DRAFT ENVIRONMENTAL IMPACT STATEMENT

Draft Environmental Impact Statement (DEIS) to Analyze Impacts of NOAA's National Marine Fisheries Service Proposed Approval of Hatchery and Genetic Management Plans for spring Chinook salmon, steelhead, and rainbow trout in the Upper Willamette River Basin Pursuant to Section 4(d) of the Endangered Species Act

Prepared by the
National Marine Fisheries Service, West Coast Region

NOAA FISHERIES

March 2018

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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

March 15, 2018

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act (NEPA), the *Draft Environmental Impact Statement to Analyze Impacts of NOAA's National Marine Fisheries Service Proposed Approval of Hatchery and Genetic Management Plans for spring Chinook salmon, steelhead, and rainbow trout in the Upper Willamette River Basin Pursuant to Section 4(d) of the Endangered Species Act* is enclosed for your review.

This Draft Environmental Impact Statement (DEIS) assesses environmental impacts associated with the National Marine Fisheries Service's (NMFS) review and approval of hatchery and genetic management plans (HGMPs) submitted by the co-managers for hatchery programs currently in operation in the Upper Willamette River Basin. The HGMPs are being evaluated under Limit 5 of the Endangered Species Act 4(d) rules for listed salmon and steelhead. Additional copies of the DEIS may be obtained from the NMFS office, as identified below. The DEIS is also accessible electronically through the NMFS West Coast Region's website at: http://www.westcoast.fisheries.noaa.gov/hatcheries/salmon_and_steelhead_hatcheries.html

Written comments may be submitted during the agency's 45-day public comment period. Please submit written comments via mail, facsimile (fax), or email to:

NMFS, Oregon Coast Hatchery DEIS
2900 NW Stewart Parkway
Roseburg, Oregon 97471
Fax: (541) 957-3386
Email: WillamettehatcheryEIS.wcr@noaa.gov

Sincerely,

Barry A. Thom
Regional Administrator

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Cover Sheet
Draft Environmental Impact Statement (DEIS)

Title of Environmental Review:	Draft Environmental Impact Statement (DEIS) to Analyze Impacts of NOAA's National Marine Fisheries Service Proposed Approval of Hatchery and Genetic Management Plans for spring Chinook salmon, steelhead, and rainbow trout in the Upper Willamette River Basin Pursuant to Section 4(d) of the Endangered Species Act
Responsible Agency and Official:	Barry Thom, Regional Administrator National Marine Fisheries Service, West Coast Region 1201 NE Lloyd Boulevard, Suite 1100 Portland, Oregon 97232-1274
Contacts:	Lance Kruzic NMFS West Coast Region 2900 NW Stewart Parkway Roseburg, OR 97471 Lance.Kruzic@noaa.gov (note: not for commenting) (541) 957-3381
Location of Proposed Activities:	Upper Willamette River
Proposed Action:	NMFS' approval of Hatchery and Genetics Management Plans in the Upper Willamette River Basin under Limit 5 of 4(d) rules affecting listed spring Chinook salmon and winter steelhead.
Abstract:	The co-managers submitted Hatchery and Genetic Management Plans for spring Chinook, steelhead, and rainbow trout programs in the Upper Willamette River Basin to NMFS for evaluation under the ESA. The analysis herein informs NMFS, hatchery operators, and the public about the current and anticipated direct, indirect, and cumulative environmental effects of operating the hatchery programs under the full range of alternatives considered.
Public Comments:	Comments on this DEIS must be received no later than May 7, 2018.

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SUMMARY

Background

The U.S. Army Corps of Engineers(Corps), Oregon Department of Fish and Wildlife (ODFW), and the Bonneville Power Administration (BPA) (collectively referred to as the "co-managers") have submitted Hatchery and Genetic Management Plans (HGMPs) for the hatchery programs currently in the Upper Willamette River Basin to the National Marine Fisheries Service (NMFS), pursuant to Limit 5 of the 4(d) Rule for salmon and steelhead promulgated under the Endangered Species Act (ESA) (65 FR 42422, July 10, 2000). Before a decision is made by NMFS on these HGMPs under the ESA, the National Environmental Policy Act (NEPA) requires Federal agencies to conduct environmental analyses of proposed actions to fully consider their effects on the human environment. NMFS's action of issuing concurrence with the HGMPs under Limit 5 of the 4(d) Rule is a major Federal action subject to environmental review under NEPA. A DEIS was prepared and is currently out for public review and comment.

Proposed Action

The co-managers have submitted HGMPs for the continued operation of hatchery programs in the Upper Willamette River Basin propagating spring Chinook salmon, summer steelhead, and rainbow trout for approval by NMFS under the ESA Limit 5 of the 4(d) Rule for ESA-listed spring Chinook salmon and winter steelhead in the Upper Willamette River. Under the Proposed Action, NMFS would make a determination that submitted HGMPs meet the requirements of Limit 5 under the 4(d) Rule of the ESA. The HGMPs for Upper Willamette hatcheries would be approved under the ESA and continue to be implemented by the co-managers.

Purpose and Need

The purpose and need of the Proposed Action is two-fold: (1) for NMFS to evaluate the submitted HGMPs to ensure the hatchery programs are not jeopardizing ESA-listed salmon and steelhead, and (2) for the co-managers to operate the hatchery programs for the conservation and recovery of ESA-listed salmon and steelhead, while providing hatchery-origin fish for recreational and commercial fisheries in the Willamette River, lower Columbia River, and ocean.

Project Area and Analysis Area

The project area is the geographic area where the Proposed Action would take place. In this case, it is the geographical area for hatchery salmon, steelhead, and trout and associated hatchery facilities used to collect, propagate, rear, and release hatchery-origin fish in specified rivers, streams, and reservoirs in the Upper Willamette River Basin (above Willamette Falls), lower Willamette River, lower Columbia River, and the ocean. The hatchery facilities (and ancillary facilities) are: Marion Forks hatchery, Minto Fish Collection Facility, South Santiam Hatchery, Foster Fish Collection Facility, Roaring River Hatchery, McKenzie hatchery, Leaburg Hatchery, Leaburg Dam, Dexter Fish Collection Facility, and Willamette Hatchery. Hatchery fish are released into the following waterbodies: Molalla, North Santiam, South Santiam, McKenzie, Middle Fork Willamette, and Coast Fork Willamette rivers.

The "analysis area" is the geographic extent that is being evaluated for a particular resource. For some resources, the analysis area may be larger than the project area, since some of the effects of the alternatives may occur outside the project area. For example, some socioeconomic effects of the hatchery programs are evaluated at the project area level (the streams and rivers where hatchery fish are released), but others are evaluated within a larger geographic scope (fisheries occurring in the Pacific Ocean off the Oregon and Washington coasts where hatchery fish are also caught). The analysis area for each resource is described in Chapter 3, Affected Environment. Direct and indirect effects on various resources within the project and analysis areas are analyzed in Chapter 4, Environmental Consequences.

In addition, a larger analysis area was defined to consider actions with effects that are potentially cumulative with the Proposed Action and, thus, require evaluation of effects outside the Upper Willamette River Basin. The evaluation of this larger analysis area for cumulative effects is described in Chapter 5, Cumulative Effects.

Alternatives Including the Proposed Action

This DEIS analyzes five alternatives in detail:

Alternative 1 (No-action)

The No-action Alternative is the continuation of the existing hatchery programs for spring Chinook salmon, summer steelhead, and rainbow trout in the Upper Willamette River Basin. These hatchery programs are currently being managed under the mandates of NMFS' 2008 Biological Opinion for the Willamette Project (13 multi-purpose federal dams in the Upper Willamette River Basin). Hatchery fish are released into the Molalla, North Santiam, South Santiam, McKenzie, Middle Fork Willamette, and Coast Fork Willamette rivers.

Alternative 2 (Proposed Action/Preferred Alternative)

Alternative 2 is the proposed action where updated HGMPs have been submitted to NMFS for approval under limit 5 of the 4(d) Rule. The primary difference between this alternative and the No-action alternative is the spring Chinook salmon programs propose to use natural-origin salmon for broodstock purposes. The use of natural-origin salmon is a Reasonable and Prudent Alternative (#6.2) of NMFS' Biological Opinion on the Willamette Project (NMFS 2008). Purposefully using natural-origin Chinook salmon for hatchery broodstock requires additional evaluation under the ESA and can only be authorized by a section 10(a)(1)(A) permit or by limit 5 of the 4(d) Rule. This alternative evaluates this proposed management change of the salmon hatchery programs to allow natural-origin salmon to be included in hatchery broodstocks.

Alternative 3 (Reduce Hatchery Production to Reintroduction Needs)

Alternative 3 evaluates a reduced hatchery production scenario compared to the No-action Alternative, where only hatchery fish needed for reintroduction purposes above the Federal dams are produced. This level of production would return sufficient numbers of adult salmon and steelhead for outplanting needs above the dams to seed available habitat.

Alternative 4 (Terminate the Existing Hatchery Programs in the Upper Willamette River Basin)

Alternative 4 evaluates eliminating all hatchery programs in the Upper Willamette River Basin and the consequences of this action compared to the No-action Alternative. No hatchery fish would be produced for any purpose.

Alternative 5 (Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits)
Alternative 5 evaluates increasing hatchery production in existing hatchery facilities up to maximum capacity in order to support enhanced fishery opportunities in the ocean and freshwater. The existing fishery impact limits authorized under the ESA would still apply under this alternative.

Affected Environment

Seven resources are described in the affected environment of the Upper Willamette River Basin by the implementation of the five alternatives:

- Water quantity
- Water quality
- Salmon and Steelhead and Their Habitats
- Other Fish and Their Habitats
- Wildlife
- Socioeconomics
- Environmental justice

Current conditions include effects of the past operation of hatchery programs in the Upper Willamette River Basin.

Environmental Consequences

This DEIS is a comprehensive evaluation of all hatchery programs in the Upper Willamette River Basin. The genetic, ecological, and social effects of hatchery fish are evaluated at multiple local and regional scales. The five alternatives evaluate a wide range of impacts associated with the identified resources for the alternatives. The relative magnitude and direction of impacts is described using the following terms:

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

Table S-1 below provides a summary of the predicted resource effects under each of the five alternatives. The summary reflects the detailed resource discussions in Chapter 4, Environmental Consequences.

Table S-1. Summary of environmental consequences for DEIS alternatives for each resource.

Resource	Alternative 1 (No-action)	Alternative 2 (Proposed Action/Preferred Alternative)	Alternative 3 (Reduce Hatchery Production to Reintroduction Needs)	Alternative 4 (Terminate the Existing Hatchery Programs in the Upper Willamette River Basin)	Alternative 5 (Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits)
Water Quantity	Negligible to low impacts at the hatchery facilities and fish collection facilities from water diversion in affected reaches. Negligible overall on a watershed scale.	Overall same as Alternative 1.	Impacts would be reduced compared to the No-action alternative because reduced hatchery production and therefore reduced water use in affected reaches. Negligible effect overall on a watershed scale.	Impacts would be eliminated under this alternative compared to the No-action alternative, with exception of continued operation of fish collection facilities. Expected benefits from not using water for hatchery purposes is negligible for all populations.	Impacts expected to be low at the hatchery facilities and fish collection facilities under this alternative compared to the No-action alternative. Maximum authorized water rights may be used, but impacts still expected to be low overall.
Water Quality	Negligible impacts downstream from the hatchery facilities. No effect on current water quality issues (303d listings) in all populations.	Overall, same as Alternative 1.	Impacts would be reduced since fewer hatchery fish would be produced. However, potential improvements would be undetectable compared to the No-action alternative.	Impacts on water quality would be eliminated, with the exception of continued operation of fish collection facilities. Negligible benefit to water quality compared to the No-action alternative.	Impacts expected to be low at and downstream of the hatchery facilities and fish collection facilities under this alternative compared to the No-action alternative. Maximum authorized water rights may be used, but impacts still expected to be negligible overall and not affect current 303(d) listings.

Resource	Alternative 1 (No-action)	Alternative 2 (Proposed Action/Preferred Alternative)	Alternative 3 (Reduce Hatchery Production to Reintroduction Needs)	Alternative 4 (Terminate the Existing Hatchery Programs in the Upper Willamette River Basin)	Alternative 5 (Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits)
Salmon and Steelhead and Their Habitats	The benefits and risks depend upon species and program. Spring Chinook Salmon Programs: Benefits include: increased spawning abundances, increased marine derived nutrients, and fishery harvest opportunities. Risks include: genetic domestication effects, masking, competition and predation by hatchery fish on natural-origin salmon. Summer Steelhead Programs: Benefits include fishery harvest opportunities. Risks include: genetic impacts (out of DPS), predation, competition. Rainbow Trout Programs: Benefits include fishery harvest opportunities. Risks include: predation and competition, disease	For spring Chinook salmon, integration of natural-origin salmon into hatchery increases demographic risk by reducing spawning abundances, but benefit from reduced genetic domestication effects of hatchery fish. For summer steelhead and rainbow trout, overall same as Alternative 1.	For the spring Chinook salmon program, a benefit would be that domestication effects would be reduced by having smaller program and higher integration of natural-origin broodstock compared to No-action alternative. However, fishery harvest opportunities would be reduced compared to No-action alternative. The summer steelhead program would be changed to a reintroduction program for winter steelhead. This would benefit winter steelhead because out-of-DPS genetic effects would be eliminated compared to No-action alternative. Other benefits would include increased spawning abundances of winter steelhead, increase marine derived nutrients. Risks would include domestication	For spring Chinook, salmon, demographic risks would increase because population viability would decrease in populations where hatchery program would be eliminated compared to No-action alternative from not having hatchery Chinook salmon spawning in the wild. However, the genetic risk would decrease compared to the No-action and preferred alternative. For winter steelhead, a benefit would be that population viability may increase from the elimination of genetic effects in populations where summer steelhead releases would be terminated in the North Santiam and South Santiam rivers. For the rainbow trout program, spring Chinook	For spring Chinook salmon, all risks would increase for this alternative compared to the No-action alternative. Harvest opportunity would increase, as would marine derived nutrients from hatchery fish. For winter steelhead, all risks would increase for this alternative from increased production of summer steelhead and rainbow trout. Fishery harvest benefits would be greater compared to the No-action alternative.

Resource	Alternative 1 (No-action)	Alternative 2 (Proposed Action/Preferred Alternative)	Alternative 3 (Reduce Hatchery Production to Reintroduction Needs)	Alternative 4 (Terminate the Existing Hatchery Programs in the Upper Willamette River Basin)	Alternative 5 (Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits)
	transfer, increased exploitation of natural-origin salmon and steelhead.		effects, predation, and competition. The rainbow trout program would be eliminated under this alternative because there are no conservation benefits of this program to salmon and steelhead.	salmon and winter steelhead competition/predation risks would decrease from termination of releases. Catch and release mortality effects may increase on salmon and steelhead from termination of harvestable trout stockings.	

Resource	Alternative 1 (No-action)	Alternative 2 (Proposed Action/Preferred Alternative)	Alternative 3 (Reduce Hatchery Production to Reintroduction Needs)	Alternative 4 (Terminate the Existing Hatchery Programs in the Upper Willamette River Basin)	Alternative 5 (Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits)
Other Fish and Their Habitats	Mix of risks and benefits from the hatchery programs. Salmon, steelhead, and trout can compete and prey upon these fish species (and vice versa). Hatchery carcasses provide valuable ecosystem nutrients. Overall low impact.	Overall, same as Alternative 1.	Negligible difference on these fish species from this alternative compared to the No-action alternative.	Mix of risks and benefits from termination of the hatchery programs. Low impact from loss of hatchery nutrient enhancement. Predation and competition by hatchery fish on native fishes would decrease. Hatchery fish as a prey source will be eliminated for many species.	Negligible difference on these fish species from this alternative compared to the No-action alternative.
Wildlife	Mix of risks and benefits from the hatchery programs. Salmon, steelhead, and trout are potential food source for most wildlife species. Hatchery carcasses provide valuable ecosystem nutrients. Overall low impact.	Overall, same as Alternative 1.	Mix of risks and benefits from the reduced hatchery production. Hatchery fish as a prey source for certain species will be reduced compared to the No-action Alternative.	Mix of risks and benefits from the termination of the hatchery programs. Hatchery fish as a prey source for many species would be eliminated. Hatchery nutrient enhancement would be eliminated.	Mix of risks and benefits from the increased hatchery production. Hatchery fish as a prey source for certain species will be enhanced compared to the No-action Alternative.

Resource	Alternative 1 (No-action)	Alternative 2 (Proposed Action/Preferred Alternative)	Alternative 3 (Reduce Hatchery Production to Reintroduction Needs)	Alternative 4 (Terminate the Existing Hatchery Programs in the Upper Willamette River Basin)	Alternative 5 (Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits)
Socio-economics	Depending upon the specific fishery, low to medium economic benefits of the hatchery programs and facilities from employment, goods and services, fisheries, and tourism. The hatchery programs that have the highest harvest rates on hatchery fish typically exhibit the greatest economic contributions.	Overall, same as Alternative 1.	Reduced economic benefits from reduced hatchery production for fisheries under this alternative compared to the No-action alternative.	Depending upon the specific fishery, low to medium impact on socioeconomics from termination of the hatchery programs compared to the No-action Alternative.	Increased economic benefits in all fisheries under this alternative compared to the No-action alternative. Most benefits expected to accrue in Willamette Basin recreational fisheries.
Environmental Justice	Undetectable to negligible impacts on low income and minority groups in the local communities.	Overall, same as Alternative 1.	Undetectable to negligible impacts on low income and minority groups in the local communities compared to the No-action Alternative.	Undetectable to negligible impacts on low income and minority groups in the local communities compared to the No-action Alternative.	Undetectable to negligible impacts on low income and minority groups in the local communities compared to the No-action Alternative.

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Acronyms and Abbreviations

BMP	Best Management Practice
BPA	Bonneville Power Administration
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CFS	Cubic feet per second
Corps	U.S. Army Corps of Engineers
DPS	Distinct population segment
EA	Environmental assessment
EFH	Essential Fish Habitat
EIS	Environmental impact statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FONSI	Finding of No Significant Impact
FTE	Full-time equivalent
HGMP	Hatchery and genetic management plan
HOR	Hatchery-origin returns
HSRG	Hatchery Scientific Review Group
IHOT	Integrated Hatchery Operations Team
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NFCP	Native Fish Conservation Policy
NMFS	National Marine Fisheries Service (also called NOAA Fisheries Service)
NOR	Natural-origin returns
NPDES	National Pollutant Discharge Elimination System
ODFW	Oregon Department of Fish and Wildlife
pHOS	Proportion of hatchery-origin spawners on spawning grounds
PNI	Proportionate Natural Influence (pNOB/(pNOB+pHOS))
pNOB	Proportion of natural-origin fish in the broodstock
ROD	Record of Decision
TRT	Technical Recovery Team
UWR	Upper Willamette River Basin
USC	U.S. Code

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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).

Adaptive management: A deliberate process of using research, monitoring, and scientific evaluation in making decisions in the face of uncertainty.

Acclimation pond: A concrete or earthen pond or a temporary structure used for rearing and imprinting juvenile fish in the water of a particular stream before their release into that stream.

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**.

Best management practice (BMP): A policy, practice, procedure, or structure implemented to mitigate adverse environmental effects.

Broodstock: A group of sexually mature individuals of a species that is used for breeding purposes as the source for a subsequent generation.

Co-managers: The agencies responsible for funding and implementing the hatchery programs in the Upper Willamette River Basin (Oregon Department of Fish and Wildlife, U.S. Corps of Engineers, and Bonneville Power Administration).

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.

Critical habitat: A specific term and designation within the ESA, referring to habitat area essential to the conservation of a listed species, though the area need not actually be occupied by the species at the time it is designated.

Dewatering: Typically, the immediate downstream habitat effects associated with a water withdrawal action that diverts the entire flow of a stream or river to another location

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:

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

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.

Diversity: Variation at the level of individual genes (polymorphism); provides a mechanism for populations to adapt to their ever-changing environment. It is also one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

Domestication: See **Hatchery-influenced selection**.

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

Endangered species: As defined in the ESA, 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.

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.

Fingerling: A juvenile fish.

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

Fitness: As used in this EIS, the propensity of a group of fish (e.g., populations) to survive and reproduce.

Forage fish: Small fish that breed prolifically and serve as food for predatory fish.

Fry: Juvenile salmon and steelhead that are usually less than one year old and have absorbed their egg sac.

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-influenced selection: The process whereby genetic characteristics of hatchery populations become different from their source populations as a result of selection in hatchery environments (also referred to as domestication).

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.
Incidental: Unintentional, but not unexpected.
Incidental fishing effects: Fish, marine birds, or mammals unintentionally captured during fisheries using any of a variety of gear types.
Integrated hatchery program: A hatchery program that intends for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the natural environment. Differences between hatchery-origin and natural-origin fish are minimized, and hatchery-origin fish are integrated with the local populations included in an ESU or DPS.
Isolated hatchery program: A hatchery program that intends for the hatchery-origin population to be reproductively segregated from the natural-origin population. These programs produce fish that are different from local populations. They do not contribute to conservation or recovery of populations included in an ESU or DPS.
Limit 5: Under section 4(d) of the ESA (see **Section 4(d) Rule**), a limit on "take" prohibitions that applies to Hatchery and Genetics Management Plans developed by a state and/or federal agency.
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 established national policy promoting the enhancement of the environment 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.
National Pollutant Discharge Elimination System (NPDES): A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the Environmental Protection Agency, a state, or, where delegated, a tribal government on an Indian reservation.
Native fish: Fish that are endemic to or limited to a specific region.
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.
Pathogen: An infectious microorganism that can cause disease (e.g., virus, bacteria, fungus) in its host.
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.
Productivity: The rate at which a population is able to produce reproductive offspring. It is one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).
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: NMFS's review and approval under Limit 5 of the 4(d) rules of the hatchery and genetic management plans (and operation of the hatchery facilities) submitted by the Corps of Engineers, Oregon Department of Fish and Wildlife, and Bonneville Power Administration for hatcheries in the Upper Willamette River Basin.

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 salmon and steelhead) 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).

Redd: The spawning site or "nest" in stream and river gravels in which salmon and steelhead lay their eggs.

Residuals: Hatchery-origin fish that out-migrate slowly, if at all, after they are released. Residualism occurs when such fish residualize rather than out-migrate as most of their counterparts do.

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.

Run size: The number of adult salmon or steelhead (i.e., harvest plus escapement) returning to their natal areas.

Salmonid: A fish of the taxonomic family Salmonidae, which includes salmon, steelhead, and trout.

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 1501.7).

Section 4(d) Rule: A special regulation developed by NMFS under authority of section 4(d) of the ESA, modifying the normal protective regulations for a particular threatened species when it is determined that such a rule is necessary and advisable to provide for the conservation of that species.

Section 7 consultation: Federal agency consultation with NMFS or USFWS (dependent on agency jurisdiction) on any actions that may affect listed species, as required under section 7 of the ESA.

Section 10 permit: A permit for direct take of listed species for scientific purposes or to enhance the propagation or survival of listed species, or for incidental take of listed species during otherwise lawful activities. Issued by NMFS or USFWS (dependent on agency jurisdiction) as authorized under section 10(a)(1) of the ESA.

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

Spatial structure: The spatial structure of a population refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. It is one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

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.

Supplementation: Release of fish into the natural environment to increase the abundance of naturally reproducing fish populations.

Take: Under the ESA, the term "take" means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Take for hatchery activities includes, for example, the collection of listed fish (adults and juveniles) for hatchery broodstock, the collection of listed hatchery-origin fish to prevent them from spawning naturally, and the collection of listed fish (juvenile and adult fish) for scientific purposes.

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.

Upper Willamette River Basin: The geographic area upstream of Willamette Falls, including the entire watershed upstream including tributaries such as Molalla, North Santiam, South Santiam, Calapooia, McKenzie, Middle Fork Willamette rivers.

Viability: As used in this EIS, a measure of the status of listed salmon and steelhead that uses four criteria: abundance, productivity, spatial distribution, and diversity.

Viable salmonid population (VSP): An independent population of salmon or steelhead that has a negligible risk of extinction over a 100-year timeframe (McElhany et al. 2000).

Water intake screen: A screen used to prevent entrainment of salmonids into a water diversion or intake. See also **Diversion screen**.

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.

Weir: An adjustable dam placed across a river to regulate the flow of water downstream; a fence placed across a river to catch fish.

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

Spring Chinook salmon (*Oncorhynchus tshawytscha*), winter steelhead (*O. mykiss*), and Columbia River bull trout (*Salvelinus confluentus*) (see Subsection 3.4)(64 FR 14308, March 24, 1999; 64 FR 14517, March 25, 1999; 63 FR 31647, June 10, 1998) are fish species listed as threatened under the Endangered Species Act (ESA) in the Upper Willamette River Basin. Therefore, actions taken by co-managers that affect ESA-listed species are required to have their hatchery programs evaluated by NMFS to ensure the programs are not jeopardizing ESA-listed salmon and steelhead.

The existing hatchery programs are continually being evaluated and adaptively managed to ensure impacts are acceptable to ESA-listed species. The first evaluation of the hatchery programs occurred in 2000 when NMFS issued a Biological Opinion directing hatchery reforms to reduce impacts on spring Chinook salmon and winter steelhead. Another Biological Opinion was issued in 2008 and directed the co-managers to pursue new plans to incorporate natural-origin fish into hatchery broodstocks. RPA #6.2 of the Biological Opinion directed the co-managers to develop new Hatchery and Genetic Management Plans (HGMPs) with specific protocols for incorporating natural-origin fish into hatchery broodstocks. These new HGMPs were submitted to NMFS in 2016 for evaluation under the ESA. Since then, NMFS has been reviewing the HGMPs under the ESA and NEPA.

Before these HGMPs can be approved under the ESA, NEPA requires NMFS to evaluate how proposed determination on the submitted HGMPs may affect the natural and physical environment and the relationship of people with that environment. The NEPA analysis provides an opportunity to consider, for example, how the action may affect conservation of non-listed species and socioeconomic objectives that seek to balance conservation with wise use of affected resources and other legal and policy mandates.

1.2. Description of the Proposed Action

Below is a description of the proposed action categorized by species.

Spring Chinook Salmon

The hatchery co-managers (BPA, ODFW, USACE) have jointly submitted four HGMPs for all spring Chinook salmon hatchery programs in the Upper Willamette River Basin for approval under the ESA limit 5 of the 4(d) Rule. In addition, the hatchery summer steelhead and rainbow trout program are also included in this evaluation using existing HGMPs[2] for these programs. All of the hatchery programs and associated facilities are currently in operation. No new facilities or changes to current production release levels are proposed in the four HGMPs. The existing hatchery facilities are considered part of current conditions existing in the environment at this point in time because the hatchery facilities have been operating for many decades (Table 1). Under the Proposed Action, NMFS would issue a letter to co-managers approving the implementation of the submitted HGMPs under limit 5 of the 4(d) Rule. NMFS approval of the spring Chinook salmon HGMPs would authorize the following activities:

- Continued collection of spring Chinook salmon for broodstock at existing fish collection facilities at Minto, Foster, Dexter dams, and McKenzie Hatchery. The new action in the HGMPs would be to use natural-origin fish collected at facilities for broodstock.
- Continued collection, transport, and release of adult spring Chinook salmon above the USACE dams (Detroit, Foster, Green Peter, Cougar, Blue River, Lookout Point, Fall Creek, Hills Creek) for reintroduction of salmon back into historical habitats.
- Holding of adult broodstock fish at the specific hatchery facilities if appropriate
- Spawning, incubation, and juvenile rearing at the specific hatchery facilities
- Continued release of juvenile hatchery spring Chinook salmon from the various hatchery release facilities, according to the production levels specified in the HGMPs
- Research, monitoring, and evaluation activities associated with the hatchery programs

All of the spring Chinook salmon HGMPs are funded by the USACE, BPA, and the ODFW. The ODFW operates the hatchery facilities and associated traps at Minto fish collection facility, Marion Forks Hatchery, Foster Dam fish collection facility, South Santiam Hatchery, Dexter fish collection facility, Willamette Hatchery, and McKenzie Hatchery. The USACE operates the fish collection facilities at Fall Creek and Cougar dams.

[2] The co-managers are updating the summer steelhead HGMP to reflect current management.

Table 1. Operations of the fish collection facilities and hatchery facilities associated with the HGMPs and reintroductions above federal dams in the Upper Willamette River Basin.

Activity	Facility	Location	Does Facility Exist under Current Conditions?	Is Facility Operated under Current Conditions?
1) Trap and haul for reintroduction above federal dams, 2) Broodstock collection	Minto Fish Collection Facility	North Santiam; RM 42	Yes	Yes
	Foster Fish Collection Facility	South Santiam River; RM 38.5	Yes	Yes
	Dexter Fish Collection Facility	Middle Fork Willamette River; RM 17	Yes	Yes
	Fall Creek Fish Collection Facility	Fall Creek (MF Willamette); RM 7.2	Yes	Yes
	Cougar Fish Collection Facility	South Fork McKenzie River; RM 4.5	Yes	Yes
	McKenzie Hatchery	McKenzie River; RM 37	Yes	Yes
	Leaburg Hatchery	McKenzie River; RM 38.5	Yes	Yes
3) Incubation and rearing of juvenile hatchery salmon, steelhead, and rainbow trout	Marion Forks Hatchery	North Santiam River; RM 73	Yes	Yes
	South Santiam Hatchery	South Santiam River; RM 38.5	Yes	Yes
	McKenzie Hatchery	McKenzie River; RM 37	Yes	Yes
	Leaburg Hatchery	McKenzie River; RM 38.5	Yes	Yes
	Oak Springs Hatchery	Deschutes River; RM 47	Yes	Yes

Activity	Facility	Location	Does Facility Exist under Current Conditions?	Is Facility Operated under Current Conditions?
	Roaring River Hatchery	Crabtree Creek; RM 1.2	Yes	Yes
	Willamette Hatchery	Middle Fork Willamette River; RM 42	Yes	Yes
4) Release of juvenile hatchery salmon, steelhead, and rainbow trout	Minto Fish Collection Facility	North Santiam; RM 42	Yes	Yes
	South Santiam Hatchery	South Santiam River; RM 38.5	Yes	Yes
	McKenzie Hatchery	McKenzie River; RM 37	Yes	Yes
	Leaburg Hatchery	McKenzie River; RM 38.5	Yes	Yes
	Dexter Fish Collection Facility	Middle Fork Willamette River; RM 17	Yes	Yes
	Willamette River	Eugene area		
	SAFE	Lower Columbia River (Chinook salmon)	Yes	Yes
	Willamette River basin	throughout basin (rainbow trout)		
5) Research, Monitoring, and Evaluation	RME specified in HGMPs	varies	Yes	Yes
	Watershed areas accessible to hatchery and		N/A	N/A

Activity	Facility	Location	Does Facility Exist under Current Conditions?	Is Facility Operated under Current Conditions?
	natural salmon migration, spawning, and rearing			

Summer Steelhead

The hatchery summer steelhead program propagates hatchery fish using many of the same collection facilities and hatcheries as for spring Chinook salmon described above (Table 1). The one exception is Roaring River Hatchery which raises summer steelhead and rainbow trout. The summer steelhead program proposed here reflects the management changes implemented in accordance with NMFS 2008 Biological Opinion and RPA actions.

Rainbow Trout

The rainbow trout program propagates hatchery fish for release into closed waterbodies (reservoirs, lakes, ponds) throughout the basin and in select rivers and streams outside of the winter steelhead DPS (e.g. McKenzie River). Rainbow trout are raised at the Roaring River, Leaburg, and Willamette hatcheries (Table 1). The rainbow trout program proposed here reflects management changes since 2008 (issuance of Biological Opinion) to the hatchery program, including funding and private firms producing these fish.

1.3. Purpose of and Need for the Action

The Reasonable and Prudent Alternative (RPA) 6.2 of the Willamette Project Biological Opinion (NMFS 2008) directed the co-managers to develop protocols for taking natural-origin fish for hatchery broodstock. New HGMPs were required to be submitted by the co-managers to NMFS for evaluation and approval under the ESA. These new HGMPs were submitted to NMFS in 2016. NMFS must then review these HGMPs to determine whether they meet the applicable standards for an exemption from section 9 of the ESA, pursuant to Limit 5 of NMFS' ESA section 4(d) regulations, which apply to the operation of hatchery programs. The purpose of the Proposed Action from NMFS' perspective is to evaluate the submitted HGMPs for ESA compliance. The need for the Proposed Action is to ensure the hatchery programs are being managed for the conservation and recovery of listed spring Chinook salmon and winter steelhead occurring in the Upper Willamette River Basin, so that the Willamette Basin Hydroelectric Project does not jeopardize these threatened salmonid species. If approved, NMFS' evaluation and potential approval of the new HGMPs would fulfill NMFS' role and satisfy RPA 6.2 of the Willamette Opinion for these ESA-listed species.

1.4. Project Area and Analysis Area

The project area is the geographic area where the Proposed Action would take place. The project area consists of the geographic areas where the hatchery facilities are located and the stream and river reaches downstream of the facilities where hatchery fish are present as they emigrate to the ocean. The project area specifically includes hatchery areas where fish are spawned, incubated, reared, acclimated, released, or harvested. Within the project area, seven hatcheries are used to propagate the hatchery fish: Marion Forks Hatchery, South Santiam Hatchery, McKenzie Hatchery, Leaburg Hatchery, Oak Springs Hatchery, Roaring River Hatchery, and Willamette Hatchery (Table 1). Additional fish collection facilities are located at Minto, Foster, Dexter, Fall Creek, and Cougar (Table 1; Figure 1).

Figure 1. Location of the fish collection facilities and hatcheries in the Upper Willamette River Basin.

The “analysis area” is the geographic extent that is being evaluated for a particular resource. For some resources, the analysis area may be larger than the project area, since some of the effects of the alternatives may occur outside the project area. For example, some socioeconomic effects of the hatchery programs are evaluated at the project area level (the streams and rivers where hatchery fish are released), but others are evaluated within a larger geographic scope (fisheries occurring in the ocean off the coasts of Washington and Oregon where hatchery fish are also caught).The analysis area for each resource is described in Chapter 3, Affected Environment. Direct and indirect effects on various resources within the project and analysis areas are analyzed in Chapter 4, Environmental Consequences.

In addition, a larger analysis area was defined to consider actions with effects that are potentially cumulative with the Proposed Action and thus, require evaluation of effects throughout the entire Washington/Oregon Coast Region (including areas where no hatchery facilities exist and no hatchery fish are released). The evaluation of this larger analysis area for cumulative effects is described in Chapter 5, Cumulative Effects.

1.5. Decisions to be Made

NMFS must decide on the following before the Proposed Action can be implemented:

- The preferred alternative following an analysis of all alternatives in this DEIS and review of public comments on the DEIS
- Whether the Proposed Action complies with ESA criteria under the section 4(d) Rule

1.5.1. Record of Decision

This NEPA process will culminate in a Record of Decision (ROD) that will record the selected alternative after public comment on this DEIS, revision, and publication of the final EIS. The ROD will identify the environmentally preferred alternative; describe the preferred alternative and the selected alternative; and summarize the impacts expected to result from implementation of the selected alternative.

1.5.2. NMFS's Determination as to Compliance with the 4(d) Rule

Discussions between the co-managers and NMFS during development of the HGMPs are conducted with the knowledge and understanding that the specific criteria under Limit 5 of the 4(d) Rule must be met before a 4(d) limit can be issued. HGMPs submitted under Limit 5 (Artificial Propagation) must meet the following criteria:

1. Specify the goals and objectives for the hatchery program.
2. Specify the donor population's critical and viable threshold levels.
3. Prioritize broodstock collection programs to benefit listed fish.

4. Specify the protocols that will be used for spawning and raising the hatchery-origin fish.
5. Determine the genetic and ecological effects arising from the hatchery program.
6. Describe how the hatchery operation relates to fishery management.
7. Ensure that the hatchery facility can adequately accommodate listed fish if collected for the program.
8. Monitor and evaluate the management plan to ensure that it accomplishes its objective.
9. Be consistent with tribal trust obligations (65 Fed. Reg. 42422, July 10, 2000).

NMFS has a limited role (i.e., approve or deny) under Limit 5 of the 4(d) Rule. The decision as to whether the ESA 4(d) Rule Limit 5 have been met will be documented in NMFS's ESA decision documents at the end of the ESA evaluation process. Included with the ESA decision documents will be responses to comments on the HGMPs received during public review as required by the 4(d) Rule.

1.5.3. Biological Opinion on NMFS's Determination as to Compliance with the 4(d) Rule

ESA section 7(a)(2) provides that any action authorized, funded, or carried out by a Federal agency shall not jeopardize the continued existence of any endangered or threatened species or result in the adverse modification or destruction of designated critical habitat. NMFS's actions under section 4(d) require compliance with section 7(a)(2), and in this case NMFS plans to prepare a biological opinion on the effects of the action. NMFS's consultations under section 7 on those actions may be informed by this NEPA analysis. The results of these consultations are documented in the Biological Opinion developed by NMFS for the species under their jurisdiction. Biological Opinions are produced near the end of the ESA evaluation and determination process, providing the NMFS conclusions regarding the likelihood that the proposed hatchery actions will jeopardize the continued existence of any listed species or adversely modify designated critical habitat for any listed species.

1.6. Scoping and Relevant Issues

The first step in preparing a DEIS is to conduct scoping of the issues that may be associated with the Proposed Action. This occurs first through internal agency reviews. The purpose of that scoping is to identify the relevant human environmental issues, to eliminate insignificant issues from detailed study, and to identify the alternatives to be analyzed in the DEIS. Scoping can also help determine the level of analysis and the types of data required for analysis.

1.6.1. Scoping Process

The scoping process for this DEIS involved the following activities.

1.6.2. Tribal Government Scoping

In January, 2017, NMFS sent letters to the following Tribal Governments who have expressed interest in the Upper Willamette River Basin:

- Burns Paiute Tribe
- Columbia River Inter-Tribal Fish Commission
- The Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians
- The Confederated Tribes of Grand Ronde
- Confederated Tribes of Siletz Indians
- Confederated Tribes of the Umatilla Indian Reservation
- Confederated Tribes of the Warm Springs Reservation of Oregon
- Coquille Indian Tribe
- Cow Creek Band of Umpqua Tribe of Indians
- The Klamath Tribe

The purpose of the letters was to inform the Tribes of NMFS' review of the HGMPs under the ESA and NEPA and to identify any specific interests and/or issues from the Tribe's perspectives. The Burns Paiute Tribe was the only Tribal government to respond back to NMFS from this request.

1.6.3. Notices of Public Scoping and Public Review and Comment

Public scoping for this EIS commenced with publication of a Notice of Intent in the Federal Register on December 15, 2016 (81 FR 90787). 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 DEIS. At the same time, all of the spring Chinook salmon HGMPs were available for public review and comment for 60 days. The HGMPs provided information to help inform the public of the upcoming DEIS. Public review of the HGMPs is also required under limit 5 of the ESA 4(d) Rule.

1.6.4. Written Comments

Five entities provided comments back to NMFS during public scoping for the DEIS and public review of the Chinook salmon HGMPs.

1.6.5. Issues Identified During Scoping

- In the McKenzie River, many details of the reintroduction effort above Cougar Dam using the hatchery program need to be further explained in the HGMP. Further details on the guidelines and protocols for integrating natural-origin salmon into the McKenzie spring Chinook salmon hatchery broodstock needs to be clarified. The scientific basis for the hatchery program need to be further elaborated. The hatchery program has two primary purposes: recover the wild population and provide harvest mitigation opportunities on hatchery salmon.
- The HGMPs are not stand alone management plans in isolation of other mandates. Hatchery management must take into account the Biological Opinion for the Willamette Project and the federal recovery plan for salmon and steelhead in the Upper Willamette River.
- Consideration should be given to initiating a conservation hatchery salmon program for the Calapooia River, where natural-origin spring Chinook are nearly extinct. Since the removal of barrier dams, salmon have not recovered and need artificial intervention to boost abundances.

1.6.6. Future Public Review and Comment

After the public review of this DEIS is completed, all public comments will be considered and evaluated. The DEIS will be revised as necessary. The final draft of the EIS will be available for review via a federal register notice. After this, any public comments will again be considered. After this, a Record of Decision (ROD) will be completed describing the alternative chosen by NMFS for this project.

1.7. Relationship to Other Plans and Policies

In addition to NEPA and ESA for hatchery authorizations, other plans and policies also affect hatchery management in the Upper Willamette River Basin. They are summarized below to provide additional context for the hatchery programs in the UWR.

1.7.1. Recovery Plans for Upper Willamette Salmon and Steelhead

For ESA species, a Federal recovery plan must be developed by the lead Federal agency. For UWR salmon and steelhead, NMFS finalized this recovery plan in 2011. This recovery plan specifies the key limiting factors/threats for each population in the UWR ESU and DPS. For hatcheries, the recovery plan describes the actions needed in order to reduce the impacts of hatchery fish on the conservation and recovery of UWR salmon and steelhead.

1.7.2. Native Fish Conservation Policy

Oregon's Native Fish Conservation Policy helps guide the management of hatcheries and fishery harvest as it relates to conserving and recovering wild fish species (ODFW 2002). This policy was enacted in 2002 and replaced the former Wild Fish Policy. One of the requirements of this policy is to develop and implement conservation plans for fish species. In areas where ESA listed salmon and steelhead occur, a federal recovery plan meets this need. For other non-listed salmonids, Oregon develops the state conservation plan. The HGMPs under evaluation reflect decisions made by ODFW under this policy..

1.7.3. Clean Water Act

The Clean Water Act (33 USC 1251, 1977, as amended in 1987), administered by the U.S. Environmental Protection Agency and state water quality agencies, is the principal Federal legislation directed at protecting water quality. Each state implements and carries forth Federal provisions, as well as approving and reviewing National Pollutant Discharge Elimination System (NPDES) applications, and establishing total maximum daily loads for rivers, lakes, and streams. The states are responsible for setting the water quality standards needed to support all beneficial uses, including protection of public health, recreational activities, aquatic life, and water supplies.

The Oregon Department of Environmental Quality (ODEQ) is the agency responsible for carrying out the provisions of the Federal Clean Water Act within Oregon. The agency is responsible for establishing water quality standards, making and enforcing water quality rules, and operating waste discharge permit programs. Hatchery operations are required to comply with the Clean Water Act and governed by NPDES permits.

1.7.4. Bald Eagle and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 USC. 668-668c), enacted in 1940 and amended several times since then, prohibits the taking of bald eagles, including their parts, nests, or eggs. The act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." The U.S. Fish and Wildlife Service, who is responsible for carrying out provisions of this Act, define "disturb" to include a "decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." Changes in hatchery production have the potential to affect eagle productivity through changes in its prey source (salmon and steelhead).

1.7.5. Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 USC 1361), as amended, establishes a national policy designated to protect and conserve wild marine mammals and their habitats. This policy was established so as not to diminish such species or populations beyond the point at which they cease to be a key functioning element in the ecosystem, nor to diminish such species below their optimum sustainable population. All marine mammals are protected under the MMPA.

NMFS is responsible for reviewing Federal actions for compliance with the MMPA. Changes in fish production can indirectly affect marine mammals by altering the number of available prey (salmon and steelhead). In addition, separately from the proposed action, NMFS is currently reviewing an application to lethally remove sea lions at Willamette Falls because of excessive predation of winter steelhead in accordance with the MMPA (82 FR 52038)

1.7.6. Executive Order 12898

In 1994, the President issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-income Populations*. The objectives of the Executive Order include developing Federal agency implementation strategies, identifying minority and low-income populations where proposed Federal actions could have disproportionately high and adverse human health and environmental effects, and encouraging the participation of minority and low-income populations in the NEPA process. Changes in hatchery production have the potential to affect the extent of harvest available for minority and low-income populations.

1.7.7. Secretarial Order 3206

Secretarial Order 3206 (*American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA*) issued by the Secretaries of the Departments of Interior and Commerce, clarifies the responsibilities of the agencies, bureaus, and offices of the departments when actions taken under the ESA and its implementing regulations affect, or may affect, Indian lands, tribal trust resources, or the exercise of American Indian tribal rights as they are defined in the order. Secretarial Order 3206 acknowledges the trust responsibility and treaty obligations of the United States toward tribes and tribal members, as well as its government-to-government relationship when corresponding with tribes. Under the order, NMFS and the U.S. Fish and Wildlife Service (Services) “will carry out their responsibilities under the [ESA] in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the [Services], and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation."

More specifically, the Services shall, among other things, do the following:

- Work directly with Indian tribes on a government-to-government basis to promote healthy ecosystems (Section 5, Principle 1)
- Recognize that Indian lands are not subject to the same controls as Federal public lands (Section 5, Principle 2)
- Assist Indian tribes in developing and expanding tribal programs so that healthy ecosystems are promoted and conservation restrictions are unnecessary (Section 5, Principle 3)
- Be sensitive to Indian culture, religion, and spirituality (Section 5, Principle 4)

1.7.8. The Federal Trust Responsibility

The United States government has a trust or special relationship with Indian tribes. The unique and distinctive political relationship between the United States and Indian Tribes is defined by statutes, executive orders, judicial decisions, and agreements and differentiates tribes from other entities that deal with, or are affected by the Federal government. Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, states that the United States has recognized Indian tribes as domestic dependent nations under its protection. The Federal government has enacted numerous statutes and promulgated numerous regulations that establish and define a trust relationship with Indian tribes. The relationship has been compared to one existing under common law trust, with the United States as trustee, the Indian tribes or individuals as beneficiaries, and the property and natural resources of the United States as the trust corpus (Cohen 2005). The trust responsibility has been interpreted to require Federal agencies to carry out their activities in a manner that is protective of Indian treaty rights. This policy is also reflected in the March 30, 1995, document, Department of Commerce - American Indian and Alaska Native Policy (U. S. Department of Commerce 1995).

