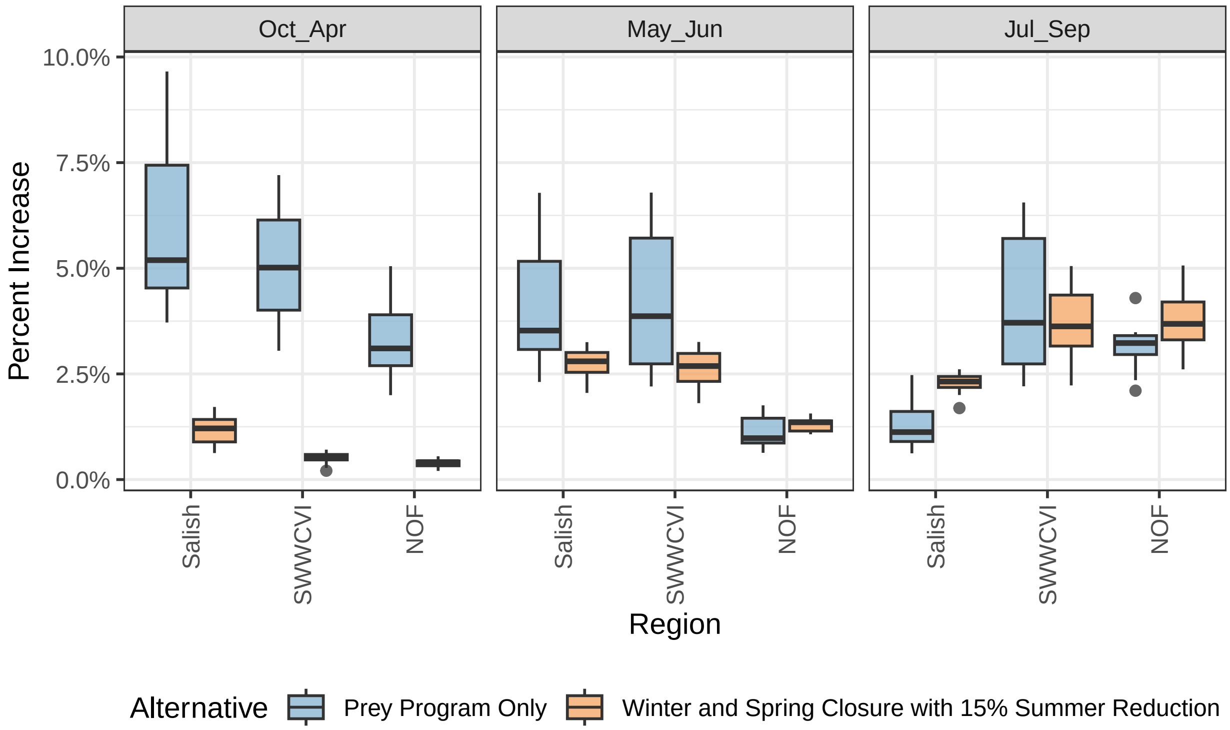

Figure 5: Summary of estimated 2009-2018 percent increases to regional Chinook abundances resulting from the full closure of all U.S. Chinook directed fisheries between October and June in addition to a fifteen percent reduction to all U.S. Chinook directed fisheries in July through September that would be expected to affect Chinook available to SRKW as prey compared to expected increases from the prey program (based on 2022 releases).

Note that Figures 4 and 5 do not include estimates for the Oregon or California coastal regions. This is due to limitations in the modeling framework that don't allow for fine tuning of the fisheries south of Cape Falcon (SOF) when it comes to effects on the abundances of Sacramento River, Klamath River, and Rogue River fall Chinook, which are processed externally to FRAM. While we have the ability to assess the effects of a closure of all SOF fisheries (e.g., for the entire year across all areas and gears), we cannot currently evaluate temporal closures that involve closing for only part of the year or reductions that involve scaling down the effort in a fishery but not closing it completely. This limitation makes it difficult to assess the effects of the modeling scenario described above on the abundances in the coastal OR and CA regions due to the significant contribution of the Sacramento, Klamath, and Rogue River fall Chinook stocks to the abundances in these areas. The effects to abundances in the other regions, however, should be minor, as the more southerly distribution of these three stocks results in generally negligible contributions to the overall abundances in regions north of Cape Falcon.

Effects on Catch

Table 5 provides a summary of the average reduction in catch associated with closing U.S. Chinook fisheries from Oct-Jun and reducing U.S. Chinook fisheries in Jul-Sep by fifteen percent. Table 6 provides the same information, but is also broken out by gear type. An important consideration in interpreting these results is that we took a very simplistic approach to modifying fisheries in that we closed or reduced all fisheries equally without consideration for which fisheries might provide greater benefit to the abundances in the specific time/area strata being targeted. It is likely that there are alternative fishing scenarios that could provide similar benefits to abundances while requiring a smaller overall reduction to catches, however, this would involve more fine tuning and unequal treatment across fisheries, resulting in a disproportionate sharing of the burden across regions.

Table 5: Mean annual reduction in catch by fishery region and time period due to Oct-Jun closure and Jul-Sep reduction of U.S. fisheries.

	CATCH REDUCTION		
FISHERY REGION	OCT-APR	MAY-JUN	JUL-SEP
SEAK	33,766	53,197	14,717
PFMC_NOF	0	48,459	6,730
PFMC_SOF	17,349	70,665	6,544
WAC	0	0	1,490
PS	8,880	2,220	3,255

Table 6: Mean annual reduction in catch by fishery region, gear type, and time period due to Oct-Jun closure and Jul-Sep reduction of U.S. fisheries.