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Five alternatives are evaluated in this DEIS: (1) status quo hatchery programs with no integration of natural-origin fish into hatchery broodstocks (No-action), (2) allow integration of natural-origin fish into hatchery broodstocks, (3) reduce hatchery production to conservation (reintroduction) needs (no fishery mitigation), (4) terminate the existing hatchery programs in the Upper Willamette River Basin, and (5) increase hatchery production to support fisheries consistent with ESA impact limits. No other alternatives that would meet the purpose and need were identified that would be appreciably different from the five alternatives described below (see Subsection 2.5, Alternatives Considered But Not Analyzed in Detail, for further description of alternatives considered but not analyzed in detail).

Current Hatchery Programs

Currently in the UWR, spring Chinook salmon, summer steelhead, and rainbow trout are released into various subbasins (Table 2). For the spring Chinook salmon hatchery program, over 5 million juvenile fish are currently released into the Molalla, North Santiam, South Santiam, McKenzie, Middle Fork Willamette and Coastal Fork Willamette river basins (Table 2). Summer steelhead are not native to the UWR, but are released to increase harvest opportunities as discussed in greater detail below. Over 500,000 hatchery juvenile summer steelhead are released into the North Santiam, South Santiam, McKenzie, Middle Fork Willamette, and mainstem Willamette rivers (Table 2). Rainbow trout (non-native Cape Cod stock) are sterilized prior to release and nearly 1 million hatchery fish are released throughout the UWR (Table 2).

Additional details of the hatchery programs, including past releases, are summarized in Section 3.4 below.

Table 2. Release of hatchery fish in the Upper Willamette River Basin under the various alternatives considered in this DEIS.

Alternative	Species	Number of fish released							
		Molalla	**North Santiam**	**South Santiam**	**McKenzie**	**Middle Fork Willamette**	**Coastal Fork Willamette**	**Mainstem Willamette**	**Total**
1 and 2	Spring Chinook	100,000	704,000	1,021,000	787,000	2,300,000[1]	267,000	0	**5,179,000**
	Steelhead[2]	0	121,000	161,500	108,000	88,428	0	68,572	**547,500**
	Rainbow[3] trout	Reservoirs throughout Upper Willamette River Basin and McKenzie River							**963,517**
3	Spring Chinook	100,000	630,000	350,000	604,750	1,672,000	0	0	**3,356,750**
	Steelhead[4]	0	121,000	161,500	0	0	0	0	**282,500**
	Rainbow trout								0
4	Spring Chinook	0	0	0	0	0	0	0	0
	Steelhead	0	0	0	0	0	0	0	0
	Rainbow trout								0
5	Spring Chinook	150,000	1,060,000	1,500,000	1,200,000	3,500,000	400,000	0	**7,780,000**
	Steelhead	0	180,000	242,000	162,000	132,000	0	103,000	**822,000**
	Rainbow trout	Rainbow trout same as Alternatives 1 and 2.							**963,517**

Source: Submitted HGMPs, Hatchery operation plans, and this DEIS.
[1] Includes 100,000 sub-yearlings released into Hills Creek Reservoir in the fall.
[2] Summer steelhead
[3] Rainbow trout are released in numerous locations (see Table 12below)
[4] Winter steelhead (new program)
[5] Assume summer steelhead

2.1. Alternative 1 (No-action): Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks

Under this alternative, NMFS would not approve the four HGMPs recently submitted by the co-managers under limit 5 of the ESA 4(d) Rule. The hatchery programs would continue to operate in accordance with the Biological Opinion on the Willamette Project (NMFS 2008), except for RPA 6.2.2 related to genetically integrated broodstocks. The co-managers would not have authorization under the Incidental Take Statement of the Biological Opinion to incorporate natural-origin spring Chinook salmon and/or winter steelhead into the hatchery broodstocks (an additional ESA authorization is needed to purposefully take natural-origin fish for broodstock). The existing ESA coverage provided by NMFS (2008) (except for broodstock integration) would continue to be in effect. This consultation only authorizes the incidental take associated with the hatchery programs. The intentional, purposeful take of natural-origin fish for broodstock is considered direct take, and would not be allowed under this alternative.

The co-managers could choose to continue to operate the existing hatchery programs under status quo conditions and not incorporate natural-origin fish into the hatchery broodstocks. There would be some risks and benefits from not incorporating natural-origin fish into the broodstocks. For purposes of this analysis, NMFS has defined the No-action Alternative 1 as the choice by the co-managers to continue to operate the existing hatchery programs in compliance with NMFS (2008) except for RPA 6.2.2 that directs the incorporation of natural-origin salmon into the hatchery broodstocks. All of the activities associated with the existing hatchery programs and covered by NMFS (2008) would continue: salmon and steelhead would be collected at the fish collection facilities, adult salmon would be reintroduced above the Federal dams, hatchery salmon would be collected for broodstock (no natural-origin fish), progeny would be incubated, reared and released, the hatchery facilities would use water for operation, and the hatcheries would discharge hatchery water effluent.

NMFS's No-action Alternative 1 represents the best estimate of what would happen in the absence of the new proposed Federal action.

2.2. Alternative 2 (Proposed Action/Preferred Alternative): Allow Integration of Natural-origin Fish into Hatchery Broodstocks

Under this alternative, NMFS would approve the recently submitted HGMPs for spring Chinook salmon by issuing an approval letter to the co-managers under limit 5 of the 4(d) Rule. The HGMPs would be authorized in entirety and grant new ESA coverage for incidental and direct take associated with the spring Chinook hatchery programs in the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette rivers. The hatchery production levels, collection and rearing protocols, use of hatchery fish for supplementation above the Federal dams would all be authorized under this Alternative 2. The Best Management Practices (BMPs) used by ODFW for hatchery management would also continue as described in the submitted HGMPs.

In addition, there are three other potential actions being evaluated as part of the proposed action: 1) initiation of a supplementation program for spring Chinook in the Calapooia River using adult hatchery spring Chinook salmon, 2) outplanting of adult winter steelhead above Mercer Dam on Rickreal Creek, and 3) initiation of a conservation hatchery program for winter steelhead in the North and South Santiam rivers for reintroduction above Corps dams, using natural-origin steelhead. These additional actions are being evaluated because the co-managers and other stakeholders have expressed interest in pursuing these actions in the future. These actions are further described below.

During the public scoping for this EIS, comments were received to consider a hatchery supplementation program for spring Chinook salmon in the Calapooia River due to very low returns of salmon observed over the last decade. Significant habitat restoration actions have occurred in the Calapooia River in recent years, including the removal of dams that impeded passage of salmon and steelhead in the Calapooia River. However, recovery of spring Chinook salmon has not occurred to date. Therefore, several stakeholders requested a possible supplementation program be evaluated for spring Chinook salmon in the Calapooia River. NMFS is considering this possible action as part of the proposed action and evaluating the impacts on the human environment of implementing this hatchery supplementation action for salmon in the Calapooia River.

Rickreal Creek, a tributary entering the Willamette River on the west side of the UWR Basin, has a run of winter steelhead, but the area is not considered essential for the recovery of the DPS (the four populations on the eastside of the Willamette are the “core” populations for recovery; ODFW and NMFS (2011)). Mercer Dam currently blocks all passage of upstream migrating fish. Several stakeholders have been interested in passing fish above Mercer Dam into historical habitat upstream of the dam. To date, no winter steelhead have been passed above the dam due to uncertainties of fish survival through the reservoir and dam and lack of ESA authorization. Coho salmon, a non-native species to Rickreal Creek, have been passed upstream with success. In the future, there may be the possibility of also passing winter steelhead above Mercer Dam if stakeholders decide it is appropriate. NMFS is considering this possible action and evaluating the impacts on the human environment of implementing the action of passing winter steelhead above Mercer Dam.

Efforts to recover winter steelhead above Corps dams in the South Santiam and North Santiam rivers are underway in accordance with the improvements specified for passage and improved temperature control in the Biological Opinion for the Willamette Project (NMFS 2008). In the event insufficient returns of natural-origin winter steelhead are available in the future for reintroduction, a conservation hatchery program may be initiated (using natural-origin fish) for the sole purpose of reintroducing winter steelhead above the Corps dams in the North and South Santiam rivers (similar to current efforts for spring Chinook salmon). NMFS is assessing this possibility for winter steelhead in the North and South Santiam rivers in Alternative 2.

Best management practices (BMPs) are protocols for the operation of hatchery facilities and hatchery programs to appropriately meet the objectives of the hatchery program, including minimizing impacts on ESA-listed fish (IHOT 1995; HSRG 2004; Mobrand et al. 2005). The BMPs in these HGMPs include:

(1) providing specific-pathogen free water source for adult and juvenile fish holding
(2) ensuring adequate alarm systems are in operation to protect rearing fish from flow disruptions
(3) ensuring that water supplies have back-up power generation in case of an electrical outage to protect rearing fish
(4) requiring appropriate disinfection procedures to prevent pathogen transmission between stocks of fish onsite
(5) providing the correct amount and type of food to achieve desired growth rates
(6) adequately screening hatchery intake water supplies to prevent fish loss
(7) ensuring that the hatchery is operated in compliance with its NPDES permit
(8) documenting the survival and production of hatchery fish at each life stage while in the hatchery.
(9) outplanting surplus carcasses from the hatchery for nutrient enhancement in the ecosystem, if appropriate according to pathology guidelines.

For the purpose of this analysis, NMFS treats the Proposed Action Alternative as implementing the hatchery production of salmon and steelhead as proposed in the HGMPs provided in 2016 and 2018 for spring Chinook salmon and steelhead. For hatchery rainbow trout, NMFS did not consider using natural-origin rainbow trout for this program. All of the following activities would occur: broodstock collection;

spawning, rearing, and release of hatchery fish; and facility operation including water intake and discharge.

2.3. Alternative 3: Reduce Hatchery Production to Reintroduction Needs

Under this alternative, the co-managers would produce only enough hatchery fish for reintroduction of adult salmon and steelhead above the Corps dams (and other areas as deemed appropriate). The hatchery programs would be managed solely for conservation and recovery purposes and providing enough returning adult salmon and steelhead for outplanting in under-utilized historical habitats. This alternative would reduce hatchery smolt releases compared to the No-action alternative (Table 2).

This alternative was crafted based on the proposed Chinook HGMPs, which identify hatchery production levels needed for reintroduction purposes above the Corps dams. NMFS is using these production levels for this alternative. The production numbers are shown in Table 2. The purpose of analyzing a reduced production alternative is that most hatchery-related impacts vary with the number of smolts released.

The proposed HGMPs for spring Chinook salmon specify a total maximum production of 5.179 million smolts annually (Alternatives 1 and 2; Table 2). The above production levels equate to 3.357 million smolts annually. Therefore, Alternative 3 would reduce hatchery Chinook production by 32% compared to Alternative 2 (Proposed Action/Preferred Alternative; Table 2). In all other respects (e.g., facility operations, monitoring, etc.), the proposed action would remain the same; except broodstock integration rates using natural-origin fish would be higher because fewer returning adult fish would require the program to incorporate more natural-origin fish into the hatchery production.

For steelhead, presently the only hatchery program propagates out-of-DPS summer steelhead. This stock is produced solely for fishery mitigation and has no conservation or recovery benefits for the DPS. For this alternative, all of the existing hatchery production for summer steelhead in the North Santiam and South Santiam (282,500 smolts/year) is evaluated as being transferred over to winter steelhead production solely for conservation/reintroduction purposes. Returning hatchery winter steelhead would be available for outplanting above the Corps dams in the North and South Santiam, similar to spring Chinook salmon.

- North Santiam winter steelhead production level: 121,000 smolts/year
- South Santiam winter steelhead production level: 161,500 smolts/year

For the rainbow trout hatchery program, there are no conservation/reintroduction benefits that could be used from the rainbow trout hatchery program using non-local, Cape Cod stock. Therefore, under Alternative 3, there would be no rainbow trout hatchery program. The hatchery programs for spring Chinook and winter steelhead, as described above, would fulfill the reintroduction needs specified for this alternative.

NMFS's 4(d) regulations do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMPs. NMFS's 4(d) regulations require NMFS to make a determination that the HGMPs, as submitted by the USACE, either meet or do not meet the standards prescribed in limit 5 of the 4(d) Rule. Nonetheless, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various hatchery management scenarios.

2.4. Alternative 4: Terminate the Existing Hatchery Programs in the Upper Willamette River Basin

Under this alternative, the co-managers would terminate the funding and implementation of all of the hatchery programs in the UWR. All of the activities associated with the hatchery programs would be terminated: no hatchery fish would be released, no broodstock would be collected at trapping locations, trapping facilities would be removed, no returning hatchery fish would be removed from various locations, the hatchery facilities would not use water for operation, and the hatcheries would not discharge hatchery water effluent. All salmon and steelhead currently being raised in hatchery facilities would be released or killed, and no additional broodstock would be collected. The existing fish collection facilities (i.e. Minto Dam FF, Foster Dam FF, Dexter Dam FF) would continue to be used to collect only natural-origin salmon for reintroduction above the federal dams. No hatchery salmon or steelhead would be available for reintroduction because the program would be terminated.

This alternative would not be expected to meet the purpose and need for action because termination of the spring Chinook salmon hatchery programs is not supported by NMFS (2008) Biological Opinion for the Willamette Project. However, NMFS will describe the effects of this action in Alternative 3 in order to gain a better understanding of the potential effects on the human environment under various management scenarios ranging from termination of the hatchery programs (this Alternative) to increased hatchery production (Alternative 5).

2.5. Alternative 5: Increase hatchery production to support fisheries consistent with ESA impact limits

Under this alternative, the co-managers would increase hatchery production to the extent possible using existing hatchery facility capacities and existing water rights. The increased hatchery production would allow for increased fishery harvest opportunities on hatchery produced fish in recreational and commercial fisheries in the ocean and freshwater. NMFS has approved Fisheries Management and Evaluation Plans (FMEPs; NMFS 2001a; NMFS 2001b) that specify the allowable fishery impacts on UWR spring Chinook salmon and winter steelhead when in freshwater. Since there are unused fishery impacts that are below the maximum authorized by the FMEPs, the additional hatchery production under Alternative 5 could be targeted in fisheries while still being within the confines of the ESA-approved FMEPs.

For this alternative, NMFS evaluated a total hatchery production level of 8.6 million salmon and steelhead smolts (900,000 pounds/year) produced annually from UWR hatchery facilities. This production level has been produced in the past using existing water rights and existing hatchery facilities. This alternative therefore represents a reasonable alternative that includes approximately 33% greater hatchery production than Alternatives 1 and 2.

2.6. Alternatives Considered But Not Analyzed in Detail

The following alternatives will not be evaluated in detail. These alternatives are eliminated because (1) they do not meet the purpose and need for the action, and/or (2) they are not meaningfully different from the five alternatives described above and would not supply additional information that would inform the decision-making process.

2.6.1. Change Locations of the Hatchery Programs Releases

Under this possible alternative, changes to the locations where hatchery fish are currently being released would be implemented. Such a modification might be considered in an attempt to reduce hatchery effects in the natural population areas for spring Chinook salmon and winter steelhead. This potential alternative was eliminated from further analysis because changes to hatchery fish release locations are not substantially different than the scope of alternatives being considered and would not result in meaningfully different impacts on the human environment, , such as genetic effects or competition and predation impacts associated with hatchery operations. Any changes to release locations would not substantively alter the range of impacts already being considered in the identified alternatives.

2.6.2. Attaining Hatchery Program Goals by Alternative Actions and Reforms

In each of the HGMP's, section 1.16 describes alternative actions and reforms that were considered by the co-managers that could be implemented to meet hatchery program goals and objectives. These alternative actions would change hatchery fish release locations, modify adult collection techniques and infrastructure, and/or make necessary improvements to the hatchery facilities if funding was available, while still meeting the original goals and objectives of the hatchery program. These identified alternative actions in the HGMPs were not further considered because the actions were not meaningfully different than the proposed actions in the HGMPs and do not provide additional information on the scale of effects to further inform decision making within the Willamette River Basin.

2.6.3. Evaluate the HGMPs under Section 10(a)(1)(A) of the ESA, instead of Limit 5 of the 4(d) Rule

Under this possible alternative, NMFS would determine that the hatchery programs, as described in the HGMPs, meet the requirements for a section 10(a)(1)(A) enhancement take permit. Under this possible alternative, the only change from the Proposed Action would be a difference in which process mechanism ESA compliance is obtained for these hatchery programs. Consequently, this potential alternative would not be meaningfully different from the Proposed Action and will not be analyzed in detail.

3. AFFECTED ENVIRONMENT

3.1. Introduction

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

- Water quantity (Subsection 3.2)
- Water quality (Subsection 3.3)
- Salmon and Steelhead and Their Habitats (Subsection 3.4)
- Other Fish and Their Habitats (Subsection 3.5)
- Wildlife (Subsection 3.6)
- Socioeconomics (Subsection 3.7)
- Environmental justice (Subsection 3.8)

No other resources were identified during internal scoping that would potentially be impacted by the Proposed Action or alternatives. Current conditions include effects of the past operation of Chinook salmon, summer steelhead, and rainbow trout hatchery programs in the Upper Willamette River Basin.

The project area is the geographic area where the Proposed Action would take place. It includes the watersheds where fish would be spawned, incubated, reared, acclimated, released, or harvested under the proposed hatchery programs (Subsection 1.4, Project Area). Each resource's analysis area includes the project area as a minimum area, but may include locations beyond the project area if effects would be expected to occur outside the project area (Subsection 1.4, Project Area).

3.2. Water Quantity

Hatchery programs can affect water quantity when they take water from a well (groundwater) or a neighboring tributary streams (surface water) to use in the hatchery facility for broodstock holding, egg incubation, juvenile rearing, and juvenile acclimation. All water, minus evaporation, that is diverted from a river or taken from a well is discharged to the adjacent river from which the water was appropriated after it circulates through the hatchery facility (non-consumptive use)(Table 3). When hatchery programs use groundwater, they may reduce the amount of water for other users in the same aquifer. When hatchery programs use surface water, they may lead to dewatering of the stream between the water intake and discharge structures, which may impact fish and wildlife if migration is impeded or dewatering leads to reduced habitat areas and/or increased water temperatures. Generally, water intake and discharge structures are located as close together as possible to minimize the area of the stream that may be impacted by a water withdrawal for the hatchery facility.

A water right permit is required for all groundwater withdrawal except those supporting single-family homes. All hatchery wells used by hatchery facilities supporting hatchery programs in the Upper Willamette River Basin are permitted by the Oregon Department of Water Resources (OWRD 2013). No hatchery facilities are located in areas designated by Oregon as Critical Groundwater Areas (OWRD 2013). For surface water use, each hatchery facility has a designated water right (Table 3) issued by the State of Oregon.

Streamflows within the watersheds where the hatchery facilities are located in the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette rivers is driven predominantly by rain (PNERC 2016). All of these watersheds drain the Cascade Mountain Range. The quantity of water within the streams and rivers is typically greatest from November through March and tapers off to the lowest streamflow conditions in August through October (PNERC 2016). Snow melt and groundwater discharge into streams and river depends upon elevation and variation in snowpack. Management of the dams and reservoirs in each of the watersheds controls discharge in the mainstem rivers below the Federal dams. In general, discharge is greater than natural conditions in the summertime and lower than natural conditions during certain periods of the wintertime (floodcontrol).Water diversions for agricultural and municipal purposes occur in each of the watersheds.

Ten main hatchery facilities are currently used to support the hatchery programs within the Upper Willamette River Basin (Figure 1). All of the hatchery facilities use surface water as their primary water source (Table 3). The South Santiam and Willamette hatcheries also use a very small amount of groundwater during specific time periods for incubating eggs in the hatchery. The length of stream affected by the hatchery’s water withdrawal (from the inlet to outlet) ranges from 370 to 7,339 feet in length for the ten hatchery facilities (Table 3). The longest distance between intake and outlet occurs at the Willamette Hatchery which uses water from Salmon Creek and empties into the Middle Fork Willamette River. While this does reduce the flow of water in Salmon Creek, it should be noted that salmon do not currently have access into the creek.

The maximum allowable water use permitted by the hatchery’s surface water right ranges from 32 to 100 cubic feet per second (cfs; Table 3). However, most of the hatchery facilities do not use their full water right throughout the entire year. Water use depends upon fish production levels and the capacity of the hatchery facility. During the lowest streamflow periods throughout the year (typically August through October), each hatchery facility uses only a small fraction of their full water right (Table 3).

Table 3. Water source and use by hatchery facility. See Appendix 1 for HGMP citations.

Hatchery Facility	Maximum Surface Water Use Permitted by Water Right (cfs)	Maximum Groundwater Use Permitted by Water Right (cfs)	Surface Water Source	Minimum Mean Monthly Surface Water Flows during Facility Operation cfs (month)	Actual Surface Water Use (cfs) by Hatchery Facility During Minimum Mean Monthly Surface Flows (previous column)[1]	Maximum length of stream affected by hatchery water withdrawal (feet)[2]	Discharge Location
Marion Forks Hatchery	34	0	Marion Creek	438 (NF Santiam upstream of Detroit Dam; September)	18.5	4,840	Horn Creek
Marion Forks Hatchery	32	0	Horn Creek		3.01	790	Horn Creek
Minto Dam FF	60	0	North Santiam River	1,010 (August)	40.5	370	North Santiam River
Roaring River Hatchery	25	0	Roaring River	NA[3](October)	5.93	1,500	Roaring River
South Santiam Hatchery	NA[3]	0.11	South Santiam River	759 (August)	25.9	NA[3] (reservoir withdrawal)	South Santiam River
Foster Dam FF	NA[3]	0	South Santiam River	759 (August)	NA[3]	NA[3] (reservoir withdrawal)	South Santiam River
Leaburg Hatchery	0.33	NA[3]	Spring	NA[3]	0	NA[3]	McKenzie River
	100	NA[3]	McKenzie River	2,200 (Vida gage) (September)	85.6	2,632	McKenzie River
McKenzie Hatchery	50	0	McKenzie River		50	NA[3] (canal withdrawal)	McKenzie River
	201	0	Cogswell Creek	NA (September)	2.2	1,892	McKenzie River

Hatchery Facility	Maximum Surface Water Use Permitted by Water Right (cfs)	Maximum Groundwater Use Permitted by Water Right (cfs)	Surface Water Source	Minimum Mean Monthly Surface Water Flows during Facility Operation cfs (month)	Actual Surface Water Use (cfs) by Hatchery Facility During Minimum Mean Monthly Surface Flows (previous column)[1]	Maximum length of stream affected by hatchery water withdrawal (feet)[2]	Discharge Location
Willamette Hatchery	87.5	0.92	Salmon Creek	1,050 (MF Willamette near Oakridge; August)	80.6	7,339	Salmon Creek
Dexter dam FF	35	0	MF Willamette River	1,740 (July)	35	NA[3] (reservoir withdrawal)	Middle Fork Willamette

[1]Monthly hatchery facility water use data reported by ODFW for Water Year 2015-16.

[2]Reported values are the maximum distance from intake of water supply to discharge point at the outfall of the hatchery facility. Some hatchery facilities have two water intake sources and the farthest intake from the facility is reported here to represent the maximum stream reach affected. Lengths were estimated visually using Google Earth.

[3]Not available or applicable.

3.3. Water Quality

Hatchery programs can affect the water quality of the adjacent stream or river from the discharge of effluent from the hatchery facility. There are potentially seven rivers or streams within the UWR affected by the operation of the hatchery facilities. The seven rivers are shown in Table 3 and Figure 1. Each of the hatchery facilities is required to have a National Pollutant Discharge Elimination System (NPDES) permit administered by the Environmental Protection Agency under the Clean Water Act. Monitoring and compliance with the permits is verified on a regular basis by testing the water quality below the hatchery to determine if discharge is within the specified limits. The most common substances found in the effluent of UWR hatcheries are ammonia, nitrogen, phosphorus, and antibiotics. Bacteria, parasites, and viruses can also be transmitted from the hatchery fish to the effluent. These substances and organisms are a byproduct of hatchery fish rearing and treating the fish to ensure high survival while being grown at very high densities.

The affected environment from the discharge of effluent from the hatchery facilities occurs from the point of discharge downstream until thorough mixing occurs in the adjacent stream or river. Even though the discharges are within the criteria of the hatchery facilities NPDES permit administered by the Oregon Department of Environmental Quality, the effluent may affect water quality, and disease and pathogen load below the hatchery facility. Bartholomew (2013) showed the effluent discharge effects to be short-lived and extending downstream for less than 200 meters before it became undetectable. Each of the hatchery facilities are required by their NPDES to circulate the effluent through an abatement pond to settle out uneaten food, fish waste, and any other substances not in solution. The South Santiam Hatchery is an exception because it does not have an effluent settlement pond, so current practices restrict the number of ponds to be cleaned at a given time in order to comply with the NPDES permits. After this, the effluent is then discharged into the adjacent stream or river to help reduce the effects on the adjacent stream or river near the hatchery facility.

The release of hatchery fish from the facilities are exposed to the broader range of water quality conditions throughout the watershed as smolts, jacks, and adults migrating to and from the ocean. Hatchery fish can contribute marine-derived nutrients to the watershed if they spawn naturally or die before being collected at the hatchery facility or harvested. The current condition of most streams and rivers within the UWR are in violation of one or more of the Federal Clean Water Act 303(d) standards (Figure 2). Dissolved oxygen, lead, mercury, temperature, weeds and algae are the current 303(d) listings for the UWR. Lack of riparian shade, effects of dams, and poor agricultural and forestry practices are some of the causes for the 303(d) listings. The hatchery facilities are not identified as a cause for any of the current 303(d) listings within the UWR. Most of the streams and rivers have 303(d) listings and are not affected in any way by the operation of the hatchery programs.

3.4. Salmon and Steelhead and Their Habitats

This section describes the salmon and steelhead affected by the proposed action, the current status of these populations in the UWR, and past and present hatchery fish releases. This information informs the comparison of alternatives in Chapter 4, Environmental Consequences.

Within the UWR, natural populations of spring Chinook salmon and winter steelhead are present. Both species are listed under the ESA (79FR 20802, April 14, 2014) and critical habitat is designated for both species. The specific distribution, abundance, and habitat of each species are further described below.

Status of ESA-listed Salmon and Steelhead

3.4.1. Upper Willamette Spring Chinook Salmon

The Upper Willamette River Chinook salmon ESU, listed as threatened under the ESA on March 24, 1999 (64 FR 14308) and reaffirmed on June 28, 2005 (70 FR 37160) and April 14, 2014 (79 FR 20802), includes all naturally spawned populations of spring-run Chinook salmon upstream from Willamette Falls and in the Clackamas River. Natural populations include Chinook salmon in the North Santiam, the South Santiam, the McKenzie, the Middle Fork Willamette, and the Clackamas River basins. Hatchery Chinook salmon released from hatcheries located on the Clackamas, North Santiam, South Santiam, McKenzie, and Middle Fork Willamette Rivers are also part of the ESU.

The current threatened status of the Upper Willamette spring Chinook salmon ESU is a result of numerous factors affecting their health. Most of the historical habitat available to spring Chinook salmon is currently blocked by impassable dams in the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette rivers, operated by the Corps of Engineers as part of the Willamette Hydropower System. Efforts to reintroduce salmon and steelhead to their historical habitat above the dams are currently ongoing, with the success of these efforts dependent upon effective downstream passage of juvenile fish through the reservoirs and dams. The Biological Opinion for the Willamette Project (NMFS 2008) specifies the improvements prescribed to reduce the effects of these dams on spring Chinook salmon.

Table 4. Water source and use by hatchery facility and applicable 303(d) listings.

Hatchery Facility	Stream or River Adjacent to Hatchery Facility	Compliant with NPDES Permit	Discharges Effluent into a 303(d) Listed Water Body	Impaired Parameters	Cause of Impairment
Marion Forks	Horn and Marion creeks (near confluence with N Santiam R)	Yes	No	None	Not applicable
Minto Ponds	North Santiam River	Yes	Yes	Temperature, Dissolved oxygen	Lack of riparian vegetation, dams
South Santiam	South Santiam River	Yes	Yes	Temperature	Lack of riparian vegetation, dams
Roaring River	Roaring River	Yes	Yes	Temperature. Biological criteria	Forest and agriculture land management
Leaburg	McKenzie River	Yes	Yes	Temperature, Lead, Mercury	Natural and man-made sources
McKenzie	McKenzie River	Yes	Yes	Temperature, Lead, Mercury	Natural and man-made sources
Willamette	Salmon Creek	Yes	No	None	Not applicable
Dexter Ponds	Middle Fork Willamette River	Yes	Yes	Temperature, Aquatic weeds or algae	Lack of riparian vegetation, dams

Source: ODEQ (2013).

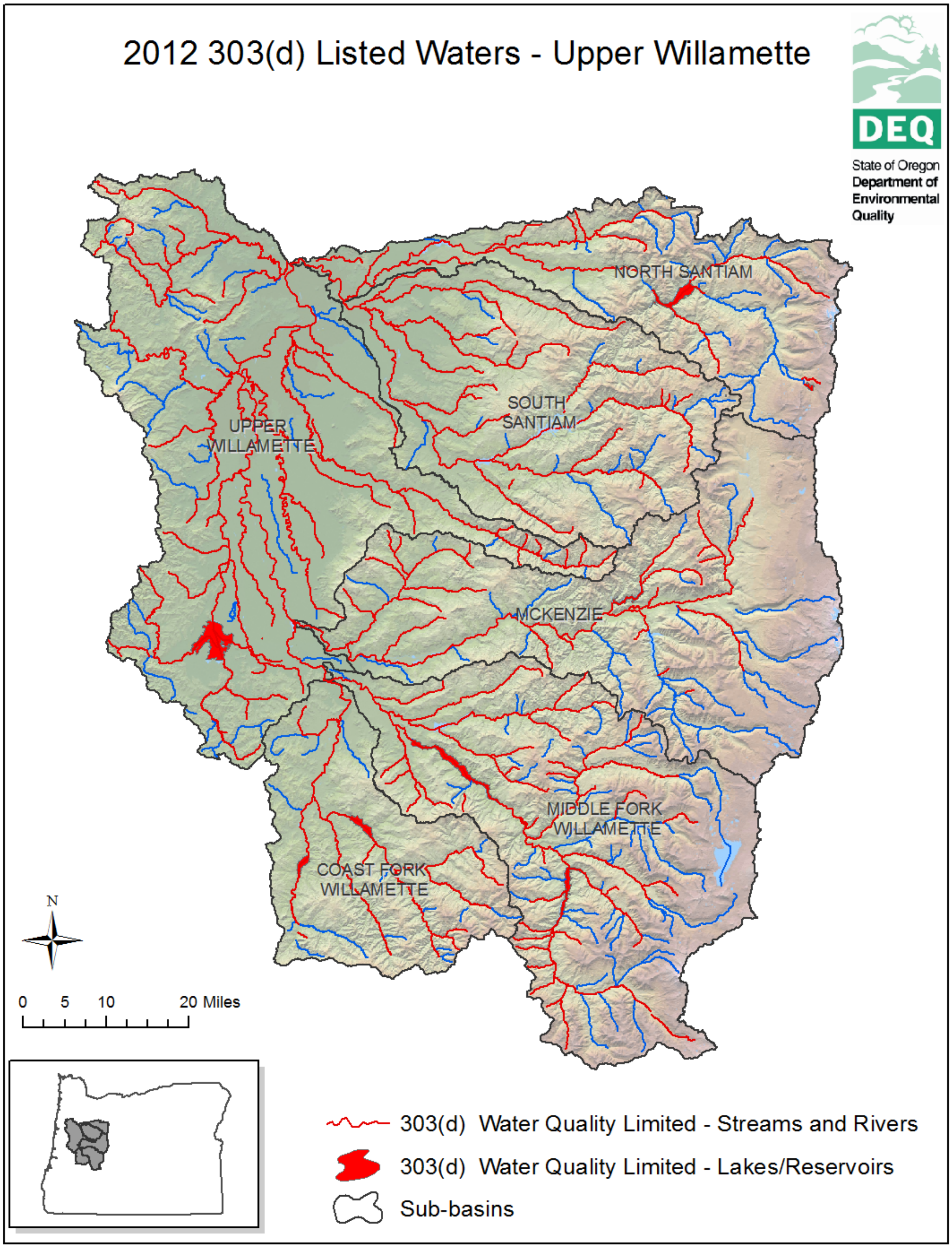

Figure 2. EPA 303(d) water-quality-impaired waters for the Upper Willamette River spring Chinook salmon ESU and winter steelhead DPS. Figure provided by ODEQ, P. Woolverton, personal communication, November, 2017.

Habitat degradation, particularly in the lowland areas of the Willamette Valley and lower Columbia River, has also reduced the quantity and quality of habitats used by both juvenile and adult spring Chinook salmon (ODFW and NMFS 2011). Mortality of adult spring Chinook salmon migrating back to spawning areas has been particularly troublesome, with some populations experiencing over 80% loss of adults prior to spawning (Figure 3). Poor water conditions and disease outbreaks for overcrowding below the dams has been the primary cause of the excessive mortality rates of adult UWR spring Chinook salmon (Bowerman et al. 2018). When spring Chinook have natural access to headwater habitat areas where the fish can over-summer in natural habitat, mortality rates have been very low (see McKenzie River in Figure 3). Fishery harvest rates have been reduced substantially since ESA listing and is no longer a key limiting factor for the ESU (ODFW and NMFS 2011). The generalized life history traits of UWR Chinook are summarized in Table 5. Today, adult UWR spring Chinook salmon begin appearing in the lower Willamette River in January, with fish entering the Clackamas River as early as March. The majority of the run ascends Willamette Falls from late April through May, with the run extending into mid-August (Myers et al. 2006). Chinook migration past the falls generally coincides with a rise in river temperatures above 50°F (Mattson 1948; Howell et al. 1985; Nicholas 1995).

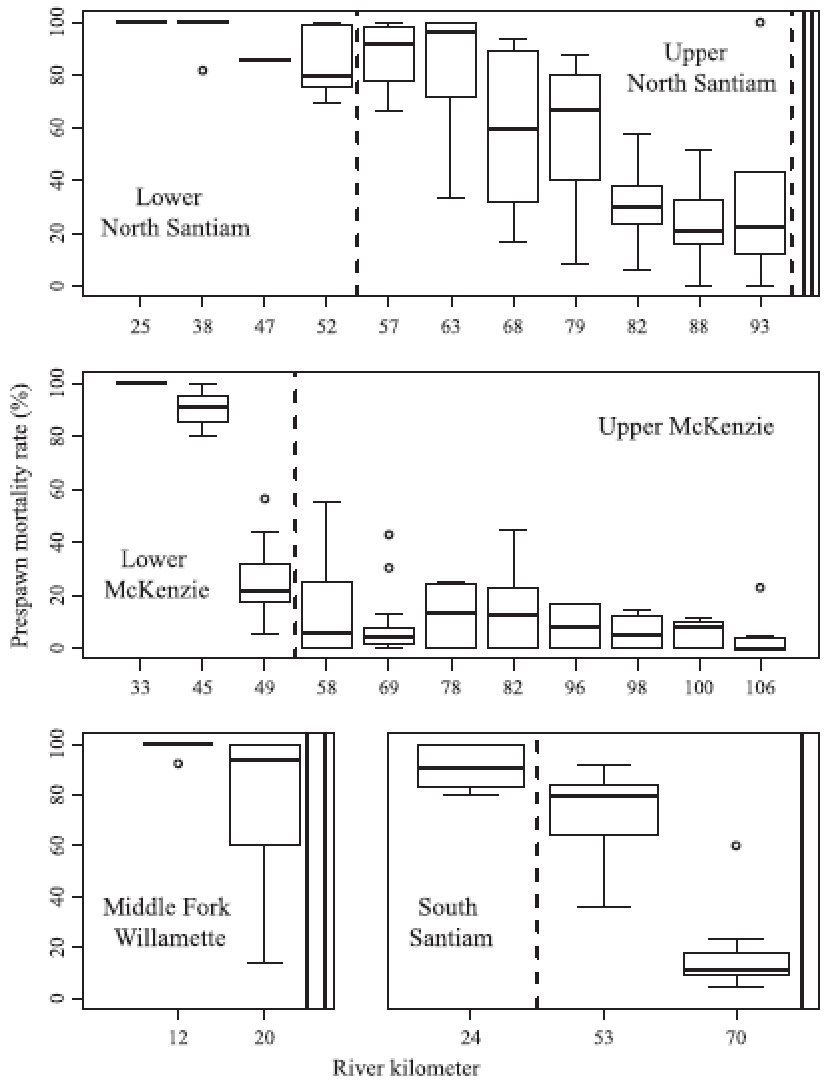

Figure 3. Mortality rates of adult spring Chinook salmon prior to spawning in populations of the UWR ESU. Figure from Bowerman et al. (2018).

Table 5. A summary of the general life history characteristics and timing of UWR Chinook salmon. Data are from numerous sources.

Life History Trait	Characteristic
Willamette River entry timing	January-April; ascending Willamette Falls April-August
Spawn timing	August-October, peaking in September
Spawning habitat type	Large headwater streams
Emergence timing	December-March
Rearing habitat	Rears in larger tributaries and mainstem Willamette
Duration in freshwater	12-14 months; sometimes 2-5 months
Estuarine use	Days to several weeks
Life history type	Stream
Ocean migration	Predominantly north, as far as southeast Alaska
Age at return	3-6 years, primarily 4-5

The following information was assembled from the most recent status review (NWFSC 2015), and focuses on the main four independent populations of spring Chinook salmon upstream from Willamette Falls; North Santiam, South Santiam, McKenzie, and Middle Fork Willamette River basins.

Chinook salmon counts at Willamette Falls have been undertaken since 1946, when 53,000 Chinook salmon were counted; however, not until 2002 with the return of nearly 100% marked hatchery-reared fish was it possible to inventory naturally-produced spring Chinook salmon with any accuracy. Fish returning in2002 benefitted from very good ocean conditions and the calculated trend since then (nearly -10%annually) is influenced by that peak; in any event, the last five years (2010-2014) have also seen a downward trend in natural-origin adult returns, with an overall geometric mean of 9,269 fish (Figure 4,).

Adult natural-origin spring Chinook salmon returns to the North Santiam River, as measured at Bennett Dam and through redd and carcass surveys, have exhibited an increase in abundance in contrast to many of the other populations in the ESU and the combined count at Willamette Falls (Figure 4). This may be related to improved fish passage at Bennett Dam, resulting in a decrease in subsequent pre-spawning mortality, or it may be related to temperature-control operations at Detroit Dam that have resulted in a more “normal” incubation temperature regime for Chinook salmon. Estimates of NORs at Bennett Dam from 2001-2005 ranged from 217 to 721, geometric mean of 514. Furthermore, of those fish that passed Bennett Dam from 2001-2005 some 63.2% were estimated to have died prior to spawning (in NWFSC (2016)). The current 5-year geometric mean of spring-run Chinook salmon ascending Bennett Dam is 1,372 (2010-2014), and the observed prespawning mortality during this period was only30.5% (Table 6).[3] Spawner abundance, based on redd count, is noticeably less than the Bennett Dam counts, 412 (2010-2014)[4], but exhibits a similar recent positive trend. Genetic analysis of returning adults suggests that there is some contribution to escapement by the progeny of hatchery-origin spawners transported above Detroit Dam. Presently, natural-origin fish that reach the fish handling facilities at Minto are transported above the fish barrier to spawn in the North Santiam reach between Minto and Big Cliff Dam. While this “sanctuary” reach is solely populated with unmarked adult Chinook salmon, temperature and dissolved gas conditions may contribute to elevated prespawning mortality levels.

Spring-run Chinook salmon adults returning to the South Santiam River are monitored via redd counts and carcass recoveries in the mainstem South Santiam. Carcass recoveries are used to estimate the proportion of NOR and HOR spawners. In addition, direct counts of returning adults are made at the Foster fish collection facility at Foster Dam, where only NORs are passed above the dam. Foster Dam counts may be biased by conditions at the adult trap below Foster Dam, because not all fish produced upstream of the dam are attracted to the trap. Additionally, some of the NORS that enter the trap may be the offspring of spawners from reaches below the dam.

For the available Foster Dam time series (2007-2014) the abundance of NOR spawners has exhibited a positive trend, although not significantly (due in part to the limited number of years) and ocean conditions during the initial years of the trend may have biased the trend; however, given the overall negative NOR abundance trend at Willamette Falls the South Santiam should be viewed in a more positive light. Prespawning mortality below and above Foster Dam averages 26.3%±5.4% and 33.3%±11.3%, respectively. Above Foster Dam PSM levels may be affected by past adult trap and haul handling protocols. Geometric mean abundance for natural-origin adults in the South Santiam River from 2010-2014 was 575. In addition, it appears that there is a very small number of Chinook salmon in Green Peter Reservoir that exhibit an adfluvial life history (Romer and Monzyk 2014); residing in freshwater their whole life and spawning above the reservoir in small tributary streams. Fish in the Green Peter Reservoir

[3] Table data reflects Bennett Dam counts to 2013.
[4]Differences between the Bennett Dam counts and redd-based spawner estimates suggest that prespawning mortality counts and redd counts and expansions contain considerable uncertainty.

are most likely the descendants of hatchery-origin fish released in the reservoir over the course of several years. Some juveniles may be able to migrate downstream to Foster Reservoir, although the contribution to the total population is likely negligible. While the presence of these fish confirms the continued suitability of the Middle Santiam River above Green Peter Dam for spawning and rearing, adaptation to the adfluvial life history may impact the productivity of the anadromous portion of the population if there is a high occurrence of this life history.

It appears that juvenile passage through Foster Dam is sufficiently high to sustain a naturally-spawning aggregation above the Dam, although total abundance is still quite low. Genetic analysis indicates that the replacement rates for the 2007 and 2008 brood years were 0.96 and 1.16,respectively(O’Malley et al. 2014). Efforts are currently underway to improve both adult collection and juvenile downstream passage at Foster Dam.

The status of spring-run Chinook salmon in the McKenzie River is monitored through both dam counts at Leaburg and Cougar dams, and through extensive spawner surveys (redd and carcass counts) throughout the basin. Genetic pedigree analysis of transported adults provides further information on the productivity of stream reaches above Cougar Dam. Numerous long-term abundance and life-history data sets exist for this population. Prior to the initiation of mass-marking for hatchery releases, hatchery contribution to spawning abundance was estimated through scale analysis, so it is possible to estimate NOR abundance prior to the 2002 return year.

Overall, McKenzie River spring-run Chinook salmon natural-origin abundance has declined to levels not seen since the time of listing. This decline has occurred despite the restoration of access to spawning habitat in the South Fork McKenzie River above Cougar Dam through a trap and haul program. Genetic pedigree based estimates of cohort replacement rate for the 2007 and 2008broodyears from hatchery adults released above the dam were both below replacement, 0.41 and0.31, respectively(Banks et al. 2014). Juvenile tagging studies suggest that total survival through Cougar Reservoir and Dam project has been poor (Beeman et al. 2013). While the effort to restore access to spawning habitat above Cougar Dam has resulted in the natural production of juveniles and returning adults, at the current levels for juvenile downstream passage and adult return there appears to be little net improvement in productivity. Overall, redd counts for the entire McKenzie River have declined over the last five years, suggesting a more systematic limiting factor. Both short-term and long-term trends for the entire population are negative (Figure 4, Table 6).

Chinook salmon in the Middle Fork Willamette River are monitored through redd and carcass surveys throughout much of the basin. In addition, fish are enumerated at both the Dexter Trap and at the Fall Creek trap below Fall Creek Dam. Presently, unmarked fish are transported above Fall Creek Dam. From 2006-2014, the pHOS for fish transported above Fall Creek Dam has averaged4.6% (±1.5%), while predominately marked hatchery fish are transported above Dexter Dam to the North Fork Middle Fork Willamette River and Hills Creek (above Hills Creek Dam). Fish transported above Dexter Dam are part of an experimental program to assess the potential for a sustained trap and haul process around the dams.[5] Although the transported hatchery-origin adults successfully reproduce, in the absence of adequate downstream juvenile fish passage facilities it is unlikely that this program currently provides any substantial direct benefit to population abundance or productivity. Alternatively, the progeny of fish passed above Fall Creek Dam have a much higher likelihood of successful downstream passage via the complete drawdown of Fall Creek Reservoir every fall. Based on returns to Fall Creek Dam, adult-to-adult return rates[6] have averaged 0.97 from 2010-2014. With the exception of spawning reaches above Fall Creek Dam, the remainder of the currently accessible portion of the Middle Fork Willamette Basin, below Dexter Dam and Fall Creek Dam, is subject to conditions that result in a very high prespawning mortality and very poor incubation and juvenile survival. Natural-origin spawners above Fall Creek averaged 138±40 fish from 2002-2014, with a slightly positive long-term trend. Estimates of prespawning mortality can be quite high in some years for the fish transported above Fall Creek Dam.[7] Of the hatchery-origin adults transported above Dexter Dam, prespawning mortalities have been high for fish transported to Hills Creek above Hills Creek Dam (49.3% 2012-14) compared to the North Fork Middle Fork Willamette River (39.0%, 2012-2014). Longer transportation times to Hills Creek are thought to be partially responsible for these differences (Naughton et al. 2015).

[5]As a secondary benefit, the progeny of transported fish provide forage for Bull Trout.
[6]Adult to adult rates calculated as NOR adults returning to Fall Creek Dam divided by the average number of adults (NOR and HOR) passed above Fall Creek Dam four and five years previously.
[7]Prespawning mortality is estimated from recovered carcasses and may be biased depending on the number and timing of surveys, the number of carcasses recovered, and the seasonal river conditions.

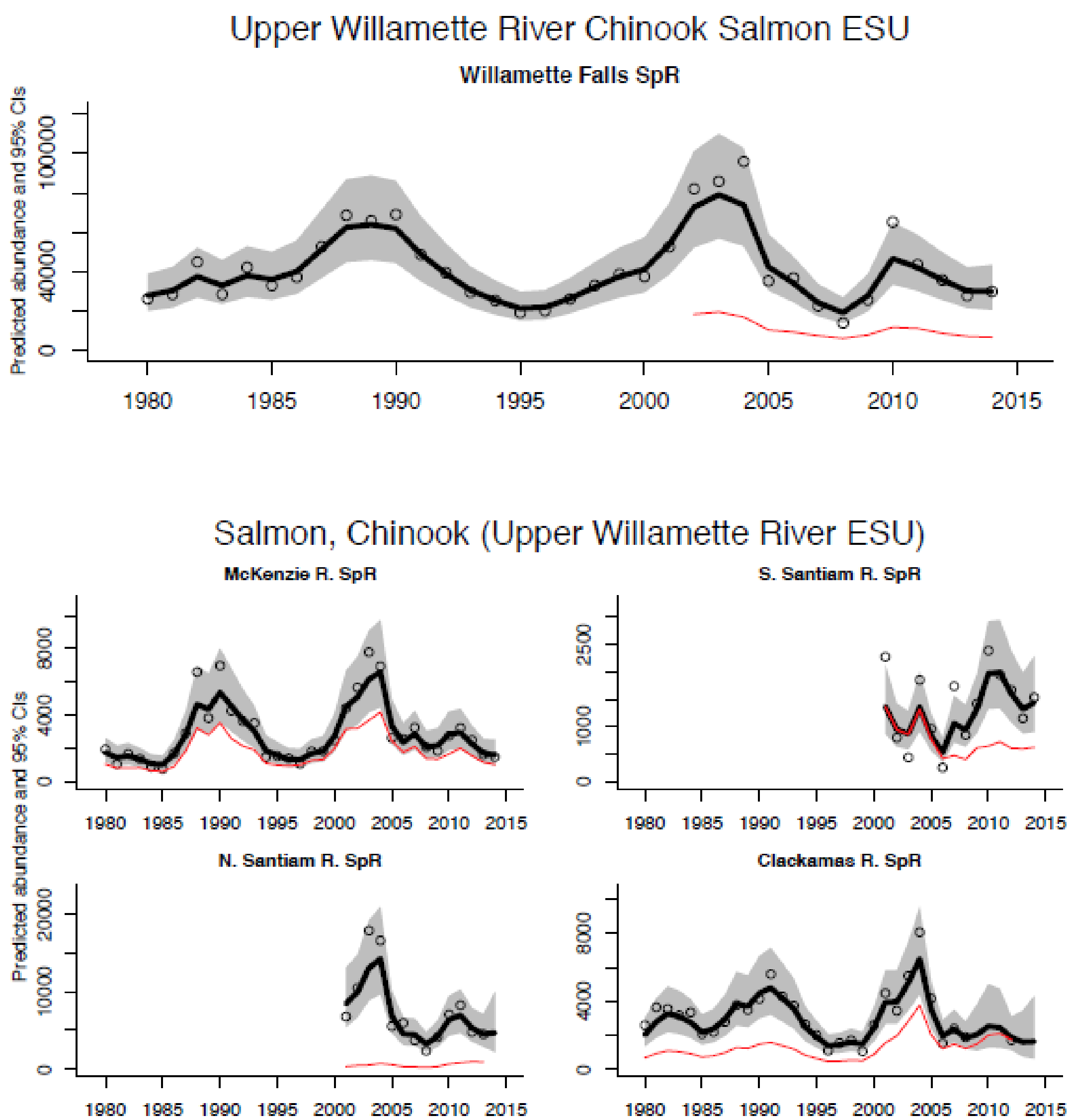

Figure 4. Smoothed trend in estimated total (thick black line) and natural (thin red line) Willamette Falls counts and population spawning abundance. Points show the annual raw spawning abundance estimates. Clackamas River data reflects counts at North Fork Dam. North Santiam River data reflect counts at Upper and Lower Bennett Dam. Figure 84 from NWFSC (2015).

Table 6. 5-year geometric mean of raw natural-origin spawner (NOS) counts. This is the raw total spawner count times the fraction NOS estimate, if available. In parentheses, 5-year geometric mean of raw total spawner counts is shown. A value only in parentheses means that a total spawner count was available but no or only one estimate of NOS available. North Santiam River data reflect counts at Upper and Lower Bennett Dam to 2013. The geometric mean was computed as the product of counts raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right. Based on Table 50 from NWFSC (2015).

Population	**1990-94**	**1995-99**	**2000-04**	**2005-09**	**2010-14**	**% Change**
Willamette Falls Spring Chinook	(39,891)	(26,608)	20,900 (66,906)	7,567 (25,547)	9,269 (38,630)	22 (51)
McKenzie	2,134 (3,583)	1,118 (1,539)	3,241 (5,100)	1793 (2,457)	1,446 (2,254)	-19 (-8)
N. Santiam			408 (12,064)	290 (4,136)	852 (5,963)	194 (44)
S. Santiam			1,108 (1,108)	450 (883)	575 (1,686)	28 (91)

Pre-spawning mortality levels are generally high in the lower tributary reaches where water temperatures and fish densities[8] are generally the highest. Areas immediately downstream of high head dams may also be subject to high levels of total dissolved gas (TDG). While the relationship between TDG levels and mortality is related to a complex interaction of fish species, age, depth, and history of exposure(Beeman and Maule 2006), the relative risks are quite high in some reaches. For example, natural-origin Chinook salmon and steelhead are passed above the barrier dam at the Minto fish facility into a short reach immediately below the Detroit/Big Cliff Dam complex. At certain times of the year, water spilled over Detroit and Big Cliff dams has the potential to produce high levels of TDG, which could affect a significant portion of the incubating embryos, in-stream juveniles, and adults in the basin, although the effect of this impact has not been quantified.

[8]Reaches downstream of fish hatcheries contain relatively large numbers of hatchery fish, which may also be more susceptible to pre-spawning mortality.

The apparent decline in the status of the McKenzie River spring Chinook salmon population in the last 10 years is a source of concern given that this population was previously seen as a stronghold of natural production in the ESU. In contrast to most of the other populations in this ESU, McKenzie River Chinook salmon have access to much of their historical spawning habitat, although access to historically high quality habitat above Cougar Dam (South Fork McKenzie River) is still limited by poor downstream juvenile passage. Additionally, the installation of a temperature control structure in Cougar Dam in 2008 was thought to benefit downstream spawning, incubation, and rearing success. Natural-origin spawners in the Middle Fork Willamette River consisted solely of adults returning to Fall Creek. While these fish contribute to the population and ESU, at best the contribution will be minor. Finally, improvements were noted in the North and South Santiam populations. The increase in abundance in both populations was in contrast to the other populations and the counts at Willamette Falls. While spring-run Chinook salmon in the South Santiam population have access to some of their historical spawning habitat, natural-origin spawners in the North Santiam are still confined to below Detroit Dam and subject to relatively high pre-spawning mortality rates.

3.4.2. Upper Willamette Winter Steelhead

The Upper Willamette River steelhead DPS (listed as threatened under the ESA on March 24, 1999 and reaffirmed January 05, 2006 (71 FR 834) and April 14, 2014 (79 FR 20802)), includes native winter-run populations from Willamette Falls upstream to and including the Calapooia River. Core populations of winter steelhead occur in the North Santiam, South Santiam, Molalla, and Calapooia rivers. Smaller natural populations occur in several West Valley tributaries (Tualatin, Yamhill, Luckiamute rivers; Rickreal Creek). There are no winter steelhead hatchery programs included in this DPS (NMFS 2006).

The run timing of UWR steelhead is a legacy of the fact that, before construction of a fish ladder at Willamette Falls in the early 1900s, flow conditions allowed steelhead to ascend Willamette Falls only during the late winter and spring. As a result, the majority of the UWR winter steelhead run return to freshwater in January through April, pass Willamette Falls from mid-February to mid-May, and spawn in March through June, with peak spawning in late April and early May. Compared to spring Chinook salmon, UWR steelhead typically migrate further upstream and can spawn in smaller, higher gradient streams and side channels. Table 7summarizes the generalized life history traits for UWR steelhead. UWR steelhead may spawn more than once, although the frequency of repeat spawning is relatively low. Repeat spawners are predominantly females and usually spend one year post spawning in the ocean and spawn again the following spring.

Juvenile steelhead rear in headwater tributaries and upper portions of the subbasins for one to four years (most often two years), then as smoltification proceeds in April through May, migrate quickly downstream through the mainstem Willamette River and Columbia River estuary and into the ocean. The downstream migration speed depends to some extent on river flow, with faster migration occurring at higher river flows. UWR steelhead typically forage in the ocean for one to four years (most often two years) and during this time are thought to migrate north to Canada and Alaska and into the North Pacific including the Alaska Gyre (Myers et al. 2006).

Table 7. A summary of the general life history characteristics and timing of UWR Steelhead. Data are from numerous sources.

Life History Trait	**Characteristic**
Willamette River entry timing	February-May
Spawn timing	March-June
Spawning habitat type	Headwater streams
Emergence timing	8-9 weeks after spawning; June-August
Rearing habitat	Headwater streams
Duration in freshwater	1-4 years (mostly 2). Smolt in April-May
Estuarine use	Briefly in spring, peak in May
Ocean migration	North to Canada and Alaska, and into the North Pacific
Age at return	3-6 years, primarily 4 years

Winter steelhead counts at Willamette Falls provide a complete count of fish returning to the DPS. In the last 10 years, returns to Willamette Falls have averaged 5,828±98 (SE) winter steelhead, of those an average of 3,832±109 returned after February 15th.[9] Of these fish, if one apportions the late winter fish to the four eastside tributaries that historically supported late-winter steelhead based on the results of the radio-tagging work from 2012-2014 (Jepson et al. 2013; Jepson et al. 2014; Jepson et al. 2015), the 10-year average for returning adults would be an average 3,409. Based on the three years of radio-tag data,

[9]February 15th marked the estimated demarcation between early run timing and late run timing winter steelhead. All natural-origin winter steelhead are listed.

an average of 59.3±3.1% (SE) of the winter-run steelhead ascending Willamette Falls enter the four primary steelhead population basins.

Trend analysis using the last 10 years of return data indicates 2.9% annual increase using the post-February 15th data and a slight 0.6% annual increase using the total winter count. Long-term abundance (1971 to present) is negative for both post-February 15th (-3.2%) and total winter-run counts (-3.5%), although the hatchery-origin winter steelhead are included in the counts from 1971through the 1990s. In general, overall abundance for the Upper Willamette River winter steelhead DPS remains low with recent trends being stable.

Population abundance estimates based on spawner (redd) surveys are only available for the Molalla and associated tributaries (Pudding River, Abiqua Creek) through 2006. These estimates relied on a proportional apportionment of winter-run steelhead counts at Willamette Falls based on index redd counts in the four winter-run steelhead populations. Recent estimates, based on the proportional migration of winter-run steelhead tagged at Willamette Falls (Jepson et al. 2013; Jepson et al. 2014),indicate that a significantly smaller portion of the steelhead arriving at Willamette Falls are destined for the Molalla River. Based on radio-tag detections and the total winter-run steelhead count at the Willamette Falls, the estimated escapement (95% CI) to the Molalla for 2012-2014 was 976 (660-1,406), 903(651-1,223), and 757 (540-1,042), respectively. As indicated by the broad confidence intervals, these estimates give only general indicator of steelhead abundance. Previous escapement estimates (1980 to 2006) had a geometric mean of 1,237 ranging from 97 to 4,658, long term trend show an annual 3.7% decline, although this decline is likely an overestimate due to the inclusion of hatchery fish in the early years. Estimated declines (Figure 6 and Table 8) in the Molalla River are based correlations with observed trends in the North and South Santiam Rivers. Given that the Molalla River has no major migration barriers, limiting factors in the Molalla River are more likely related to habitat degradation. Abundance is likely relatively stable, but at a depressed level.

Late-winter steelhead spawn throughout the North Santiam Basin except for reaches above the Big Cliff/Detroit Dam complex. [As discussed above, the Willamette Hydro Project is a major limiting factor in the status of UWR steelhead and Chinook.] Currently, the best measure of steelhead abundance is the count of returning winter-run adults to Upper and Lower Bennett Dam. Recent passage improvements at the dams and an upgraded video counting system have contributed to a higher level of certainty in adult estimates. While there are steelhead spawning below Bennett, it is likely that these dam counts approximate the population run size. The Bennett Dam counts may also approximate spawner counts, given that post-dam prespawning mortality is thought to be low for winter steelhead. Unfortunately, steelhead were not counted at Bennett Dam from 2006 to 2010. The most recent average count for unmarked (presumed native) winter steelhead (2010-1014) is 1,195 ± 194. Longer term trends 1999-2014 are negative, -5 ±3%. Radio-tagging studies (Jepson et al. 2013; Jepson et al. 2014; Jepson et al. 2015) provided additional estimates of abundance that were similar to the Bennett Dam counts (Figure 6), with an average abundance of 1,154.

Survey data (index redd counts) is available for a number of tributaries to the South Santiam River; in addition, live counts are available for winter steelhead transported above Foster Dam. Temporal differences in the index reaches surveyed and the conditions under which surveys were undertaken make the standardization of data among tributaries very difficult. For the Foster Dam time series, the most recent 5-year average (2010-2014) has been 304±34, with a negative trend in the abundance over those years (recognizing that the 2010 return reflected good ocean conditions). Longer time series are less meaningful, in that abundance estimates before 2009 were developed using different methodologies. Expanding the radio-tag tracking data (Jepson et al. 2013; Jepson et al. 2014; Jepson et al. 2015) for 2012-2014 yields South Santiam abundances of 1,226 (875-1,693), 1,134 (853-1,474), and 1,312 (1,010-1,758), respectively. In addition to steelhead spawning in the mainstem South Santiam River, annual spawning surveys of tributaries below Foster Dam (Thomas, Crabtree, and Wiley creeks) indicate the consistent presence of low numbers of spawning steelhead, primarily in the headwater areas of the tributaries (Figure 5).

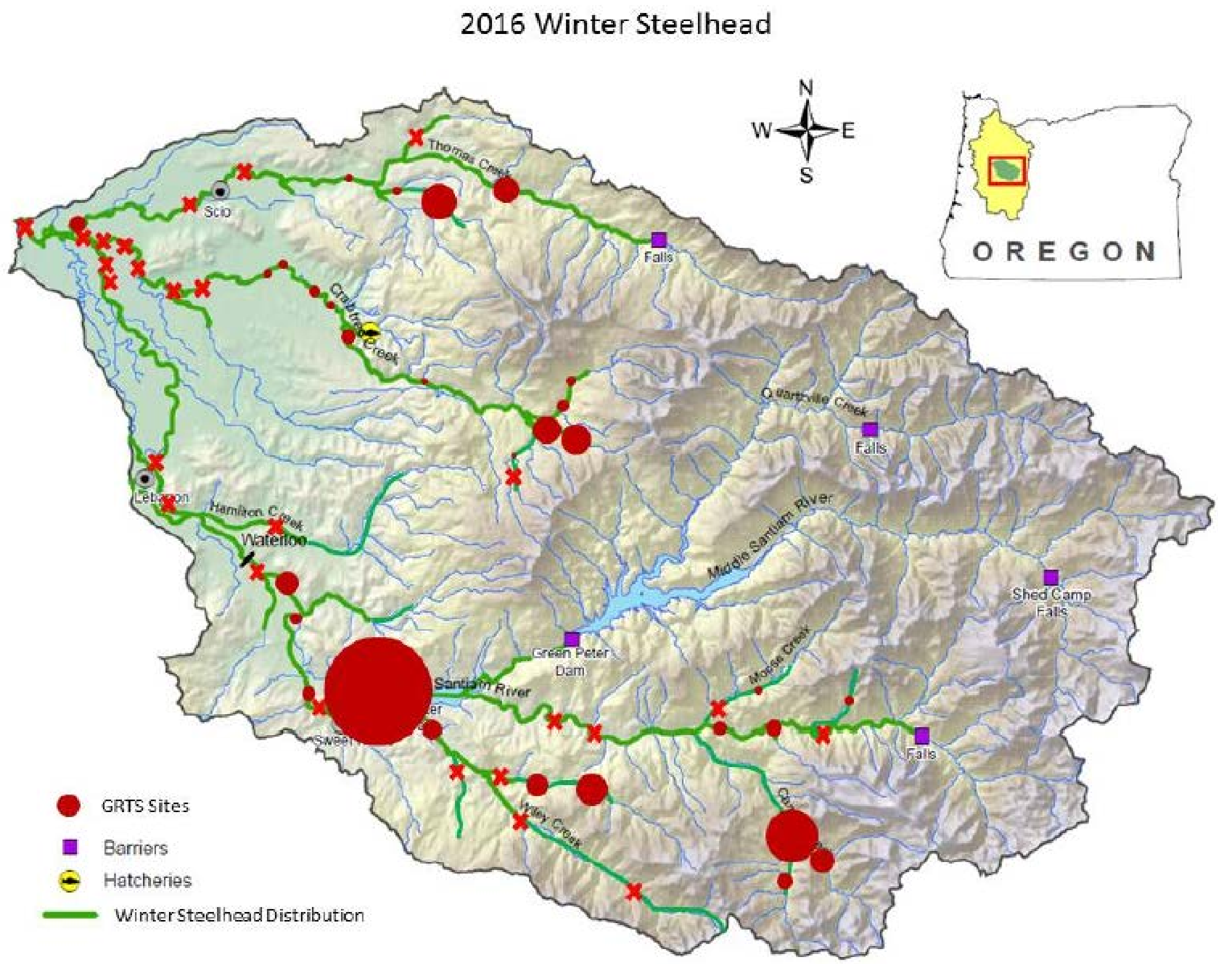

Figure 5. Spawning distribution and density of winter steelhead redds observed in the South Santiam River Basin, 2016. Figure taken from Mapes et al. (2017).

There is a nearly complete and consistent time series for index reach redd counts in the Calapooia River dating back to 1985. While there is not an expansion available from index reach to population spawner abundance, the trend in redds/mile is generally negative, although this is due in part to the time series beginning at a time of good ocean conditions. The redds/mile trend generally reflects good ocean conditions in the late 1980s and early 2000s, in addition to a period of poor ocean conditions in the mid-1990s. Abundance is thought to be rather low, population estimates (95% CI) based on radio tagged winter steelhead (Jepson et al. 2013; Jepson et al. 2014; Jepson et al. 2015) for 2012, 2013, and2014 are 127 (43-366), 204 (99-408), and 126 (54-289) respectively. These numbers would suggest that abundances have been fairly stable, albeit at a depressed level.

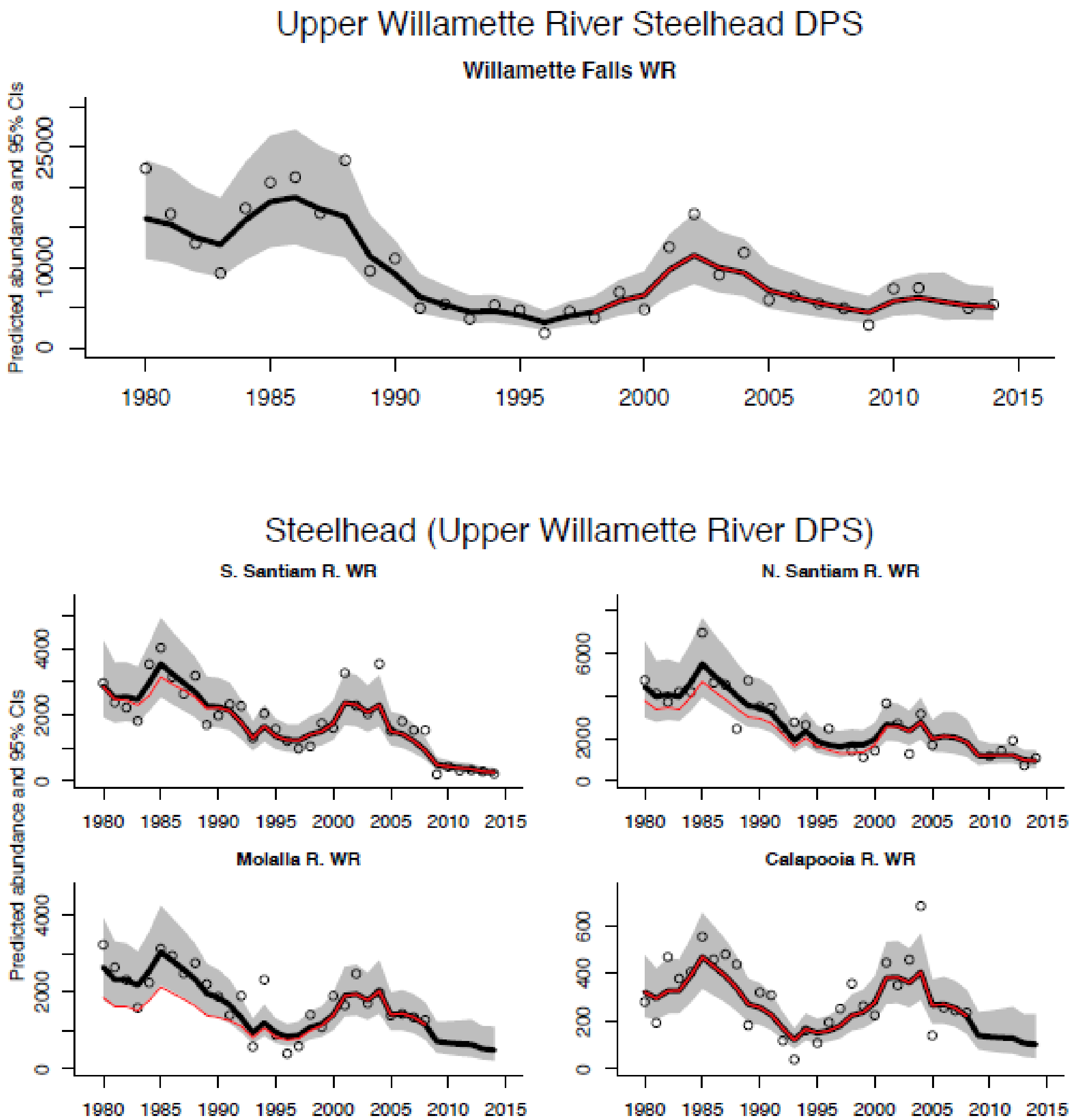

Figure 6. Smoothed trend in estimated total (thick black line) and natural (thin red line) population spawning abundance of winter steelhead. Points show the annual raw spawning abundance estimates. Figure taken from NWFSC (2015).

Table 8. 5-year geometric mean of raw natural origin spawner counts. This is the raw total spawner count times the fraction natural origin estimate, if available. In parentheses, 5-year geometric mean of raw total spawner counts is shown. A value only in parentheses means that a total spawner count was available but no or only one estimate of natural origin spawners available. The geometric mean was computed as the product of counts raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the most recent two 5-yearperiods is shown on the far right. Based on Table 53 of NWFSC (2015).

Population	1990-94	1995-99	2000-04	2005-09	2010-14	% Change
Willamette Falls	(5619)	5039 (3961)	10135 (10135)	4926 (4926)	6164 (6164)	25 (25)
S. Santiam	1940 (1940)	1277 (1277)	2440 (2440)	1044 (1044)	306 (306)	-71 (-71)
N. Santiam	2494 (2928)	1285 (1611)	2178 (2234)		1195 (1195)	
Molalla	1182 (1462)	726 (798)	1924 (1924)	1357 (1357)		
Calapooia	149 (149)	219 (219)	406 (406)	214 (214)		

Populations in this DPS have experienced long-term declines in spawner abundance. The underlying cause(s) of these declines is not well understood. Returning winter steelhead do not experience the same deleterious water temperatures as the spring-run Chinook salmon. Although the recent magnitude of these declines is relatively moderate, continued declines would be a cause for concern. Improvements to Bennett Dam fish passage and operational temperature control at Detroit Dam maybe providing some stability in abundance in the North Santiam River population. It is unclear if sufficient high quality habitat is available below Detroit Dam to support the population reaching its VSP recovery goal, or if some form of access to the upper watershed is necessary to sustain a “recovered” population. Similarly, the South Santiam Basin may not be able to achieve its recovery goal status without access to historical spawning and rearing habitat above Green Peter Dam (Quartzville Creek and Middle Santiam River) and/or improved juvenile downstream passage at Foster Dam.

Past and Present Hatchery Fish Releases

Spring Chinook Salmon

The past (since 1990) and present releases of hatchery spring Chinook salmon fish from UWR hatcheries is shown in Figure 7. Total releases of spring Chinook salmon have remained relatively constant since about 2000, and have fluctuated between approximately 3 million to 4.5 million smolts per year. Releases of spring Chinook salmon have remained fairly constant from the Willamette and North Santiam hatcheries and have recently (since 2010) been reduced at the South Santiam and McKenzie hatcheries (Figure 7). The location of hatchery fish releases have varied over time. Most of the hatchery fish releases occur at the hatchery facilities (Table 2; Figure 1 (page 7)).All of the current hatchery facilities (Figure 1 (page 7)) have been in operation for at least the last 20 years.

Hatchery spring Chinook salmon are primarily released in the early spring through late spring as yearlings (smolts; Table 9), although a small proportion are released as sub-yearlings in the fall. This two-pronged strategy mimics the life history of natural-origin juvenile spring Chinook salmon, that appear in rotary screw traps in the fall and very early spring as sub-yearlings and as yearlings later in the spring and summer (Romer et al. 2017). The size of hatchery fish is generally larger than their natural-origin fish (Table 9).

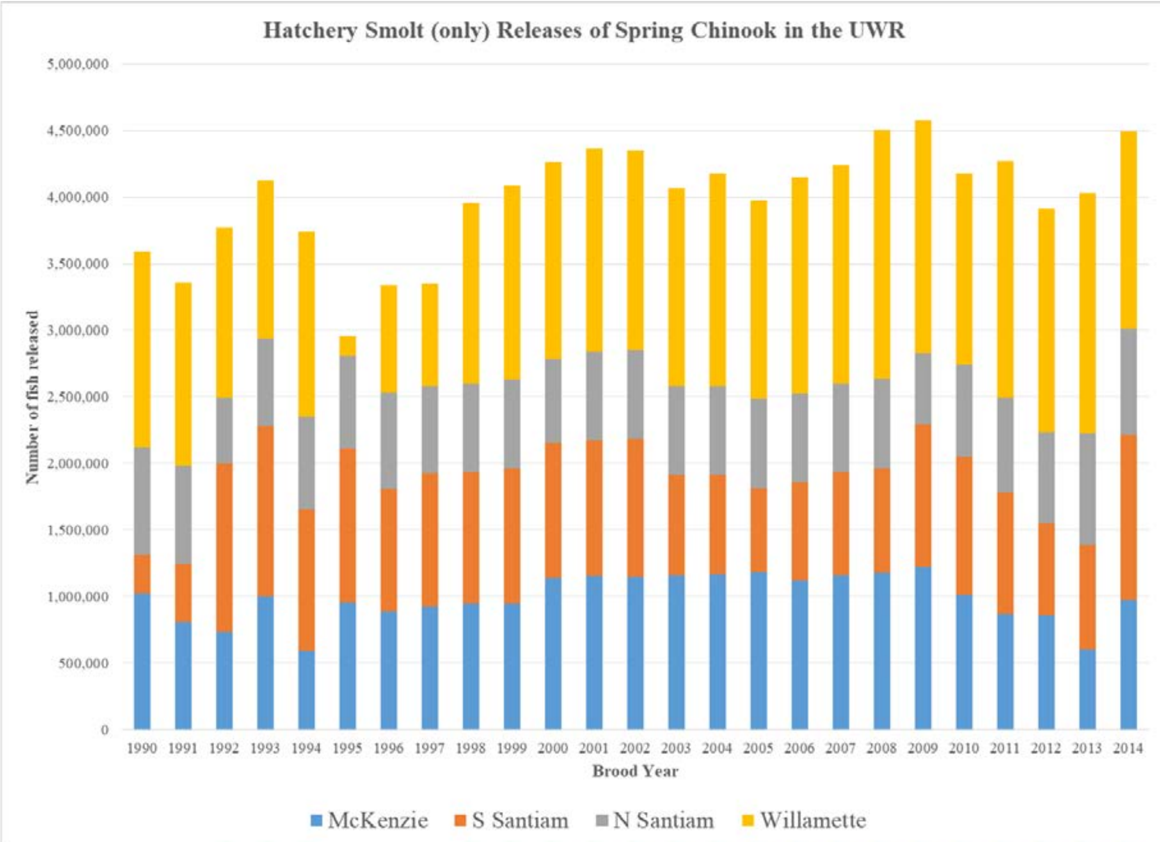

Figure 7. Smolt releases of spring Chinook salmon between 1990 and 2014 by ODFW from the McKenzie, South Santiam, North Santiam, and Willamette Hatcheries. The numbers do not include releases of unfed fry and fingerling life stages. Data from HGMPs (see Appendix 1) and ODFW's fish propagation reports (http://www.dfw.state.or.us/fish/hatchery/).

Table 9. Comparative individual sizes and freshwater occurrence timings for rearing and/or emigrating natural-origin salmon and steelhead juveniles by species and life stage, and hatchery-origin fish released from UWR hatchery programs.

Species/Origin	Life Stage	Individual Size average fork length (range; mm)	Predominant Occurrence or Release Timing
Chinook salmon (wild)	Fry	<40 (~30-60)	February - May
Chinook salmon (wild)	Parr-Subyrlg.	>60 (~40-100)	May – June and September-December
Chinook salmon (wild)	Yearling	>100 (~75-180)	Mid-March – mid-May
Chinook salmon (hatchery)	Sub-yearling	120 (60 -200)	May - November
Chinook salmon (hatchery)	Yearling	170 (150-200)	January - March
Steelhead (wild)	Fry	60 (23-100)	June - Oct.
Steelhead (wild)	Parr	96 (65-131)	Oct.- mid-May
Steelhead (wild)	Smolt	165 (109-215)	Late-April - June
Steelhead (hatchery)	Smolt	195 (180-220)	March - April
Rainbow trout (hatchery)	Fingerling	100 (50-150)	Spring, fall
Rainbow trout (hatchery)	Legal	>200 (200-400)	Spring, summer, fall

Notes and sources:

- Wild Chinook salmon data from Romer et al. (2017).
- Wild steelhead individual size data and occurrence estimates from Shapovalov and Taft (1954) and WDFW juvenile out-migrant trapping reports (Volkhardt et al., 2006a, 2006b; Kinsel et al., 2007).
- Hatchery-origin fish release size and timing data are average individual fish size and standard release timing targets as cited in ODFW's Hatchery Operation Plans for 2017and submitted HGMPs.

The proposed number of spring Chinook salmon to be released in the UWR is over 5 million fish (Table 2). The number of fish released per sub-basin ranges from near 700,000 (McKenzie Hatchery) to potentially over 2,000,000 from the Willamette Hatchery in the Middle Fork Willamette River (Table 2).

Summer-run Steelhead

Summer-run steelhead are not native to the UWR. The hatchery program was initially started in the UWR in the late 1960s as mitigation for lost winter steelhead production caused by the construction of the

Foster and Green Peters dams. Native winter steelhead had not been providing the angling opportunity desired by sportsmen and fisheries managers, because they spawned and were essentially gone from the system by late May. High water through the late winter and spring often impacted, and sometimes substantially reduced, sport angling efforts for winter steelhead. In addition to mitigating for the construction and effects of operation of the dams, the creation of a summer run of steelhead was intended to expand the duration of the steelhead angling season through the summer and fall.

The facilities that are used to raise and release hatchery summer-run steelhead into the North Santiam, South Santiam, McKenzie, Middle Fork Willamette rivers, and the mainstem Willamette River, are summarized in Table 10 and shown in Figure 1. Eight different facilities are used for incubation, rearing, acclimation and release for the summer-run steelhead program (Table 10).

Hatchery summer-run steelhead are released in the spring as yearlings (smolts; Table 9). While natural-origin steelhead generally spend at least two years in freshwater before emigrating to the ocean, hatchery-origin steelhead are released as yearlings after accelerated growth in the hatchery. The size of hatchery fish are generally larger than their natural-origin counterparts (Table 9).

Table 10. Summary of facilities and locations for the production of summer steelhead in the Willamette River Basin. Based on information provided in the most recent hatchery operating plans (http://www.dfw.state.or.us/fish/hatchery/).

Production Phase	Facility	Location
Broodstock collection, adult holding, and spawning	Foster Dam Fish Facility (South Santiam FH)	South Santiam River; RM 38.5
Incubation	South Santiam FH	South Santiam River; RM 38.5
	Oak Springs FH	Deschutes River; RM 47
Rearing	South Santiam FH	South Santiam River; RM 38.5
	Oak Springs FH	Deschutes River; RM 47
	Willamette FH	MF Willamette River; RM 42
	Roaring River FH	Crabtree Creek; RM 1.2
	Leaburg FH	McKenzie River; RM 39
	Dexter FH	Middle Fork Willamette River; RM 17

Production Phase	Facility	Location
Release	Minto Ponds	North Santiam; RM 42
	South Santiam FH	South Santiam River; RM 38.5
	Roaring River FH	Main stem Willamette River
	Dexter Ponds	Middle Fork Willamette River; RM 17
	Leaburg FH	McKenzie River; RM 39

FH = fish hatchery; RM = river mile

The proposed fish release goal for the summer-run steelhead program is nearly 550,000 (Table 2, Table 11). Since 2003, the average release of summer-run steelhead in the UWR has been approximately 584,000, ranging between 500,000 to about 670,000 (Figure 8).

Table 11. Hatchery facilities used to raise summer-run steelhead, release subbasin, and the number of fish released within the Upper Willamette River Basin.

Hatchery Facilities	Release sub-basin	Number
South Santiam/Willamette/Minto	North Santiam	66,000
South Santiam/Minto	North Santiam	55,000
Total for Sub-basin		**121,000**
South Santiam	South Santiam	161,500
Total for Sub-basin		**161,500**
South Santiam/Oak Springs/Leaburg	McKenzie	108,000
Total for Sub-basin		**108,000**
South Santiam/Willamette/Dexter	MF Willamette	61,000
South Santiam/Willamette/Roaring River	MF Willamette	27,428
Total for Sub-basin		**88,428**
South Santiam/Willamette/Roaring River	Main stem Willamette	68,572
Total for Sub-basin		**68,572**
Grand Total for UWR Basin		**547,500**

Source: Data from annual hatchery operations plans: http://www.dfw.state.or.us/fish/hatchery/
Note: All releases are smolts (yearlings).

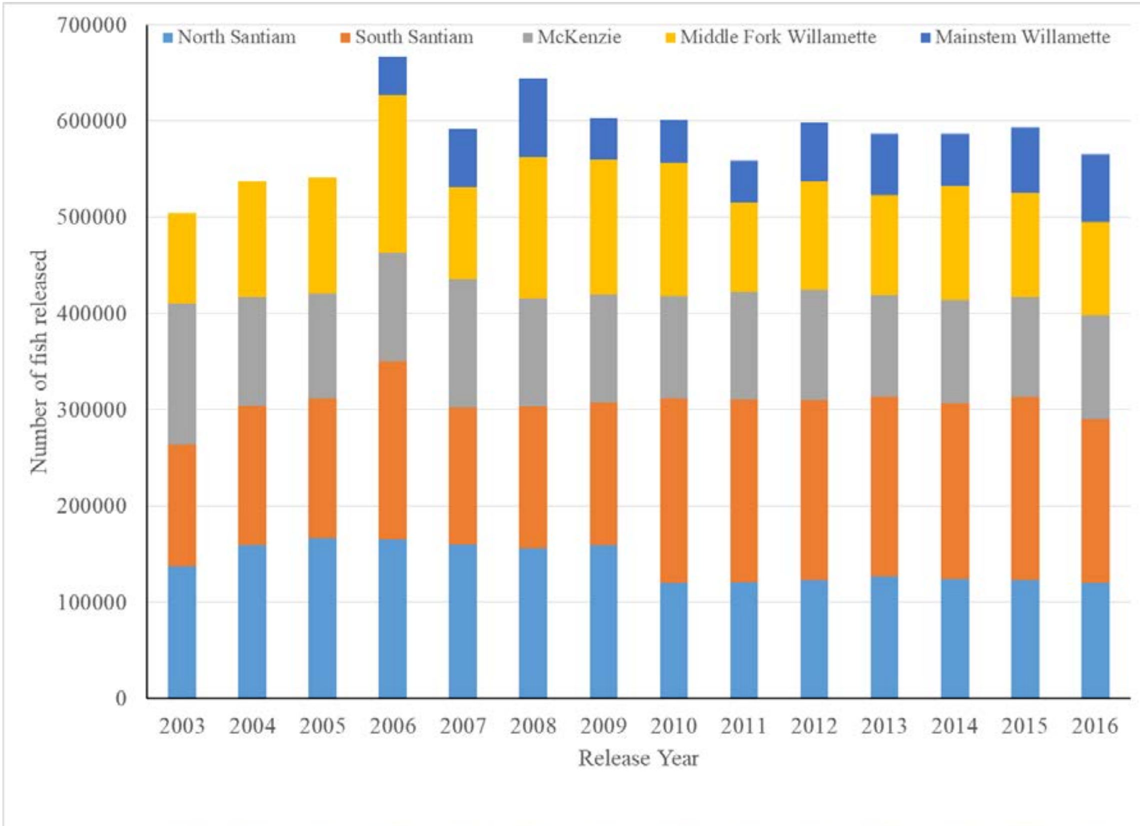

Figure 8. Releases of summer-run steelhead smolts in the Upper Willamette River Basin between 2003 and 2016. Data from ODFW (http://www.dfw.state.or.us/fish/hatchery/) accessed November 6, 2017.

Rainbow Trout

The goal of the rainbow trout hatchery program is to mitigate for trout harvest opportunities lost as a result of the construction and operation of Big Cliff, Detroit, Green Peter and Foster dams in the Santiam River subbasin, Fern Ridge Dam in the Long Tom River subbasin, Blue River and Cougar dams in the McKenzie River subbasin, and Fall Creek, Lookout Point, Dexter, Dorena, Cottage Grove and Hills Creek dams in the Middle Fork and upper Willamette River subbasin.

Broodstock for the program is maintained and spawned at the Roaring River Hatchery (Figure 1). The eggs are stocked shortly after fertilization to make the fish sterile, so that they cannot reproduce in the wild. For the portion of rainbow trout that are eventually released in the UWR, 1.5 million eyed eggs are transported to Willamette Hatchery in January. In addition, 250,000 fingerlings (about 50 fish per pound) are released into Detroit Reservoir in late June from Roaring River Hatchery.

Different sizes of fish are released in the numerous water bodies that receive hatchery rainbow trout (Table 12). In sum total, approximately 960,000 hatchery rainbow trout are released into the Willamette River Basin from this hatchery program (Table 12).

Table 12. Annual production goals for the Upper Willamette River rainbow trout hatchery program.

Hatchery	Release location	Number	Size (fish per pound)	Release timing
Roaring River	Mid-Willamette District; 16 waterbodies	5,400	75.0	March-July
		250,000	50.0	
		82,503	3.0	
		835	1.5	
		400	0.5	
Leaburg	Mid-Willamette District; 7 waterbodies	148,800	3.0	January-December
		7,725	1.5	
		700	1.0	
		275	0.5	
	Upper Willamette District; 3 waterbodies	234,135	3.0	February-September
		27,855	1.5	
Willamette	Mid-Willamette District; 4 waterbodies	88,900	3.0	May-October
		6,000	1.5	
	Upper Willamette District; 9 waterbodies	30,000	20.0	March-October
		5,000	3.0	
		74,989	2.0	
Grand total		**963,517**		

Source: ODFW hatchery operating plans; http://www.dfw.state.or.us/fish/hatchery/ accessed November 7, 2017

The average number of rainbow trout released from the three hatchery facilities since 2003 is just over 1 million fish, and has fluctuated between approximately 755,000 and 1,300,000 (Figure 9).

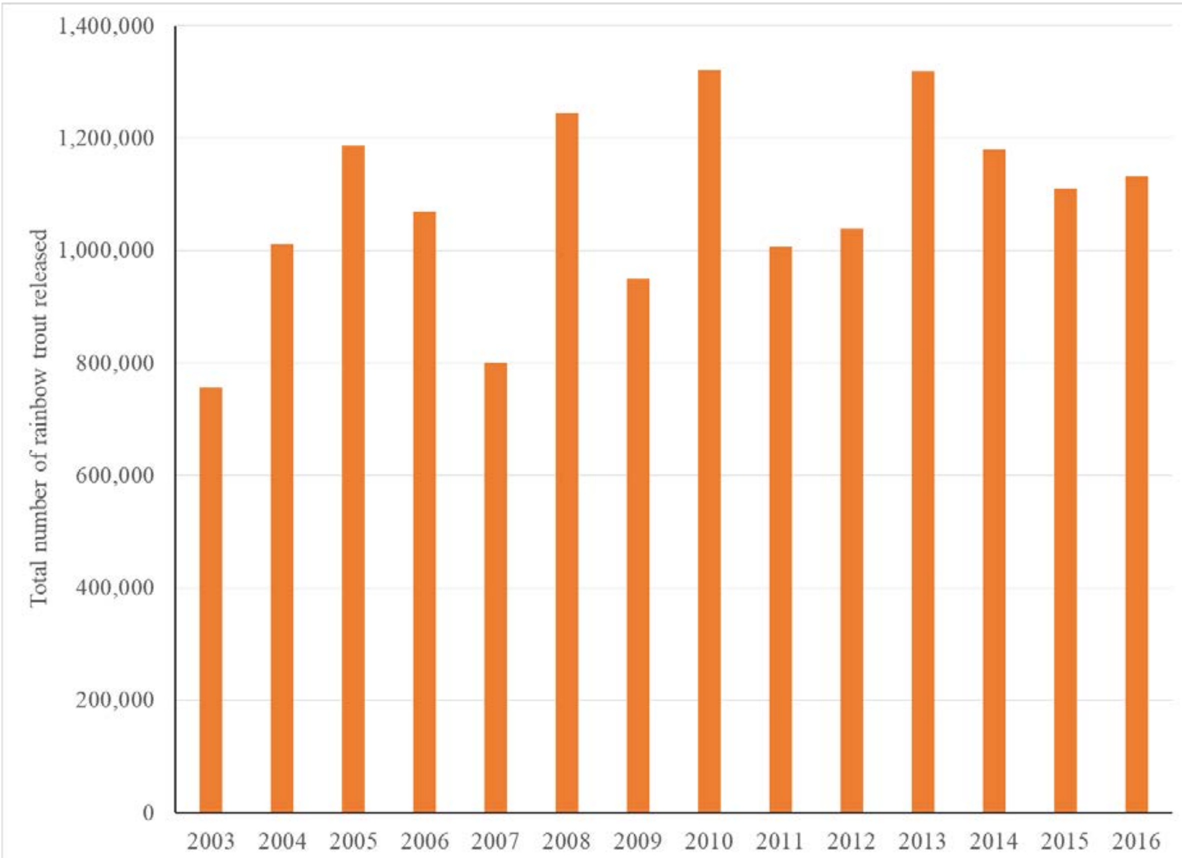

Figure 9. Total number of rainbow trout released from the Leaburg, Roaring River, and Willamette fish hatcheries between 2003 and 2016. Data from ODFW annual fish propagation reports (http://www.dfw.state.or.us/fish/hatchery/).

3.5. Other Fish and Their Habitats

This section includes other fish species (not salmon and steelhead) within the UWR that have a relationship with hatchery fish either as prey, predators, or competitors (Table 13). Generally, interactions among resident fish and hatchery fish would occur (1) through competition for space or food used by hatchery fish, and other fish in the analysis area, or (2) if hatchery fish are prey for other fish species or vice-versa. In the UWR, all resident fish species may compete with, be predators of, and/or serve as prey for hatchery fish depending upon the life stage and time of year (Table 13).