		CATCH REDUCTION		
FISHERY REGION	GEAR	OCT-APR	MAY-JUN	JUL-SEP
SEAK	Net	0	4,266	757
SEAK	Sport	0	28,239	1,462
SEAK	Troll	33,766	20,692	12,497
PFMC_NOF	Sport	0	4,626	3,043
PFMC_NOF	Troll	0	43,833	3,687
PFMC_SOF	Sport	7,951	11,059	2,402
PFMC_SOF	Troll	9,398	59,606	4,142
WAC	Net	0	0	1,490
PS	Net	176	0	682
PS	Sport	6,443	1,133	2,525
PS	Troll	2,260	1,087	49

3. Pairing the reduced fisheries Alternative with the prey program

To model this Alternative we started with the final set of model runs from the fishery reduction Alternative, where U.S. fisheries were closed in Oct-Jun and reduced by fifteen percent in Jul-Sep. We modified the stock-age specific starting abundances in these runs to reflect estimated effects of the prey program, using total production levels (WA State and Federally funded) that actually occurred in 2022 (see Section 1). In this modeling exercise, all fisheries were modeled to maintain the existing effort levels (i.e., if the abundance of a given stock doubled, then the fishery would catch twice as many of that stock). From these model results we calculated the expected percent increases in regional abundance. Figure 6 compares these combined benefits with the percent increases expected from the hatchery prey program Alternative (2022 release scenario from Section 1) and the reduced fishery Alternative (Section 2), with additional detail provided in Appendix A9. It demonstrates that the benefit from each Alternative is essentially additive if the two were to be applied in concert with each other. For example, for SWWCVI in the summer, when looking at the hatchery prey program and fishery reduction Alternatives individually, the estimated increases in Chinook abundance were similar, around 3.7%, and when the two Alternatives were modeled simultaneously the estimated increase in Chinook abundance was ~7.5%.

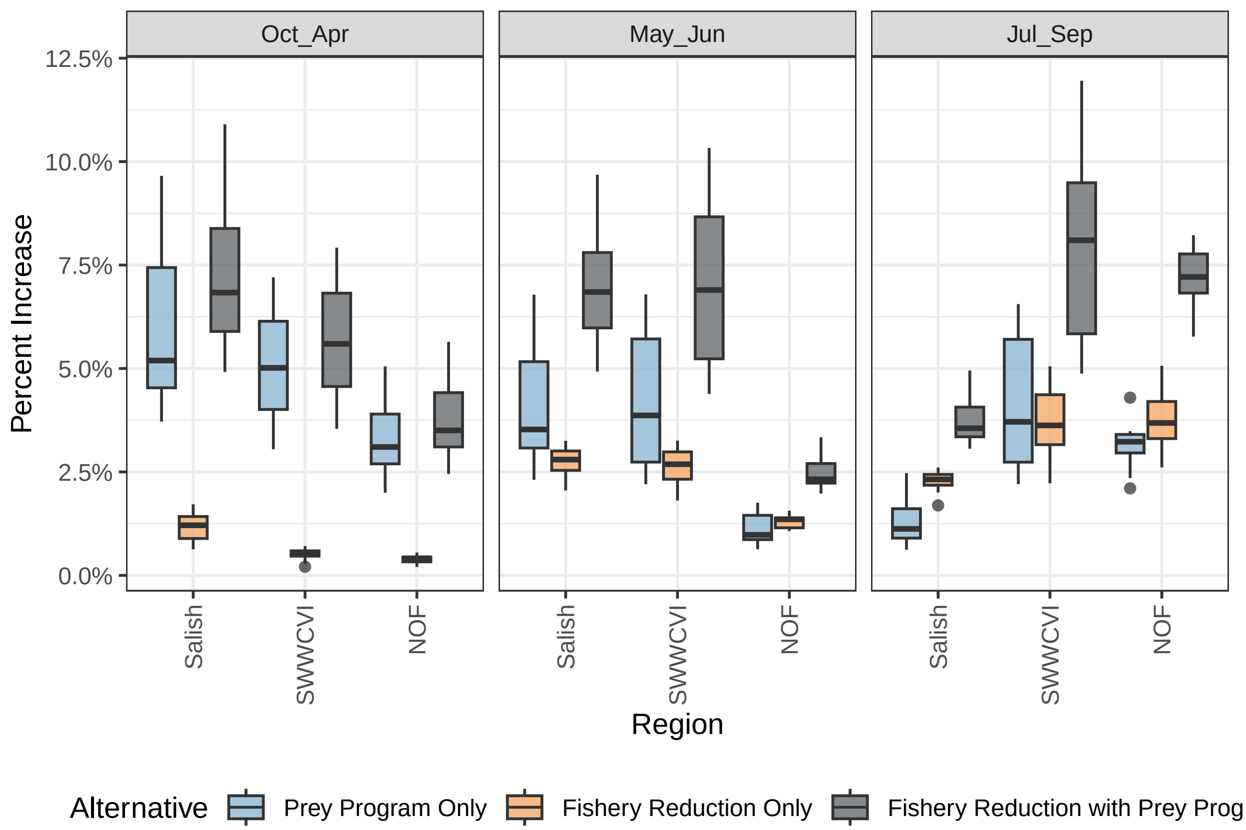

Figure 6: Summary of estimated 2009-2018 percent increases to regional Chinook abundances compared between prey program only, fishery reduction only, and fishery reduction with prey program Alternatives. Note that in both cases, the level of production modeled for the prey program was the total (Federal and WA State funded) production that was actually released in 2022.

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APPENDIX A

Appendix A1: Number of Chinook released in 2022 as part of the hatchery prey program.