Resident hatchery rainbow trout are stocked into many reservoirs, lakes, and ponds throughout the UWR. Hatchery trout are stocked as fingerlings and legal-sized fish (>8 inches in length). Hatchery trout that are stocked into free-flowing rivers and streams where anadromous salmon and steelhead are currently sterilized (triploidy) prior to being released.

Pacific lamprey, river lamprey, Western Brook lamprey, coastal cutthroat troutare Federal “species of concern” (Table 13). Lamprey and cutthroat trout are widespread throughout the UWR. All of these fish species may prey or are preyed upon certain life stages of salmon and steelhead.

In the analysis area, all of the hatchery facilities may intercept and/or attract these fish species because water is used during operation. The inlet and outlet water discharge for the 10 hatchery facilities are screened to prevent fish from entering the facilities. During collection of returning hatchery salmon and steelhead, any other fish species that are incidentally collected are returned back to the river unharmed. For other broodstock collection and smolt release locations, the standard protocol is to release all other fish unharmed. Rainbow and cutthroat trout, pikeminnow, dace, sculpin, and sucker are the most common fish species incidentally captured and released within the UWR. The hatchery collection facilities are designed specifically to capture and collect adult salmon and steelhead. Most of the non-salmonid species commonly occurring in the Affected Environment are smaller-sized fish and thus freely pass through the facilities unimpeded and are not captured. Non-target species typically are less than five percent of the total catch.

Table 13. Range and status of other fish species that may interact with UWR spring Chinook salmon and steelhead. This is not an exhaustive list of fish species, but includes the fish most abundant and widespread in the analysis area.

Species	Range within the Willamette River Basin	Federal/State Listing Status	Type of Interaction with Hatchery Fish in Analysis Area
Bull trout	McKenzie and Middle Fork Willamette River basins	Federally listed as threatened	• May benefit by preying on releases of juvenile hatchery fish • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
White sturgeon	Mainstem Willamette River downstream of Willamette Falls	Not listed	• Predator of juvenile and adult salmon and steelhead. • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
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	Common in the main river channel and in sloughs and tributaries. Mostly the juveniles of this species are present in seasonal watercourses.	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 additional marine-derived nutrients provided by hatchery-origin fish
Coastal cutthroat trout	Common in the main river channel and in sloughs, tributaries, and seasonal watercourses	Not listed. Federal species of concern	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food • May benefit from additional marine-derived nutrients provided by hatchery-origin fish

Species	Range within the Willamette River Basin	Federal/State Listing Status	Type of Interaction with Hatchery Fish in Analysis Area
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
Walleye	Mainstem and lower portions of major tributaries	Non-native species	• Freshwater predator of salmon and steelhead • May benefit from additional marine-derived nutrients provided by hatchery-origin fish

Species	Range within the Willamette River Basin	Federal/State Listing Status	Type of Interaction with Hatchery Fish in Analysis Area
Smallmouth bass	Common in the main river channel and sloughs, occasional in seasonal watercourses of the lower Willamette Valley	Non-native species	• Freshwater predator of salmon and steelhead • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Largemouth bass	Occasionally found in the main river channel, but 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
Other centrarchids (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
Yellow perch	Common in the main river channel and in sloughs and tributaries; rarely in seasonal watercourses	Non-native species	• Freshwater predator of salmon and steelhead • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Common carp	Common throughout the main river channel and in sloughs and tributaries. Occasionally found in seasonal watercourses.	Non-native species	• Carp have a strong negative impact on aquatic ecosystems. Their feeding behavior uproots plants, which disturbs habitat for invertebrates, fish, and waterfowl and increases water turbidity
American shad	Main river channel	Non-native species	• May compete with salmon and steelhead for food • May benefit from additional marine-derived nutrients provided by hatchery-origin fish

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

3.6. Wildlife

Within the analysis area, many species occur and potentially interact with hatchery salmon and steelhead within the UWR (Table 14). Many species are listed under the ESA including: yellow-billed cuckoo, streaked horned lark, northern spotted owl, marbled murrelet, and the red tree vole is a candidate species (Table 14). However, most of these ESA-listed species do not interact with hatchery salmon and steelhead because of their habitat and food preferences and distribution. No interaction is expected to occur between salmon and steelhead and northern spotted owl, gray wolf, yellow-billed cuckoo, or streaked horned lark because they are not likely to be found in the analysis area or do not feed upon aquatic species (Table 14Table 14). Other ESA-listed species, such as the green sturgeon, eulachon, southern killer whale, humpback whale, Stellar sea lion have been analyzed in NMFS (2014) or NMFS (2017).

There are several species of birds that feed on juvenile salmon including Caspian terns and cormorants. During the spring when salmon and steelhead juvenile out-migrate to the Pacific Ocean, they may be a major food source for these bird populations within the UWR, but 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).

Finally, fishing in the analysis area has created fishery access points, roads, boat launches, and campsites that result in ongoing, but likely minor, habitat disruptions to terrestrial wildlife.

Table 14. Range and status of wildlife species that may interact with Upper Willamette River hatchery salmon and steelhead.

Species	Range within the Willamette River Valley	Federal Listing Status	Type of Interaction with Salmon and Steelhead in Analysis Area
Northern spotted owl	Forest habitat Cascade Mountains	Threatened	• No interaction
Marbled murrelet	Potential forest habitat primarily west of crest of Coast Range Mountains (in general), but may occur east of the crest of the Coast Range in the western tributaries of the Willamette River valley	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 region	Threatened	• No interaction
Other bird species dependent upon aquatic environment (osprey, heron, cormorant, bald eagle, dipper, gull, Caspian tern, duck, geese)	Throughout region	Not listed	• Predators of juvenile and adult salmon and steelhead in freshwater and saltwater areas
Small mammals (river otter, mink, raccoon, weasel, fisher)	Throughout region. Typically riparian areas	Not listed. Fisher is a candidate species	• Predators of juvenile and adult salmon and steelhead in freshwater areas
Red tree vole	Potentially higher elevations	Candidate species	• No interaction
Grey wolf, Canada lynx	Not currently present	Wolf-endangered. Lynx-threatened	• Not applicable.

Species	Range within the Willamette River Valley	Federal Listing Status	Type of Interaction with Salmon and Steelhead in Analysis Area
Other reptile species dependent upon aquatic environment (e.g.,snakes, lizards)	Coastwide	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, northwestern salamander)	Coastwide	Not Federally listed, although many of these species are species of concern	• Potential predator of eggs, fry, carcasses in freshwater areas

Sources: NMFS (2013), USFWS (2013), and http://pages.uoregon.edu/titus/herp/ (accessed April 8, 2014).

3.7. Socioeconomics

Socioeconomics is defined as the study of the relationship between economics and social interactions with affected regions, communities, and user groups. In addition to providing fish for harvest, hatchery programs directly affect socioeconomic conditions in the economic impact regions where the hatchery facilities operate and where hatchery fish are released. Hatchery facilities generate economic activity by providing employment opportunities and through local procurement of goods and services for hatchery operations.

The focus of this socioeconomic analysis area is the Willamette River Basin, Lower Columbia River downstream of the confluence, and the Pacific Ocean(Figure 10).Issues addressed in this section include socioeconomic effects related to hatchery operations, gross and net economic values derived from production and harvest of hatchery-origin fish produced from Willamette hatcheries (where estimates are available), and the ways hatcheries and the fish produced in Willamette River Basin hatcheries affect personal income and employment. The analysis area includes sites outside the project area because salmon that are produced within the project area can migrate outside the project area (e.g., Pacific Ocean) and contribute to fisheries in these other areas. Changes in salmon fisheries may lead to socioeconomic effects. Willamette River Basin steelhead are typically only caught in freshwater fisheries and not in ocean fisheries. Information on socioeconomic conditions related to tribal harvests is provided in Section 3.8, Environmental Justice.

This section describes recent trends and baseline conditions for hatchery program costs, harvest, economic values associated with commercial and recreational fisheries, and regional economic conditions. For an historical overview of salmon and steelhead harvest, please see NMFS(2014).

Figure 10. Analysis areas for socioeconomic impact region. The focus areas are the Willamette Basin, lower Columbia, and Pacific Ocean off British Columbia and Southeast Alaska. Figure 3-1 from NMFS (2014).

Hatchery Program Costs

Salmon and steelhead hatchery programs have operated in the states of Oregon and Washington for more than 100 years. Currently, 176 salmon and steelhead hatchery programs operate at 80 hatcheries and associated artificial production facilities in the Columbia River Basin (NMFS 2014).

Between 2005 and 2014, an average of 4.2 million spring Chinook salmon and nearly 600,000 summer steelhead have been released from UWR hatcheries (Table 15).

Table 15. Hatchery production (number of fish) of salmon and steelhead released from Upper Willamette River Basin hatcheries between 2005 and 2014.

Release year	Spring Chinook	Summer Steelhead
2005	3,976,218	541,057
2006	4,148,974	666,557
2007	4,239,837	591,635
2008	4,505,156	643,951
2009	4,572,201	602,930
2010	4,178,153	600,650
2011	4,271,248	558,564
2012	3,913,528	597,914
2013	4,028,916	586,925
2014	4,496,135	586,445
Avg.	4,233,037	597,663

Hatchery program expenses include production, headquarters administrative and management, acclimation and liberation, and hatchery facility and other fixed costs. Information pertinent to estimating hatchery facility costs was developed by TRG (2009) and includes the following:

- **Hatchery production costs:** Hatchery production costs include expenses accrued at the primary hatchery facility, as well as other hatchery facilities where the fish might be taken for rearing. Unit cost information includes the following:
    - Time spent in the hatchery facility affects production costs. The size of most released smolts ranges from 10 to 15 smolts per pound for spring Chinook salmon and steelhead. The spring Chinook salmon and steelhead spend about 18 months in the hatchery system.
    - Feed costs range from $0.40 to $0.80 per pound of feed.

    - Marking hatchery-origin fish is a Federal directive for federally operated, administered, or funded programs that produce fish for harvest. The two most common methods to mark hatchery-origin fish are with an adipose fin clip and/or a coded wire tag (CWT). Marking costs are about $0.05 per smolt, depending on the proportion of smolts receiving CWT inserts, which are about $0.20 per smolt.
    - Labor costs (excluding labor overhead) are the largest component of production costs, usually comprising about 50 percent of production costs.
- **Headquarters administrative and management costs:** Headquarters administrative and management costs include indirect expenses for central office overhead, with management and administration, that can range from about $0.03 to $0.40 per smolt produced.
- **Acclimation and liberation costs:** Some hatchery programs produce fish at a hatchery facility and then move the fish to a different location before release. Fish are then acclimated to the water at the new site before release. There are additional costs associated with this process.
- **Hatchery facility and other fixed costs:** This includes the cost of maintaining and/or improving hatchery facilities.

Average cost information from Table 16 was used, along with the number of fish released, to estimate the total cost of fish production at all hatchery facilities in the Upper Willamette River Basin. The cost to operate the 80 hatcheries and associated facilities in the Columbia River Basin varies by the operating agency. Production cost information for hatcheries for each operating agency is presented in Table 16.

Using the average number of fish released (Table 15) and the average costs associated with rearing Chinook and steelhead from Table 16, the cost of raising the number of spring Chinook and steelhead released in the UWR is approximately $5.7 million ($4.1 million for spring Chinook and $1.6 million for steelhead). The hatcheries in the UWR employ 37 FTE jobs and two seasonal positions (information from submitted HGMPs).

Table 16. Average cost per smolt from Mitchell Act-funded hatchery programs.Based on Table 3-12 from NMFS (2014).

Agency	Species	Average Cost per Smolt ($)[1,2]
ODFW	Chinook Salmon	0.743
	Steelhead	2.147
USFWS	Chinook Salmon	1.174
	Steelhead	3.260
WDFW	Chinook Salmon	1.095
	Steelhead	2.696
Yakama Nation	Chinook Salmon	0.829
Average for Chinook		0.960
Average for steelhead		2.701

Source: Compiled by TCW Economics (Appendix J of NMFS (2014)).

[1] All dollar values are expressed in 2007 dollars, as presented in the source document identified in Appendix J in NMFS (2014). The computation of total costs for smolt production were adjusted to 2009 dollars for estimating regional economic effects of the alternatives.

[2] Includes operation costs, headquarters' overhead costs, amortized capital costs, and acclimation and transport costs, where applicable.

Commercial Harvest and Economic Value

This section contains reports on recent historical levels of commercial harvest of salmon and steelhead in the following fisheries: Columbia River Basin salmon fisheries; Oregon and Washington coastal salmon fisheries, British Columbia salmon fisheries, and Southeast Alaska salmon fisheries.

Columbia River Basin[10]

The Columbia River mainstem commercial salmon fishery is currently divided into a non-tribal and a tribal fishery. The non-tribal commercial fishery is located downstream of Bonneville Dam, as well as in the Select Areas (i.e., off channel areas of the lower Columbia River). This fishery intercepts UWR natural- and hatchery-origin fish. The tribal in-river commercial fishery is upstream of Bonneville Dam and will not be analyzed in this DEIS because UWR fish are harvested in negligible numbers upstream of Bonneville Dam. There are no non-tribal steelhead commercial fisheries in the Columbia River.

[10] There are currently no commercial fisheries for salmon or steelhead in the Willamette River Basin.

Visual stock identification (VSI) and coded-wire tag (CWT) recoveries indicate that spring Chinook salmon destined for the Willamette River typically comprised a large percentage of the spring Chinook salmon caught during past winter commercial seasons and during March in Columbia River recreational fisheries (Table 17).

In the lower Columbia River fisheries, commercial fishermen have harvested an annual average of approximately 2,400 fish between 2000 and 2016 (Table 17). Using the annual harvest value (known as the ex-vessel value, which is the price received for the product at the dock; $31.82 per fish) of Chinook salmon caught in the non-tribal commercial fisheries in the lower Columbia River economic impact region from the Mitchell Act FEIS (NMFS 2014), the annual commercial harvest value between 2000 and 2016 averaged $75,431 (these values are in 2009 dollars).

Table 17. Commercial and sport catch of Willamette Spring Chinook Salmon in the Lower Columbia River (downstream of the Willamette River) and Lower Willamette River (downstream of Willamette Falls).

	Lower Columbia River Mainstem		**Lower Willamette River**
Catch year	**Commercial[1]**	**Sport[2]**	**Sport[3]**
2000	1,100	200	9,000
2001	3,500	3,800	7,600
2002	7,400	5,200	10,800
2003	1,800	7,200	13,500
2004	7,200	5,900	12,000
2005	300	2,800	5,800
2006	2,700	2,000	7,200
2007	1,300	1,600	5,700
2008	100	200	4,600
2009	300	1,400	4,500
2010	3,300	5,400	22,700
2011	2,300	2,100	22,800
2012	2,300	3,200	15,800
2013	1,800	1,700	7,400
2014	1,300	2,300	8,100
2015	2,600	3,500	13,600
2016	1,000	1,400	6,000
Average	**2,371**	**2,935**	**10,418**

Source: Based on Table 3 from Joint Columbia River Management Staff (2017).

[1]Includes spring Chinook destined for the Willamette River landed in Select Area commercial fisheries of Youngs Bay (since 1992), Tongue Point (since 1998), and Blind Slough (since 1998). Also, includes estimated release mortalities from Lower Columbia mainstem commercial selective fisheries since 2001.
[2] Includes spring Chinook destined for the Willamette River landed in Columbia River boat and/or bank fisheries. Also includes estimated hook and release mortalities in the Lower Columbia mainstem selective recreational fishery since 2001.
[3] Includes estimated hook and release mortalities in the Lower Willamette selective recreational fishery since 2000.4Includes estimated hook and release mortalities in the Lower Willamette selective recreational fishery since 2000.

Pacific Ocean

Columbia River stocks of Chinook salmon contribute to commercial fisheries in the Pacific Ocean. This section describes economic values for commercial salmon fisheries in the Pacific Ocean where Columbia River (including UWR) are intercepted. This summary of the economic impacts relies on the analysis and the conclusions from the Mitchell Act FEIS (NMFS 2014). Catch values and associated economic values presented in this section are for all salmon stocks, not just salmon stocks from the Columbia (and UWR) River Basin. About 32 percent of the Chinook salmon in non-tribal commercial fisheries and 22 percent of the Chinook salmon harvested in tribal commercial fisheries north of Cape Falcon consist of Columbia River stocks(NMFS 2014). Stocks of Columbia River Chinook salmon do not substantially contribute to the salmon fisheries south of Cape Falcon; however, Columbia River stocks of Chinook salmon do contribute to Chinook salmon commercial fisheries in the Astoria area of northern Oregon. Columbia River stocks also account for about 28 percent of Chinook salmon harvested in the Southeast Alaska commercial fishery and about 7 percent of the commercial harvest of Chinook salmon harvested in British Columbia marine waters(NMFS 2014).

In terms of economic value, the average annual harvest value (ex-vessel value) of Chinook salmon caught along the Washington Coast by tribal commercial fishers was $1,201,946, and by non-tribal commercial fishers was $1,457,827. The average annual non-tribal commercial catch of Columbia River Chinook salmon for the Oregon Coast (near Astoria) was $361,859, and $13,798,782 and $13,003,266 for British Columbia and Southeast Alaska, respectively (Table 18).

Table 18. Average Annual (2002 through 2009) Chinook Catch and Commercial Ex-vessel Value for Tribal and Non-tribal Commercial Fisheries for the Pacific Ocean. Based on Table 3-18 from NMFS (2014).

	Tribal		Non-tribal Commercial	
Economic Impact Region	**Average Catch (number of fish)1**	**Ex-vessel Value ($)2**	**Average Catch (number of fish)1**	**Ex-vessel Value ($)2**
Oregon Coast (Astoria3)			6,808	361,859
Washington Coast	28,470	1,201,946	29,056	1,457,827
British Columbia			234,375	13,798,782
Southeast Alaska			268,398	13,003,266
TOTAL	**28,470**	**1,201,946**	**538,637**	**28,621,734**

Recreational Harvest and Economic Value

Columbia River Basin (Lower Columbia and Lower Willamette Rivers)

The recreational fishery on the mainstem Columbia River below Bonneville Dam includes two main management areas: the mainstem Columbia River extending from Bonneville Dam downstream to the Tongue Point/Rocky Point line, and the Buoy 10 area extending from below the Tongue Point/Rocky Point line to Buoy 10, which marks the ocean/in-river boundary. In the Lower Columbia River, sport fishermen have averaged nearly 3,000 UWR spring Chinook salmon per year (Table 17). In the lower Willamette River (downstream of Willamette Falls), sport fishermen have harvested an annual average of nearly 10,500 between 2000 and 2016 (Table 17).

Upper Willamette River Basin

In the Upper Willamette River Basin, there are recreational fisheries for spring Chinook salmon and summer-run steelhead. The average catch of spring Chinook salmon has decreased from about 6,500 to 4,300, while harvest of summer-run steelhead stayed approximately the same (10,427 to 10,144) between the periods of 1995 to 2005 and 2006 to 2016 (Figure 11). Part of the reason for the decline of spring Chinook salmon is that returning hatchery fish were not differentially marked from natural-origin fish until 2002, so some portion of the fish harvested from 1995 through 2001 were natural-origin fish. Once externally marked hatchery spring Chinook salmon began returning, all natural-origin (non-marked) fish had to be released upon capture. The fishery for hatchery-origin summer-run steelhead has remained relatively constant (Figure 11).

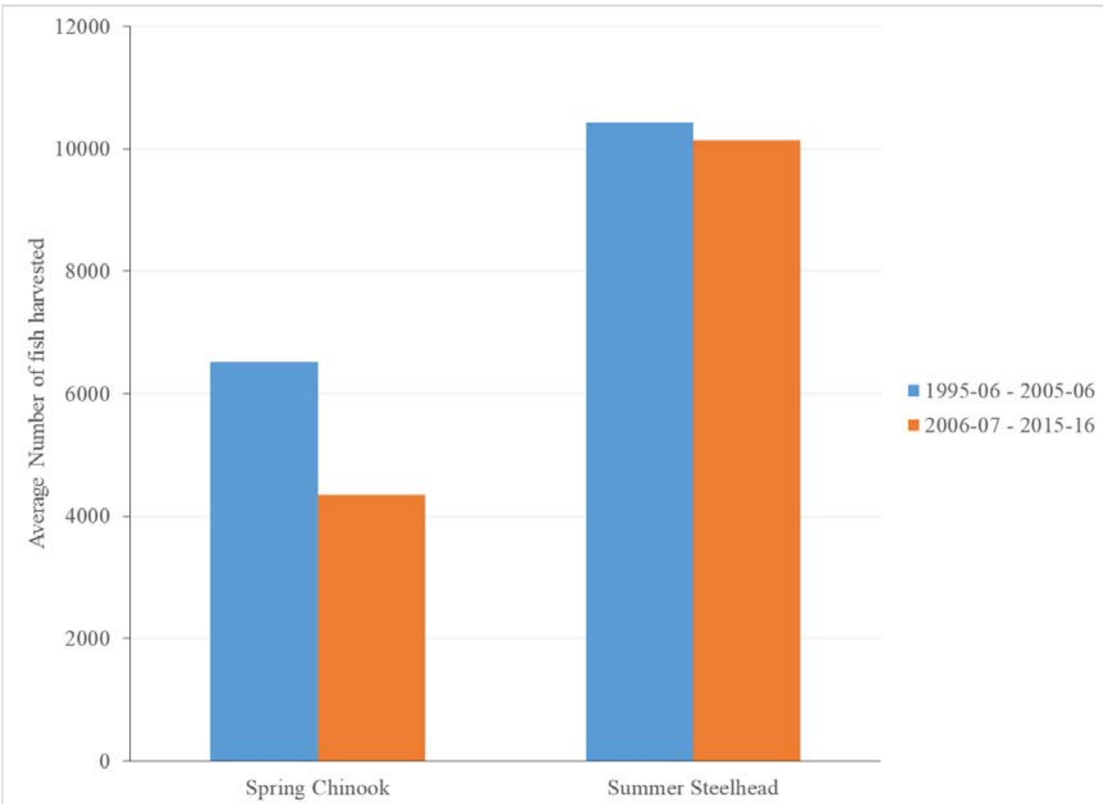

Figure 11. Comparison of the average recreational harvest of spring Chinook salmon and summer steelhead in the Upper Willamette River Basin between 1995-05 and 2006-16, excluding harvest in the mainstem Willamette River downstream of Willamette Falls. Source: ODFW: **http://www.dfw.state.or.us/resources/fishing/sportcatch.asp**, accessed on October 25, 2017.

NMFS (2014) estimated that between 2002 and 2009, there was an annual average of over 584,000 fishing trips in the Lower Columbia River economic impact region, which includes the Willamette River valley, and recreational anglers spent nearly $48 million annually (Table 19).

Table 19. Average annual (2002 through 2009) catch, number of trips, and trip expenditures for recreational Chinook salmon and steelhead fisheries for the lower Columbia River Basin. Based on Table 3-19 from NMFS (2014).

Economic Impact Region/Species	Average Catch (number of fish)	Number of trips	Trip Expenditures ($)[1]
Lower Columbia River			
Chinook Salmon	77,497	373,089	30,604,491
Steelhead	40,187	211,511	17,350,247
TOTAL	**117,684**	**584,600**	**47,954,738**

Sources: Average catch estimates are based on 2002 through 2009 historical averages and modeled harvest estimates developed by the Mitchell Act Fishery Modeling Team. See Appendix J of NMFS (2014) for how the number of trips and trip expenditures was derived.

[1] All dollar values are expressed in 2009 dollars.

Pacific Ocean

Recreational fishing for Chinook salmon[11] in Pacific Coast waters is limited to hook-and-line gear and is conducted mostly from privately owned pleasure craft and charter boats. There is little shore-based (e.g., piers and jetties) angling in the ocean for salmon.

Recreational anglers caught an average of 1,725, 24,984, 105,995, and 60,147 Chinook salmon in fisheries off the coasts of Oregon, Washington, British Columbia, and Southeast Alaska, respectively between 2002 and 2009 (Table 20). This accounts for an annual average of just under 200,000 Chinook salmon caught (Table 20). These fisheries are supported by fish released from hatcheries in the Columbia River (and UWR) basins.

Based on an estimated range in effort of 0.8 to 1.2 fishing days per fish caught and average spending estimates ranging from $119.70 to $147.52 per day (TRG 2009), anglers incurred an estimated $3,272,724 in trip-related expenditures to catch Chinook salmon (26,709 fish) in recreational fisheries along the Washington and Oregon coasts (Table 21). For British Columbia and Southeast Alaska, the

[11] It is important to understand that most of the Chinook salmon caught in the ocean are not spring-run.

average recreational catch for Chinook salmon was 136,182 fish and trip-related expenditures were $26,118,339 (Table 21).

Table 20. Historical (2002 through 2009) Chinook salmon catch in recreational Pacific ocean supported by Columbia River Stocks. Based on Table 3-21 from NMFS (2014).

Economic Impact Region	**Number of fish[1]**								
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Annual Average**
Oregon Coast	2,754	2,330	2,183	3,635	509	594	817	980	1,725
Washington Coast	57,821	34,183	24,907	36,369	10,667	8,944	14,635	12,351	24,984
British Columbia	107,089	114,172	129,902	106,599	88,493	107,229	94,056	100,426	105,995
Southeast Alaska	64,683	68,852	78,505	70,040	63,500	61,851	25,662	48,089	60,147
TOTAL	**232,347**	**219,537**	**235,497**	**216,643**	**163,169**	**178,618**	**135,170**	**161,846**	**192,851**

Sources: Catch data for the California, Oregon, and Washington Coasts are from PFMC (2003, 2004, 2005, 2006, 2007, and 2011 in NMFS (2014)). Catch data for Puget Sound/Strait of Juan de Fuca are from WDFW (2008; in NMFS (2014)). Catch data for British Columbia and Southeast Alaska are from PSC (2003, 2004, 2005, 2006, 2007, 2008, 2009, and 2011 in NMFS (2014)).

[1] Catch values reported in this table are for all stocks, not just Columbia River Basin stocks.

[3] Includes salmon fisheries in the Astoria area of northern Oregon only; potential effects of the DEIS alternatives on Chinook salmon ocean fisheries south of the Astoria area would be expected to be negligible. Refer to the Socioeconomics Impact Methods Appendix (Appendix J) in NMFS (2014)for additional details pertaining to this assumption.

Table 21. Average annual (2002 through 2009) catch, number of trips, and trip expenditures for Chinook salmon recreational fisheries for the Pacific Ocean. Based on Table 3-22 from NMFS (2014).

Economic Impact Region	Average Catch (number of fish)[1]	Number of Trips	Trip Expenditures ($)[2]
Oregon Coast (Astoria3)	1,725	2,104	251,829
Washington Coast	24,984	20,478	3,020,895
British Columbia	105,995	86,881	16,662,935
Southeast Alaska	60,147	49,301	9,455,404
Total	192,851	158,764	29,391,063

Source: Average catch estimates are 2002 through 2009 historical averages. See Appendix J in NMFS (2014) for a description of how number of trips and trip expenditures were derived.
[1] Catch values reported in this table are for all stocks, not just Columbia River Basin stocks
[2] All dollar values are expressed in 2009 dollars.
[3] Includes salmon fisheries in the Astoria area of northern Oregon only.

Regional Economic Conditions

Lower Columbia River Economic Impact Zone

Commercial and recreational fisheries generate personal income and support jobs in regional and local economies throughout the Lower Columbia River economic impact zone. Commercial landings of salmon and steelhead are frequently sold directly, or after processing, to persons or businesses located outside the region. The transfer of money to businesses within the region supports payments of wages and other forms of compensation, and that money is then re-spent regionally (i.e., the multiplier effect). Similarly, non-local recreational anglers (i.e., anglers who live outside the local area) spend money on guide services, lodging, and other goods and services within the Lower Columbia River economic impact zone that generate income for local and non-local communities. Last, money spent on hatchery operations and management, which often comes from state or Federal sources located outside the local area, provides an additional infusion of income to local economies.

The estimated amount of personal income and the number of jobs supported in Lower Columbia River economic impact zone (both hatchery-origin and natural-origin salmon and steelhead) is based on the analysis that was done for the Lower Columbia River impact zone from NMFS (2014). These estimates are based on average annual harvest conditions for all salmon and steelhead caught in the economic impact region. The lower Columbia River economic impact region generates $52,577,674 in personal income and supports about 1,333 jobs (39 for just hatchery personnel).

Hatchery operations (including related ongoing weir operations) in the Columbia River Basin also generate direct, indirect, and induced economic effects within the basin's four economic impact regions, as shown in Table 22. Hatchery production spending on labor and procurement of goods and services is estimated to generate a total of $64,088,521 in personal income and about 1,282 jobs in the basin (Table 22). Hatchery-generated economic activity is greatest in the lower Snake River economic impact region, where $24,009,550 in personal income and 480 jobs are estimated to be supported by hatchery operations (Table 22). Economic activity is similar in the lower Columbia River economic impact region, where $22,728,721 in personal income and 455 jobs are estimated to be supported by hatchery operations (Table 22).

Table 22. Economic Effects of the Lower Columbia River Economic Impact Zone Hatchery Operations and Associated Harvest. Based on Table 3-23 from NMFS (2014).

Sector	Hatchery Operations[1]			Harvest-related Effects1	
	Operating Costs ($)[2]	Personal Income ($)[2]	Number of Jobs[3]	Personal Income ($)[2]	Number of Jobs[3]
Tribal	**-** [4]	-	-	0	0
Non-tribal commercial	**-**	-	-	6,232,855	158
Recreational	**-**	-	-	46,344,819	1,174.50
TOTAL	**29,500,000**	22,728,721	**455**	**52,577,674**	**1,332.50**

[1] Source: Hatchery operation costs, which include related weir operation costs, are from Table 4-85 in NMFS (2014), and the number of jobs was estimated using jobs per million dollars of production cost factors described in Appendix J of NMFS (2014). Harvest-related effects on personal income and jobs are based on average annual harvest estimates and on application of personal income and jobs factors identified in Appendix J of NMFS (2014).
[2] All dollar values are expressed in 2009 dollars.
[3] Jobs are expressed in full- and part-time jobs.
[4] Dashes mean unknown because funding for hatchery operations is not allocated among user groups.

Pacific Ocean

Columbia River stocks support fisheries that generate personal income and support jobs in affected economic impact regions and local economies throughout the Columbia River Basin and Pacific Coast. However, unlike the Columbia River Basin, economic impact regions and local economies outside the Columbia River Basin (that are within the Pacific Ocean) are generally more dependent on fish originating from their local river systems, even though Columbia River stocks contribute to the fisheries. Fisheries that affect the Oregon and Washington Coasts, however, are exceptions. Fisheries in these areas depend substantially on Columbia River Basin stocks. The amount of personal income and the number of jobs supported in these economic impact regions by all salmon and steelhead stocks (not just Columbia River Basin stocks) is as follows (from NMFS 2014):

- Average annual harvest of salmon in commercial and recreational fisheries along the Washington coast generates $13,199,490 in personal income and supports an estimated 389 jobs.
- Commercial and recreational salmon fisheries along the Oregon coast generate $4,231,696 in personal income and 126 jobs.

These reported values for personal income and jobs on the Washington and Oregon coasts represent average annual conditions over the 2002 through 2009 period(NMFS 2014). 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.

3.8. 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*, EPA states 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[12]
- 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. More specifically, potential environmental justice impacts are assumed to occur in an area if the percentage of minority, lower per capita income, and percentage below poverty level are meaningfully greater than the percentage of minority, lower per capita income, and percentage below poverty level in the state of Oregon as a whole.

[12] "Hispanic" is an ethnic and cultural identity and is not the same as race.

The 10 hatchery facilities located in the UWR release hatchery Chinook salmon and steelhead into rivers which are located in the counties listed in Table 23.All of the counties in the analysis area are environmental justice communities of concern because they meaningfully exceed thresholds for low income or minority populations, with the exception of Clackamas County (Table 23).

Table 23. Demographic information regarding counties in the analysis area (USCB 2016).

County	Black (percent)	American Indian or Alaska Native (percent)	Hispanic or Latino (percent)	Poverty Rate (percent)	Per Capita Income (dollars)
Multnomah	5.8	1.5	11.4	15.7	31,544
Clackamas	1.1	1.1	8.4	9.4	34,047
Marion	1.4	2.5	26.2	16.8	22,490
Linn	0.7	1.6	8.8	15.8	21,706
Lane	1.1	1.3	7.6	17.4	24,105
Oregon (statewide average)	**2.1**	**1.8**	**12.8**	**13.3**	**27,684**

Note: Shaded cells represent values that were meaningfully different (in general, greater than 10 percent) than those of the reference population (which is treated here as the state of Oregon average values), making them an environmental justice community of concern.
Source: https://www.census.gov/quickfacts/fact/table/US/PST045216. Data accessed November 2, 2017.

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).

Confederated Tribes of the Grand Ronde

The Confederated Tribes of the Grand Ronde include the Umpqua, Mololla, Rogue River, Kalapuya, and Chasta Tribes (as spelled by the Tribe). Their reservation is located in the coast range of Oregon (http://www.grandronde.org). When the tribes' Federal recognition was restored in 1983, there remained some potential conflicts with the state of Oregon regarding fishing rights (K. Dirksen, pers. comm., Tribal Fish and Wildlife Program Manager, Cowlitz Tribe, February 17, 2010, in NMFS (2014)). In 1986, the tribe and the state of Oregon signed a consent decree, which identified and explained, in part, how the tribe would manage and fish for salmon. Tribal members engage in ceremonial and subsistence fishing throughout original ceded lands. The tribe has participated in salmon recovery planning covering the reservation and ceded lands.

Burns Paiute Tribe

The Burns Paiute Tribe, located in southeast Oregon, is also a native American tribe involved and interested in the hatchery programs of the Upper Willamette River basin. In recent years, adult hatchery spring Chinook salmon from the Middle Fork Willamette River have been used for ceremonial fisheries in the Malheur River for tribal members. The Burns Paiute Tribe has expressed concern with continuing this program during public scoping for this EIS.

4. ENVIRONMENTAL CONSEQUENCES

4.1. Introduction

This section evaluates the potential impacts of the five alternatives (including the Proposed Action) on the human environment including the biological, physical, and human resources described in Subsection 3, Affected Environment. NMFS has defined the No-action Alternative (Alternative 1) as the continued operation of the hatchery programs without ESA authorization to use natural-origin fish for broodstock purposes. The Proposed Action Alternative (Alternative 2) is NMFS approval of the HGMPs under limit 5 of the 4(d) Rule, which includes authorization to use natural-origin fish for broodstock purposes. Alternative 3 is reducing hatchery production to levels producing hatchery fish for reintroduction purposes. Alternative 4 is terminating all hatchery programs in the Upper Willamette River Basin. Alternative 5 is increasing hatchery production to support enhanced fisheries up to ESA-approved fishery impact limits.

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

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

In this chapter, there are two general aspects of impacts analyzed. First, is the effect from the operation of the hatchery facility (e.g., McKenzie Hatchery) on the affected environment. Second, is the effect from releasing hatchery fish from a particular program (e.g., McKenzie spring Chinook salmon program) on the affected environment. Many of the effects on resources evaluated in this section lend themselves more readily to either a discussion based on hatchery facility or discussion based on a specific program. To a large extent, it is most appropriate to consider effects on water quantity (Subsection 4.2, Effects on Water Quantity), water quality (Subsection 4.3, Effects on Water Quality), salmonid habitat (Subsection 4.4, Effects on Salmon and Steelhead and Their Habitats, and Subsection 4.5, Effects on Other Fish and Their Habitats), and wildlife (Subsection 4.6, Effects on Wildlife)largely in terms of the facilities, since facility operation and other associated structures are the primary, potential source of impact, though any effects of individual programs on such resources are also addressed. Conversely, effects that are more the result of interactions of an ecological nature with fish originating from the proposed programs are the primary focus of the analyses on salmon and steelhead (Subsection 4.4, Effects on Salmon and Steelhead and Their Habitats) and other fish (Subsection 4.5, Effects on Other Fish and Their Habitats). Consequently, the analyses also addresses potential effects from individual programs. Effects on socioeconomics (Subsection 4.7, Effects on Socioeconomics), and environmental justice (Subsection 4.8, Effects on Environmental Justice) would also be expected to accrue more from the presence and/or exploitation of the proposed fish releases; therefore, analyses of these resources primarily addresses the effects of the individual programs.

4.2. Effects on Water Quantity

4.2.1. Alternative 1 (No-Action) – Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks

Under Alternative 1, the existing hatchery facilities in the UWR Basin would continue to operate in accordance with NMFS (2008) (see section 2.1Alternative 1 (No-action): Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks for more information see Appendix A). Consequently, short- and long-term surface water and groundwater use would be the same as current conditions (no changes are proposed to current hatchery operations). There would be no change in compliance with water permits or water rights at any of the hatchery facilities under Alternative 1 because the hatchery programs have existing permits and water rights to divert water as proposed in the submitted HGMPs. An analysis of the site-specific effects under Alternative 1 is provided below.

All of the facilities associated with the hatchery programs (Marion Forks Hatchery, Minto Dam FF, South Santiam Hatchery, Foster Dam FF, Roaring River Hatchery, McKenzie Hatchery, Leaburg Hatchery, Willamette Hatchery, and Dexter Dam FF) use surface water. All water diverted from the stream, river, or reservoir (minus evaporation) is returned after it circulates through each facility, so the only segment of the river that may be impacted by these hatchery facilities would be the area between the water intake and discharge structures (Subsection 3.2, Water Quantity). Willamette hatchery and South Santiam hatchery are permitted to use both surface and groundwater (**Table 24**). However, most of the water used is surface water because the groundwater water rights are low (0.11 to 0.3 cfs) (**Table 24**).

4.2.1.1 Amount of Water Used

Under Alternative 1, all of the hatchery facilities would continue to operate, and between 25 and 100.33 cfs of water could be used (by permitted water rights) from rivers, streams, reservoirs, and diversions between the water intake and discharge structures at the specific hatchery facility locations (**Table 24**).

For the UWR Basin, natural streamflows from August through October are typically the lowest throughout the year. The flows downstream of the dams are managed and can be greater than natural flows during this period depending upon water management. During this period of low streamflow, if the hatchery facility uses water up to the full water right this could result in low streamflows in the area affected by the hatchery's water withdrawal (the area affected is described below). For each hatchery facility, the actual water use by the facility was assessed for the time period of lowest streamflows in the stream or river where the hatchery facility is located (ODFW 2017). Streamflow information is available for every location (Table 3).

Surface water use by the hatchery facilities during the minimum mean monthly flows ranges from 2.2 to 85.6 cfs (Table 3). The percentage of streamflow affected during the lowest streamflows is reported in Table 3, and ranges from one to eight percent of the available streamflow during the lowest discharge periods of the year. There are essentially two categories of effect from the hatchery facilities using water from the adjacent streams and reservoirs: hatcheries that use water from natural, free-flowing streams, and hatcheries that take water from existing reservoirs and canals. Roaring River Hatchery, Marion Forks Hatchery, and Willamette Hatchery are located adjacent to free-flowing streams where water use ranges from 3.01 to 80.6 cfs during the lowest streamflows of the year (Table 3).

For all of the other hatchery facilities (Minto FF, South Santiam Hatchery, Foster FF, Leaburg Hatchery, McKenzie Hatchery, and Dexter FF), water is used from existing reservoirs and canals managed for other water purposes. The greatest use is for Leaburg Hatchery, where 85.6 cfs is used in September from the McKenzie River. It is important to note the Leaburg-Walterville diversion canal also withdraws water from the McKenzie River in this same reach (averages >1,000 cfs in September). Consequently, this reach of river is affected by two water withdrawals. Given the amount of water diverted down the Leaburg-Walterville canal, the effect of Leaburg hatchery's withdrawal is negligible on the affected reach of the McKenzie River.

For all of the hatchery facilities, the percent of the adjacent stream, river, reservoir, or diversion used during low streamflows ranges is relatively minor (Table 3). The hatchery facilities would not completely dewater the adjacent stream or river nor inhibit rearing and migration of any fish species. Therefore, under Alternative 1, if hatchery operations continue as proposed, there would continue to be negligible adverse impact from water withdrawal for the operation of the hatchery facilities (Table 3). The length of stream affected by the water diversion at the hatchery facilities is described below.

4.2.1.2 Length of Stream Affected by Water Use

Under Alternative 1, the length of stream or river impacted from having the water withdrawn for hatchery purposes would range from 370 to 7,339 feet in length (Table 3). This length of stream or river is the distance between the intake and outlet of the hatchery facility (the length of water diversion for hatchery purposes). For the hatchery facilities associated with a dam (i.e. Minto FF, South Santiam Hatchery, Foster FF, Leaburg Hatchery, McKenzie Hatchery, and Dexter FF) it is difficult to quantify impacts to the adjacent river because the water withdraw is located in the reservoir behind the dam. In every case, the water is taken upstream of the associated dam and discharged back into the river in the near vicinity of the tailrace of the dam. It is also difficult to quantify the effects of water withdrawal on fish migration because the dam is a complete barrier to fish passage unless the fish migrate into fish ladders, and water taken for the hatchery does not affect flow in the fish ladders. Given these circumstances, the effects of the hatchery's water use on affected stream reach is undetectable.

For the other hatchery facilities located adjacent to free-flowing streams (Roaring River Hatchery, Marion Forks Hatchery, and Willamette Hatchery), the maximum length of stream affected by water withdrawal ranges from 790 to 7,339 feet (Table 3). The greatest effect of water withdrawal is in Salmon Creek adjacent to Willamette Hatchery due to the length of stream affected and amount of water used during low streamflows. In no circumstance does the hatchery water withdrawals impede fish passage because most of the water is left in the affected stream from hatchery intake to effluent discharge. In terms of available habitat for aquatic species, the length of stream affected by hatchery water withdrawal is minor. Therefore, the amount of stream habitat affected by the hatchery facilities use of water before getting returned back to the stream under Alternative 1 would be low and only adversely affect the stream around the localized area of the hatchery.

Table 24. Total water use (cfs up to permit rights for ground and surface water) by alternative for all of the hatchery facilities cumulatively within each salmonid population area. For specific water uses, see Table 4 in Chapter 3.

Hatchery Facilities (by population area)	Alternative 1 (No-action)	Alternative 2 (Proposed Action)	Alternative 3 (Reduce production to reintroduction needs)[3]	Alternative 4 (Terminate the existing hatchery programs)	Alternative 5 (Increase hatchery production)	Maximum Percentage of Surface Water Diverted Under Alternatives 1,2, (percent)[1]	Maximum Percentage of Surface Water Diverted Under Alternative 5 (percent)[1]
North Santiam (Marion Forks hatchery & Minto Dam FF)	126	126	86	0	126	< 5%	< 15%
South Santiam (South Santiam hatchery, Roaring River hatchery, and Foster Dam FF[4])	31.94	31.94	22	0	31.94	< 4%	< 6%
McKenzie (McKenzie hatchery & Leaburg hatchery)	170.33	170.33	116	0	170.33	< 4%	< 11%
Middle Fork Willamette (Willamette hatchery & Dexter Dam FF)	122.5	122.5	83.3	0	122.5	< 8%	< 8%

Source: HGMPs (see Appendix 1 for citations), United States Geological Survey data sets (http://waterdata.usgs.gov), http://streamflow.engr.oregonstate.edu/links/gages_mainx.htm

[1] This calculation is the actual surface water use by the hatchery facility (column 6 of Table 5 in Section 3.2, Water Quantity) divided by the minimum mean surface water flows during lowest annual streamflows (column 5 of Table 5 in Section 3.2, Water Quantity).

[2] This metric is calculated as the total stream miles of designated critical habitat for winter steelhead and/or spring Chinook salmon in the population area where the hatchery facilities are located for the Upper Willamette ESU and DPS.

[3] Alternative 3 reduces hatchery production by 32% compared to No-action alternative. Therefore water use reduced by 32% for this alternative.

[4] No water allocated for Foster Fish Collection Facility in this calculation.

4.2.2. Alternative 2 (Proposed Action/Preferred Alternative) – Allow Integration of Natural-origin Fish into Hatchery Broodstocks

Under Alternative 2, the effects on water quantity would be exactly the same as Alternative 1 (No-Action).The difference between Alternative 2 and the No-action alternative relate to how natural-origin fish are used in hatchery broodstocks, and therefore, does not change how water is used at the hatchery facilities. There would be no change in compliance with water permits or water rights at any of the hatchery facilities under Alternative 2 because the hatchery programs have existing permits and water rights to divert water as proposed in the submitted HGMPs. The analysis of the site-specific effects under Alternative 2 would be identical to effects analyzed under Alternative 1 (which result in negligible adverse impacts from water withdrawals at the hatcheries).

4.2.3. Alternative 3 – Reduce Hatchery Production to Reintroduction Needs

Under Alternative 3, hatchery production levels would be reduced to produce only hatchery fish needed for reintroduction purposes throughout the UWR Basin. This equates to 32% less hatchery production compared to the No-action alternative. The number of fish targeted to be produced in a hatchery is in direct relationship to the amount of water needed to produce those fish. If fewer hatchery fish are produced in Alternative 3, compared to the No-action Alternative, then less water is going to be used at the hatchery to produce those fish. This is done by hatchery managers to optimize rearing densities and minimize costs associated with pumping water, etc. Therefore, since Alternative 3 is a production level 32% lower than the No-action alternative, the amount of water needed to produce those fish would be approximately 32% lower under Alternative 3. This assessment of impact focuses on the critical time period when natural streamflows are lowest throughout the year and the hatchery withdrawals would be of greatest impact. This represents the greatest impact on water resources. During other periods of the year (e.g. winter, early summer when natural streamflows are higher than in September through October), impacts from the hatchery facilities would be less because more water is flowing in adjacent streams and rivers.

Since the hatchery facilities would still need water to produce hatchery fish under Alternative 3, the length of stream affected between water intake and hatchery outfall would be the same for this alternative compared to the No-action Alternative 1.

4.2.4. Alternative 4 – Terminate the Existing Hatchery Programs in the Upper Willamette River Basin

Under Alternative 4 all hatchery production in the UWR Basin would be terminated. Three facilities (Roaring River Hatchery, Marion Forks Hatchery, and Willamette Hatchery) would not use any water for hatchery production. Therefore, the adjacent stream reaches at the hatchery facilities would no longer be affected by water withdrawals to raise hatchery fish compared to the No-action alternative 1. An additional one to eight percent of available streamflow during the lowest periods of the year would remain in the streams instead of being diverted for hatchery purposes. However, since the affected stream reaches are relatively short, and water use by the hatchery limited, the benefits of Alternative 4 on water quantity, compared to the no-action alternative, would be low.

For the water quantity impacts related to operation of the remaining hatchery facilities (Minto FF, South Santiam Hatchery, Foster FF, Leaburg Hatchery, McKenzie Hatchery, and Dexter FF), the effects under Alternative 4 would be mixed because several of the fish facilities would continue to be operated to collect natural-origin salmon and winter-run steelhead to pass upstream of the dams. Water would still be used at the same rate and during the same periods as the No-action alternative 1 in order to attract and collect natural-origin salmon and steelhead. The South Santiam Hatchery, Leaburg Hatchery, and McKenzie Hatchery facilities would not be in operation, but the benefits of not using water for the facility would be negligible because water for these facilities is taken from existing reservoirs and diversions that would continue to operate under Alternative 4.

4.2.5. Alternative 5 – Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits

Under Alternative 5, hatchery production would be increased up to the available capacity of the existing hatchery facilities (an increase in production of approximately 33% compared to the No-action Alternative). For further information on this alternative, see Section 2.5, "Alternative 5: Increase hatchery production to support fisheries consistent with ESA impact limits". The effects of Alternative 5 on water quantity would be technically identical to the No-action alternative because existing water rights would not be increased. However, as evaluated in Alternative 1, there are periods of time when the hatcheries do not use their full water right for hatchery production Table 3). Since this is the case, there is the possibility of increased water use for hatchery production within the existing limits of permitted water rights and hatchery capacity in order to produce the additional hatchery production under Alternative 5. For example, Willamette Hatchery currently uses 80.6 cfs during August under the No-action alternative, but the permitted water right is up to 87.5 cfs. Therefore, under Alternative 5 up to 87.5 cfs could be used for increased hatchery production during August. If it is assumed the hatchery facility would use the full water right legally available during the lowest streamflow period of the year, the amount of water used by the hatcheries ranges from 2% to 15% of the adjacent stream or river (Table 24). The greatest potential diversion from using the full water right under this alternative occurs in Marion and Horn creeks at Marion Forks hatchery on the North Santiam River (15% usage in Alternative 5 compared to 5% under the No-action alternative). Alternative 5 could result in greater use of water during the lowest streamflow periods in some locations, which would impact the adjacent stream reach from point of intake to point of discharge at the hatchery facility. However, the overall impacts on water quantity for this stretch of stream or river is low compared to the No-action alternative. The nature or character of the affected stream reach would not be changed in terms of aquatic organisms and stream habitat. The current water quality issues (e.g. 303(d) listings) identified for the streams would still exist under Alternative 5.

The length of stream affected by water withdrawals from the hatchery facilities would be the same for Alternative 5 compared to the No-action Alternative because the intake and outfall locations at each facility would be unchanged.

4.3. Effects on Water Quality

4.3.1. Alternative 1 (No-Action) – Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks

Under Alternative 1, the existing hatchery facilities in the UWR Basin would continue to operate in accordance with the Biological Opinion for the Willamette Project (NMFS 2008). See section 2.1, “Alternative 1 (No-action): Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks” for more information. Consequently, discharge of treated effluent (in compliance with the hatchery facility’s NPDES permit) would continue as under current conditions. Levels of ammonia, nitrogen, phosphorus, and antibiotics (the most typical substances discharged)) would continue to be monitored at the hatchery facilities to ensure the effluent is within specified limits. The effect of the effluent discharge from the hatchery facility into adjacent streams and rivers would be low and temporary because the effluent plume would mix with natural streamflows. There is likely some localized impacts from hatchery effluent at the point of discharge. The chemicals, bacteria, and viruses expelled from the hatchery may impact algae growth in the stream and aquatic insects until the discharge is diluted downstream. However, we have no information beyond this likely effect as to the impacts that have occurred previously or would transpire under any of the alternatives. Effluent discharge from the facilities is typically a low proportion of the overall flow in the adjacent stream or river making dilution quick from the discharge location. Table 24 shows the effluent discharge from the facilities and actual streamflows during the low flows periods throughout the year; making this the worst case for effluent dilution into adjacent streams. Aquatic organisms would be exposed to higher concentrations of chemicals, viruses, parasites, and bacteria within the outfall plume immediately below the hatchery facilities. However, the effect is likely to be undetectable farther than 200 meters downstream of the hatchery outfall (Bartholomew 2013).

Bartholomew (2013) found hatchery-related disease and pathogen transmission and outbreak in effluent of UWR hatchery facilities to be localized, with greatest mortality occurring at the hatchery and no mortality of fish observed in the receiving waters 400 feet downstream from the hatchery. Therefore, the potential adverse impacts are expected to be temporary and confined exclusively to the small area directly at the hatchery outfall. No impacts are expected on critical habitat and EFH as the effluent dilutes downstream (see Chapter 3, Affected Environment).

Alternative 1 would not be expected to change any of the Clean Water Act 303(d) listings because effluent resulting from the UWR hatchery facilities is included in the current conditions of the streams and rivers described in Subsection 3.3, Water Quality. In addition, the current 303(d) list violations related to temperature, dissolved oxygen, lead, and mercury of which hatchery effluent would not affect (Table 5). For example, the 303(d) listing for the North Santiam River is attributed to temperature and dissolved oxygen due to lack of riparian vegetation and upstream dams (Table 5); hatchery-related effluent parameters are not a factor in this listing. Also, the 303(d) listings apply to most of the streams and rivers in the UWR, of which many do not have any hatchery facility within the subbasin (e.g. Molalla, Calapooia, Coast Fork Willamette, Long Tom, Marys, Luckiamute, Yamhill, and Tualatin (Figure 2). Therefore, operation of hatchery facilities in the project area do not contribute to the Clean Water Act 303(d) list violations for the streams and rivers near the hatchery facilities, and do not contribute in any detectable manner to the existing water quality issues in the streams and rivers near the hatchery facilities. Thus, any impacts on existing water quality issues are expected to be undetectable under this alternative.

4.3.2. Alternative 2 (Proposed Action/Preferred Alternative) – Allow Integration of Natural-origin Fish into Hatchery Broodstocks

Under Alternative 2, the UWR hatchery facilities would continue to operate as proposed in submitted HGMPs (see section 2.2, “Alternative 2 (Proposed Action/Preferred Alternative): Allow Integration of Natural-origin Fish into Hatchery Broodstocks”).The effects of Alternative 2 would be identical to the No-action Alternative because the only difference between these alternatives relates to management of hatchery broodstocks (and not facility operations). Discharge of treated effluent (in compliance with the hatchery facility’s NPDES permit) would continue as under current conditions and as analyzed under Alternative 1. This would be a localized, small area of adverse impact directly below the hatchery outfall from discharge of hatchery effluent. However, as the effluent mixes with surrounding waters in the streams and rivers, the impact from hatchery discharge is likely to be undetectable 400 feet downstream from the hatchery outfall. Impacts from hatchery effluent on water quality parameters and NPDES 303(d) listings would be identical to those described under the No-action Alternative 1. Present water quality concerns are related to temperature, dissolved oxygen, lead, and mercury of which the hatchery facility does not affect.

4.3.3. Alternative 3 – Reduce Hatchery Production to Reintroduction Needs

Under Alternative 3, the hatchery programs would be managed only to provide sufficient adult returns to provide for broodstock and reintroduction needs. Hatchery production in Alternative 3 would be reduced by 32% compared to Alternative 2 (Proposed Action/Preferred Alternative). With fewer hatchery fish being spawned, incubated, and reared at the hatchery facilities, effluent discharge would decrease compared to the No-action alternative. This would result in lower levels of chemicals, bacteria, and viruses being discharged from hatchery facilities into the adjacent river or stream, and fewer localized impacts to algae growth and insects. If rearing densities remained constant, it would be expected effluent would be reduced in accordance with the reduction in the number of hatchery fish being produced (in this case a 32% reduction under Alternative 3 compared to the No-action Alternative). Since the present issues with water quality (as determined by the 303(d) listings for water quality) do not relate the products discharged in the hatchery effluent, Alternative 3 would result in even lower effects than the No-action alternative.

4.3.4. Alternative 4 – Terminate the Existing Hatchery Programs in the Upper Willamette River Basin

Under Alternative 4, all of the existing hatchery programs in the UWR would be terminated. However, the fish collection facilities would still operate to collect and pass natural-origin salmonids at the various dams throughout the UWR. There would be no effects on water quality under Alternative 3 because there would be no effluent discharge from the hatcheries.

4.3.5. Alternative 5 – Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits

Under Alternative 5, hatchery production would increase compared to the No-action alternative. However, the additional hatchery fish would be produced with the existing hatchery facilities and water rights under this alternative. Since it would take more water to produce additional hatchery fish under Alternative 5 (up to existing permitted water rights), discharge of effluent would likely increase compared to the No-action alternative during the lowest streamflow periods (Table 3). In particular, it would be expected the full water rights during the summer would be used, which currently does not occur under the No-action alternative. Consequently, hatchery effluent would increase into adjacent streams and rivers under Alternative 3. However, since this effect is of limited scope and duration with effects non-detectable greater than 200 m from the discharge point(Bartholomew 2013), effects overall will be negligible, compared to other factors that have been identified as water quality limiting factors in the basin. Overall, Alternative 5 would increase water quality impacts compared to the No-action alternative, but the expected impacts are low.

4.4. Effects on Salmon and Steelhead and Their Habitats

The environmental consequences of Alternatives 1-5 on salmon and steelhead and their habitats are described below. The principal mechanisms upon which hatchery programs can affect salmon and steelhead are found in Table 25. 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. However, 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.

The effects of the hatchery programs builds upon information presented in prior sections of this document. Section 3.4, Salmon and Steelhead and Their Habitats, provides an overview of the location of hatchery facilities, the number of hatchery fish released, the size of hatchery fish released, and the locations of where hatchery fish are released. It is important to consider the specific locations of the hatchery facilities within the population areas (see Table 1 and Figure 1).). Table 9 describes the time periods and size at release of hatchery fish, which helps inform potential competition and predation effects.

The following assessment information informs the environmental consequences of Alternatives 1-5 on salmon and steelhead and their habitats (see Table 27; Figure 12; Figure 13; Figure 14; Figure 15). This information is related to the ecological interactions between natural- and hatchery-origin juvenile and adults while in the freshwater areas of the Willamette and Columbia rivers. Overall, 27% of the designated critical habitat for UWR spring Chinook salmon and winter steelhead is affected by juvenile hatchery fish. Approximately 73% of the critical habitat does not have the presence of juvenile hatchery fish. This information is further evaluated under each alternative for spring Chinook salmon and winter steelhead.

Effects of Hatchery Programs on Natural-origin Fish

The existing hatchery programs within the UWR affect natural-origin salmon and steelhead and their habitat. Generally speaking, operation of hatchery facilities and release of hatchery fish into the natural environment could affect overlapping populations of natural-origin salmon and steelhead through genetic introgression of hatchery fish into the natural population, increased competition and predation from hatchery fish, transfer of pathogens from hatchery fish and/or the hatchery facility to the adjacent river or stream, operation of the hatchery facility using water and discharging effluent, masking of natural population status from having hatchery fish spawning in the wild, incidental fishing effects, and nutrient input from carcasses (Table 25). The extent of adverse effects depends on how the hatchery program is managed, the current status of the natural-origin populations and how affected they are by the hatchery program, and the condition of the habitat; among other factors.

Hatchery programs can also provide benefits to the natural-origin populations by increasing the amount of marine-derived nutrients to the freshwater environment from having hatchery fish spawn naturally and from the outplanting of carcasses from the hatchery facility. Hatchery programs can also potentially benefit the abundance, productivity (in some cases where the demographic risk of extinction is high), spatial structure, and diversity of natural populations (McElhany et al. 2000). For example, the original intent of the UWR spring Chinook salmon hatchery programs was to enhance harvest opportunity (societal benefit), but since ESA listings, hatchery releases have been used for reintroduction into historical habitat and are being managed more for conservation purposes (ESA benefit) in addition to enhancing harvest opportunity. The summer-run steelhead and rainbow trout programs are not considered conservation programs because the broodstock origin is from out of DPS fish, and potential negative genetic and ecological effects on natural-origin winter steelhead populations.

Hatchery fish that spawn in the wild can interbreed with natural-origin fish and affect the genetic integrity of the natural population (Table 25). Depending upon how the hatchery broodstock has been managed, hatchery fish that interbreed with natural fish can reduce the productivity and long-term fitness of the wild population to varying degrees from inbreeding and outbreeding depression. Prior to release from the hatchery, hatchery fish experience different selection pressures than fish in the wild. This hatchery-influenced selection (often referred to as domestication) occurs in hatchery fish which may alter the genetic make-up of the natural-origin population. Consequently, when hatchery fish interbreed in the wild, genetic changes may occur to the wild population from the hatchery program depending upon the demographic condition of the natural-origin population, and level of straying and interbreeding.

Juvenile and adult hatchery fish can compete with and/or predate upon natural-origin salmon and steelhead (Table 25). Hatchery fish can be much larger than co-occurring natural-origin fish (Table 9); making natural-origin fish vulnerable to predation during the period when the hatchery fish emigrate to the ocean. Hatchery fish can residualize in freshwater and not emigrate to the ocean, which may promote competition with co-occurring natural fish if resources (space and food) are limited.

Hatchery programs can also introduce diseases and pathogens into natural fish populations (Table 25). However, this is most likely uncommon within the UWR because the hatchery programs all use spring Chinook salmon and steelhead[13] from within the region that are naturally exposed to these diseases and

[13] Broodstock for the summer steelhead program is collected at Foster Dam FF, and originated from Skamania stock summer-run steelhead.

pathogens. Hatchery facilities can result in elevated levels of disease and pathogen downstream of the hatchery facility effluent discharge. This is commonly caused by higher densities of fish rearing in the hatchery, which results in greater disease and pathogen levels in the hatchery than under natural conditions. Although poorly managed hatchery programs can increase disease and pathogen transfer risks, compliance with applicable protocols for fish health can effectively minimize this risk. The elevated levels of disease and pathogen are typically concentrated near the hatchery effluent and then are diluted by water as it discharges downstream. The higher concentration of disease and pathogens associated with hatcheries is typically localized and short-lived (Bartholomew et al. 2013).

The operation of hatchery facilities can affect salmon and steelhead by the withdrawal of water from adjacent streams and rivers, whereby decreasing the amount of habitat available for natural fish in the affected reach (Table 25). The discharge of effluent from the hatchery facility can expose natural fish to elevated levels of bacteria and viruses. Both of these potential effects are described above in Section 3.2, Water Quantity and Section 3.3, Water Quantity.

Table 25. General mechanisms through which hatchery programs can affect natural-origin salmon and steelhead 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 which 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
	• Impingement of downstream migrating fish

Natural population masking	o 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.
Population viability benefits	Depending upon the objective of the specific hatchery program, hatchery fish can potentially: • Increase the abundance of natural-origin fish from additional natural spawning in the wild. • Increase the productivity of the natural population from hatchery fish spawning and nutrient enhancement, particularly if abundance of natural-origin fish is low. • 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.

Hatchery fish can mask the true status of natural populations if straying and spawning by hatchery fish in the wild is substantial (Table 25). The continual supplementation of natural spawning by hatchery fish (intentional or unintentional) can increase total abundance of fish on the spawning grounds and thereby increase uncertainty of the status of the natural population to sustain itself without hatchery influence. Within the UWR, most natural populations of spring Chinook salmon currently have high percentages of hatchery fish on the spawning grounds (e.g., 40 to 70 percent; Table 26). Managers are planning to reduce the percentage of hatchery-origin fish on the spawning grounds once natural-origin fish abundance increases (Table 26). For summer-run steelhead in the UWR, it is the intent of managers to reduce natural spawning of hatchery fish to the lowest degree possible, but some introgression from summer-run hatchery fish with natural-origin winter-run steelhead has been detected (Johnson et al. 2013).

Table 26. The future target and current estimate of the percentage of hatchery-origin spawners (pHOS) in Upper Willamette River sub-basins where spring Chinook salmon are released. Information on targets and current estimate from HGMPs.

Sub-basin	Percentage of hatchery-origin spawners in the wild (pHOS)		Comment
	Future Target	**Current estimate**	
North Santiam	< 10% pHOS upstream of Detroit Dam and ≤ 21% downstream of dam	66%	Current estimate is the average between 2002-2017 from C. Sharpe, ODFW, personal communication
South Santiam	<30% in the natural population of the South Santiam River (0% above Foster, <80% below Foster)	65%	Current estimate is average from 2007-2017 from C. Sharpe, ODFW, personal communication. pHOS is much greater downstream of Foster Dam (76%) and much lower upstream of the dam (32%).
McKenzie	< 10% for total natural spawning population in the McKenzie River subbasin, excluding the South Fork McKenzie Basin above Cougar Dam and the McKenzie Basin above Trail Bridge Dam.	35% (total basin); 78% downstream of Leaburg Dam, and 26% upstream of dam	Current estimate is average from 2002-2017C. Sharpe, ODFW, personal communication
Middle Fork Willamette	<10% in Fall Creek Basin and upstream of Dexter and Lookout Point dams	81% downstream of Dexter Dam (2002-2017), 19% upstream of Fall Cr. Dam (2002-2017), 98% North Fork Middle Fork River	Current pHOS estimate is average between 2002-2013 from Table 2.2.2-2 of the HGMP for the area between

Sub-basin	Percentage of hatchery-origin spawners in the wild (pHOS)		Comment
	Future Target	Current estimate	
		(2002-2015), and 99% upstream of Hill Cr Dam (2012-2015)67%	Dexter and Jasper, including Fall Creek.

Hatchery programs provide fish for fishery harvest opportunities in the ocean and freshwater (Table 25). Natural-origin salmon and steelhead can be affected by these fisheries to varying degrees. In most cases, natural-origin fish are required to be released upon capture and externally marked hatchery-origin fish can be kept. The incidental effects of these catch-and-release fisheries on natural-origin fish typically range from 0 to 15 percent mortality (NMFS 2001a; NMFS 2001b).

Hatchery programs may also maintain and/or increase salmonid abundance and productivity (in some cases), spatial structure, and diversity (Table 25). Natural spawning by hatchery fish occurs because collection efficiency at the hatchery facilities is not 100 percent and not all excess hatchery fish are harvested. Salmon and steelhead by nature do stray and spawn in non-natal areas. The recent level of hatchery fish spawning in the wild depends upon the specific population (Table 26).

The current hatchery programs have benefitted natural-origin salmon and steelhead by providing additional hatchery fish returns to the freshwater ecosystem, thereby enhancing the amount of marine-derived nutrients available from the decomposed carcasses (Table 25).Marine-derived nutrients are important to the streams of the Project Area, because streams in those areas tend to be low in terrestrial nutrients; the return of anadromous fish from the ocean environment acts as a key mechanism for bringing nutrients into the freshwater ecosystems (Cederholm et al. 1999). The carcasses can provide food for aquatic and terrestrial species via direct consumption. The carcasses can also decompose with the primary nutrients available in the water and deposited in the sediments which are then available for primary production by plants and animals. Both of these pathways increase the productivity of the freshwater environment from salmon and steelhead carcasses.

The proposed action includes the benefit of marine-derived nutrients into the freshwater environment from hatchery fish returns. Hatchery fish that are not harvested or collected at hatchery facilities can spawn in the wild and contribute marine derived nutrients to the environment. This currently occurs at high levels in the natural populations of spring Chinook salmon where the hatchery fish return and spawn in the wild. In addition, hatchery fish collected at the facilities in excess of broodstock needs can be outplanted in streams for nutrient enhancement after routine fish health testing to ensure carcasses are not carrying non-endemic pathogens and diseases, to avoid elevating the level of risk of diseases and pathogens in the wild. In most years, thousands of hatchery fish carcasses are available for outplanting for nutrient enhancement or other beneficial uses (see HGMPs).

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) designated Essential Fish Habitat (EFH) for Pacific salmon, which includes Chinook salmon within the UWR. The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Chapter 4, Environmental Consequences, evaluates the effects of the alternatives on EFH. In its evaluation of the HGMPs, NMFS will include analysis of the effects of the proposed action on EFH. For the purposes of this NEPA analysis, effects on habitat – and, in particular, designated critical habitat – will include effects on EFH.

A more detailed discussion of the general effects of hatchery programs on salmon, steelhead, and their habitat 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).

Table 27. Assessment of hatchery fish releases (CHS- spring Chinook, STS-summer steelhead) and risk of interaction with natural-origin salmon and steelhead in freshwater areas throughout the UWR basin.

Population Area where Hatchery Fish Released	Time Period for Hatchery Fish Releases	Potential Area of Overlap between Hatchery and Natural Salmon and Steelhead	Relative Magnitude of Potential Hatchery Fish Interaction with Natural-origin Salmon and Steelhead
Molalla (Trout Creek)	CHS- Feb to March	Molalla/Trout Creek confluence downstream to Willamette River (27 miles)	Low
North Santiam (Minto FF)	CHS- Feb to March STS- April	Minto FF downstream to Willamette River (53 miles)	Medium
South Santiam (Foster Dam)	CHS- Feb, Mar, Oct STS- April	Foster Dam downstream to Willamette River (48 miles)	Medium
McKenzie (hatchery and Leaburg Dam)	CHS- Jan to March STS- April	Leaburg Dam downstream to Willamette River (34 miles)	Medium
Middle Fork Willamette (Dexter FF)	CHS- Feb to April STS- April	Dexter FF downstream to Willamette River (27 miles)	High
Coast Fork Willamette (dam)	CHS- Feb	Cottage Grove dam downstream to Willamette River (29 miles)	Low
Willamette (Eugene)	STS- April (CHS – from tributaries)	Eugene to Columbia River (174 miles)	Low (for STS at Eugene) to Very High (as hatchery fish accumulate from tributaries)

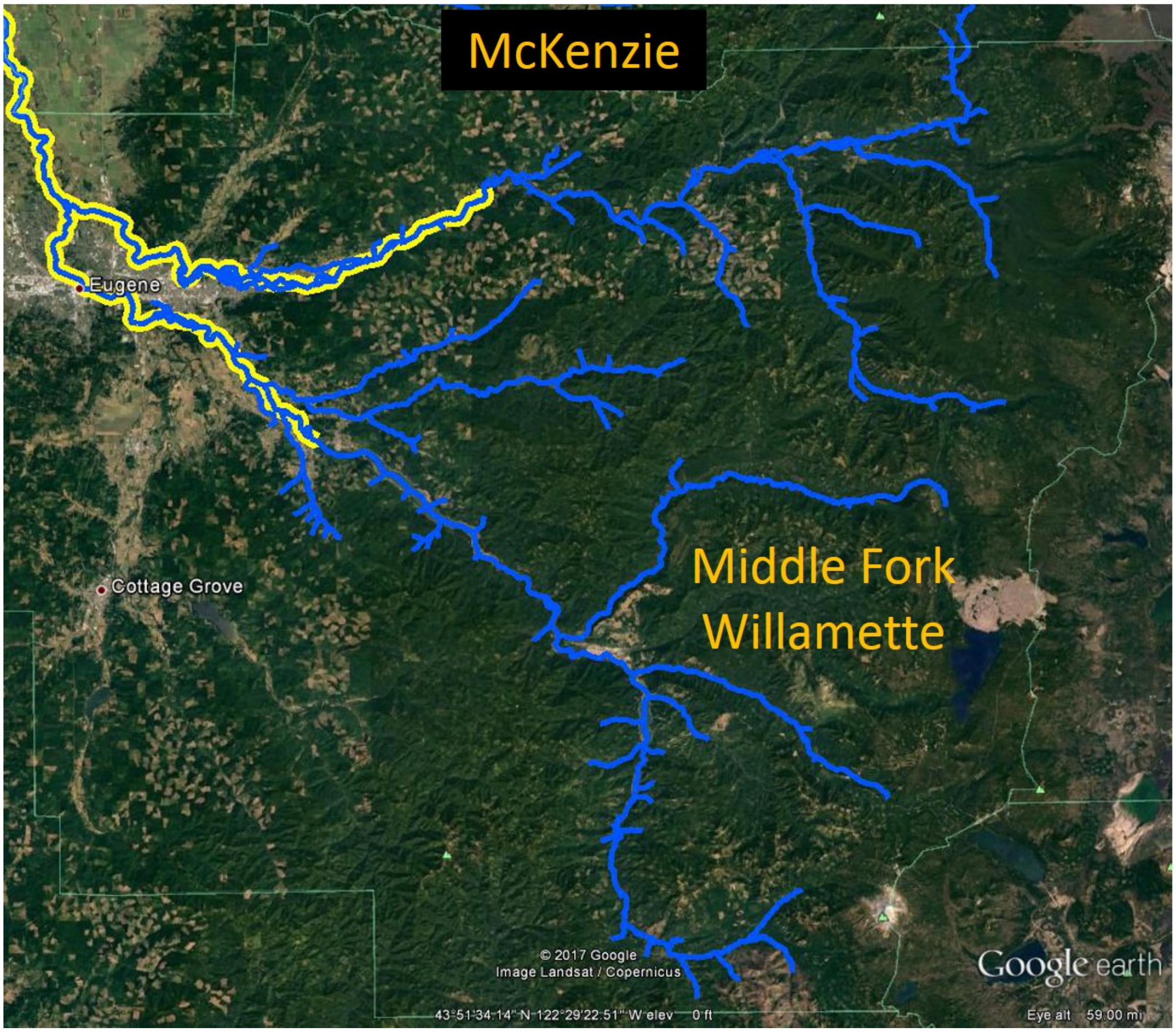

Figure 12. Geographic extent of the interaction area between hatchery fish and natural fish in the upper Willamette region. Hatchery fish are released in the McKenzie and Middle Fork Willamette rivers. The reaches where hatchery fish are released are the yellow lines. Stream reaches designated as critical habitat for UWR spring Chinook salmon and winter steelhead are identified as the blue colored lines.

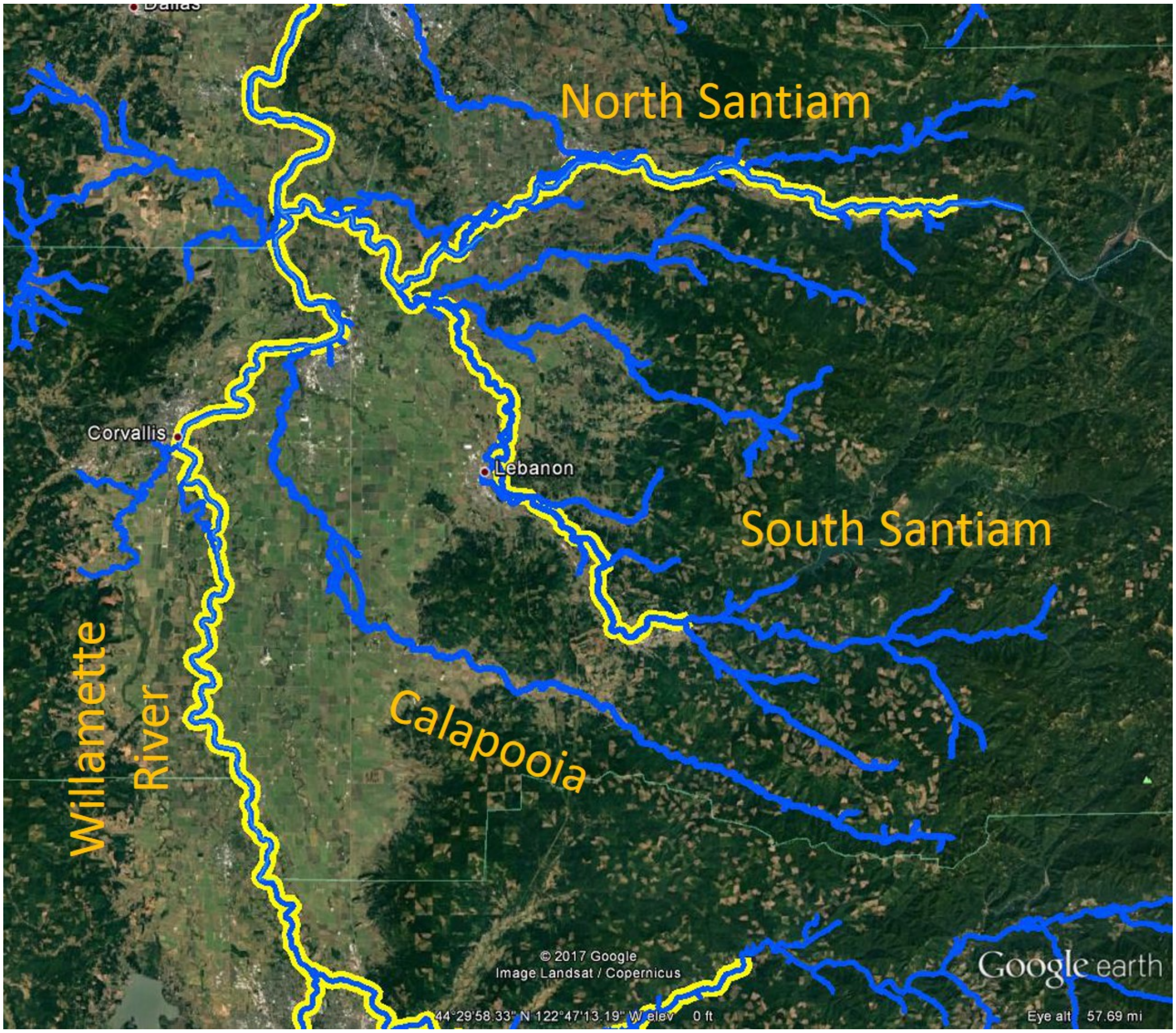

Figure 13. Geographic extent of the interaction area between hatchery fish and natural fish in the mid-Willamette region. Hatchery fish are released into the North Santiam and South Santiam rivers. The reaches where hatchery fish are released are the yellow lines. Stream reaches designated as critical habitat for UWR spring Chinook salmon and winter steelhead are identified as the blue colored lines.

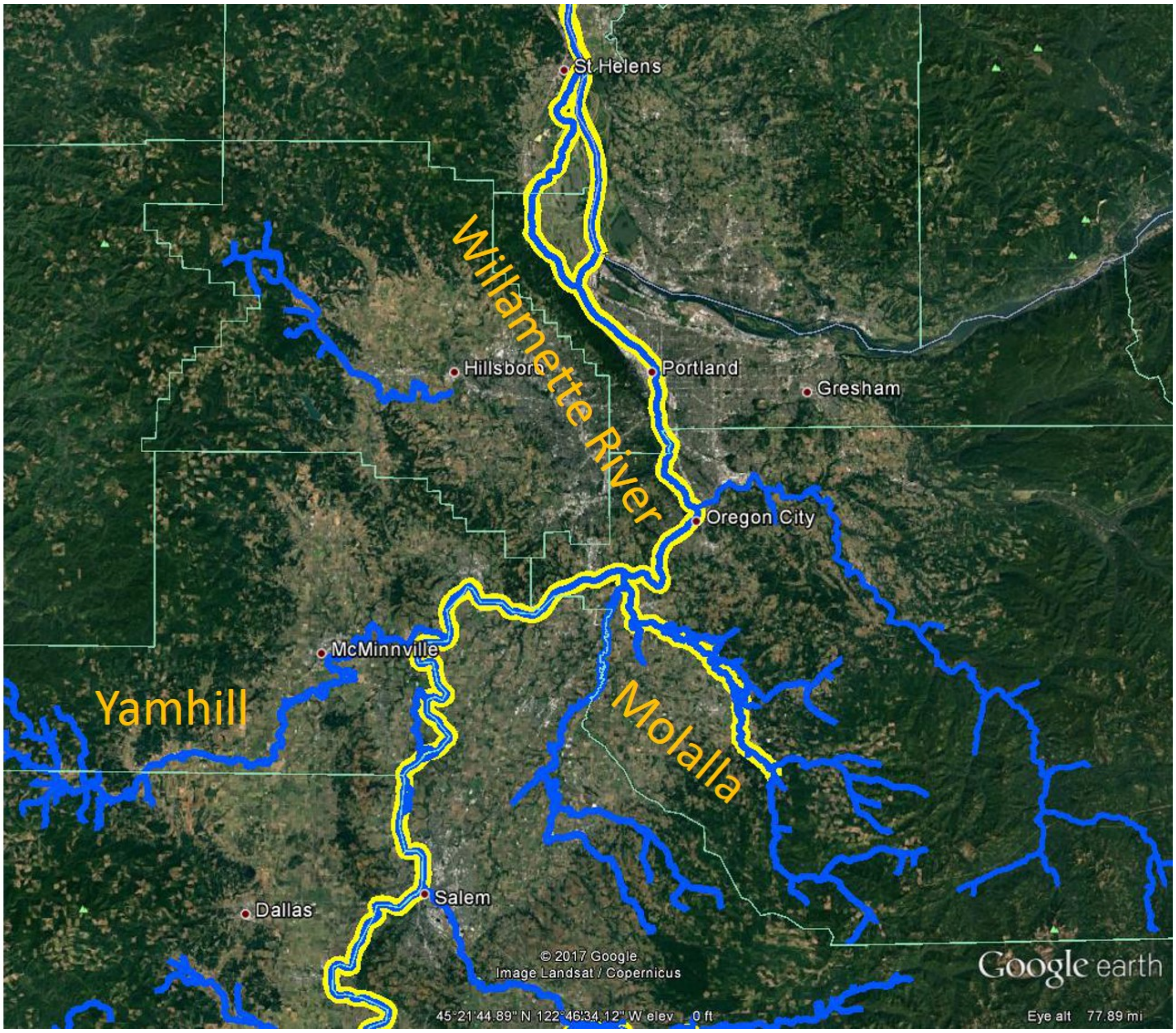

Figure 14. Geographic extent of the interaction area between hatchery fish and natural fish in the Lower Willamette region. Hatchery spring Chinook salmon are released into the mainstem Molalla River. The reaches where hatchery fish are released are the yellow lines. Stream reaches designated as critical habitat for UWR spring Chinook salmon and winter steelhead are identified as the blue colored lines.

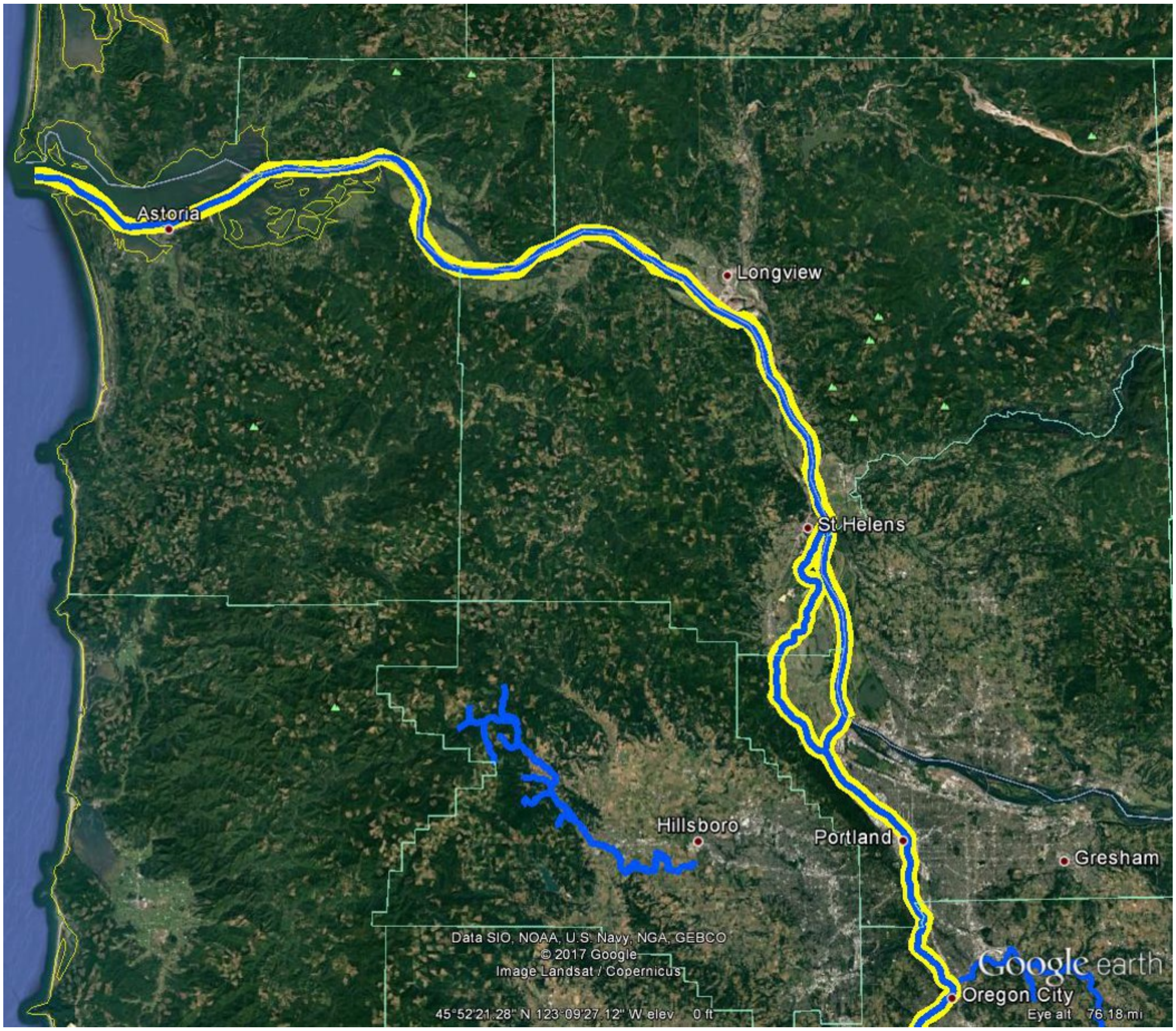

Figure 15. Geographic extent of the interaction area between hatchery fish and natural fish in the Columbia River region. The reaches where hatchery fish (from UWR releases) occur are the yellow lines.Stream reaches designated as critical habitat for UWR spring Chinook salmon and winter steelhead are identified as the blue colored lines.

4.4.1. Alternative 1 (No-Action) – Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks

Under Alternative 1, the hatchery facilities, and associated hatchery programs, throughout the UWR Basin would continue to operate in accordance with the Biological Opinion for the Willamette Project (NMFS 2008). Alternative 1 would continue to pose short- and long-term risks associated with demographic and genetic effects, competition and predation effects, hatchery facility effects, incidental fishing effects, and transfer of pathogens from hatchery fish and/or the hatchery facility to the adjacent river or stream where natural-origin salmon and steelhead occur. Alternative 1 would continue to provide some benefits to natural populations from hatchery fish spawning in the wild increasing total spawning escapement above the Corps dams and increase ocean-derived nutrient cycling in the ecosystems (Subsection 3.4, Salmon and Steelhead and Their Habitat). The species-specific effects of Alternative 1 are discussed below.

Critical Habitat under the ESA is designated for spring Chinook salmon and winter steelhead in the UWR Basin. Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act applies to spring Chinook salmon. The operation of the hatchery facilities adversely affects critical habitat and EFH in the local vicinity where the facilities are located. The primary impact on critical habitat and EFH is from the effluent discharge from the hatchery facilities (Subsection 4.2 and 4.3, above). Alternative 1 would result in undetectable physical habitat changes to critical habitat and EFH compared to current conditions.

UWR spring Chinook Salmon

The No-action Alternative 1 would continue to operate the hatchery facilities and associated programs for spring Chinook salmon and summer steelhead in accordance with the Biological Opinion on the Willamette Project (NMFS 2008) and Upper Willamette River Conservation and Recovery Plan (ODFW and NMFS 2011). This section evaluates the effects of these hatchery programs on natural-origin spring Chinook salmon in the UWR ESU.

For the assessment of Alternative 1 here (and the other alternatives below), it is important to first describe the strategy outlined in the Upper Willamette River Conservation and Recovery Plan (ODFW and NMFS 2011) for the management of natural-origin and hatchery-origin Chinook salmon in the population areas of the UWR ESU. Each spring Chinook salmon population has unique circumstances with its current risk status, current limiting factors/threats, and reintroduction efforts to put salmon back into historical habitat above impassable dams. The overall ESU strategy can be summarized into two conservation and recovery strategies (Figure 16): 1) protect natural-origin Chinook salmon in population areas where they are successfully reproducing, and 2) reintroduce Chinook salmon back into core historical habitats, where they have been eliminated, using the most appropriate stock of hatchery fish (ODFW and NMFS 2011). In summary, management is structured to minimize hatchery-related risks where natural production currently is occurring in greater abundance in the Clackamas River, McKenzie River, South Santiam River above Foster Dam, and Fall Creek above the dam. The goal in these population areas is to minimize pHOS and implement actions to reduce hatchery fish spawning to less than 10% (ODFW and

NMFS 2011). For the other population areas above the federal dams, intentional outplanting of hatchery Chinook salmon is occurring in an effort to restore production back into historical habitat of spring Chinook salmon above Big Cliff, Detroit, Green Peter, Cougar, Dexter, Lookout Point, and Hills Creek dams. No outplanting of salmon is occurring above Dorena, Cottage Grove, or Fern Ridge dams.

The success of reintroduction above the federal dams is being evaluated principally through genetic pedigree analyses, where all salmon outplanted above the dams are genetically sampled. All resultant offspring that are sampled at various life stages (juvenile and adult) can then be genetically tested to verify whether the salmon is offspring from outplanting/reintroduction efforts above the dams (essentially tracing the family tree of salmon outplanted above the dams). To date, extensive monitoring and evaluation have shown hatchery salmon outplanted above the federal dams to produce 100,000's of juvenile spring Chinook salmon fry in the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette population areas (Monzyk et al. 2016; Romer et al. 2016). These juvenile salmon emigrate to the reservoirs, but successful passage downstream of the reservoirs and dams has been poor overall (Hansen et al. 2017).

To date, there have been several cases where reintroductions above dams using hatchery Chinook salmon has resulted in substantial numbers of returning natural-origin Chinook salmon. These successes demonstrate the validity of the hatchery management approach in the UWR described by ODFW and NMFS (2011). In the Clackamas River, reintroduction of spring Chinook salmon occurred in the late 1970's when Clackamas hatchery program was initiated. Improvements to upstream and downstream passage at River Mill, Faraday, and North Fork dams on the mainstem Clackamas River have allowed natural-origin Chinook salmon to recover. Current management allows only the passage of unmarked, natural-origin Chinook salmon above North Fork Dam. The Clackamas River now supports the highest abundance of natural-origin Chinook salmon (1,000's of salmon returning annually) throughout the UWR ESU. Fall Creek is another successful reintroduction using hatchery Chinook salmon. The primary improvement to Fall Creek has been the drawdown of the reservoir in the fall to stream level that allows juvenile salmon to emigrate downstream of the dam. Returns of natural-origin Chinook salmon number in the hundreds of fish and hatchery Chinook salmon are no longer needed for reintroduction. In the South Santiam, returns of natural-origin salmon have increased at Foster Dam in sufficient numbers to eliminate the need for hatchery supplementation. Foster reservoir and dam are relatively small and allow for some downstream passage of Chinook salmon. With these recent successes using hatchery Chinook salmon for reintroduction into historical habitats throughout the ESU, it is likely increases will also occur in the North Santiam, South Fork McKenzie, and Middle Fork Willamette population areas once improvements to downstream passage are implemented (Figure 17).