FUNDING SOURCE	FACILITY	REGION	RUN	STAGE	BROOD SOURCE	RELEASE	FRAM STOCK
Federal	Tulalip Bernie Gobin Hatchery	Puget Sound	Summer	Sub-yearling	Wallace	958,415	Tulalip Fall Fing
Federal	SAFE	Columbia River	Spring	Yearling	Willamette River	1,507,467	Willamette River Spring
Federal	Little White/Willard NFH	Columbia River	Spring	Yearling	Little White	380,578	NA
Federal	Issaquah Hatchery	Puget Sound	Fall	Sub-yearling	NA	707,026	Mid PS Fall Fing
Federal	Soos Creek Hatchery	Puget Sound	Fall	Sub-yearling	Green River	2,077,000	Mid PS Fall Fing
Federal	East Bank and Marion Drain Hatcheries	Columbia River	Summer	Yearling	Entiat/Chelan/Wells	19,755	CR Upriver Summer
Federal	Umatilla Hatchery	Columbia River	Fall (URB)	Sub-yearling	Little White	127,931	CR Upriver Bright
Federal	Bonneville Hatchery	Columbia River	Fall (tules)	Sub-yearling	Bonneville Pool	250,000	CR Oregon Hatchery Tule
Federal	Wells Hatchery	Columbia River	Summer	Sub-yearling	Wells	544,979	CR Upriver Summer
Federal	Spring Creek NFH	Columbia River	Fall (tules)	Sub-yearling	Columbia River Gorge tules	66,294	CR Bonneville Pool Hatchery
WA State	Kendall	Puget Sound	Spring	Sub-yearling	Kendall	635,697	Nooksack Spr Hatchery
WA State	Whatcom Cr.	Puget Sound	Fall	Sub-yearling	Samish	543,181	Nooksack/Samish Fall
WA State	Hupp Springs	Puget Sound	Spring	Sub-yearling	Minter	515,642	White River Spring Fing
WA State	Samish	Puget Sound	Fall	Sub-yearling	Samish	906,459	Nooksack/Samish Fall
WA State	Wallace River	Puget Sound	Summer	Sub-yearling	Wallace River	1,049,421	Snohomish Fall Fing
WA State	Marblemount	Puget Sound	Spring	Sub-yearling	Marblemount	128,022	Skagit Spring Year
WA State	Sol Duc	WA Coast	Summer	Sub-yearling	Sol Duc	558,969	NA
WA State	Sol Duc	WA Coast	Summer	Yearling	Sol Duc	28,588	NA
WA State	Minter	Puget Sound	Fall	Sub-yearling	Minter	291,083	South PS Fall Fing
WA State	Naselle	WA Coast	Fall	Sub-yearling	Naselle	2,577,982	Willapa Bay
WA State	Forks Creek	WA Coast	Fall	Sub-yearling	Forks Creek	108,072	Willapa Bay
WA State	Wells Hatchery	Columbia River	Summer	Sub-yearling	Wells	520,239	CR Upriver Summer
WA State	Quinault Lake	WA Coast	Fall	Sub-yearling	Quinault	446,651	WA North Coast Fall
WA State	Sol Duc/Bear Springs	WA Coast	Summer	Sub-yearling	Sol Duc	115,179	NA
WA State	Sol Duc/Bear Springs	WA Coast	Summer	Sub-yearling	Sol Duc	72,651	NA
WA State	Wilkeson Creek	Puget Sound	Fall	Sub-yearling	Clarks Creek	400,000	Mid PS Fall Fing
WA State	Clarks Creek	Puget Sound	Fall	Sub-yearling	Clarks Creek	611,685	Mid PS Fall Fing
WA State	White River	Puget Sound	Spring	Sub-yearling	White River	238,335	White River Spring Fing
WA State	Lummi Bay Hatchery	Puget Sound	Spring	Sub-yearling	Kendall	499,193	Nooksack Spr Hatchery
WA State	Klickitat Hatchery	Columbia River	Fall (URB)	Sub-yearling	Klickitat/Little White	574,715	CR Upriver Bright
WA State	Lewis River	Columbia River	Spring	Yearling	Lewis River	268,950	Cowlitz River Spring

Appendix A2: Number of Chinook released in 2023 as part of the hatchery prey program.

FUNDING SOURCE	FACILITY	REGION	RUN	STAGE	BROOD SOURCE	RELEASE	FRAM STOCK
Federal	Dworshak NFH	Columbia River	Spring	Yearling	Clearwater	493,858	NA
Federal	Carson NFH	Columbia River	Spring	Yearling	Carson	74,123	NA
Federal	East Bank and Marion Drain Hatcheries	Columbia River	Summer	Yearling	Entiat/Chelan/Wells	109,876	CR Upriver Summer
WA State	Lewis River	Columbia River	Spring	Sub-yearling	Lewis River	290,165	Cowlitz River Spring
Federal	Bonneville Hatchery	Columbia River	Fall (tule)	Sub-yearling	Bonneville	234,871	CR Oregon Hatchery Tule
WA State	Klickitat Hatchery	Columbia River	Fall	Sub-yearling	Klickitat/Little White	154,835	CR Upriver Bright
Federal	Wells Hatchery	Columbia River	Summer	Sub-yearling	Wells	514,076	CR Upriver Summer
WA State	Wells Hatchery	Columbia River	Summer	Sub-yearling	Wells	514,075	CR Upriver Summer
Federal	Little White/Willard NFH	Columbia River	Spring	Yearling	Little White	497,692	NA
Federal	SAFE	Columbia River	Spring	Yearling	Willamette Tribs	1,430,813	Willamette River Spring
WA State	Skookum Creek	Puget Sound	Spring	Sub-yearling	Skookum Creek	762,084	Nooksack Spr Hatchery
WA State	Clarks Creek	Puget Sound	Fall	Sub-yearling	Clarks Creek	675,200	Mid PS Fall Fing
WA State	Wilkeson Creek	Puget Sound	Fall	Sub-yearling	Clarks Creek	386,049	Mid PS Fall Fing
Federal	Issaquah Hatchery	Puget Sound	Fall	Sub-yearling	Issaquah Hatchery	1,000,000	Mid PS Fall Fing
Federal	Soos Creek-Palmer Pond Hatchery Chinook	Puget Sound	Fall	Sub-yearling	Green River	2,137,191	Mid PS Fall Fing
WA State	Lummi Bay Hatchery	Puget Sound	Spring	Sub-yearling	Kendall	504,080	Nooksack Spr Hatchery
WA State	Kendall	Puget Sound	Spring	Sub-yearling	Kendall	532,756	Nooksack Spr Hatchery
WA State	Samish	Puget Sound	Fall	Sub-yearling	Samish	1,042,500	Nooksack/Samish Fall
WA State	Whatcom Cr.	Puget Sound	Fall	Sub-yearling	Samish	520,964	Nooksack/Samish Fall
WA State	Marblemount	Puget Sound	Spring	Sub-yearling	Marblemount	204,190	Skagit Spring Year
WA State	Marblemount	Puget Sound	Spring	Yearling	Marblemount	499,293	Skagit Spring Year
WA State	Wallace River	Puget Sound	Summer	Sub-yearling	Wallace River	1,151,558	Snohomish Fall Fing
WA State	Wallace River	Puget Sound	Summer	Yearling	Wallace River	79,315	Snohomish Fall Year
WA State	Minter	Puget Sound	Fall	Sub-yearling	Minter	419,058	South PS Fall Fing
Federal	Tulalip Bernie Gobin Hatchery	Puget Sound	Summer	Sub-yearling	Wallace	1,808,692	Tulalip Fall Fing
WA State	White River	Puget Sound	Spring	Sub-yearling	White River	273,385	White River Spring Fing
WA State	Hupp Springs	Puget Sound	Spring	Sub-yearling	Minter	476,501	White River Spring Fing
WA State	Sol Duc/Bear Springs	WA Coast	Summer	Sub-yearling	Sol Duc	73,122	NA
WA State	Sol Duc/Bear Springs	WA Coast	Summer	Yearling	Sol Duc	20,170	NA
WA State	Sol Duc	WA Coast	Summer	Sub-yearling	Sol Duc	553,736	NA
WA State	Sol Duc	WA Coast	Summer	Yearling	Sol Duc	64,982	NA
WA State	Quinault Lake	WA Coast	Fall	Sub-yearling	Quinault	500,000	WA North Coast Fall
WA State	Forks Creek	WA Coast	Fall	Sub-yearling	Forks Creek	84,308	Willapa Bay
WA State	Naselle	WA Coast	Fall	Sub-yearling	Naselle	1,826,352	Willapa Bay

Appendix A3: RMIS query results for adipose fin clipped hatchery releases by Puget Sound FRAM stock for brood years that contributed to the 2009-2018 return years.

BROOD YEAR	NOOKSACK/ SAMISH FALL	NOOKSACK SPRING	SKAGIT SPRING	SNOHOMISH FALL	TULALIP FALL	MID-PUGET SOUND FALL	SOUTH PUGET SOUND FALL	WHITE RIVER SPRING
2004	4,131,337	575,946	329,764	864,068	871,052	7,850,399	9,298,328	1,207,892
2005	3,076,746	644,700	453,274	665,931	631,876	8,029,038	10,325,435	943,587
2006	3,428,802	538,117	325,670	908,596	1,416,909	10,067,592	10,664,882	956,430
2007	4,725,746	649,793	279,957	813,010	1,454,572	8,725,073	11,143,657	1,615,426
2008	5,685,216	573,135	331,769	959,818	1,269,856	8,636,504	11,169,211	1,993,986
2009	5,215,421	619,980	349,117	1,050,308	1,212,932	8,576,246	8,691,804	1,244,325
2010	5,254,095	615,849	320,033	802,361	2,350,291	10,172,139	10,976,905	1,258,454
2011	5,039,573	611,457	293,714	1,562,009	2,400,654	9,020,533	8,626,100	879,573
2012	5,227,115	961,169	373,394	863,093	1,704,712	8,907,625	9,865,846	911,704
2013	5,116,893	845,678	370,591	841,453	2,069,986	5,408,199	9,031,590	1,475,086
2014	5,023,502	884,463	465,154	857,206	2,351,392	7,300,402	9,289,473	566,384
2015	5,391,056	871,655	443,600	891,121	2,260,025	8,961,833	7,515,973	783,585
2016	3,786,085	830,408	388,387	758,966	1,936,200	8,303,974	9,105,392	1,227,522

Appendix A4: RMIS query results for adipose fin clipped hatchery releases by Columbia River and Washington Coastal FRAM stock for brood years that contributed to the 2009-2018 return years.

BROOD YEAR	COWLITZ SPRING	WILLAMETTE SPRING	COLUMBIA SUMMER	COLUMBIA UPRIVER BRIGHT	COLUMBIA OR TULE	COLUMBIA BONNEVILLE POOL HATCHERY	WASHINGTON NORTH COAST FALL	WILLAPA BAY FALL
2004	2,164,087	7,327,150	1,959,956	5,660,272	268,564	14,103,694	1,486,682	597,053
2005	2,530,768	7,109,765	1,166,611	11,015,277	234,079	14,790,728	1,025,323	2,438,315
2006	2,109,163	7,795,601	2,098,215	5,625,472	4,210,265	15,022,357	969,218	9,178,859
2007	2,651,585	6,990,827	1,960,353	11,565,752	4,018,254	14,448,272	1,288,519	7,205,850
2008	2,622,600	8,290,048	3,881,758	14,637,321	7,960,365	12,746,912	1,417,014	7,244,549
2009	2,268,888	8,130,635	4,266,996	15,880,918	8,573,093	12,147,017	1,090,685	4,630,642
2010	2,933,697	7,966,999	3,372,056	14,601,170	7,715,779	12,261,685	1,387,827	7,100,337
2011	2,999,836	7,792,413	3,628,913	15,455,031	7,901,326	12,352,339	1,904,334	5,993,346
2012	3,606,838	7,452,389	2,680,540	16,537,660	7,428,683	12,682,866	1,253,514	6,612,844
2013	3,713,648	7,080,269	3,812,867	16,418,912	8,644,922	10,336,664	1,035,603	6,923,821
2014	3,677,188	6,727,818	3,872,978	16,813,047	9,252,691	10,020,574	1,478,578	6,906,901
2015	3,043,928	6,799,252	3,236,338	15,657,840	9,096,236	9,765,769	1,781,165	4,126,030
2016	3,065,965	6,673,263	3,599,085	16,882,494	5,379,154	10,369,524	956,335	5,810,492

Appendix A5: Annual estimates of percent increase in abundance by funding source, region, and time step for the hatchery prey program based on 2022 releases.