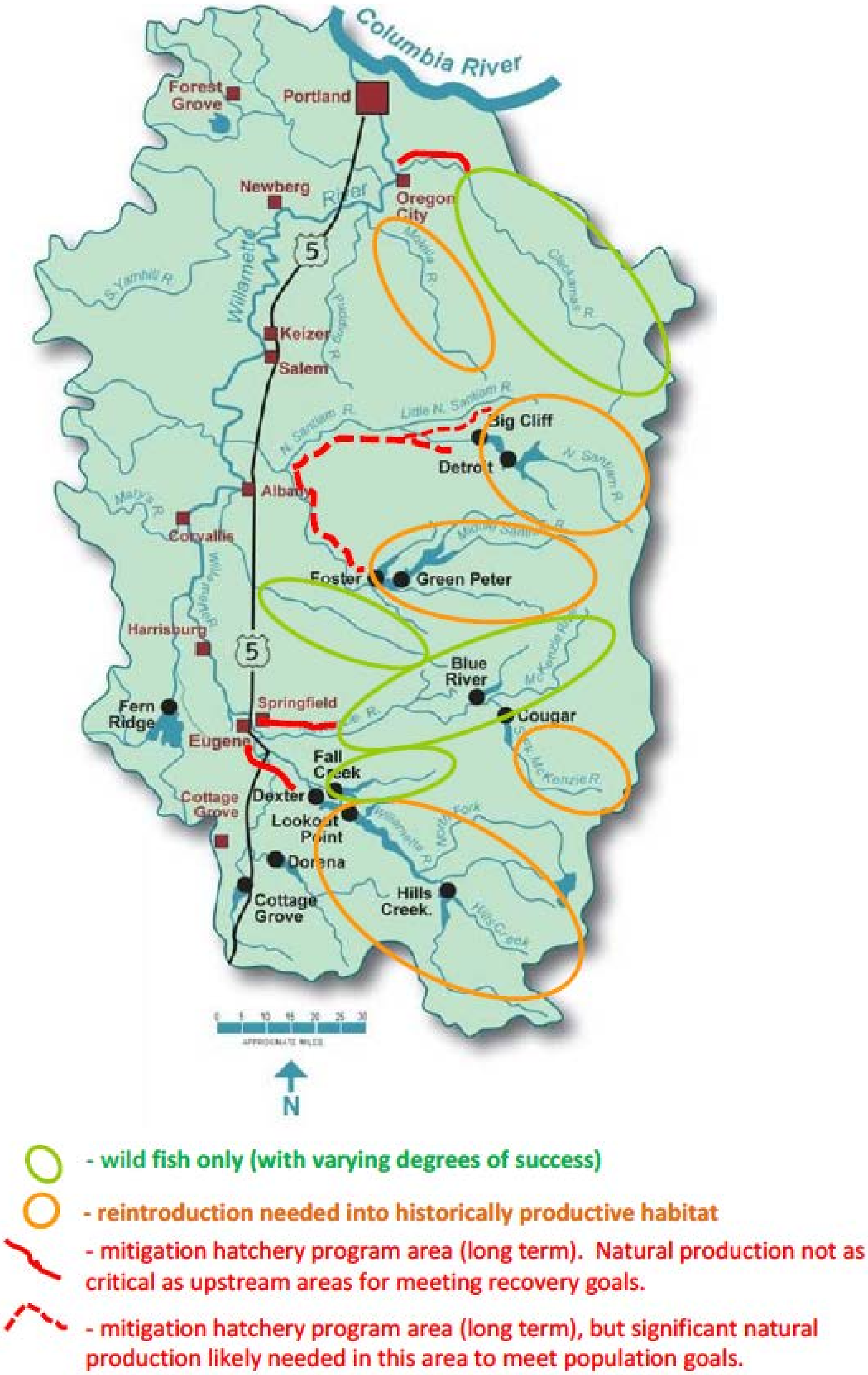

Figure 16. Map of spring Chinook salmon population areas showing the goals for natural-origin fish management areas, reintroduction areas, and hatchery mitigation areas. Figure taken from the Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead (ODFW and NMFS 2011).

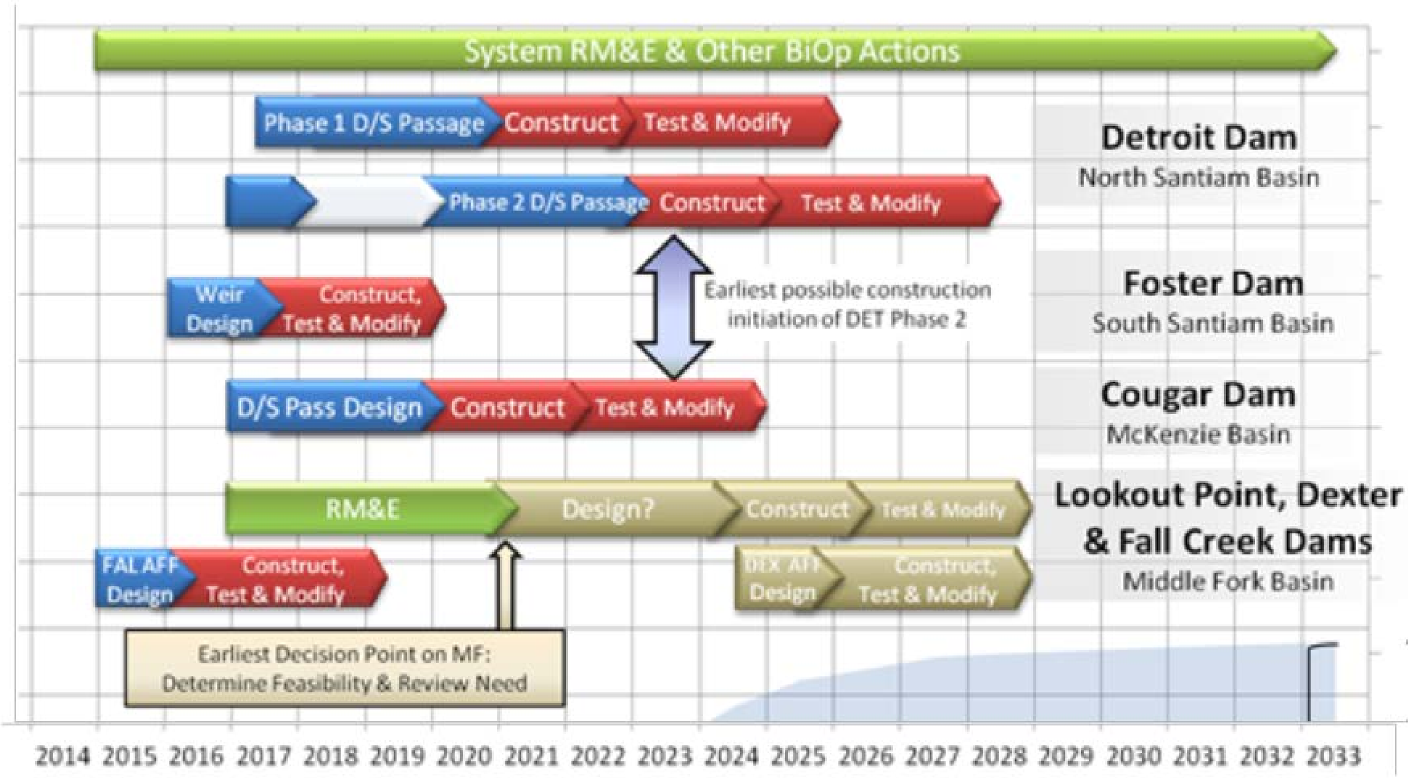

Figure 17. Timetable for design, construction, and modification of adult collection and downstream passage systems at Corps projects in the Upper Willamette Basin (from U.S. Army Corps of Engineers). Figure taken from Myers (2017).

Genetic Effects

The percentage of hatchery-origin spawners (pHOS) on the spawning grounds can indicate the potential effect of the hatchery program on the genetic diversity of the natural-origin population. It is important to understand pHOS is a ratio of hatchery to natural-origin spawners and does not take into account spawner abundance. For example, pHOS can be high when there are only a few natural-origin fish in a population and a low percentage of the returning hatchery fish stray into the wild which can lead to a very high pHOS value (e.g. 10 natural-origin vs 90 hatchery equates to 90% pHOS). This is the current situation with most populations of spring Chinook salmon in the UWR, where natural-origin spawner abundances are low and hatchery-origin returns are high. All of the hatchery programs have low stray rates (defined here as the proportion of hatchery fish that do not return or are not collected at fish collection facilities).

However, pHOS values are high due primarily to the low numbers of natural-origin spring Chinook salmon being produced in the wild.

Currently, pHOS for all core spring Chinook salmon populations, except the McKenzie River population, is greater than 50 percent (Table 26). However, in the McKenzie River population, while the basin-wide pHOS estimate is 35percent, pHOS for fish that spawn downstream of Leaburg Dam is estimated at over 75 percent (and around 25 percent upstream of the dam; Table 26). It is important to understand that when managers try to balance the demographic risk to a population with the genetic risk, it may mean that pHOS is higher than desired in some populations to ensure that the demographic risk is lowered (with more spawning adults, regardless of origin). Another factor that needs to be considered for the UWR spring Chinook salmon ESU is that most of the historical habitat that this ESU used is now inaccessible because of dams, which limits the ESU's productivity. However, as shown in Table 26, long-term management goal for the spring Chinook ESU is to reduce pHOS in all populations.

While pHOS is one indicator of potential genetic effects to a population, another indicator is the proportionate natural influence (PNI). PNI of a population, which is a measure of the natural environment's influence on the genetic diversity of a population, as a whole, is a function of both pHOS in the natural escapement and the proportion of natural-origin broodstock (pNOB) incorporated into the hatchery program. The hatchery science review group (HSRG) suggests that if the desire is to ensure that the natural environment (as opposed to the hatchery environment) influences the genetic diversity of a population, then PNI should be greater than 67 percent (HSRG 2004). Because the UWR natural-origin spring Chinook salmon run is depressed (Table 6; Figure 4), and there can be very high pre-spawning mortality of spring Chinook salmon (see Section 3.4), natural-origin fish have only been incorporated into the hatchery broodstock at very low rates recently, essentially reducing PNI to near zero (along with high pHOS). In recent years, the co-managers have not had ESA authorization to use natural-origin Chinook salmon for broodstock and so there has not been any intentional use of natural-origin Chinook salmon for broodstock purposes (i.e. not legally permitted by the ESA yet).

The genetic effects of the current hatchery program on natural-origin spring Chinook salmon likely ranges from low (e.g. upstream of Foster dam where only natural-origin fish are transported and released) to high where pHOS estimates are greater than 60 to 70 percent (e.g. downstream of Detroit, Foster, Leaburg, and Dexter dams). Overall, at the population level, PNI values are very low for every population where hatchery spring Chinook salmon occur. The Calapooia population has a high PNI value of 1.0 because no hatchery fish are released in that river, but the population abundance is less than 50 annually (nearly extinct).

It is also important to acknowledge the recent genetic studies of hatchery and natural-origin spring Chinook populations throughout the Upper Willamette River Basin because it provides insight on the current genetic issues facing these populations. Johnson and Friesen (2014) evaluated the genetic structure and diversity of spring Chinook salmon in the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette populations. There currently is some distinction among populations and all hatchery stocks resemble their respective natural population. However, the genetic heterozygosity is severely constrained in most natural populations due to small population size of natural-origin salmon. Genetic heterozygosity is presently greater in the hatchery stocks, due to the relatively high abundance of hatchery fish compared to natural-origin salmon. Therefore, hatchery fish spawning in the wild is likely providing demographic (increasing the number of natural spawners) and genetic benefits to natural populations (Johnson and Friesen 2014). Since short-term resiliency and long-term adaptive potential depends upon genetic heterozygosity, the current hatchery programs are benefitting the conservation and recovery of natural spring Chinook salmon populations in the UWR (Johnson and Friesen 2014).

Recent pedigree analyses of spring Chinook salmon reintroduced above federal dams in the UWR has also shown the benefits of hatchery Chinook salmon spawning (Black et al. 2017; Evans et al. 2016; O'Malley et al. 2017(a); O'Malley et al 2017(b); Sard et al. 2017). Outplanting of hatchery Chinook above the dams is increasing spawner abundances and producing significant numbers of juvenile offspring (Hansen et al. 2017; Monyzk et al. 2013). The fitness of hatchery salmon spawning in the wild above the federal dams in the UWR has been not significantly different than natural-origin salmon in most studies (Table 28; Evans et al. 2016); demonstrating the value of using hatchery supplementation to restore salmon above the federal dams (Black et al. 2017; Evans et al. 2016; O'Malley et al. 2017(a); O'Malley et al 2017(b); Sard et al. 2017). In some cases where downstream passage survival of juvenile salmon through the reservoirs and dams is adequate, substantial numbers of returning adults have been observed back to the population areas (i.e. Fall Creek, see below); demonstrating the ultimate success of hatchery reintroductions when survival conditions are adequate. The outplanting of hatchery salmon above the dams has provided significant population benefits by increasing the number of natural-origin salmon returning in the North Santiam River, South Santiam River, and Fall Creek in recent years. Without hatchery salmon supplementation, natural-origin salmon returns would be substantially lower; resulting in higher extinction risks for these populations. The benefits of hatchery supplementation producing natural-origin salmon in these populations (coupled with other recovery actions) has increased their abundance and helped less the risk of the ESU (NWFSC 2015).

Table 28. Summary of fitness estimates for male and female Chinook salmon reintroduced above Foster Dam on the South Santiam River. Note the mean returns of adult offspring produced by natural and hatchery salmon. Table taken from Evans et al. (2016). Abbreviations: TLF (total lifetime fitness), HOR (hatchery origin recruits), NOR (natural origin recruits).

		Adult offspring				
	N	Mean	Median	SD	Min.	Max.
2007 TLF						
Male	127	3.57	1	6.92	0	38
Female	125	2.15	1	3.22	0	19
2008 TLF – HOR						
Male	338	1.50	0	3.33	0	24
Female	155	2.65	0	4.94	0	26
2008 TLF – NOR						
Male	103	1.13	0	3.69	0	25
Female	53	2.94	0	5.63	0	30
2009 TLF						
Male	254	2.37	0	5.13	0	40
Female	158	3.58	1	5.62	0	28
2010 fitness (age-3 and age-4 progeny)						
Male	467	0.09	0	0.36	0	3
Female	233	0.16	0	0.53	0	4
2011 fitness (age-4 progeny)						
Male	677	0.03	0	0.22	0	4
Female	526	0.04	0	0.28	0	5

A recent success with using hatchery Chinook salmon for reintroduction above federal dams has occurred in Fall Creek, a tributary to the Middle Fork Willamette River. This effort is described here as an example of the potential success that can be achieved using hatchery supplementation. The run of spring Chinook salmon has extirpated when Fall Creek dam was finished in 1966. Since 1998, hatchery salmon from Dexter fish collection facility on the Middle Fork Willamette River have been outplanted above the dam in an effort to restore the benefits of salmon to the local ecosystem. As the supplementation continued, natural-origin spring Chinook salmon began to return to the base of Fall Creek dam and were counted and outplanted by trap and haul above the dam. The numbers of natural-origin salmon returns continued to increase and have stabilized at an annual return in the range of 300 to 600 natural-origin salmon returning to Fall Creek. Due to the increases in natural-origin returns, hatchery supplementation has been reduced and since 2010 only natural-origin spring Chinook salmon have been outplanted above the dam. The run has continued at a level of 400 to 600 salmon annually for several generations. In terms of abundance of a creek the size of Fall Creek, this level of abundance is surprising and very valuable for reducing risk to the ESU. The run of natural-origin salmon to Fall Creek now represents the only production area for the Middle Fork Willamette population presently, and represents a significant proportion of natural-origin returns to the Upper Willamette spring Chinook salmon ESU.

The recovery of the salmon run in Fall Creek is largely due to the successful downstream passage of juvenile salmon through Fall Creek reservoir and dam. The draining of the reservoir every year down to essential stream-level has allowed all juvenile salmon to emigrate downstream past the dam. Even though passage is less than ideal, survival rates are high enough to allow sufficient numbers of salmon pass through. The combination of enhanced growth by juvenile salmon in the reservoirs through the summer and complete draining of the reservoir in the fall (where all salmon emigrate downstream) has resulted in significant natural-origin salmon returns annually to Fall Creek. The run was founded entirely from hatchery fish supplementation and natural-origin fish are adapting to their local conditions in the absence of continual hatchery influences (O'Malley and Bohn 2018).

Ecological Effects

Ecological effects (interactions between hatchery- and natural-origin fish) include, but are not limited to, competition for space and food, predation, disease transference, and density-dependent effects. Hatchery management practices that release large numbers of hatchery juveniles can reduce available food resources for natural origin juveniles; limiting growth and health. Potential effects are greatest in the population areas that have the greatest density of hatchery fish per habitat area. The potential ecological effects are also influenced by the location where hatchery fish are released in the watershed. Releases of hatchery fish in the upper areas of the watershed would potentially have the greatest amount of time and space to affect naturally-occurring salmonids. In addition, if hatchery fish are released in principal spawning and rearing areas of natural-origin salmonids (i.e., tributaries), the interactions would be potentially greater than if hatchery fish are released in mainstem river areas. Therefore, the potential ecological interactions is dependent upon hatchery- and natural-origin fish sharing space and time within the specific population areas (Table 27).

The potential intermingling in space between hatchery fish and natural-origin spring Chinook salmon was evaluated in this DEIS as the percent of UWR spring Chinook salmon critical habitat affected by the releases of all species of hatchery fish. The river and stream reaches where hatchery fish are released compared to spring Chinook salmon critical habitat is shown in Figure 12, Figure 13, Figure 14, Figure 15. Overall, 27 percent of critical habitat is affected by hatchery fish in the spring Chinook salmon ESU. The principal habitat areas affected by hatchery fish are the mainstem river areas, lower Columbia River, and estuary. The vast majority of spring Chinook salmon critical habitat does not have any hatchery fish present (Figure 12, Figure 13, Figure 14, Figure 15). All of the habitat upstream of the federal dams do not have any hatchery smolts released. Rainbow trout are released into the reservoirs.

Another aspect of the ecological interaction between hatchery fish and natural-origin spring Chinook salmon is the period of time affected by the presence of hatchery fish in the streams and rivers. The target release size for hatchery fish within the UWR is the smolt life stage for all steelhead and spring Chinook salmon, although a very small percentage of spring Chinook salmon are released as pre-smolts in the fall. Depending upon the species, average fork length ranges from two inches (~60mm) for fall-released spring Chinook salmon (the smallest) to near 400 mm for rainbow trout (the largest; Table 9). Given hatchery spring Chinook salmon and steelhead are released as smolts and some spring Chinook salmon released as pre-smolts, the interaction period is relatively short-lived because monitoring shows that the vast majority of hatchery fish (smolts) are actively emigrating to the ocean very soon after release. However, some of the pre-smolts released may not emigrate initially.[14]

Hatchery rainbow trout are released into most of the reservoirs where juvenile natural-origin spring Chinook salmon are present. Hatchery rainbow trout are also released in the McKenzie River. Age-0 Chinook salmon are likely to be most susceptible to ecological impacts from hatchery rainbow trout due to their smaller size. The older age classes of Chinook salmon (ages 1-6; Romer and Monzyk 2014) that reside in the reservoirs year round from inadequate downstream passage (Romer et al. 2015) are less likely to be affected by hatchery trout. The larger age classes of Chinook salmon (e.g. 5 to 15 pound

[14] Currently, pre-smolts are only released in Hills Creek Reservoir, which is upstream of two dams that do not have juvenile passage, so it is not expected that these fish will return in large enough numbers to increase natural-origin abundance.

Chinook salmon that have been caught) may even predate upon the smaller hatchery trout (Romer and Monzyk 2014; Stewart and Ibarra 1991).

The goal of all hatchery programs (except rainbow trout) is to release fish when they are ready to migrate to the ocean immediately or soon after liberation. Since all of the fish released from hatchery programs in the UWR are released over 150 miles from the ocean, the total amount of time hatchery fish could potentially interact with natural-origin fish in freshwater habitat areas may be up to 1 to 2 weeks.

Predation is also another form of ecological interaction. While few studies have been completed in the UWR, Naman and Sharpe (2012) reported a wide range of predation impacts from hatchery fish on natural-origin salmonids when they reviewed studies along the West Coast. In general, predation rates were greatest when the number of hatchery fish released was high and the release coincided with the presence of natural-origin salmonids. In most cases, predation by hatchery fish was low overall. However, in specific circumstances and locations, hatchery fish predation could be substantial (i.e., loss of tens of thousands juvenile salmonids). For the UWR, predation by hatchery fish on natural-origin salmonids does occur. Hatchery steelhead predation upon Chinook salmon fry during the release periods of April through May is likely to be the greatest impact. Steelhead fry are probably less impacted because most of the steelhead are still incubating in the gravel when spring Chinook salmon and summer steelhead smolts are released. In addition, hatchery spring Chinook salmon are likely to have lower impacts on natural-origin fish species because they are smaller in size (i.e. more similar in size to natural-origin fish) and thus cannot consume as many fish compared to the larger hatchery steelhead. In all cases, the vulnerability of natural-origin fish to co-occurring hatchery fish is limited in time to a couple of weeks as the majority of the hatchery smolts actively emigrate[15] through the river to the estuary and ocean. In local situations at the individual fish scale, it may be limited to hours or days as the hatchery fish emigrated downstream.

In the UWR subbasins, there is concern that reservoirs associated with floodcontrol/hydropower facilities have created habitat conditions that make juvenile migrants more susceptible to introduced predatory fishes, with greatest concern being largemouth and smallmouth bass. Predation by largemouth bass in Green Peter Reservoir was identified as a limiting factor/threat (LFT) for UWR juvenile salmonids. Centrarchid abundance in Lookout Pt. Reservoir is reported to be high, particularly for crappie (Greg Taylor, USACE Willamette Review symposium 2010), but the magnitude of crappie predation on

[15] Hatchery released steelhead are known to residualize in the UWR and will be discussed in more detail in this section under UWR Winter Steelhead.

juvenile salmonids is unclear. Predation by bass may be a concern in other areas as well, such as slow water areas in sub-basins and the mainstem Willamette River that are associated with the remaining floodplain (Table 13).

Predation by introduced salmonids in the Willamette River Basin has also been identified as LFT for some UWR spring Chinook salmon and steelhead populations. The loss of winter steelhead habitat due to floodcontrol/hydropower facilities is being mitigated with a hatchery program using an out-of-DPS summer steelhead broodstock. Predation on juvenile UWR spring Chinook salmon by summer steelhead has been identified as a secondary LFT for the North Santiam, South Santiam, and McKenzie Chinook populations. In addition, predation on juvenile UWR spring Chinook salmon by an introduced strain of rainbow trout (Cape Cod strain) that supports a hatchery trout mitigation program, has been identified as a secondary LFT for the McKenzie River Chinook salmon population.

Competition between hatchery fish and natural-origin spring Chinook salmon may occur if a resource becomes limited in space and time. Quantifying the impact is difficult because of the variety of factors influencing competition such as availability of potentially limiting resources in space and time and variability in natural-origin salmonid production from year to year that influences density-dependence. Within the UWR, competition between hatchery fish and natural-origin spring Chinook salmon is likely to be very low or non-existent for the following reasons. The greatest impact from hatchery fish are likely to occur if the hatchery fish residualize and do not emigrate to the ocean. Recent information indicates less than 10 percent of the total hatchery release residualize and hatchery steelhead are the most prominent species to residualize (Hausch and Melnychuk 2012). The primary area of competitive interaction area is the area downstream of the hatchery release points. Since this interaction area is relatively small compared to the total amount of habitat available for juvenile Chinook salmon rearing (Figure 12, Figure 13, Figure 14, Figure 15), impacts from competition between hatchery fish and natural-origin fish is likely to be low.

In addition to the risks and concerns mentioned above regarding interactions between juvenile fish, another ecological effect of the hatchery program can be interactions between adult hatchery- and natural-origin fish. Upon returning to the natal river (or river where released), adult Chinook salmon generally seek specific habitat that provides cool water and cover that they utilize while waiting more than a month to spawn. If most of the fish returning to a subbasin are hatchery-origin, it is reasonable to assume they are competing with natural-origin adults for holding and spawning habitat. This may be a risk in areas where fish are in high densities, or where habitat has been compromised. This generally occurs downstream of dams in the UWR, and is considered a major concern.

Disease transfer is another potential ecological interaction. The work done by Bartholomew (2013)and Fast et al. (2015) suggest that transference of disease from hatchery fish to natural-origin fish is rare, and therefore not a major concern.

The ecological effects of the current hatchery program on natural-origin spring Chinook salmon ranges from low (upstream of dams where mostly natural-origin fish are transported) to medium/high where pHOS estimates are greater than 60 to 70 percent (downstream of Detroit, Foster, Leaburg, and Dexter dams).

Effect of the hatchery program on viability

The viability of salmon populations is described in terms of four interrelated parameters: productivity, abundance, diversity and spatial structure (McElhany et al. 2000). In general, for hatchery programs designed to have fish spawn in the wild (supplementation), the number of spawners and spatial distribution can increase (Black et al. 2017; Fast et al. 2015; O'Malley et al. 2017a; O'Malley et al. 2017b). However, there remains concern that large proportions of hatchery-origin fish on the spawning grounds could reduce fitness of the natural population over the long-term. This concern is based on numerous studies that have shown the relative reproductive success of hatchery fish is lower than natural-origin fish (Araki et al. 2007; Araki et al. 2008; Williamson et al. 2010; Berntson et al. 2011; Christie et al. 2014). In specific pedigree studies conducted in the Willamette River Basin for spring Chinook salmon, the fitness of natural-origin salmon and hatchery-origin salmon have not been significantly different (Table 28; Evans et al. 2016). Hatchery-origin males typically have the lowest fitness and hatchery and natural females being about equal in fitness with spring Chinook salmon in the Willamette Basin. The hatchery stocks also contain important genetic diversity characteristics not found in the depressed natural populations (Johnson and Friesen 2013). Therefore, the effects of the hatchery program have to be considered in the short- and long-term. Presently, the hatchery Chinook salmon programs are providing demographic benefits such as increases in abundance above the below the federal dams, where natural-origin returns are chronically low. The hatchery programs are helping preserve and rebuild genetic resources until limiting factors are addressed. Over the long-term, there are risks with the continual use of hatchery supplementation. However, at present the demographic risks outweigh longer term genetic risks because the natural populations are at high risk of extinction (NWFSC 2015).

There have been a number of operational changes for the spring Chinook salmon hatcheries in the UWR. Mass marking of hatchery-origin Chinook salmon began in 1997, with all returning adults being marked by 2002. Off-station releases within some basins have been curtailed in an effort to limit natural spawning by hatchery-origin fish. Releases of juvenile Chinook salmon into the Coast Fork River, a tributary that does not support an independent natural Chinook salmon population, have been made in an effort to maintain a harvestable hatchery return, but also reduce hatchery *x* natural adult interaction on the natural spawning grounds in Eastside tributaries. Recent improvements at the Cougar (2010), Minto (2012), and Foster (2014) fish collection facilities offer the potential for collecting more hatchery-origin adults and removing them from the natural-spawning component of the populations. These facilities should be able to reduce pHOS in both the North and South Santiam populations.

Analyzing the effects of hatchery fish on the viability of the UWR spring Chinook salmon ESU is complicated because most of the historical habitat is now upstream of high-head dams. In the absence of effective passage programs (that are currently being pursued), spring Chinook salmon will continue to be confined to more lowland reaches where land development, water temperatures, and water quality are limiting production of spring Chinook salmon.

In addition, pre-spawning mortality is a major factor affecting the number of spawners making it back to census points and spawning grounds. Jepson et al. (2013, 2014) found that mortality was higher for hatchery-origin spring Chinook than natural-origin fish. Pre-spawning mortality levels are generally high in the lower tributary reaches where water temperatures and fish densities are generally the highest. Historically, spring Chinook salmon held in the cooler headwater habitats upstream of the federal dams.

Areas immediately downstream of high head dams may also be subject to high levels of total dissolved gas (TDG). While the relationship between TDG levels and mortality is related to a complex interaction of fish species, age, depth, and history of exposure (Beeman and Maule 2006), the relative risks are quite high in some reaches.

In terms of diversity, an outcome of hatchery influence in the UWR (and in other programs; see Fast et al. (2015) and Hillman et al. (2012)) has been that hatchery spring Chinook salmon have differences in various life history and morphological characteristics compared to the historic populations in the Willamette Basin. Most hatchery juveniles are released as age-1 smolts in the spring, whereas a more continuous migration of naturally produced smolts through the fall and spring periods was observed in the historic populations (Willis et al.1995, cited in NMFS(2004); see also Schroeder et al.(2007)). Hatchery Chinook salmon return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis et al. 1995, cited in NMFS (2004)). It is unknown if younger adults is the result of genetic changes as the result of hatchery operations or fisheries, or simply the result of releasing larger smolts than occurred naturally(ODFW and NMFS 2011).

Hatcheries have been implicated in both decreases in age and size of maturity in Pacific salmon stocks (Bigler et al. 1996). The main hatchery-caused factor appears to be high hatchery growth rates triggering early onset of maturity (physiology; Larsen et al. (2004)), along with potentially other factors (density-dependent growth after release (ocean carrying capacity), and size selection of larger, older fish by selective fisheries (genetic selection)). Decreased body size at reproduction produces potential reductions in reproductive behavior, fecundity, egg size, and survivorship of progeny (Bigler et al. 1996; Berejikian et al. 1997; Berejikian et al. 2000; Heath et al. 2003).

Overall, when considering all of the LFTs for the UWR spring Chinook salmon ESU, hatchery effects appear to be a minor concern for viability, but managers should continue the current long-term strategy to reduce pHOS, which should have positive effects on productivity of the ESU.

UWR Winter Steelhead

The No-action Alternative 1 would continue to operate the hatchery facilities and associated programs for spring Chinook salmon and summer steelhead in accordance with the Biological Opinion (see section 2.1Alternative 1 (No-action): Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks for further details). This section evaluates the effects of these hatchery programs on natural-origin winter steelhead in the UWR DPS.

Genetic Effects

In evaluating the genetic effects of hatchery summer steelhead on natural-origin winter steelhead, it is important to first note that summer and winter steelhead can co-occur naturally in the same population areas. There are many populations of steelhead throughout California, Oregon, and Washington that have healthy summer and winter runs of natural-origin steelhead co-occurring in the same watershed. For example, summer and winter run steelhead occur naturally in the Klamath, Rogue, Umpqua, Siletz, Kalama, Cowlitz, Hood, and many others in Puget Sound (Busby et al. 1996; Matala et al. 2009; NMFS

2017). In all cases, summer steelhead are at higher risk of extinction due to their life history of having to deal with high water temperatures during the summer as adults. Prince et al. (2017) have shown summer steelhead to possess rare and unique genetic alleles that are not found in their winter-run *O. mykiss* counterparts. Winter steelhead are typically more abundant, have less genetic risk, and are not as exposed to freshwater habitat pressures as are summer steelhead. Problems with genetic and ecological interactions between summer and winter steelhead typically occur only after human actions disrupt natural conditions that allow for temporal and spatial separation of these runs (Matala et al. 2009).

Winter-run steelhead hatchery programs were terminated in the late 1990s. Currently, the only steelhead programs in the UWR release summer steelhead originally taken from Skamania Hatchery on the Washougal River from the Lower Columbia River DPS. Annual total releases have been relatively stable at around 600,000 from (2009-2014), although the distribution has changed with fewer fish being released in the North Santiam River (in response to RPA 6.1.8 of the Willamette Project Biological Opinion (NMFS 2008)) and corresponding increases in the South Santiam and Middle Fork Willamette rivers. Adult summer steelhead typically return to the UWR Basin between March and October, and spawn timing can overlap with native winter steelhead (particularly early spawning winter steelhead in January through March (**Figure 21**; Firman et al. 2004). Marked summer steelhead have been observed on spawning grounds (**Figure 19**; Schroeder et al. 2006; Mapes et al. 2017)[16], raising concerns about potential negative ecological interactions and genetic introgression with native winter steelhead in the UWR.

Johnson et al. (2013) found that about 10 percent of unmarked juvenile *O. mykiss* sampled at Willamette Falls in 2009-2011 were summer steelhead and that an additional 10 percent of samples were summer *x* winter steelhead hybrids. Most *O. mykiss* sampled from the McKenzie River were either summer steelhead or summer *x* winter steelhead hybrids. Natural production of pure summer steelhead appeared to be very low in the North and South Santiam rivers, though summer steelhead hybrids represented 11.1 percent and 14.8 percent of samples. Van Doornik et al. (2015) concluded that late winter-run (primarily from eastside tributaries to the Willamette River) steelhead had largely maintained their genetic distinctiveness over time. Even in the absence of long-term introgression, there are still concerns that hybridization will decrease the overall productivity of the native population. In their report, Johnson et al. (2013) make recommendations on reducing the occurrence of summer steelhead on the spawning grounds

[16] Because of water conditions during steelhead spawning (high flow and lower visibility), it is difficult to estimate the proportion of hatchery-origin spawners on the spawning grounds, and therefore, there are no estimates of pHOS downstream of collection facilities where some spawning occurs.

and improving reproductive isolation between hatchery summer steelhead and natural-origin winter steelhead.

Based on the above information, the summer steelhead hatchery program has a medium genetic risk to winter steelhead.

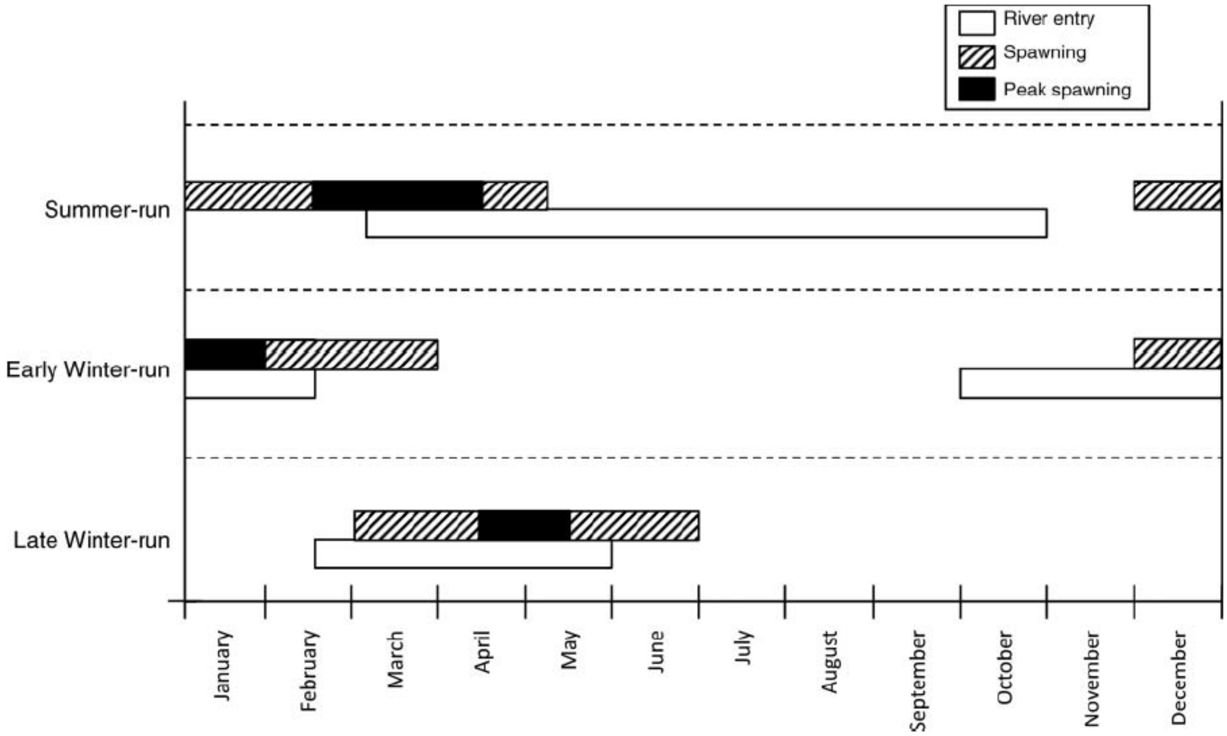

Figure 18. Timing of summer steelhead, early winter-run, and late winter-run entry to freshwater and spawning in the Upper Willamette River. Figure taken from Van Doornik et al. (2015).

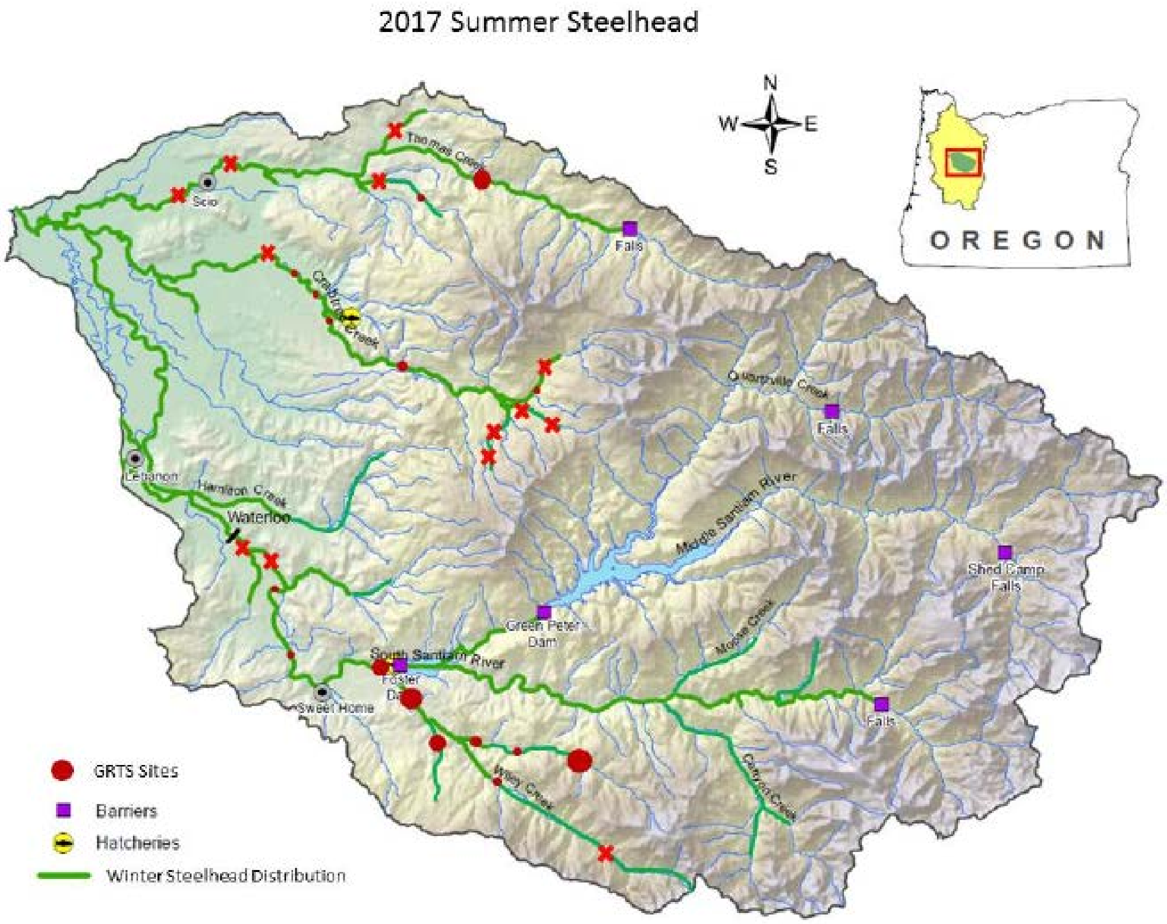

Figure 19. Distribution of summer steelhead redds in the South Santiam River Basin. Size of circle corresponds to density of redds. “X” represents sampling site but no redds were found. No summer steelhead are outplanted above Foster/Green Peter dams. Figure taken from Mapes et al. (2017).

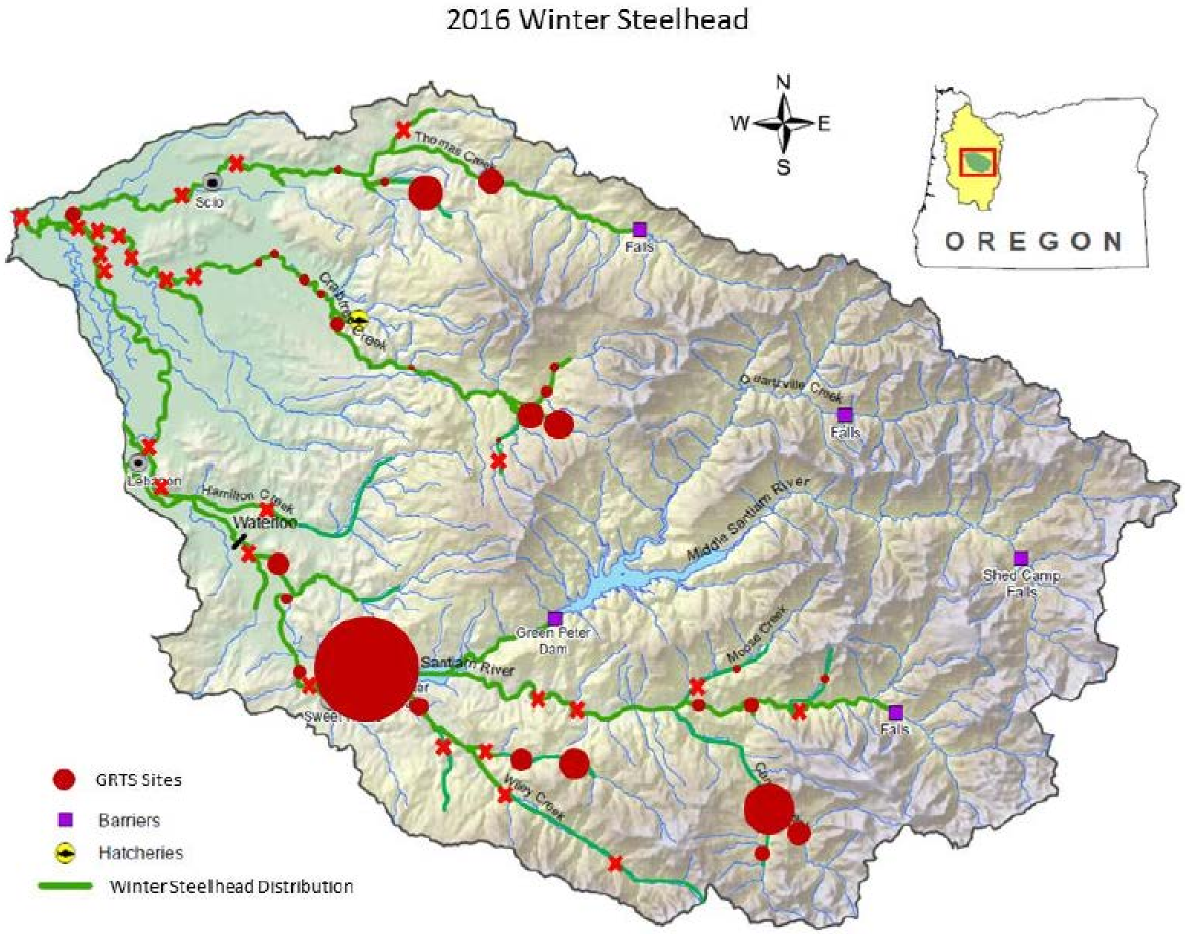

Figure 20. Distribution of winter steelhead redds in the South Santiam River Basin. Size of circle corresponds to density of redds. "X" represents sampling site but no redds were found. No winter steelhead are outplanted above Green Peter dam. Figure taken from Mapes et al. (2017).

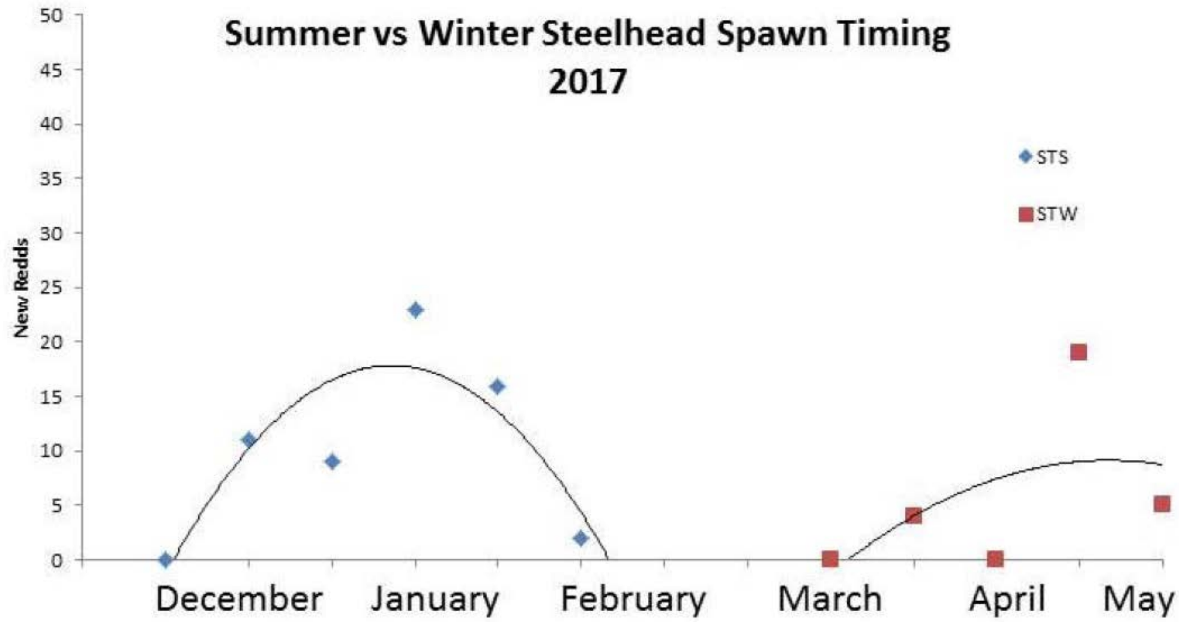

Figure 21. Spawn timing of summer steelhead and winter steelhead in the South Santiam River, 2016-2017. Figure taken from Mapes et al (2017).