TIMESTEP	REGION	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEAN	MEDIAN
FEDERAL													
Oct_Apr	Salish	1.98%	1.42%	1.51%	2.42%	1.38%	0.94%	1.57%	3.99%	4.09%	3.54%	2.28%	1.77%
Oct_Apr	NOF	1.70%	2.18%	1.82%	1.66%	1.06%	1.05%	1.57%	2.11%	2.77%	2.43%	1.84%	1.76%
Oct_Apr	OR	0.39%	0.74%	0.53%	0.25%	0.22%	0.28%	0.48%	0.59%	0.68%	0.39%	0.45%	0.44%
Oct_Apr	Cali	0.79%	1.71%	0.87%	0.29%	0.20%	0.34%	1.13%	0.78%	1.03%	0.45%	0.76%	0.78%
Oct_Apr	SWWCVI	2.50%	2.39%	1.97%	2.01%	1.07%	1.01%	1.62%	2.67%	3.27%	3.08%	2.16%	2.20%
May_Jun	Salish	1.62%	1.12%	1.21%	2.01%	1.15%	0.77%	1.27%	3.11%	3.29%	2.82%	1.84%	1.44%
May_Jun	NOF	0.56%	0.49%	0.45%	0.47%	0.32%	0.26%	0.39%	0.72%	0.94%	0.87%	0.55%	0.48%
May_Jun	OR	0.13%	0.13%	0.10%	0.05%	0.06%	0.05%	0.10%	0.16%	0.18%	0.11%	0.11%	0.11%
May_Jun	Cali	0.04%	0.07%	0.03%	0.01%	0.01%	0.01%	0.05%	0.02%	0.04%	0.02%	0.03%	0.03%
May_Jun	SWWCVI	1.83%	1.40%	1.31%	1.72%	0.81%	0.70%	1.01%	2.67%	3.36%	3.22%	1.80%	1.56%
Jul_Sep	Salish	0.47%	0.39%	0.19%	0.70%	0.34%	0.22%	0.40%	0.87%	0.78%	0.68%	0.50%	0.43%
Jul_Sep	NOF	1.84%	1.59%	1.25%	0.89%	0.98%	0.64%	1.36%	1.12%	1.29%	1.22%	1.22%	1.23%
Jul_Sep	OR	0.17%	0.17%	0.13%	0.05%	0.08%	0.06%	0.14%	0.16%	0.16%	0.10%	0.12%	0.13%
Jul_Sep	Cali	0.04%	0.06%	0.03%	0.01%	0.01%	0.01%	0.04%	0.02%	0.04%	0.02%	0.03%	0.03%
Jul_Sep	SWWCVI	1.49%	1.18%	1.06%	1.36%	0.68%	0.55%	0.85%	2.35%	2.94%	2.78%	1.52%	1.27%
STATE													
Oct_Apr	Salish	3.56%	3.01%	3.00%	4.22%	3.46%	2.78%	3.03%	5.67%	4.83%	4.17%	3.77%	3.51%
Oct_Apr	NOF	1.53%	1.15%	1.14%	1.31%	1.25%	0.95%	1.03%	1.98%	2.28%	1.94%	1.46%	1.28%
Oct_Apr	OR	0.23%	0.21%	0.17%	0.12%	0.16%	0.14%	0.20%	0.41%	0.41%	0.21%	0.23%	0.20%
Oct_Apr	Cali	0.38%	0.34%	0.21%	0.11%	0.12%	0.15%	0.37%	0.50%	0.62%	0.24%	0.30%	0.29%
Oct_Apr	SWWCVI	3.54%	2.73%	2.73%	2.90%	2.25%	2.04%	2.16%	3.51%	3.93%	3.69%	2.95%	2.82%
May_Jun	Salish	2.22%	1.78%	1.84%	2.77%	2.06%	1.54%	1.91%	3.68%	2.80%	2.48%	2.31%	2.14%
May_Jun	NOF	0.64%	0.47%	0.49%	0.54%	0.52%	0.37%	0.43%	0.82%	0.81%	0.75%	0.58%	0.53%
May_Jun	OR	0.17%	0.15%	0.13%	0.07%	0.12%	0.10%	0.12%	0.23%	0.28%	0.16%	0.15%	0.14%
May_Jun	Cali	0.16%	0.14%	0.09%	0.04%	0.06%	0.07%	0.10%	0.17%	0.32%	0.14%	0.13%	0.12%
May_Jun	SWWCVI	2.68%	2.04%	2.02%	2.57%	1.66%	1.50%	1.53%	3.45%	3.43%	3.32%	2.42%	2.31%
Jul_Sep	Salish	0.56%	0.48%	0.43%	0.69%	0.64%	0.60%	0.82%	1.60%	0.98%	1.00%	0.78%	0.67%
Jul_Sep	NOF	2.45%	1.85%	1.94%	1.46%	2.29%	1.46%	1.96%	1.76%	2.20%	1.96%	1.93%	1.95%
Jul_Sep	OR	0.21%	0.20%	0.16%	0.08%	0.16%	0.12%	0.17%	0.24%	0.26%	0.15%	0.17%	0.17%
Jul_Sep	Cali	0.13%	0.11%	0.07%	0.03%	0.05%	0.05%	0.09%	0.14%	0.26%	0.11%	0.10%	0.10%
Jul_Sep	SWWCVI	2.84%	2.13%	2.22%	2.75%	1.84%	1.65%	1.70%	3.82%	3.62%	3.51%	2.61%	2.49%
TOTAL													
Oct_Apr	Salish	5.54%	4.43%	4.51%	6.64%	4.84%	3.72%	4.60%	9.66%	8.92%	7.70%	6.06%	5.19%
Oct_Apr	NOF	3.23%	3.33%	2.96%	2.97%	2.31%	2.00%	2.61%	4.09%	5.05%	4.37%	3.29%	3.10%
Oct_Apr	OR	0.62%	0.94%	0.70%	0.37%	0.37%	0.41%	0.68%	1.00%	1.09%	0.60%	0.68%	0.65%
Oct_Apr	Cali	1.17%	2.05%	1.08%	0.40%	0.32%	0.49%	1.50%	1.28%	1.64%	0.70%	1.06%	1.13%
Oct_Apr	SWWCVI	6.04%	5.12%	4.70%	4.92%	3.32%	3.05%	3.78%	6.18%	7.20%	6.77%	5.11%	5.02%
May_Jun	Salish	3.83%	2.90%	3.04%	4.78%	3.22%	2.31%	3.18%	6.78%	6.08%	5.29%	4.14%	3.53%
May_Jun	NOF	1.21%	0.96%	0.94%	1.00%	0.84%	0.63%	0.82%	1.53%	1.76%	1.61%	1.13%	0.98%
May_Jun	OR	0.30%	0.28%	0.23%	0.12%	0.18%	0.15%	0.22%	0.40%	0.45%	0.27%	0.26%	0.25%
May_Jun	Cali	0.20%	0.21%	0.12%	0.05%	0.06%	0.08%	0.15%	0.19%	0.36%	0.16%	0.16%	0.16%
May_Jun	SWWCVI	4.51%	3.43%	3.33%	4.30%	2.47%	2.20%	2.54%	6.12%	6.79%	6.54%	4.22%	3.87%
Jul_Sep	Salish	1.03%	0.88%	0.62%	1.39%	0.98%	0.82%	1.22%	2.47%	1.76%	1.69%	1.28%	1.12%
Jul_Sep	NOF	4.29%	3.44%	3.19%	2.35%	3.27%	2.10%	3.31%	2.88%	3.49%	3.18%	3.15%	3.23%
Jul_Sep	OR	0.38%	0.37%	0.29%	0.13%	0.24%	0.17%	0.31%	0.40%	0.42%	0.25%	0.30%	0.30%
Jul_Sep	Cali	0.17%	0.18%	0.10%	0.04%	0.05%	0.06%	0.13%	0.17%	0.30%	0.13%	0.13%	0.13%
Jul_Sep	SWWCVI	4.32%	3.31%	3.29%	4.11%	2.52%	2.21%	2.55%	6.17%	6.56%	6.30%	4.13%	3.71%