Ecological Effects

Assessing the ecological effects of hatchery steelhead on listed winter steelhead is complicated by a variety of factors. Hatchery steelhead released before the smolting phase (active emigration to the ocean) leads to the hatchery steelhead residing in the release location for longer periods of time until they develop into smolts physiologically. Conversely, hatchery steelhead released after the smolting phase have the tendency to residualize near the hatchery release location and not emigrate to the ocean at all but reside in freshwater for extended periods of time. The hatcheries actively manage hatchery steelhead releases for the time period of active smolting to minimize the above ecological interactions with natural-origin, winter steelhead. In addition, even though the vast majority of the hatchery steelhead may be exhibiting smolting, there is still a proportion of hatchery steelhead that are either not quite fully smolts, or more developed smolts based upon the bell shaped curve of the hatchery steelhead population. In addition, steelhead populations are highly diverse and a small proportion of steelhead offspring may not have the propensity to emigrate to the ocean (anadromous life form) but reside in freshwater their entire life as resident, rainbow trout. The resident *O. mykiss* life history form is known to be present in many steelhead populations throughout the west coast region (Busby et al. 1996).

Juveniles of the summer steelhead hatchery mitigation program in the UWR may compete with juveniles of native winter steelhead, and this potential interaction has been identified as a key limiting factor in the North and South Santiam subbasins (ODFW and NMFS 2011).During the one-to-two week period of interaction while in freshwater (see discussion above), the greatest impact is likely to occur in areas where hatchery steelhead are co-occurring with natural-origin salmonids (e.g., mainstem Willamette River). In the North and South Santiam rivers, juveniles are largely confined below much of their historical spawning and rearing habitat. Releases of large numbers of hatchery-origin summer-run steelhead may temporarily exceed rearing capacities and displace winter-run juvenile steelhead (NWFSC 2016).

While most insight regarding ecological effects on steelhead has come from steelhead populations outside the UWR DPS (Chilcote 2003; Kostow et al. 2003; Kostow 2004; Kostow and Zhou 2006), the impacts are likely relevant to the UWR DPS as well. For example, Kostow and Zhou ((2006); citing references therein) suggested that because adult hatchery summer steelhead typically spawn earlier than do wild winter steelhead and their offspring emerge earlier, they may have a competitive advantage in occupying choice feeding territories prior to the emergence of winter steelhead. In addition, when large hatchery releases result in the localized carrying capacity to be exceeded, which is presumed to be the case in UWR sub-basins, there is increased potential for density-dependent mortality on wild fish for early life stages. If a significant number of summer steelhead juveniles residualize in the UWR sub-basins, they could compete with native wild steelhead parr, which primarily have a 1-2 year residence time in freshwater.

Residualization of hatchery steelhead (fish that do not migrate to the ocean in the year of their release) can increase the amount of interaction between naturally produced rearing fish and hatchery summer steelhead. This increase in interaction would occur because the time of potential negative effects through competition and predation would increase. While naturally produced steelhead also exhibit a residual life history strategy, releasing an excessive number of residual hatchery steelhead may have ecological, demographic, and genetic effects not intended by managers (ISRP and ISAB 2005). However, for most steelhead hatchery programs, the estimated residualism rate is less than 10 percent (Snow et al. 2013; Larsen et al. 2017). Hausch and Melnychuk (2012) reviewed 48 estimates of residualism of hatchery-reared steelhead from 16 different studies and found that residualism ranged from 0 percent to 17 percent, averaging 5.6 percent.

A study has been implemented in the UWR to determine the extent to which juvenile hatchery summer steelhead, *O. mykiss*, and wild winter steelhead overlap in space and time, to evaluate the extent of residualism among hatchery summer steelhead in the South Santiam River, and to evaluate the potential for negative ecological interactions among hatchery summer steelhead and wild winter steelhead (Harnish et al. 2014; McMichael et al. 2014).These researchers found, using two independent methods in 2013 and 2014, a substantial portion[17] of the hatchery summer steelhead released as smolts did not emigrate from the South Santiam River. Based on radio telemetry, they found that the majority of the tagged fish were last detected in the Santiam River basin and, less than one-third of the tagged fish were last detected in the Willamette River downstream of Willamette Falls. Further, snorkeling revealed that residual hatchery steelhead (those present >30 days after release) were present in all locations visited through the final snorkel survey in both 2013 and 2014.

In 2014, snorkeling revealed considerable overlap of habitat use (in space and time) by residual hatchery steelhead and naturally produced *O. mykiss* in the South Santiam River. Results from the study (and others) also indicated that hatchery steelhead juveniles typically dominate interactions with naturally produced *O. mykiss* juveniles. The overlap in space and time, combined with the competitive advantage that residual hatchery steelhead appear to have over naturally produced *O. mykiss*, increases the potential for negative ecological interactions that could have population-level effects on the wild winter steelhead population of the South Santiam River.

In 2014, the researchers also detected a potential displacement of naturally produced *O. mykiss* by residual hatchery juvenile summer steelhead. They observed the highest densities of residual hatchery steelhead in sites located within about seven miles of the South Santiam Hatchery, whereas the density of naturally produced *O. mykiss* generally increased with increasing distance from the hatchery. Much of the quality rearing habitat located downstream of Foster Dam appears to be situated in the roughly 10 miles between Foster Dam and McDowell Creek where the river has a higher gradient. Downstream of McDowell Creek, the South Santiam River has much lower gradient and consists of many long, slow glide habitats. Thus, it is possible that residual hatchery steelhead may be displacing naturally produced *O. mykiss* from the highest quality rearing habitat into suboptimal habitats, which could also negatively affect the wild population.

Hatchery steelhead are large sized when released within the UWR (Table 9), and thus have the high potential to prey upon a variety of other fish species. Residualized summer steelhead may also prey upon juvenile Chinook salmon, and this has been identified as a secondary limiting factor in the Santiam

[17] Because of the study design, the researchers did not estimate a percentage of fish that did not migrate.

populations, as well as the McKenzie population where releases support a sports fishery (ODFW and NMFS 2011).

Based on the information presented above, the ecological risk of the summer steelhead program on natural-origin winter steelhead is medium-high.

Effect of the hatchery program on viability

There is some concern that the summer-run steelhead releases in the South Santiam River may be influencing the viability of native steelhead in the North and South Santiam rivers(NWFSC 2015). Introgression of hatchery summer steelhead with naturally produced winter steelhead is a major concern regarding viability for the winter steelhead DPS in the UWR. Even if the long-term introgression rate is low, there are still concerns that hybridization will decrease the overall productivity of the native population.

As with the UWR spring Chinook ESU, analyzing the effects of hatchery fish on the viability of the UWR winter steelhead DPS is complicated because most of the historical habitat is now upstream of high-head dams. In the absence of effective passage programs (that are currently being pursued), some of the winter steelhead populations will continue to be confined to more lowland reaches where land development, water temperatures, and water quality may be limiting.

For UWR steelhead, the diversity goals for recovery are partially achieved through the closure of winter-run steelhead hatchery programs in the upper Willamette River(NWFSC 2016). However, because the summer steelhead program is operated as a segregated program, where adult fish returning from the hatchery are not meant to spawn naturally, the largest risk from the summer steelhead program on winter steelhead is most likely from ecological interaction as juveniles and potentially adults. Introgression is a concern, but appears to currently be a low rates, albeit any introgression is still a concern.

Overall, as with spring Chinook salmon, when considering all of the LFTs for the UWR winter steelhead DPS, hatchery effects appear to be a low to medium concern for viability, but managers should continue to investigate and manage ecological interactions and overlap of summer- and winter-run steelhead on the spawning grounds, which should have positive effects on productivity of the DPS.

4.4.2. Alternative 2 (Proposed Action/Preferred Alternative) – Allow Integration of Natural-origin Fish into Hatchery Broodstocks

Under Alternative 2, the 10 hatchery facilities and associated hatchery programs within the UWR would operate as proposed in the submitted HGMPs (Subsection 2.2, Alternative 2 (Proposed Action/Preferred Alternative): Approve ODFW's HGMPs for Operation of Hatchery Programs in the UWR); Appendix A). Short- and long-term risks associated with competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer from the hatchery programs would be the same under Alternative 2 as described under Alternative 1 (No-Action). There would likely be a change in the genetic effects under Alternative 2 because including natural-origin broodstock would reduce the genetic risks associated with the current operation of the hatcheries. The analysis of the site-specific effects under Alternative 2 would be identical to effects analyzed under Alternative 1. The hatchery programs would continue to pose short- and long-term adverse risks associated with genetic effects (although reduced somewhat), 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.

UWR Spring Chinook Salmon

The primary difference between Alternative 1 and Alternative 2 is that natural-origin spring Chinook salmon would be used in the broodstock. Using natural-origin spring Chinook in the broodstock would decrease the potential for negative genetic effects of domestication to the population (hatchery- and natural-origin fish). By including natural-origin fish in the broodstock, any genetic legacy of local adaption to the natural environment will be incorporated into the population to a higher degree. If, at the same time the long-term goal of reducing pHOS is achieved, the productivity and long-term fitness of the population (and ESU) would increase.

For Alternative 2, integration of natural-origin Chinook salmon into the hatchery broodstocks would be on a sliding scale basis; meaning when returns of natural-origin salmon are poor, no fish would be taken for broodstock purposes and when natural-origin salmon returns are high, a larger percentage of fish could be taken for broodstock purposes. The strategy of sliding scale broodstock integration management is to protect natural-origin salmon to the greatest extent possible when returns are low, but allow some natural-origin fish to be taken from the population for broodstock purposes when returns are higher. In any case, take of natural-origin salmon for broodstock should never result in a major impact to the affected, natural population. In Alternative 2, pNOB (proportion of natural-origin salmon in the broodstock) ranges from zero to 100% depending upon specific criteria. The most likely averages for pNOB for the hatchery programs defined in Alternative 2 is 0.05 to 0.20. The lowest pNOB will be the Middle Fork Willamette hatchery program because few natural-origin salmon are available and the hatchery program is large. The greatest pNOB could occur in the McKenzie program, where natural-origin returns are greatest and the program is moderately sized.   The resultant PNI values depend upon what pNOB and pHOS values are assumed in the future. In general, PNI values for all spring Chinook populations with hatchery releases (Molalla, North Santiam, South Santiam, McKenzie, Middle Fork Willamette, Coast Fork Willamette) will increase compared to the No-action Alternative. For Alternative 2, resultant PNI values will likely be in the range of 0.3 to 0.8, depending upon the specific population. PNI values for the No-action alternative are in the range of 0 to 0.2.

All other analyses and conclusions regarding the effects of the hatchery programs (ecological interactions, viability) that were discussed in Section 4.4.1 would remain the same, and the overall determination of low and medium-high risk to population viability would be reduced.

UWR Winter Steelhead

Because the difference between Alternative 1 and Alternative 2 regard natural-origin spring Chinook incorporation into the broodstock, there would be no change in the analyses and conclusions regarding the risk of the hatchery program regarding genetic and ecological interaction risks, and viability of UWR winter steelhead that was determined in Section 4.4.1.

4.4.3. Alternative 3 – Reduce Hatchery Production to Reintroduction Needs

Under Alternative 3, the hatchery programs would be managed only to provide sufficient adult returns to provide for broodstock and reintroduction needs. Hatchery production of spring Chinook salmon in Alternative 3 would be reduced by 32% compared to Alternative 2 (Proposed Action/Preferred Alternative). However, Alternative 3 also revises the current summer steelhead program and switches to winter steelhead, which will be further analyzed below.

UWR Spring Chinook Salmon

By releasing fewer spring Chinook salmon under this alternative, there would likely be some benefits and risks to the corresponding natural population. The potential benefits of Alternative 3 would be fewer hatchery fish on the spawning grounds below the federal dams, which would reduce pHOS and increase PNI. Natural selection would drive adaptation in the population to a larger degree and less genetic introgression by hatchery fish into the natural populations would result. However, there would also be increased risk to the natural population by having fewer spawners reproducing; as pedigree analyses has shown hatchery Chinook salmon to successfully reproduce in the wild. Since most Chinook salmon populations in the ESU suffer from low population abundance, the demographic risks (too few spawners) typically are of more concern than long-term genetic risks (domestication selection). In Alternative 3, PNI values for most populations would range from 0.3 to 0.8 on average, and would be substantially higher than the No-action alternative. This alternative would allow managers to reach the long-term pHOS goals more readily, but harvest of returning adults would likely be reduced.

By releasing fewer spring Chinook salmon, the potential negative effects of ecological interaction would also be reduced. Fewer juveniles would be competing for potentially limited resources in the areas currently being utilized downstream of the dams. Potential negative effects of predation would also likely be reduced.

Alternative 3 is likely to have less risk on the viability of the spring Chinook salmon ESU than the preferred alternative (Alternative 2) because of the lower chance of negative interactions between hatchery fish and natural-origin fish that could reduce productivity. However, the positive effects of the preferred alternative (additional marine nutrients in the watershed, increased opportunity for sport fishing, and increased forage for bull trout) would also be reduced with fewer spring Chinook salmon being released and returning.

Since Alternative 3 would provide hatchery production only for broodstock and reintroduction purposes, other beneficial uses of the surplus adult spring Chinook salmon would be eliminated compared to the No-action alternative. No surplus adult salmon would be available for Tribal ceremonial and subsistence use, sales of fish carcasses would be eliminated, salmon provided to local food banks would be eliminated, and nutrient enhancement to the ecosystem would be eliminated from surplus hatchery carcasses. Of particular interest and value would be the loss of spring Chinook salmon provided from the Middle Fork Willamette River hatchery program to the Burns-Paiute Tribe for their ceremonial salmon fisheries in the Malheur River in recent years. The Burns Paiute Tribe has expressed an interest in continuing this program for these purposes during the public scoping for this EIS. Further analysis of the impacts of Alternative 3 on the Burns Paiute Tribe is included in section 4.8.3 below.

UWR Winter Steelhead

It is generally agreed that the current summer steelhead program does not promote conservation or recovery efforts to the UWR winter steelhead DPS. By switching the program from summer steelhead to winter steelhead, as proposed in this alternative, potential benefits to the UWR winter steelhead DPS could increase. However, additional risks associated with using natural-origin winter steelhead for broodstock are discussed below.

Current information suggests that there is some interbreeding of summer- and winter-run steelhead in the UWR (Johnson et al. 2013). By eliminating the summer-run steelhead program in the UWR, this major genetic risk for the UWR winter steelhead DPS is removed. However, if (at least initially) natural-origin winter steelhead are then taken into the hatchery for broodstock and released into historical habitat, then pHOS becomes a concern and all of the risks associated with the effects on long-term productivity and fitness (see discussion in Section 4.4.1) of hatchery-origin fish spawning in the wild will then become a potential effect of the new program.

The ecological effects of the hatchery program would not change under the switch in the steelhead program from summer to winter run broodstock. There would still be concerns of high densities of fish after release competing for at times limiting resources (see Section 4.4.1 for further discussion). However, if hatchery winter steelhead were only released into historical habitat (currently upstream of dams), then the ecological interactions may be reduced because currently, habitat condition upstream of the dams is in general better condition than habitat downstream of dams. Therefore, the chance of space and food being limited is reduced compared to conditions that are met with the current release of summer steelhead downstream of the dams. However, it would remain uncertain whether large releases of hatchery fish upstream of the dam would still increase density in certain areas at specific times where negative effects could occur.

The viability of the UWR winter steelhead DPS would likely increase if the summer steelhead hatchery program were discontinued because of interbreeding and ecological effects, however, beginning a winter steelhead hatchery program would also present some risks to the viability of the UWR winter steelhead DPS (see discussion in Section 4.4.1).

4.4.4. Alternative 4 – Terminate the Existing Hatchery Programs in the Upper Willamette River Basin

Under this alternative, the co-managers would terminate the funding and implementation of all of the hatchery programs in the UWR. All of the activities associated with the hatchery programs would be terminated: no hatchery fish would be released, no broodstock would be collected at trapping locations, trapping facilities would be removed, no returning hatchery fish would be removed from various locations, the hatchery facilities would not use water for operation, and the hatcheries would not discharge hatchery water effluent. The existing fish collection facilities (i.e. Minto Dam FF, Foster Dam FF, Dexter Dam FF) would continue to be used to collect only natural-origin salmon for reintroduction above the federal dams.

UWR Spring Chinook Salmon

Any risks associated with the current hatchery program for spring Chinook salmon (see discussion in Section 4.4.1) would be gone. However, any of the benefits of the program, such as using fish for reintroduction upstream of dams into historical habitat, increases in marine derived nutrients associated with increase of fish on the spawning grounds, and forage for bull trout in some watersheds would also be gone. Overall, Alternative 4 would result in a substantial increase in extinction risk for the ESU from the termination of the spring Chinook salmon hatchery programs. Abundance and productivity of natural populations would decrease from the elimination of all hatchery-origin spawners above and below the federal dams. The spatial structure of the populations would be substantially reduced from the discontinuation of the outplanting of hatchery Chinook salmon above the federal dams where insufficient numbers of natural-origin fish are available (e.g. above Big Cliff, Detroit, Green Peter, Cougar, Blue River, Dexter, Lookout Point, and Hills Creek dams). Since the genetic diversity and heterozygosity in the hatchery stocks of the UWR ESU are greater than in most natural-origin populations due to depressed population sizes (Johnson and Friesen 2014), terminating the hatchery programs would also result in significant impacts to the ESU from the loss of hatchery stocks (which in many cases represent the only genetics of historical runs extirpated by the construction of the federal dams).

UWR Winter Steelhead

As discussed above, there is potential that eliminating the summer steelhead hatchery program may increase the viability of the UWR winter steelhead DPS by reducing the genetic effects of interbreeding and the ecological interaction effects with hatchery summer steelhead. Discontinuing the rainbow trout hatchery program would also likely increase the viability of the UWR winter steelhead DPS by reducing ecological effects and potentially fishing mortality associated with the rainbow trout program. However, the current sport fishery that brings increased financial benefit to the area would also disappear.

4.4.5. Alternative 5 – Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits

Under Alternative 5, the co-managers would increase hatchery production to the extent possible using existing hatchery facility capacities and existing water rights. The increased hatchery production would allow for increased harvest opportunities on hatchery produced fish in recreational and commercial fisheries in the ocean and freshwater.

UWR Spring Chinook Salmon

Increasing the release of hatchery spring Chinook salmon would likely intensify the risks associated with the current program (see Section 4.4.1). Even though the intent of increasing the number of fish released is to increase the opportunity to harvest more fish, it is likely that a larger percentage of hatchery spring Chinook salmon would be interacting with natural-origin fish on the spawning grounds since it is difficult to harvest the full allotment of fish. This would likely increase the prespawning mortality rates (Bowerman et al. 2018), the amount of interbreeding between hatchery- and natural-origin spring Chinook salmon, possibly reducing productivity and long-term fitness of the ESU. Additional hatchery spring Chinook on the spawning grounds would make it more difficult to meet the long-term pHOS goals that are described in the submitted HGMPs.

Additional releases of hatchery spring Chinook would also likely increase competition with natural-origin juveniles in areas where they overlap, especially in areas downstream of dams where the habitat is limited in some watersheds. Predation may increase too by the large number of hatchery fish attracting predators and additional natural-origin fish being preyed upon.

However, the additional hatchery adults returning would increase the amount of marine derived nutrients that would be beneficial to production. In some areas, the increase in the number of juveniles released could also increase forage for bull trout.

Assuming that pHOS would increase, and other potential ecological interactions, it is likely that increasing the number of hatchery spring Chinook salmon would most likely have a detrimental effect on the viability of the UWR spring Chinook salmon ESU.

UWR Winter Steelhead

An increase in the number of summer steelhead released in the UWR would most likely increase the concerns and risks associated with the current hatchery program (see Section 4.4.1). Additional returns of adult hatchery summer steelhead could increase pHOS and subsequent interbreeding with winter steelhead, potentially lowering productivity, genetic diversity, and long-term fitness. Ecological interactions, discussed in Section 4.4.1, would likely increase, further negatively affecting productivity of winter steelhead.

In general, increases in releases of summer steelhead would likely reduce the viability of the UWR winter steelhead DPS.

4.5. Effects on Other Fish and Their Habitats

4.5.1. Alternative 1 (No-Action) – Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks

Alternative 1 would maintain all existing hatchery programs within the UWR. Alternative 1 would continue current conditions for bull trout, lamprey, sculpin, shiners, dace, trout, sucker, pikeminnow, chub, and non-native fish species (Table 13. Range and status of other fish species **that may interact with UWR spring Chinook salmon and steelhead. This is not an exhaustive list of fish species, but includes the fish most abundant and widespread in the analysis area.**

.Some of these species are affected by hatchery facilities, compete with hatchery fish, and certain fish (i.e., redside shiners, dace, sculpin) are potentially eaten by hatchery fish. Other species such as bull trout and lamprey would benefit from hatchery fish as a potential prey base. Genetic risks of hatchery fish spawning in the wild would continue to be non-existent because no hatchery programs exist for these species, with the possible exception of rainbow trout.[18] Hatchery fish would contribute nutrients from naturally spawning carcasses and from outplants of surplus fish from the hatcheries similar to current conditions. Alternative 1 would result in similar hatchery impacts on these other fish species as under current conditions from incidental harvest impacts and operation of the hatchery collection facilities. Thus, the adverse effects of these impacts are expected to be negligible from the hatchery programs.

4.5.2. Alternative 2 (Proposed Action/Preferred Alternative) – Allow Integration of Natural-origin Fish into Hatchery Broodstocks

Under Alternative 2, the 10 hatchery facilities within the UWR would operate as proposed in the submitted HGMPs (Subsection 2.2, Alternative 2 (Proposed Action/Preferred Alternative): Approve ODFW's HGMPs for Operation of Hatchery Programs on the Oregon Coast); Appendix A). Alternative 2 would continue current conditions for bull trout, lamprey, sculpin, shiners, dace, trout, sucker, pikeminnow, chub, and non-native fish species (Table 13. Range and status of other fish species **that may interact with UWR spring Chinook salmon and steelhead. This is not an exhaustive list of fish species, but includes the fish most abundant and widespread in the analysis area.**

As with Alternative 1, under Alternative 2, some species of fish are affected by hatchery facilities, compete with hatchery fish, and certain fish (i.e., redside shiners, dace, sculpin) are eaten by hatchery fish. These effects are expected to be negligible in total, but result in some beneficial (medium effect from hatchery carcass nutrient enhancement) and low adverse effects (from operation of the hatchery facility and potential incidental catch of these species from targeting hatchery fish).

4.5.3. Alternative 3 – Reduce Hatchery Production to Reintroduction Needs

Under Alternative 3, the co-managers would produce only enough hatchery fish for reintroduction of adult salmon and steelhead above the Corps dams (and other areas as deemed appropriate). The hatchery programs would be managed solely for conservation and recovery purposes and providing enough returning adult salmon and steelhead for outplanting in under-utilized historical habitats. This alternative would reduce hatchery smolt releases compared to the No-action alternative.

The effect to other fish species would be negligible, and for some species, such as dace, red-side shiners and others that are preyed on by hatchery fish, this alternative could have a positive effect on the species

[18] Rainbow trout that are currently released in the UWR are sterilized prior to release, but there is very low potential for it not to be 100 percent effective.

productivity. For other species that prey upon hatchery fish (e.g., Northern pikeminnow, bull trout), there may be a negligible negative effect.

4.5.4. Alternative 4 – Terminate the Existing Hatchery Programs in the Upper Willamette River Basin

Under Alternative 4, the co-managers would terminate the funding and implementation of all of the hatchery programs in the UWR. The effects from this alternative on other fish species is assumed to be similar to those of Alternative 3, but potentially more amplified.

4.5.5. Alternative 5 – Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits

Under Alternative 5, the co-managers would increase hatchery production to the extent possible using existing hatchery facility capacities and existing water rights. Since in the UWR, all resident fish species may compete with, be predators of, and/or serve as prey for hatchery fish depending upon the life stage and time of year (Table 13), it is likely that there would be medium to high effects from increasing the hatchery program releases.

The effects from this alternative would be low to medium depending on the interaction between hatchery fish and these other species.

4.6. Effects on Wildlife

4.6.1. Alternative 1 (No-Action) – Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks

Under Alternative 1, the hatchery facilities within the UWR would continue to operate as proposed in submitted HGMPs (Subsection 2.2, Alternative 2 (Proposed Action/Preferred Alternative): Approve ODFW's HGMPs for Operation of Hatchery Programs in the UWR)). Consequently, the number of salmon and steelhead (juvenile and adult) available to predators and scavengers that use salmon as a food source (Subsection 3.6, Wildlife), would be the same as under current conditions. Most of the ESA-listed wildlife species do not interact with hatchery salmon and steelhead because of their habitat and food preferences and distribution (Table 14).

Alternative 1 would maintain the number of juvenile salmon and steelhead available as a food source for bird populations as current conditions.

Habitat disruption may occur from physical damage or disruption by anglers targeting hatchery-origin salmon and steelhead. Operation of the hatchery facilities uses water from the adjacent stream. The area from intake to outfall would be affected, although these areas are extremely limited. There is also some potential for these activities to displace wildlife that may be in the area. Habitat impacts from fishing activities are usually localized and short-lived and are currently occurring related to ongoing fisheries in the analysis area. Additionally, fishery access points, roads, boat launches, and campsites are already present in the analysis area.

Alternative 1 would result in a negligible beneficial effect overall. The hatchery programs would provide hatchery fish as a prey source for all wildlife (e.g., birds, marine mammals, and terrestrial mammals) that feed upon juvenile and adult salmon and steelhead (medium benefit). There would be a negligible adverse effect from habitat alterations near the hatchery facilities from operation and anglers fishing near the local vicinity.

4.6.2. Alternative 2 (Proposed Action/Preferred Alternative) – Allow Integration of Natural-origin Fish into Hatchery Broodstocks

Under Alternative 2, the hatchery facilities within the UWR would operate as proposed in the submitted HGMPs (Subsection 2.2, Alternative 2; Appendix A). Salmon and steelhead (juvenile and adult) would be available to predators and scavengers that use salmon as a food source for Alternative 2 as described under Alternative 1 (No-Action).

The analysis of the site-specific effects under Alternative 2 would be identical to effects analyzed under Alternative 1. Alternative 2 would result in a negligible beneficial effect overall. The hatchery programs would provide hatchery fish as a prey source for all wildlife (e.g., birds, marine mammals, and terrestrial mammals) that feed upon juvenile and adult salmon and steelhead (medium benefit). There would be a negligible adverse impact from habitat alterations near the hatchery facilities from operation and anglers fishing near the local vicinity.

4.6.3. Alternative 3 – Reduce Hatchery Production to Reintroduction Needs

Under Alternative 3, the co-managers would produce only enough hatchery fish for reintroduction of adult salmon and steelhead above the Corps dams (and other areas as deemed appropriate). The hatchery programs would be managed solely for conservation and recovery purposes and providing enough returning adult salmon and steelhead for outplanting in under-utilized historical habitats. This alternative would reduce hatchery smolt releases compared to the No-action alternative.

The effect to wildlife would be negligible, and for some species that prey upon hatchery fish (e.g., cormorants, osprey, Caspian terns, etc.), there may be a negligible negative effect.

4.6.4. Alternative 4 – Terminate the Existing Hatchery Programs in the Upper Willamette River Basin

Under Alternative 4, the co-managers would terminate the funding and implementation of all of the hatchery programs in the UWR. The effects from this alternative on wildlife is assumed to be similar to those of Alternative 3, but potentially more amplified.

4.6.5. Alternative 5 – Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits

Under Alternative 5, the co-managers would increase hatchery production to the extent possible using existing hatchery facility capacities and existing water rights. In the UWR, some wildlife species are predators of hatchery fish (Table 14), it is likely that there would be a medium positive effect from increasing the hatchery program releases.

4.7. Effects on Socioeconomics

4.7.1. Alternative 1 (No-Action) – Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks

Under Alternative 1, 10 hatchery programs within the UWR would continue to operate as proposed in submitted HGMPs (Subsection 2.2, Alternative 2 (Proposed Action/Preferred Alternative): Approve ODFW's HGMPs for Operation of Hatchery Programs in the UWR)). There would continue to be 37full-time jobs associated with the hatchery programs (Subsection 3.7, Socioeconomics). Additionally, these hatchery programs would continue to use local goods and services, which would contribute to personal income or jobs within the UWR.

Alternative 1 would continue to provide salmon and steelhead available for commercial and recreational harvest within the UWR. Fishing opportunities provided under Alternative 1 would continue similar to current conditions for the purchase of supplies such as fishing gear, camping equipment, consumables, and fuel at local businesses (Subsection 3.7, Socioeconomics). Additionally, anglers would continue to contribute to the economy through outfitter/guide/charter fees. Alternative 1 would maintain the $48million spent by anglers fishing in the lower Columbia River (Subsection 3.7, Socioeconomics). For the UWR, the hatchery programs provide substantial benefits (medium to high effect) to socioeconomics. Depending upon the specific fishery, the benefits can be high to the local economy. Even though fishing-related expenditures is a low percentage of total state revenue (less than one percent), in the UWR, fisheries can be an important local economic contribution particularly during the seasons when spring Chinook salmon and summer steelhead return.

In addition to the economic benefits from having hatchery fish available to catch in ocean and freshwater fisheries, there is also possible economic losses on fisheries that target natural-origin salmon and steelhead in the populations where hatchery programs occur. As described in Subsection 4.4, Effects on Salmon and Steelhead and Their Habitats and Subsection 4.5, Effects on Other Fish and Their Habitats, hatchery programs can have negative effects on the abundance and productivity of natural-origin fish populations. Consequently, natural production may be reduced in the population areas where hatchery programs occur. This translates into fewer natural-origin fish being available for fisheries. Depending upon the specific population and hatchery program, the effect of the negative impacts of hatchery fish on natural production and fisheries likely ranges from a negligible to a very low effect on the overall socioeconomics for the UWR.

4.7.2. Alternative 2 (Proposed Action/Preferred Alternative) – Allow Integration of Natural-origin Fish into Hatchery Broodstocks

Under Alternative 2, six hatchery programs within the UWR would continue to operate as proposed in submitted HGMPs (Subsection 2.2, Alternative 2, Proposed Action/Preferred Alternative). There would continue to be 37full-time jobs associated with the hatchery programs (Subsection 3.7, Socioeconomics). Additionally, these hatchery programs would continue to use local goods and services, which would contribute to personal income or jobs within the UWR as described under Alternative 1 (No-Action). Depending upon the specific fishery and circumstances, the hatchery programs would provide substantial benefits (medium to high effect) to the local economies from anglers targeting hatchery fish. For the popular fisheries targeting predominately hatchery-origin salmon, the hatchery program provides a definitive boost to the local economies in the UWR from the purchasing of tackle, sporting goods, fishing guide services, food, and lodging purchases that facilitate their outdoor activities.

4.7.3. Alternative 3 – Reduce Hatchery Production to Reintroduction Needs

Under Alternative 3, the co-managers would produce only enough hatchery fish for reintroduction of adult salmon and steelhead above the Corps dams (and other areas as deemed appropriate). The hatchery programs would be managed solely for conservation and recovery purposes and providing enough returning adult salmon and steelhead for outplanting in under-utilized historical habitats. This alternative would reduce hatchery smolt releases compared to the No-action alternative.

Since the facilities that are currently in use would be used to capture adults for broodstock and relocation, raise hatchery fish for release would continue to operate, there would be no reduction in jobs, but the fisheries for hatchery-origin fish would likely be reduced. This could have a low to medium effect on the amount of money that is currently funneled into local economies, depending on the specific fisheries affected.

4.7.4. Alternative 4 – Terminate the Existing Hatchery Programs in the Upper Willamette River Basin

Under this alternative, the co-managers would terminate the funding and implementation of all of the hatchery programs in the UWR. All of the activities associated with the hatchery programs would be terminated. This would likely have a medium to high effect on the local economies in the UWR, with the loss of jobs and money associated with the fisheries for hatchery-origin fish.

4.7.5. Alternative 5 – Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits

Under Alternative 5,the co-managers would increase hatchery production to the extent possible using existing hatchery facility capacities and existing water rights. The increased hatchery production would allow for increased fishery harvest opportunities on hatchery produced fish in recreational and commercial fisheries in the ocean and freshwater. This alternative would improve the current local economies within the UWR. While the number of jobs would likely not increase, the revenue generated by the increased fishing opportunity would have a medium to high effect on local economies with the UWR.

4.8. Effects on Environmental Justice

4.8.1. Alternative 1 (No-Action) – Status Quo Hatchery Programs with No Integration of Natural-Origin Fish into Hatchery Broodstocks

Four of the five counties in the analysis area are environmental justice communities of concern because they meaningfully exceed thresholds for low income or minority populations (Table 23). In addition, all native American tribes interested or with reservation lands within the Upper Willamette River basin are of concern. In particular, the Confederated Tribes of the Grand Ronde and Burns Paiute Tribe have expressed interest during public scoping for this EIS (section 3.8).

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:

- No change in the amount of hatchery salmon and steelhead potentially available to native American tribes to meet Tribal fishery needs annually. Depending upon the year, surplus adult spring Chinook salmon from Upper Willamette hatchery programs are taken by Tribal governments for fishery needs.
- A negligible reduction in the amount of surface and ground water around the local vicinity of the hatchery facilities, but would be of no consequence to environmental justice communities (Subsection 4.3.1, Effects on Water Quantity)
- A negligible reduction in water quality around the local vicinity of the hatchery facilities. Impacts are undetectable downstream of the hatchery facilities (Subsection 4.4.2, Effects on Water Quality)
- A medium to high beneficial impact to environmental justice communities from the purchase of goods and services to support hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A medium to high beneficial impact to environmental justice communities from the employment of 37 full-time 2seasonal employees at the hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A medium to high beneficial impact to environmental justice communities from fisheries targeting hatchery salmon and steelhead 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 (Subsection 4.8.2, Effects on Socioeconomics)
- There would be a medium beneficial impact in environmental justice communities through the hiring of guide and charters to take people fishing (Subsection 4.8.2, Effects on Socioeconomics)

4.8.2. Alternative 2 (Proposed Action/Preferred Alternative) – Allow Integration of Natural-origin Fish into Hatchery Broodstocks

Four of the five counties in the analysis area are environmental justice communities of concern because they meaningfully exceed thresholds for low income or minority populations (Table 23). In addition, all native American tribes interested or with reservation lands within the Upper Willamette River basin are of concern. In particular, the Confederated Tribes of the Grand Ronde and Burns Paiute Tribe have expressed interest during public scoping for this EIS (section 3.8). Under Alternative 2, the proposed programs would have ecological, cultural, economic, and social effects and effects on environmental justice communities identical to those described under Alternative 1 (No-Action).

- A negligible reduction in the amount of surface and ground water around the local vicinity of the hatchery facilities, but would be of no consequence to environmental justice communities (Subsection 4.3.1, Effects on Water Quantity)
- A negligible reduction in water quality around the local vicinity of the hatchery facilities. Impacts are undetectable downstream of the hatchery facilities (Subsection 4.4.2, Effects on Water Quality)
- A medium to high beneficial effect to environmental justice communities from the purchase of goods and services to support hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A medium to high beneficial effect to environmental justice communities from the employment of 37 full-time 2seasonal employees at the hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A medium to high beneficial effect to environmental justice communities from fisheries targeting hatchery salmon and steelhead 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 (Subsection 4.8.2, Effects on Socioeconomics)
- There would be a medium beneficial effect in environmental justice communities through the hiring of guide and charters to take people fishing (Subsection 4.8.2, Effects on Socioeconomics)

4.8.3. Alternative 3 – Reduce Hatchery Production to Reintroduction Needs

Under Alternative 3, the proposed programs would have ecological, cultural, economic, and social effects and effects on environmental justice communities similar to those described under Alternative 1 (No-

Action), with the exception of surplus adult salmon being available for Tribal governments. The following is a summary of impacts of Alternative 3 compared to the No-action alternative:

- Elimination of adult hatchery salmon for Tribal use. This would predominately affect the Burns Paiute Tribe, who have relied upon Willamette salmon exclusively for their ceremonial fisheries in the Malheur River. Other Tribal governments would potentially have other hatchery salmon available for tribal needs outside of the Willamette River basin from other hatcheries in the Columbia Basin.
- A negligible reduction in the amount of surface and ground water around the local vicinity of the hatchery facilities, but would be of no consequence to environmental justice communities (Subsection 4.3.1, Effects on Water Quantity)
- A negligible reduction in water quality around the local vicinity of the hatchery facilities. Impacts are undetectable downstream of the hatchery facilities (Subsection 4.4.2, Effects on Water Quality)
- A medium to high beneficial effect to environmental justice communities from the purchase of goods and services to support hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A medium to high beneficial impact to environmental justice communities from the employment of 37 full-time 2seasonal employees at the hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A medium to high beneficial effect to environmental justice communities from fisheries targeting hatchery salmon and steelhead 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 (Subsection 4.8.2, Effects on Socioeconomics)
- There would be a medium beneficial effect in environmental justice communities through the hiring of guide and charters to take people fishing (Subsection 4.8.2, Effects on Socioeconomics).

4.8.4. Alternative 4 – Terminate the Existing Hatchery Programs in the Upper Willamette River Basin

Under this alternative, the co-managers would terminate the funding and implementation of all of the hatchery programs in the UWR. All of the activities associated with the hatchery programs would be terminated. It is expected that this would have a high effect on the environmental justice communities within the UWR.

- A reduction in the amount of surface and ground water around the local vicinity of the hatchery facilities, which would likely have a low effect to environmental justice communities (Subsection 4.3.1, Effects on Water Quantity)
- An increase in water quality around the local vicinity of the hatchery facilities (Subsection 4.4.2, Effects on Water Quality)
- A medium to high negative effect to environmental justice communities from the purchase of goods and services to support hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A medium to high negative effect to environmental justice communities from the employment of 37 full-time 2seasonal employees at the hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A medium to high negative effect to environmental justice communities from the lack of fisheries targeting hatchery salmon and steelhead that decrease the local purchase of supplies such as fishing gear, camping equipment, consumables, and fuel at local businesses; these decreases would have a negative effect on environmental justice communities (Subsection 4.8.2, Effects on Socioeconomics)
- There would be a medium negative impact in environmental justice communities because there would be no hiring of guide and charters to take people fishing (Subsection 4.8.2, Effects on Socioeconomics).

4.8.5. Alternative 5 – Increase Hatchery Production to Support Fisheries Consistent with ESA Impact Limits

Under Alternative 5,the co-managers would increase hatchery production to the extent possible using existing hatchery facility capacities and existing water rights. The increased hatchery production would allow for increased fishery harvest opportunities on hatchery produced fish in recreational and commercial fisheries in the ocean and freshwater. Under Alternative 5, the proposed programs would have larger ecological, cultural, economic, and social effects and effects on environmental justice communities then those described under Alternative 1 (No-Action) and Alternative 2 (Proposed Action/Preferred Alternative).

- A negligible reduction in the amount of surface and ground water around the local vicinity of the hatchery facilities, but would be of no consequence to environmental justice communities (Subsection 4.3.1, Effects on Water Quantity)

- A negligible reduction in water quality around the local vicinity of the hatchery facilities. Impacts are undetectable downstream of the hatchery facilities (Subsection 4.4.2, Effects on Water Quality)
- A high beneficial effect to environmental justice communities from the purchase of goods and services to support hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A high beneficial effect to environmental justice communities from the employment of 37 full-time 2seasonal employees at the hatchery facilities (Subsection 4.8.2, Effects on Socioeconomics)
- A high beneficial effect to environmental justice communities from fisheries targeting hatchery salmon and steelhead 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 (Subsection 4.8.2, Effects on Socioeconomics)
- There would be a high beneficial effect in environmental justice communities through the hiring of guide and charters to take people fishing (Subsection 4.8.2, Effects on Socioeconomics)

5. Cumulative Impacts

5.1. Introduction

The National Environmental Policy Act defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). The cumulative effects of a Proposed Action can be represented as an equation:

Proposed Action + Past Actions + Present Actions + Reasonably Foreseeable Future Actions = Cumulative Effects

The CEQ provides an 11-step process for cumulative effects analyses that is woven into the larger NEPA process and into documents supporting a Federal action (CEQ 1997) (Table 28**Error! Reference source not found.**). Other subsections of this DEIS are relevant as support for this cumulative effects analysis. Chapter 3, Affected Environment, describes the existing conditions (or baseline, for the purposes of this chapter) for each resource and reflects the effects of past actions and present condition. Chapter 4, Environmental Consequences, evaluates the direct and indirect effects of the alternatives on each resource's baseline conditions. This chapter considers the cumulative effects of each alternative in the context of past actions, present conditions, and reasonably foreseeable future actions and conditions.

Table 29. CEQ cumulative effects analysis process and documentation within this DEIS.

		Steps in the Process	Location within this DEIS
Scoping	1	Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals	Subsections 1.2, 1.3, 1.6, and 5.5
	2	Establish the geographic scope for the analysis	Subsections 1.4 and 5.1.1
	3	Establish the time frame for the analysis	Subsection 5.1.1
	4	Identify other actions affecting the resources, ecosystems, and human communities of concern	Subsection 5.4
Describing the	5	Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stresses	

		Steps in the Process	Location within this DEIS
	6	Characterize the stresses affecting these resources, ecosystems, and human communities and relations to regulatory thresholds	Chapter 3
	7	Define a baseline condition for the resources, ecosystems and human communities	
Determining the Environmental Consequences	8	Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities	Chapter 3 and Subsections 5.2 to 5.5
	9	Determine the magnitude and significance of cumulative effects	Subsection 5.6
	10	Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects	Chapter 2
	11	Monitor the cumulative impacts of the selected alternatives and apply adaptive management	Alternative 2 (Proposed Action) includes monitoring and adaptive management as described in HGMPs

5.1.1. Geographic and Temporal Scales

The cumulative effects analysis area includes the project area and the analysis area described in Subsection 1.4, Project Area and Analysis Area. This cumulative effects area was determined based on the geography, topography, waterways, and natural interactions that occur among the ecosystems present in the Willamette and lower Columbia basins. Biological resources and human populations in the Willamette Basin cumulative effects area share a common airshed, common watershed, and common flyway. The Willamette River basin region has a population size of approximately 2.8 million residents in 2016. The greatest number of people live in the Portland metropolitan area near the confluence of the Willamette and Columbia rivers.

The temporal scope of past and present actions for the affected resources encompasses actions that occurred prior to and after the listing of Chinook salmon and winter steelhead under the ESA. This is also the temporal context within which affected resources are described in Chapter 3, Affected Environment, whereby existing conditions are a result of prior and ongoing actions in the DEIS project area.

5.1.2. Other Programs, Plans, and Policies

Provided below are known past, present, and future actions within the Willamette/Lower Columbia Region that have occurred, are occurring, or are reasonably likely to occur within the cumulative effects analysis area. Subsection 5.2, Past Actions, summarizes past actions that affected the cumulative effects analysis area; Subsection 5.3, Present Conditions, describes current overall trends for the area; and Subsection 5.4, Future Actions and Conditions, describes climate change effects, development, habitat restoration, hatchery production, and fisheries activities and objectives supported by agencies and other non-governmental organizations to restore habitat in the cumulative effects analysis area. Finally, Subsection 5.5, Cumulative Effects by Resource, describes how these past, present, and future actions affect each resource evaluated in this DEIS, and specifically focuses on the effects of alternatives, when possible.

5.2. Past Actions

Humans occupied the Willamette/Lower Columbia Region for thousands of years. Before Europeans arrived in the late 1700s, most human inhabitants were hunter-gatherers associated with the Native American Tribes. They relied on aquatic and terrestrial resources for food and clothing, and trees for building materials. Indigenous peoples were known to use the waterways of the region as trading routes. Fire was used in some areas of the Willamette Valley to modify the environment, to clear areas to aid hunting, to promote berry production, and to support the growth of grasses for making nets, baskets, and blankets.

In the 1800s, with the continued increase in European descendants to Oregon, trapping, logging, and fishery harvest were initiated on a large scale, which dramatically altered the landscape. The lower Columbia River near Astoria, Oregon became the first development by European descendants, with fur trading and salmon harvest the principal economies. As time passed, further development, increases in human populations, and natural resource extraction began to substantively affect the natural ecosystems of the Willamette/Lower Columbia region. Land ownership became fragmented with many different owners and purposes (Figure 22). Most of the old-growth forest was harvested by private, state, and federal identities, and much forestland in the lowland, open areas was converted to human-dominated uses, such as agriculture and urban development in private ownership. Many tributary rivers of the Willamette and Columbia rivers were dammed in order to reduce the impacts of flooding on human development and to produce hydroelectric power for society. This dramatically reduced historical habitat for salmonids and reduced the natural characteristics of the rivers below the dams. Other freshwater ecosystem types also declined, floodplains were altered, rivers and streams were channelized, estuary and wetland areas were filled, shorelines were hardened and/or modified, water and air quality declined, pollution and marine traffic increased, and habitat was lost.