Appendix A6: Annual estimates of percent increase in abundance by funding source, region, and time step for the hatchery prey program based on 2023 releases.

TIMESTEP	REGION	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEAN	MEDIAN
FEDERAL													
Oct_Apr	Salish	2.39%	1.86%	1.86%	2.74%	1.65%	1.11%	1.97%	5.21%	5.28%	4.51%	2.86%	2.18%
Oct_Apr	NOF	1.79%	2.18%	1.83%	1.66%	1.03%	0.98%	1.54%	2.37%	3.11%	2.71%	1.92%	1.81%
Oct_Apr	OR	0.39%	0.71%	0.50%	0.24%	0.20%	0.25%	0.45%	0.59%	0.68%	0.39%	0.44%	0.42%
Oct_Apr	Cali	0.76%	1.63%	0.83%	0.27%	0.19%	0.32%	1.07%	0.74%	0.98%	0.43%	0.72%	0.75%
Oct_Apr	SWWCVI	2.76%	2.60%	2.11%	2.10%	1.06%	0.97%	1.70%	3.23%	3.96%	3.68%	2.42%	2.36%
May_Jun	Salish	1.92%	1.44%	1.45%	2.27%	1.36%	0.89%	1.56%	3.98%	4.17%	3.52%	2.26%	1.74%
May_Jun	NOF	0.62%	0.52%	0.47%	0.48%	0.31%	0.24%	0.40%	0.87%	1.13%	1.03%	0.61%	0.50%
May_Jun	OR	0.14%	0.13%	0.10%	0.05%	0.05%	0.04%	0.10%	0.18%	0.20%	0.12%	0.11%	0.11%
May_Jun	Cali	0.04%	0.07%	0.03%	0.01%	0.01%	0.01%	0.04%	0.02%	0.04%	0.02%	0.03%	0.03%
May_Jun	SWWCVI	2.12%	1.66%	1.52%	1.89%	0.89%	0.75%	1.15%	3.39%	4.24%	4.01%	2.16%	1.77%
Jul_Sep	Salish	0.48%	0.46%	0.07%	0.77%	0.34%	0.21%	0.43%	0.97%	0.77%	0.66%	0.52%	0.47%
Jul_Sep	NOF	1.97%	1.66%	1.26%	0.86%	0.79%	0.52%	1.35%	1.20%	1.40%	1.32%	1.23%	1.29%
Jul_Sep	OR	0.18%	0.18%	0.13%	0.05%	0.06%	0.05%	0.14%	0.17%	0.17%	0.11%	0.12%	0.13%
Jul_Sep	Cali	0.04%	0.06%	0.03%	0.01%	0.01%	0.01%	0.04%	0.03%	0.04%	0.02%	0.03%	0.03%
Jul_Sep	SWWCVI	1.77%	1.47%	1.27%	1.51%	0.78%	0.62%	1.01%	3.11%	3.86%	3.60%	1.90%	1.49%
STATE													
Oct_Apr	Salish	4.90%	4.40%	4.25%	5.47%	4.58%	3.75%	3.85%	7.21%	7.06%	5.79%	5.13%	4.74%
Oct_Apr	NOF	1.91%	1.50%	1.44%	1.58%	1.37%	1.10%	1.13%	2.44%	3.21%	2.62%	1.83%	1.54%
Oct_Apr	OR	0.29%	0.27%	0.22%	0.14%	0.17%	0.15%	0.21%	0.51%	0.59%	0.31%	0.29%	0.24%
Oct_Apr	Cali	0.55%	0.51%	0.31%	0.15%	0.15%	0.19%	0.44%	0.69%	1.00%	0.39%	0.44%	0.41%
Oct_Apr	SWWCVI	3.94%	3.15%	2.99%	3.14%	2.15%	2.06%	2.14%	3.98%	4.98%	4.44%	3.30%	3.15%
May_Jun	Salish	2.69%	2.23%	2.27%	3.27%	2.44%	1.89%	2.21%	4.28%	3.55%	3.04%	2.79%	2.57%
May_Jun	NOF	0.68%	0.50%	0.51%	0.56%	0.46%	0.35%	0.41%	0.88%	0.94%	0.84%	0.61%	0.53%
May_Jun	OR	0.21%	0.19%	0.16%	0.08%	0.12%	0.10%	0.13%	0.30%	0.42%	0.23%	0.19%	0.17%
May_Jun	Cali	0.29%	0.27%	0.17%	0.07%	0.09%	0.10%	0.16%	0.31%	0.62%	0.26%	0.23%	0.21%
May_Jun	SWWCVI	3.18%	2.52%	2.43%	2.99%	1.82%	1.72%	1.67%	4.04%	4.45%	4.13%	2.90%	2.76%
Jul_Sep	Salish	0.56%	0.50%	0.43%	0.73%	0.60%	0.61%	0.81%	1.72%	1.06%	1.06%	0.81%	0.67%
Jul_Sep	NOF	2.19%	1.63%	1.58%	1.13%	1.41%	0.97%	1.56%	1.52%	2.04%	1.74%	1.58%	1.57%
Jul_Sep	OR	0.23%	0.22%	0.17%	0.08%	0.13%	0.10%	0.16%	0.28%	0.36%	0.20%	0.19%	0.19%
Jul_Sep	Cali	0.24%	0.22%	0.13%	0.05%	0.07%	0.08%	0.13%	0.25%	0.50%	0.21%	0.19%	0.17%
Jul_Sep	SWWCVI	3.25%	2.54%	2.54%	3.10%	1.97%	1.84%	1.81%	4.35%	4.47%	4.16%	3.00%	2.82%
TOTAL													
Oct_Apr	Salish	7.29%	6.25%	6.11%	8.21%	6.23%	4.86%	5.82%	12.42%	12.34%	10.30%	7.98%	6.77%
Oct_Apr	NOF	3.70%	3.68%	3.27%	3.24%	2.40%	2.08%	2.68%	4.81%	6.32%	5.34%	3.75%	3.47%
Oct_Apr	OR	0.68%	0.97%	0.72%	0.38%	0.36%	0.41%	0.67%	1.10%	1.27%	0.69%	0.73%	0.69%
Oct_Apr	Cali	1.30%	2.14%	1.14%	0.42%	0.34%	0.51%	1.51%	1.43%	1.98%	0.82%	1.16%	1.22%
Oct_Apr	SWWCVI	6.70%	5.75%	5.11%	5.25%	3.21%	3.04%	3.84%	7.21%	8.94%	8.12%	5.72%	5.50%
May_Jun	Salish	4.61%	3.67%	3.72%	5.54%	3.80%	2.78%	3.77%	8.26%	7.72%	6.56%	5.04%	4.21%
May_Jun	NOF	1.30%	1.02%	0.98%	1.04%	0.78%	0.59%	0.81%	1.75%	2.07%	1.87%	1.22%	1.03%
May_Jun	OR	0.35%	0.32%	0.26%	0.14%	0.17%	0.15%	0.22%	0.48%	0.61%	0.35%	0.30%	0.29%
May_Jun	Cali	0.33%	0.34%	0.20%	0.08%	0.09%	0.12%	0.20%	0.33%	0.65%	0.28%	0.26%	0.24%
May_Jun	SWWCVI	5.31%	4.18%	3.94%	4.88%	2.72%	2.47%	2.82%	7.43%	8.69%	8.14%	5.06%	4.53%
Jul_Sep	Salish	1.03%	0.96%	0.50%	1.50%	0.93%	0.82%	1.24%	2.68%	1.83%	1.72%	1.32%	1.14%
Jul_Sep	NOF	4.16%	3.29%	2.83%	1.99%	2.21%	1.49%	2.92%	2.73%	3.43%	3.07%	2.81%	2.88%
Jul_Sep	OR	0.42%	0.40%	0.29%	0.13%	0.19%	0.15%	0.29%	0.45%	0.53%	0.31%	0.32%	0.30%
Jul_Sep	Cali	0.27%	0.29%	0.16%	0.06%	0.08%	0.09%	0.17%	0.28%	0.54%	0.23%	0.22%	0.20%
Jul_Sep	SWWCVI	5.03%	4.01%	3.81%	4.61%	2.75%	2.45%	2.83%	7.47%	8.33%	7.76%	4.90%	4.31%

Appendix A7: Annual estimates of percent increase in abundance by region and time step for the fishing scenario with U.S. Chinook fisheries closed from Oct-Jun.

TIMESTEP	REGION	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEAN	MEDIAN
Oct_Apr	SWWCVI	0.45%	0.53%	0.57%	0.55%	0.21%	0.60%	0.52%	0.71%	0.67%	0.28%	0.51%	0.54%
Oct_Apr	Salish	1.43%	1.15%	1.72%	1.41%	1.28%	1.05%	0.65%	0.84%	1.65%	0.63%	1.18%	1.21%
Oct_Apr	NOF	0.31%	0.43%	0.44%	0.40%	0.20%	0.43%	0.38%	0.52%	0.55%	0.23%	0.39%	0.41%
May_Jun	SWWCVI	3.09%	2.67%	3.07%	2.72%	1.81%	2.58%	2.23%	2.71%	3.26%	2.24%	2.64%	2.69%
May_Jun	Salish	3.14%	2.90%	3.25%	2.89%	2.47%	2.50%	2.71%	2.66%	3.04%	2.05%	2.76%	2.80%
May_Jun	NOF	1.34%	1.26%	1.39%	1.11%	1.10%	1.56%	1.38%	1.37%	1.50%	1.07%	1.31%	1.36%
Jul_Sep	SWWCVI	3.79%	2.79%	3.80%	3.51%	1.97%	2.72%	2.27%	3.80%	4.61%	2.65%	3.19%	3.15%
Jul_Sep	Salish	1.52%	1.64%	1.57%	1.39%	1.11%	1.46%	1.58%	1.48%	1.38%	0.94%	1.41%	1.47%
Jul_Sep	NOF	2.78%	2.53%	2.92%	2.48%	2.73%	3.86%	3.47%	3.70%	3.39%	1.92%	2.98%	2.85%

Appendix A8: Annual estimates of percent increase in abundance by region and time step for the fishing scenario with U.S. Chinook fisheries closed from Oct-Jun and decreased by 15% from Jul-Sep.

TIMESTEP	REGION	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEAN	MEDIAN
Oct_Apr	SWWCVI	0.45%	0.53%	0.57%	0.55%	0.21%	0.60%	0.52%	0.71%	0.67%	0.28%	0.51%	0.54%
Oct_Apr	Salish	1.43%	1.15%	1.72%	1.41%	1.28%	1.05%	0.65%	0.84%	1.65%	0.63%	1.18%	1.21%
Oct_Apr	NOF	0.31%	0.43%	0.44%	0.40%	0.20%	0.43%	0.38%	0.52%	0.55%	0.23%	0.39%	0.41%
May_Jun	SWWCVI	3.09%	2.67%	3.07%	2.72%	1.81%	2.58%	2.23%	2.71%	3.26%	2.24%	2.64%	2.69%
May_Jun	Salish	3.14%	2.90%	3.25%	2.89%	2.47%	2.50%	2.71%	2.66%	3.04%	2.05%	2.76%	2.80%
May_Jun	NOF	1.34%	1.26%	1.39%	1.11%	1.10%	1.56%	1.38%	1.37%	1.50%	1.07%	1.31%	1.36%
Jul_Sep	SWWCVI	4.38%	3.20%	4.35%	4.02%	2.23%	3.23%	2.61%	4.37%	5.05%	3.15%	3.66%	3.63%
Jul_Sep	Salish	2.42%	2.45%	2.56%	2.61%	2.00%	2.15%	2.27%	2.30%	2.34%	1.69%	2.28%	2.32%
Jul_Sep	NOF	3.65%	3.18%	3.72%	3.26%	3.45%	5.07%	4.23%	4.82%	4.12%	2.61%	3.81%	3.68%

Appendix A9: Annual estimates of percent increase in abundance by region and time step for the Alternative that combines the hatchery prey program Alternative (based on 2022 release levels) with the fishery reduction Alternative (U.S. Chinook fisheries closed from Oct-Jun and decreased by 15% from Jul-Sep).

TIMESTEP	REGION	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	MEAN	MEDIAN
Oct_Apr	SWWCVI	6.52%	5.69%	5.32%	5.50%	3.54%	3.67%	4.31%	6.92%	7.92%	7.07%	5.65%	5.60%
Oct_Apr	Salish	7.22%	5.75%	6.45%	8.27%	6.33%	4.92%	5.32%	10.61%	10.90%	8.42%	7.42%	6.84%
Oct_Apr	NOF	3.56%	3.80%	3.44%	3.40%	2.53%	2.45%	3.00%	4.64%	5.64%	4.62%	3.71%	3.50%
May_Jun	SWWCVI	7.82%	6.27%	6.60%	7.20%	4.39%	4.89%	4.85%	8.99%	10.33%	8.95%	7.03%	6.90%
May_Jun	Salish	7.20%	5.97%	6.50%	7.89%	5.87%	4.93%	6.02%	9.68%	9.44%	7.53%	7.10%	6.85%
May_Jun	NOF	2.61%	2.26%	2.38%	2.17%	1.98%	2.23%	2.23%	2.95%	3.34%	2.73%	2.49%	2.32%
Jul_Sep	SWWCVI	8.97%	6.70%	7.85%	8.35%	4.88%	5.55%	5.27%	10.76%	11.95%	9.66%	7.99%	8.10%
Jul_Sep	Salish	3.62%	3.46%	3.31%	4.22%	3.13%	3.06%	3.61%	4.95%	4.27%	3.50%	3.71%	3.56%
Jul_Sep	NOF	8.22%	6.82%	7.14%	5.77%	6.83%	7.29%	7.68%	7.87%	7.80%	5.93%	7.13%	7.21%

15. APPENDIX H VALIDATED PRE-FISHING ABUNDANCES

Estimated pre-fishing Chinook salmon abundances aggregated by spatial box for each time step since 1992 are provided below. These estimates were derived using the post-season validation runs as described in Appendix F. These values represent starting abundances in October, prior to natural or fishery mortality estimates that occur in each subsequent time step.

	Region				
Year	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**
1992	494,850	942,511	652,570	461,505	331,211
1993	494,585	962,580	694,962	726,617	614,654
1994	416,597	780,136	515,793	556,886	576,280
1995	479,499	863,217	704,852	1,301,233	1,343,781
1996	494,208	885,175	667,092	908,855	869,789
1997	494,644	1,039,093	726,362	801,451	963,725
1998	412,878	841,894	540,346	635,501	649,538
1999	501,909	1,054,270	626,975	564,584	692,145
2000	430,718	852,973	755,960	1,030,571	1,030,259
2001	771,771	1,314,062	1,372,350	1,170,271	1,005,699
2002	880,148	1,180,661	1,482,669	1,488,779	1,387,006
2003	879,460	1,318,493	1,373,535	1,520,145	1,275,724
2004	866,138	1,197,040	1,288,536	1,117,257	1,011,330
2005	668,957	999,356	874,622	789,442	843,790
2006	590,470	1,140,814	736,300	451,607	436,108
2007	438,487	876,223	547,222	492,807	339,898
2008	593,106	1,059,407	762,858	344,385	134,161
2009	490,486	762,396	704,193	551,623	198,153
2010	810,242	1,174,961	1,253,484	876,757	320,456
2011	665,107	941,321	940,670	711,864	351,394
2012	654,030	877,935	980,600	1,241,745	869,781
2013	1,062,118	1,059,295	1,181,022	1,116,532	896,463
2014	882,178	1,059,875	1,177,498	982,485	638,421
2015	994,244	955,923	1,335,017	987,391	347,879
2016	628,543	900,657	781,476	408,739	223,186
2017	614,695	1,060,960	731,845	438,495	211,895
2018	527,210	1,009,215	663,662	596,483	362,720
2019	543,690	1,024,051	633,225	561,412	505,310
2020	589,009	810,150	674,293	520,301	395,985