Forest and agricultural management continued to drive the local economies. Splash damming occurred in several watersheds as a method to get timber to local mills, which degraded the aquatic habitat dramatically. By the late 1980s, most of the Willamette/Lower Columbia region had been logged at least one time, with the exception of designated wilderness areas or other special designation that helped preserve the local landscape. All of the associated activities that occur with logging, like road building and building stream crossings, became extensive across the landscape. All of these activities severely affected the aquatic habitat in streams and rivers throughout the region. Much of the stream complexity that included large woody debris, deep pool habitat, braided channels, and intact riparian areas was lost. Streams and rivers are now much simpler, less complex, dominated by shallow riffle habitat, and exhibited warmer water temperatures than occurred historically.

Fishery harvest of salmon and steelhead and other aquatic species also increased with the increase in human population across the region. Initially, fishery harvest occurred for subsistence needs but then grew into commercial harvest in the rivers and ocean. By the 1920s, fishery harvest in freshwater had severely affected the salmon and steelhead runs from the millions of pounds harvested annually. Commercial and recreational harvest increased throughout the 20th century until the early 1990s when many of the salmon runs plummeted to all-time low abundances. Fishery harvest rates were dramatically reduced and still occur at much lower harvest rates than occurred historically.

The decreases in salmon and steelhead harvest from overexploitation and reduced productivity from freshwater habitat degradation initiated hatchery programs for salmon and steelhead since the late 1800s in the Willamette/Lower Columbia region in an effort to increase fishery harvest. The hatchery programs increased fishery harvest in many cases, especially during the high ocean survival periods. However, many concerns arose over excessive harvest of natural-origin stocks, interbreeding between hatchery- and natural-origin fish, and competition reduced hatchery production beginning in the 1980s. Over 200 million hatchery fish were released in the Columbia River Basin prior to the mid-1990s

5.3. Present Conditions

As described in Subsection 5.2, Past Actions, substantial changes have occurred to terrestrial and aquatic ecosystems over the last century in the Willamette/Lower Columbia region. Presently, the landscape continues to be managed for agriculture and timber production over a broad landscape given the superb growing conditions for timber and various crops. Several regulations and best management practices have been implemented and are still in effect to help recover and protect aquatic habitat, such as the Oregon State Forest Practices Act and the Northwest Forest Plan (Subsection 1.7.1, Oregon Plan for Salmon and Watersheds). Federal lands in the region have greater riparian protections and are managed to a greater extent for late-successional timber stands than what typically occurs on private timberlands in the region. On private lands, timber harvest occurs regularly on 25-35 year rotations. Over the last two decades, timber harvest has decreased overall on federal lands but increased on private lands. Agriculture, including the growing of grass seed, hazelnuts, nursery stock, and other products, continues to dominant the landscape in the Willamette Valley. Land development has been a major influence in the lower Willamette River Basin, where the Portland metropolitan area occurs. Other communities are expanding such Salem, Corvallis, and Eugene in the Willamette Valley.

The existing hatchery programs within the UWR affect natural-origin salmon and steelhead and their habitat (Subsection 3.4, Salmon and Steelhead and Their Habitats). Operation of the hatchery facilities and release of hatchery fish into the natural environment has affected natural-origin salmon and steelhead through genetic introgression of hatchery fish into the natural population, increased competition and predation from hatchery fish, transfer of pathogens from hatchery fish and/or the hatchery facility to the adjacent river or stream, operation of the hatchery facility using water and discharging effluent, masking of natural population status from having hatchery fish spawning in the wild, incidental fishing effects, and nutrient input from carcasses (Table 25). The extent of adverse effects depends on how the hatchery program is managed, the current status of the natural-origin populations and how affected by the hatchery program, and the condition of the habitat; among other factors.

Hatchery programs within the UWR can also provide benefits to the natural-origin populations by increasing the amount of marine-derived nutrients to the freshwater environment from having hatchery fish spawn naturally and from the outplanting of carcasses from the hatchery facility. Hatchery programs can also potentially benefit the abundance, productivity (in some cases), spatial structure, and diversity of natural populations (McElhany et al. 2000). Current spring Chinook salmon hatchery programs within the UWR are managed for the supplementation or restoration of natural-origin populations and to augment harvest opportunities. The summer steelhead and rainbow trout hatcheries are managed to increase harvest opportunities only.

Hatchery programs within the UWR continue to be operated and managed by ODFW at levels specified in the current HGMPs being considered in this DEIS. Overall production levels have remained stable over the last 10 years. There were some reforms that occurred from implementation of ODFW's Management Plans under its Native Fish Conservation Policy (ODFW 2002), but production levels have remained similar across the UWR overall. For ESA-listed spring Chinook salmon, total hatchery releases for the entire UWR is greater than 4,000,000 smolts annually. In addition, over 550,000 summer steelhead and about 960,000 rainbow trout are released annually in the UWR.

Altogether, the stressors described above under present conditions (e.g., human development and habitat degradation, hatchery practices, and fisheries) are expected to continue under future actions and conditions as described below.

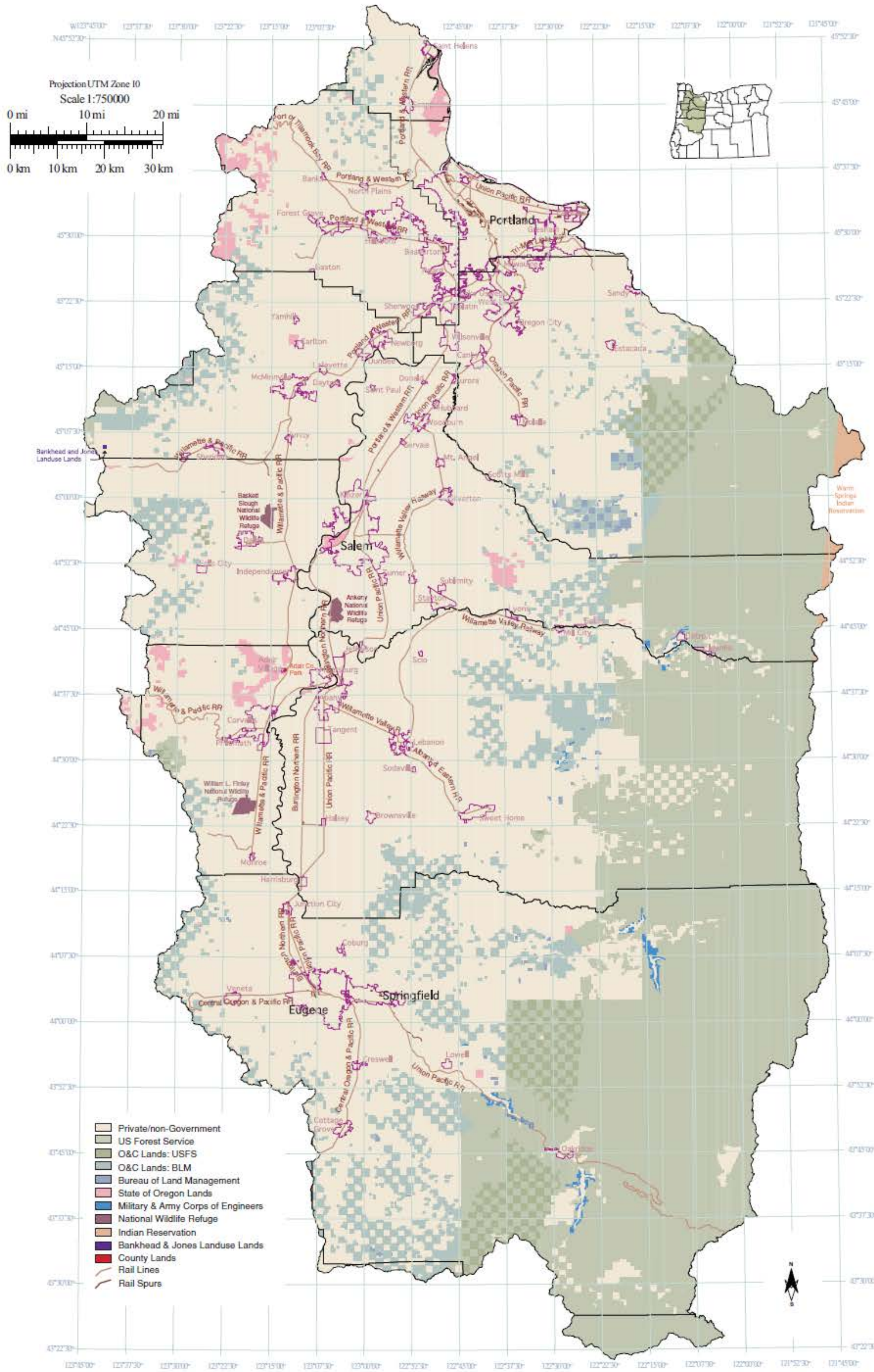

Figure 22. Land ownership throughout the Willamette River Basin. Figure taken from Willamette River Basin Atlas (PNERC 2016).

5.4. Future Actions and Conditions

Reasonably foreseeable future actions and conditions include forest management, land use and development, hatchery production, fisheries, habitat restoration activities, and climate change. Many plans, regulations, and laws are in place at the local, state, and federal levels within the UWR to continue economic benefits while minimizing and/or reducing environmental degradation (Subsection 1.7.1, Oregon Plan for Salmon and Watersheds). However, it is unclear if these plans, regulations, and laws will be successful in meeting their environmental goals and objectives. It is not possible to predict the magnitude of effects from future timber harvest, land use and development, and habitat restoration with certainty for several reasons: (1) the activities may not have yet been formally proposed, (2) mitigation measures specific to future actions may not have been identified for many proposed projects, and (3) there is uncertainty whether mitigation measures for these actions will be fully implemented. However, it is possible to evaluate carefully thought out potential future management and land use scenarios and use a model to predict projected effects to the environment that can be compared between various scenarios (Hulse et al. 2002). In addition, when the projected changes in environment are considered in combination with climate change, a general trend in expected cumulative effects can be estimated for each resource as described in Subsection 5.5, Cumulative Effects by Resource.

Because of the large geographic scope of this analysis, it is not feasible to conduct a detailed assessment of all project-level activities that have occurred, are occurring, or are planned in the future for the cumulative effects analysis area. Rather, this cumulative effects analysis qualitatively assesses the overall trends in cumulative effects considering past, present, and reasonably foreseeable future actions, and describes how the alternatives contribute to those trends.

The Willamette River Basin Planning Atlas (see http://oregonstate.edu/dept/pnw-erc/; accessed November 28, 2017) evaluated the long-term, large-area perspective on the combined effects of the multiple policies and regulations affecting the quality of the environment and natural resources within the Willamette River Basin. The process[19]produced a suite of alternative potential scenarios for the future expressed as maps of land use and land cover that reflected the possible outcomes of the scenarios. The

[19]The Willamette Restoration Initiative was established in 1998 to develop a basin-wide strategy to protect and restore fish and wildlife habitat, increase populations of declining species, enhance water quality, and properly manage flood-plain areas – all within the context of human habitation and continued basin growth (http://www.oregonwri.org).

alternative evaluation included characterizing the current and historical landscape, development of two or more alternative scenarios for the future landscape that reflected varying assumptions about land and water use and the range of stakeholder viewpoints, and the likely effects of these landscape changes and alternative futures on ecological and socio-economic endpoints. Three future alternatives were evaluated; one represented the expected future landscape should current policies be implemented as written and recent trends continue, another reflected additional conservation measures to protect habitat to a greater degree, and the last loosened current policies to allow freer rein to market forces across all components of the landscape, but still within the range of what stakeholders considered plausible. The results of this analysis forms the basis for the discussion below concerning forest management and land use effects.

5.4.1. Forest Management

The modeling results of Hulse et al. (2002) suggested that under the scenario where current practices and trends continued, there would be older aged forests, primarily on federally managed lands, and the area of conifer forest that was greater than 80 year in age was reduced by 19 percent relative to 1990. Under the potential scenario that relaxed current land use practices, there was a greater amount of clear-cutting and less stream and riparian protection. The area of conifer forest greater than 80 years in age declined by 22 percent relative to 1990. Under the additional conservation measures scenario, private forestry lands included a 30-meter or wider riparian buffers on all streams, a gradual decrease in the average clear-cut size, and retention of small patches of legacy trees. The modeled result suggested that there would be a 17% increase in the area with conifer forests aged 80 years and older, relative to 1990. Still, the extent of older age conifer forest would be less than half of what occurred prior to Euro-American settlement

5.4.2. Land Use and Development

The number of people living in the Willamette River Basin is expected to nearly double between the early 2000s and 2050(Hulse et al. 2002). The modeling results of Hulse et al. (2002) suggested that under model scenario where current practices and trends continued, new development occurred only within designated urban growth boundaries and existing rural residential zones. As a result, population density within urban areas almost doubled relative to ca. 1990 (from 9.4 residents/ha in ca .1990 to 18.0 in 2050), while the amount of urbanized land plus land influenced by rural development increased by less than 25 percent. Surface water consumption increased by 57 percent, reflecting a 20 percent increase in diversions for municipal and industrial uses and 65-120 percent increase in diversions for irrigated agriculture. Demands for water for municipal, industrial, and domestic uses were met in most areas; however, stream flows declined.

Under the scenario where land use regulations were relaxed, population densities within urban growth boundaries increased by 55 percent (to 14.6 residents/ha) relative to 1990. Urbanized areas expanded by almost 50 percent and the area influenced by rural structures by 68 percent. Most of this new development occurred on agricultural lands. Furthermore, the location of urban growth boundaries, a consequence of historical settlement patterns, predisposes urban expansion to occupying higher quality soils and particularly valuable agricultural resource lands. Twenty-four percent of 1990 prime farmland was lost. In this scenario, water consumption for out-of-stream uses increased markedly, by 58 percent relative to ca. 1990.

Under the scenario where greater priority on ecosystem protection and restoration, Hulse et al. (2002) found that there was relatively little (2 percent) conversion of agricultural lands to urban or rural development. Yet, 15 percent of ca. 1990 prime farmland was still lost, converted in this scenario mostly to natural vegetation. Conservation strategies on agricultural lands included 30-meter or wider riparian buffers along all streams, conversion of some cropland to native vegetation (in particular natural grasslands, wetlands, oak savannah, and bottomland forests) in high priority conservation zones, establishment of field borders and consideration of wildlife habitat as a factor in crop selection in environmentally sensitive areas, and a 10 percent increase in irrigation efficiency. Areas along the Willamette River that historically had complex, dynamic channels were targeted for restoration of river habitat complexity and bottomland forest. Under this scenario, water consumption increased relative to ca. 1990, but to a somewhat lesser degree than for the other scenarios. No water planning areas were projected to have near zero flow in a moderately dry summer, although an estimated 225 km of 2nd to 4th order streams would still go dry (70% more km than ca. 1990).

5.4.3. Hatchery Production

It is likely that the type and extent of salmon and steelhead hatchery programs and the numbers of fish released in the analysis area will change over time. These changes are likely to reduce effects to natural-origin salmon and steelhead such as genetic effects, competition, and predation risks that are described in Subsection 3.4, Salmon and Steelhead and Their Habitats, especially for those species that are listed under the ESA. For example, effects to natural-origin salmon and steelhead would be expected to decrease over time to the extent that hatchery programs are reviewed and approved by NMFS under the ESA. Hatchery program compliance with conservation provisions of the ESA will ensure that listed species are not jeopardized, and that “take” under the ESA from salmon and steelhead hatchery programs is minimized or avoided.

Where needed, reductions in effects on listed and natural-origin salmon and steelhead may occur through changes such as refinement of times and locations of fish releases to reduce risks of competition and predation; management of overlap in hatchery-origin and natural-origin spawners to meet gene flow objectives; decreased use of isolated hatchery programs; increased use of integrated hatchery programs for conservation purposes; when available, incorporation of new research results and improved best management practices for hatchery operations; decreased production levels; or termination of programs. Similar changes would be expected for non-listed species as well, motivated by the desire to avoid species from becoming listed or further threatening listed species. For example, if the winter steelhead DPS continues to decline, a conservation hatchery program for winter steelhead may be necessary to reintroduce fish back into historical habitat above the federal dams.

Since the existing hatchery programs are managed by ODFW, substantial increases in hatchery production is not likely in the foreseeable future because the hatchery programs in the UWR are primarily federal mitigation programs. These programs are likely to be continually funded, but will not likely increase in production because of the original mitigation obligations when the UWR dams were built.

5.4.4. Fisheries

It is likely that the salmon and steelhead fisheries in the analysis area will change over time. These changes are likely to reduce effects to natural-origin salmon and steelhead listed under the ESA. For example, effects to natural-origin salmon and steelhead would be expected to decrease over time to the extent that fisheries management programs continue to be reviewed and approved by NMFS under the ESA, as evidenced by the beneficial changes to programs that have thus far undergone ESA review. Fisheries management program compliance with conservation provisions of the ESA will ensure that listed species are not jeopardized and that “take” under the ESA from salmon and steelhead fisheries is minimized or avoided. Where needed, reductions in effects on listed salmon and steelhead may occur through changes in areas or timing of fisheries, or changes in types of harvest methods used.

5.4.5. Habitat Restoration

To rehabilitate the negative human-induced changes that have affected biodiversity in the cumulative effects analysis area (Subsection 5.4.1, Forest Management and Subsection 5.4.2, Land Development) habitat conservation and restoration activities are occurring in the UWR. Funding for habitat conservation and restoration is likely to continue into the foreseeable future because the majority of habitat restoration projects occurs from Federal funding to the state of Oregon's Watershed Enhancement Board to local Watershed Councils for on-the-ground implementation of projects. As funding continues for habitat restoration projects, projects that reduce the most critical limiting factors and threats within the watershed will be prioritized. These habitat restoration projects will continue to enhance the conservation and recovery of the watersheds and the fish and wildlife species within them.

5.4.6. Climate Change

The changing climate is becoming recognized as a long-term trend that is occurring throughout the world. Within the Pacific Northwest, Ford (2011) summarized expected climate changes in the coming years as leading to the following physical and chemical changes (certainty of occurring is in parentheses):

- Increased air temperature (high certainty)
- Increased winter precipitation (low certainty)
- Decreased summer precipitation (low certainty)
- Reduced winter and spring snowpack (high certainty)
- Reduced summer stream flow (high certainty)
- Earlier spring peak flow (high certainty)
- Increased flood frequency and intensity (moderate certainty)
- Higher summer stream temperatures (moderate certainty)
- Higher sea level (high certainty)
- Higher ocean temperatures (high certainty)
- Intensified upwelling (moderate certainty)
- Delayed spring transition (moderate certainty)
- Increased ocean acidity (high certainty)

These changes will affect human and other biological ecosystems within the cumulative effects analysis area (Ecology 2012a). Changes to biological organisms and their habitats are likely to include shifts in timing of life history events, changes in growth and development rates, changes in habitat and ecosystem structure, and rise in sea level and increased flooding (Littell et al. 2009; Johannessen and Macdonald 2009).

For the Pacific Northwest portion of the United States, Hamlet (2011) notes that climate changes will have multiple effects. Expected effects include:

- Overtaxing of storm water management systems at certain times
- Increases in sediment inputs into water bodies from roads
- Increases in landslides
- Increases in debris flows and related scouring that damages human infrastructure
- Increases in fires and related loss of life and property
- Reductions in the quantity of water available to meet multiple needs at certain times of year (e.g., for irrigated agriculture, human consumption, and habitat for fish)
- Shifts in irrigation and growing seasons
- Changes in plant, fish, and wildlife species' distributions and increased potential for invasive species
- Declines in hydropower production
- Changes in heating and energy demand
- Impacts to homes along coastal shorelines from beach erosion and rising sea levels

The most heavily affected ecosystems and human activities along the Pacific coast are likely to be near areas having high human population densities, and the continental shelves off Oregon and Washington (Halpern et al. 2009).

5.5. Cumulative Effects by Resource

Provided below is an analysis of the cumulative effects of forest management, land development, hatchery production, fisheries, habitat restoration, and climate change under the alternatives and for each resource analyzed in this DEIS. The resources for which cumulative effects are described are:

- Water quantity
- Water quality
- Salmon and Steelhead and Their Habitats
- Other Fish and Their Habitats
- Wildlife
- Socioeconomics
- Environmental justice

5.5.1. Water Quantity

Subsection 3.2, Water Quantity, describes the baseline conditions of water quantity, and Subsection 4.2, Effects on Water Quantity, evaluates the direct and indirect effects of the five alternatives of the hatchery programs within the UWR. All of the hatchery facilities divert water from nearby sources, pass the water through the hatchery, and then discharge the water back into the stream or river. There is typically a net gain of water at the point of discharge from the hatchery if groundwater sources are used at the hatchery. The amount of water available in the stream or river at the hatchery and local groundwater sources is the result of many years of past practices of forest management, land use and development, and climate change.

Future actions in the overall cumulative effects analysis area are described in Subsection 5.4, Future Actions and Conditions. This subsection considers effects that may occur as a result of the alternatives being implemented at the same time as other anticipated future actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on water quantity.

Successful operation of hatcheries depends upon the use of water from adjacent streams and rivers and groundwater at the hatchery facilities. The hatchery programs are subject to the amount and availability of water at the hatchery facility by all of the other prior influences and uses. The primary upstream influence on water quantity for the hatchery facilities within the UWR is forest management and climate change. Land use and development and urbanization are not primary influences because all of the major population areas are primarily downstream of the hatchery facilities.

Habitat restoration could principally influence water quantity, especially if diversions are eliminated. Fisheries do not influence water quantity. It is uncertain how water quantity will be affected at the hatchery facilities due to Federal land management being more conservative now and into the future for recovering aquatic habitat and climate change likely leading to less water being available during the low streamflow periods of the summer (surface and groundwater). Given these future conditions, it is likely water quantity in the analysis area will be the same or slightly worse than current conditions.

All of the five alternatives evaluated in Subsection 4.2, Effects on Water Quantity, resulted in negligible impacts on water quantity from the operation of the hatchery facilities. Therefore, hatchery programs are not likely to influence future conditions for water quantity downstream of the hatchery facilities. None of the five alternatives evaluated in this DEIS are likely to contribute to the issues related to water quantity downstream of the hatchery facility because there is no net loss of water from use at the hatchery. At Willamette Hatchery, water used through the hatchery is discharged into a different stream before flowing together downstream (area affected is approximately 7,400 feet in length (Table 3).

In summary, cumulative effects from forest management, land use and development, climate change, and habitat restoration would likely impact water quantity in the analysis area more than the direct or indirect effects of the hatchery water withdrawal that is described in Subsection 4.2, Effects on Water Quantity, under all alternatives. However, implementation of any of the five alternatives would not affect or contribute to the overall trend in cumulative effects on water quantity within the UWR.

5.5.2. Water Quality

Subsection 3.3, Water Quality, describes the baseline conditions of water quality, and Subsection 4.3, Effects on Water Quality, evaluates the direct and indirect effects of the five alternatives of the hatchery programs within the UWR. All of the hatchery facilities divert water from nearby sources, pass the water through the hatchery, and then discharge the water back into a stream or river. The hatchery fish and operations add substances and diseases to the water within the specified limits of the NPDES permit for each hatchery.

Future actions in the overall cumulative effects analysis area are described in Subsection 5.4, Future Actions and Conditions. This subsection considers effects that may occur as a result of the alternatives being implemented at the same time as other anticipated future actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on water quality.

The most common substances found in the effluent of UWR hatcheries are ammonia, nitrogen, phosphorus, and antibiotics. Bacteria, parasites, and viruses can also be transmitted from the hatchery fish to the effluent. These substances and organisms are a byproduct of hatchery fish rearing and treating the fish to ensure high survival while being grown at very high densities. Most of the streams and rivers within the UWR have reaches that are on the EPA's 303(d) list for impaired waters. Water temperature, fecal coliform, sedimentation, dissolved oxygen are the current 303(d) listings for the UWR, regardless of whether there is a hatchery facility in the basin or not (Figure 2). Lack of riparian shade, effects of dams, and forestry practices are some of the causes for the current 303(d) listings. The hatchery facilities are not identified as a cause for any of the current 303(d) listings within the UWR (ODEQ 2013).

As long as the hatchery facilities continue to operate as evaluated under the alternatives of this DEIS (Chapter 4, Environmental Consequences), the hatcheries will continue to discharge substances, viruses, and bacteria into the effluent of the hatchery facility. However, as evaluated in Subsection 4.3, Effects on

Water Quality, the effects are minimal and short-lived because the effluent is diluted as it travels downstream and becomes undetectable a few hundred meters downstream (Bartholomew et al. 2013). The 303(d) list impairments for water quality are expected to continue into the foreseeable future in areas where hatchery facilities are (and are not) present. Future forest management on non-federal lands, land development, and climate change can be expected to further impair water quality on existing 303(d) stream reaches due to increases in water temperature, continued agricultural practices, and logging activities. However, such impairments from these activities would not be increased by hatchery operations under any alternative.

5.5.3. Salmon and Steelhead and Their Habitats

Subsection 3.2, Salmon and Steelhead, describes baseline conditions for salmon and steelhead. These conditions are the result of many years of dam construction and operation, forest management, climate change, land use and development, habitat restoration, hatchery production, and fisheries (Lackey et al. 2006). The expected direct and indirect effects of the alternatives on salmon and steelhead are described in Subsection 4.4, Effects on Salmon and Steelhead and Their Habitat.

Future actions are described in Subsection 5.4, Future Actions and Conditions. This subsection describes cumulative effects on salmon and steelhead that may occur as a result of implementing any of the alternatives at the same time as other future actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on salmon and steelhead.

Salmon and steelhead abundance naturally alternates between high and low levels on large temporal and spatial patterns that may last centuries and on more complex ecological scales than can be easily observed (Rogers et al. 2013). Cumulative effects on salmon and steelhead may be greater than the direct and indirect effects of each alternative as analyzed in Subsection 4.4, Effects on Salmon and Steelhead and Their Habitats, under all alternatives. This subsection provides brief overviews of the effects of forest management, climate changes, land use and development, habitat restoration, hatchery production, and fisheries on salmon and steelhead.

Within the UWR, the effects of forest management on salmon and steelhead have been widespread across the landscape. Timber harvest on unstable slopes and riparian areas has led to the decoupling of watershed processes. Improperly located, constructed, or maintained roads have degraded stream flow and sediment supply processes. The effects of these actions create conditions in streams where they lack complex structure needed to retain gravels for spawning and invertebrate production, and the connectivity with shallow, off-channel habitat areas that once provided refugia from floods, over-wintering and hiding cover, and productive early-rearing habitat. The legacy effects of splash dams to transport logs continues to inhibiting stream structural complexity and available spawning gravel in several stream systems(ODFW and NMFS 2011). Some species of salmon have been more impacted by forest management than other species that spend a minimal time rearing as juvenile fish in freshwater (Meehan 1991). ESA-listed spring Chinook and salmon and steelhead have been and are impacted from these actions (ODFW and NMFS 2011). Future projections suggest salmon and steelhead and their habitat will continue to be impacted by forest management (Hulse et al. 2002). However, the magnitude and severity of those impacts varies greatly depending upon land ownership. Private, industrial timberlands are expected to be harvested in compliance with Oregon Forest Practices Act, which are less protective of riparian and aquatic habitats than would occur from timber harvest on Federal lands.

One of the largest threats to UWR spring Chinook salmon and winter steelhead is from the effects of construction and continued operation of the dams that were built as part of the Willamette Project for flood control and power production. Specific threats from flood control and hydropower management include: 1) blocked or impaired fish passage for adults and juveniles, 2) loss of some riverine habitat (and associated functional connectivity) due to reservoirs, 3) reduction in instream flow volume due to water withdrawals, 4) lack of sediment transport and role in habitat function, 5) altered physical habitat structure, and 5) altered water temperature and flow regimes (ODFW and NMFS 2011). Within the UWR, the flood control structures block or delay adult fish passage to major portions of the historical holding and spawning habitat for UWR spring Chinook salmon (North Santiam, South Santiam, McKenzie and Middle Fork Willamette subbasins), and for UWR winter steelhead in the North Santiam and South Santiam basins. In addition, past operations and current configurations of the Willamette Project have effected several salmonid life stages, through impacts on water flows, water temperatures, total dissolved gas (TDG), sediment transport, and channel structure.

The Biological Opinion for the Willamette Project describes a Reasonable and Prudent Alternative (RPA) with a suite of actions to be implemented that would avoid jeopardizing ESA-listed spring Chinook salmon and winter steelhead (NMFS 2008). Several actions have been implemented including the rebuilding of the fish collection facilities at Minto dam and Foster dam to allow safer handling, collection, and transporting of adult salmon and steelhead above the federal dams. Additional actions to improve juvenile fish passage through the reservoirs and dams in the North Santiam, McKenzie, and Middle Fork Willamette populations are in the planning phases. A water temperature control tower in planned for

Detroit reservoir/dam in the North Santiam River. All of these future actions will significantly benefit these salmon and steelhead populations and their habitat once implemented.

Effects of land management on UWR spring Chinook salmon and steelhead include current land use practices causing limiting factors, as well as current practices that are not adequate to restore limiting factors caused by past practices (legacy impacts). Past land use (including agricultural, mining and grazing activities, diking, damming, development of transportation, and urbanization) are significant factors now limiting viability of UWR spring Chinook salmon and winter steelhead. These factors severed access to historically productive habitats, and reduced the quality of many remaining habitat areas by weakening important watershed processes and functions that sustained them.

Agricultural development, especially along lowland valley bottoms in the mainstem Willamette River reaches, and lower reaches of principal subbasins has directly impacted riparian areas and floodplains. Historical floodplain habitats were also lost through the filling of wetlands and levee construction. Runoff from agricultural lands where pesticides, herbicides, and fertilizers are applied has reduced sediment and water quality;

- Livestock grazing has directly impacted soil stability (trampling) and streamside vegetation (foraging), and delivered potentially harmful bacteria and nutrients (animal wastes) to streams;
- Construction of small scale dams, culverts, and other barriers has limited access to spawning and rearing habitats;
- Urban and rural-residential development in the lower subbasins and the mainstem Willamette River floodplain has led to the degradation of riparian and floodplain conditions, as well as an alteration of the natural drainage network due to roads, ditches and impervious surfaces. For example, prior to the 1850s, the lower Willamette River was comprised of approximately 80 percent shallow water and 20 percent deep habitat. Those proportions have now reversed, and the river is 80 percent deep and 20 percent shallow water habitat.
- Sand and gravel mining along some Willamette basin streams has impacted stream channels by altering instream substrate and sediment volumes.

Together these activities continue to inhibit the amount and quality of spawning and rearing habitats available to UWR spring Chinook salmon and winter steelhead populations, principally by severing access to historically productive habitats, and by weakening the important watershed processes and functions that once created and maintained healthy freshwater ecosystems for UWR spring Chinook salmon and winter steelhead production. Today, many streams have lower frequency and complexity of pools compared to historical conditions. And many of those that remain lack the complex structure needed to retain gravels for spawning and invertebrate production, and the connectivity with shallow, off-channel habitat areas that once provided refugia from floods, over-wintering and hiding cover, and productive early-rearing habitat.

In addition, accidental discharges of oil, gas, and other hazardous materials and the potential for landowner and developer noncompliance with regulations continue to affect aquatic habitat used by salmon and steelhead. Although regulatory changes for increased environmental protection (such as local critical areas ordinances), monitoring, and enforcement have helped reduce impacts of development on salmon and steelhead in freshwaters, development and noncompliance may continue to reduce salmon and steelhead habitat, decrease water quality, and contribute to salmon and steelhead mortality.

Today, many land use practices are better than they were in the past and, as a result, many stream reaches once degraded by past practices are recovering. Many landowners now understand the advantages of good conservation practices and are changing their approaches to contribute to restoration of healthy watershed processes and functions. A suite of regulatory programs have also been implemented to protect and restore salmon and steelhead physical habitat and water quality. Together these changes are improving the physical quality of salmon and steelhead habitats and providing more suitable environments for spawning and rearing.

The primary cause of these continuing effects on salmon and steelhead habitat is the continued increase in human population in the cumulative effects analysis area (Subsection 5.4.2, Land Development). Effects from development are expected to affect salmon and steelhead similarly under all alternatives because preferred development sites would not change by alternative scenario.

Restoration of habitat in the cumulative effects analysis area will improve salmon and steelhead habitat in general under all alternatives, with particular benefits to environments considered to be important for the survival and reproduction of fish. As a result, habitat restoration would be expected to improve fish survival in local areas. However, habitat restoration alone will not substantially increase survival and abundance of salmon and steelhead. In addition, habitat restoration is dependent on continued state or Federal funding, which is difficult to predict. Benefits from habitat restoration are expected to affect salmon and steelhead survival similarly under all alternatives.

The effects to natural-origin salmon and steelhead from releases of hatchery fish in the future is expected to be stable or decrease over time for a variety of reasons (Subsection 5.4.4, Hatchery Production).If abundance and productivity of natural-origin populations of salmon and steelhead increases enough to provide fishery opportunities on healthy natural-origin runs, many of the existing hatchery programs may be reduced or terminated. However, unless access to historical habitat is improved by successful juvenile fish passage, the hatchery mitigation programs in the UWR are not likely to be reduced due to the ongoing impacts of Willamette Project dams and reservoirs.

The effects of climate change on salmon and steelhead are described in general in ISAB (2007), and would vary among species and among species' life history stages. Effects of climate change may affect the life history of UWR spring Chinook salmon and winter steelhead in the cumulative effects analysis area (Glick et al. 2007; Mantua et al. 2009). Cumulative effects from climate change, particularly changes in streamflow and water temperatures, would likely impact hatchery-origin and natural-origin salmon and steelhead life stages in various ways as shown in **Table 29**. Under all alternatives, impacts to salmon and steelhead from climate change are expected to be similar, because climate change would impact fish habitat under each alternative in the same manner.

Table 30. Examples of potential impacts of climate change by salmon and steelhead life stage under all alternatives.

Life Stage	Effects
Egg	1) Increased water temperatures and decreased flows during spawning migrations for some species would increase pre-spawning mortality and reduce egg deposition. 2) Increased maintenance metabolism would lead to smaller fry. 3) Lower disease resistance may lead to lower survival. 4) Changed thermal regime during incubation may lead to lower survival. 5) Faster embryonic development would lead to earlier hatching. 6) Increased mortality for some species because of more frequent winter flood flows as snow level rises. 7) Lower flows would decrease access to or availability of spawning

Life Stage	Effects
Spring and Summer Rearing	1) Faster yolk utilization may lead to early emergence. 2) Smaller fry are expected to have lower survival rates. 3) Higher maintenance metabolism would lead to greater food demand. 4) Growth rates would be slower if food is limited or if temperature increases exceed optimal levels; growth could be enhanced where food is available, and temperatures do not reach stressful levels. 5) Predation risk would increase if temperatures exceed optimal levels. 6) Lower flows would decrease rearing habitat capacity. 7) Sea level rise would eliminate or diminish the rearing capacity of tidal wetland habitats for rearing salmon, and would reduce the area of estuarine beaches for spawning by forage fishes.
Overwinter Rearing	1) Smaller size at start of winter is expected to result in lower winter survival. 2) Mortality would increase because of more frequent flood flows as snow level rises. 3) Warmer winter temperatures would lead to higher metabolic demands, which may also contribute to lower winter survival if food is limited, or higher winter survival if growth and size are enhanced. 4) Warmer winters may increase predator activity/hunger, which can also contribute to lower winter survival.

Sources: ISAB (2007), Glick et al. (2007), Beamish et al. (2009), and Beechie et al. (2013).

In summary, habitat capacity has been reduced significantly in most freshwater areas, and it is unknown to what extent this capacity will be restored with continual anthropogenic impacts still occurring across the landscape. To the extent aquatic habitat will continue to degrade over time under all alternatives, the abundance and productivity of natural-origin salmon and steelhead populations may continue to be reduced in the future. Hatchery-origin salmon and steelhead may be similarly affected, but likely to lesser extent.

The potential benefits of habitat restoration actions within the cumulative effects analysis area may not fully mitigate for the impacts of climate change and development on fish and wildlife and their associated habitats. However, climate change and land use and development will continue to occur over time and affect aquatic habitat, while habitat restoration (which is dependent on funding and is localized in areas where agencies and stakeholders' habitat restoration actions occur) is less certain under all alternatives.

The current impacts from the operation of the hatchery facilities and release of hatchery fish are likely to continue into the future. Since hatchery production is not likely to increase given current constraints with funding and hatchery capacity, hatchery impacts will most likely remain constant into the future. However, if natural-origin salmon and steelhead populations continue to decrease from other factors, then hatchery impacts could increase (e.g., higher pHOS from having fewer natural-origin fish spawning in the wild).

Impacts from commercial and recreational fisheries in freshwater and in the ocean that catch hatchery fish produced from UWR hatcheries will likely remain similar to current levels into the future. The fisheries management structure is based upon the status of natural-origin salmon and steelhead, and not on the abundance of hatchery fish. Therefore, fisheries will continue to be restricted if natural-origin fish abundance decreases, and liberalized in years when abundance increases. The harvest of available hatchery fish will be within the limits established for natural-origin salmon and steelhead, and thus not likely change substantially in the future.

Although none of the alternatives would affect the overall trend in cumulative effects on salmon and steelhead, Alternative 3 and Alternative 4 could help mitigate some of the negative genetic and ecological effects on natural-origin steelhead and salmon associated with hatchery programs. That is, because under Alternative 3 hatchery programs would be reduced, and under Alternative 4 hatchery production would be terminated. However, since the existing hatchery programs overall result in relatively low impacts to the affected species populations, reducing or eliminating these hatchery programs would not substantially affect the adverse risks facing these populations in the future due to other factors (dams, forest management, land use and development, climate change, fisheries). Substantial improvements to the status of natural-origin salmon and steelhead within the UWR is not likely if the current hatchery programs were reduced and/or eliminated. Alternative 5 could potentially increase the genetic and ecological impacts associated with hatchery programs, but increasing the number of hatchery fish released is not expected to increase the risk to natural-origin fish because the other factors affecting abundance and productivity outweigh the hatchery effects.

5.5.4. Other Fish Species and Their Habitats

Subsection 3.5, Other Fish and Their Habitat, describes the baseline conditions of fish species other than salmon and steelhead. These conditions are the result of many years of forest management, climate change, land use and development, habitat restoration, hatchery production, and fisheries. The direct and indirect effects of the alternatives on other fish species are described in Subsection 4.5, Effects on Other Fish and Their Habitat.

Future actions in the overall cumulative effects analysis area are described in Subsection 5.4, Future Actions and Conditions. This subsection considers effects that may occur as a result of the alternatives being implemented at the same time as other anticipated future actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on fish species other than salmon and steelhead.

Other fish species that have a relationship to salmon and steelhead include rainbow trout, coastal cutthroat trout, sturgeon, lamprey, forage fish, and other resident freshwater fish, both native and non-native to the UWR (Subsection 3.5, Other Fish and Their Habitats). Similar to salmon and steelhead species, these fish species require and use a diversity of habitats. However, similar to effects described above for salmon and steelhead, these other fish species, including bull trout may also be affected by climate change and development because of the overall potential for loss or degradation of aquatic habitat or the inability to adapt to warmer water temperatures. In addition, climate change and land use and development may attract non-native aquatic plants that may, over time, out-compete native aquatic plants that provide important habitat to native fish (Patrick et al. 2012). Non-native fish, such as bass and walleye may actually thrive and increase in abundance and productivity as the climate (and water temperatures) warms, further negatively affecting UWR spring Chinook salmon and winter steelhead viability.

As discussed in Subsection 5.4.3, Habitat Restoration, the extent to which habitat restoration actions may mitigate impacts from climate change and development is difficult to predict. These actions most likely will not fully mitigate for the effects of climate change and development.

As discussed in Subsection 5.4.4, Hatchery Production, changes in hatchery programs over time may affect other fish species that have a relationship to salmon and steelhead. For example, reductions in hatchery production or terminations of hatchery programs may decrease the prey base available for other fish species (like cutthroat and bull trout) that use salmon and steelhead as a food source.

In summary, cumulative effects from dams, forest management, climate change, land use and development, habitat restoration, and hatchery production on other fish species would likely result in a decrease in the abundance of those fish species in the analysis area. Cumulative effects on fish species that compete, prey on, or are prey items for salmon and steelhead may be greater than the direct and indirect effects described under Subsection 4.5, Other Fish and Their Habitats. None of the alternatives would affect the overall trend in cumulative effects on other fish species because the range of production levels under the alternatives would be a small fraction of the total salmon and steelhead in the analysis area that these other fish species could compete with, prey on, or be prey items for.

5.5.5. Wildlife

Subsection 3.6, Wildlife, describes the baseline conditions for wildlife. These conditions represent the effects of many years of dams, forest management, climate change, land use and development, habitat restoration, and hatchery production. The expected direct and indirect effects of the alternatives on wildlife are described in Subsection 4.6, Effects on Wildlife.

Future actions are described in Subsection 5.4, Future Actions and Conditions. This subsection considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on wildlife.

The cumulative effects on wildlife from the alternatives varies depending upon the specific alternative. Alternative 1 and Alternative 2 are expected to provide benefits to nearly all wildlife species because hatchery fish are an important prey item for wildlife. These benefits would help offset some of the impacts expected in the future due to forest management and land use and development and the resultant loss in natural production of salmonids. Alternative 3 and Alternative 4, which would reduce or eliminate hatchery production and the number of fish released, would result in negligible, and negative impacts to wildlife species from the loss of salmon and steelhead as a potential food source. When combined with future forest management and land use and development, Alternative 3 and Alternative 4 would have the greatest negative effects on wildlife. Alternative 5, which increases hatchery releases could have a positive effect on wildlife.

5.5.6. Socioeconomics

Subsection 3.7, Socioeconomics, describes the baseline conditions for socioeconomics. These conditions represent the effects of many years of dams, forest management, climate change, land use and development, habitat restoration, and hatchery production. The expected direct and indirect effects of the alternatives on socioeconomics are described in Subsection 4.7, Effects on Socioeconomics.

Future actions are described in Subsection 5.4, Future Actions and Conditions. This subsection considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on socioeconomic resources.

Although unquantifiable, climate change and land use and development actions, and changes in hatchery production and fisheries may reduce the number of salmon and steelhead available for sport fisheries (catch and release on natural-origin fish) over time as described in Subsection 5.5.3, Salmon and Steelhead and Their Habitats. This, in turn, may reduce angler expenditure and economic revenue relative to conditions considered in Subsection 4.7, Effects on Socioeconomics. Likewise, it may reduce the number of salmon and steelhead available to the public as a food source and may increase reliance on other consumer goods or increase travel costs to participate in other fisheries.

The potential benefits of habitat restoration actions within the cumulative effects analysis area are difficult to quantify. These actions may not fully mitigate for the impacts of climate change and land use and development.

As discussed in Subsection 5.4.4, Hatchery Production, and Subsection 5.4.5, Fisheries, changes in hatchery programs and fisheries may occur over time. Changes in hatchery programs may affect the socioeconomic effects from hatchery production of salmon and steelhead. For example, reductions in hatchery production or terminations of hatchery programs may decrease the number of fish available for harvest, decrease associated angler expenditures and revenues generated from fishing, and reduce the number of salmon and steelhead available to the general public.

In summary, it is likely that cumulative effects from dams, forest management, climate change, land use and development, and hatchery production would decrease the number of fish available for sport and commercial fisheries and reduce angler expenditure and economic revenue relative to conditions considered in Subsection 4.7, Socioeconomics.

5.5.7. Environmental Justice

Subsection 3.8, Environmental Justice, describes environmental justice communities and counties of concern in the analysis area. Environmental justice user groups and communities of concern within the cumulative effects analysis area include people that fish for salmon and steelhead and low income or minority communities. The expected direct and indirect effects of the alternatives on environmental justice are described in Subsection 4.8, Effects on Environmental Justice.

Future actions are described in Subsection 5.4, Future Actions and Conditions. This subsection considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on environmental justice user groups and communities of concern.

Forest management, dams, climate change and land use and development actions, and changes in hatchery production and fisheries may reduce the number of salmon and steelhead available for sport fisheries (catch and release on natural-origin fish) over time as described in Subsection 5.5.3, Salmon and Steelhead and Their Habitats. This, in turn, may reduce fishing opportunity in the analysis area relative to conditions considered in Subsection 4.8, Effects on Environmental Justice.

The potential benefits of habitat restoration actions within the cumulative effects analysis area are difficult to quantify. These actions may not fully mitigate for the impacts of climate change and land use and development on the abundance of fish that would be available for commercial or recreational harvest.

As discussed in Subsection 5.4.3, Hatchery Production, and Subsection 5.4.4, Fisheries, changes in hatchery programs and fisheries may occur over time. Changes in hatchery programs may affect the number of salmon and steelhead available for harvest by environmental justice communities.

In summary, it is likely that cumulative effects from climate change, development, and hatchery production would decrease the number of fish available for harvest relative to conditions considered in Subsection 4.8, Effects on Environmental Justice. However, none of the alternatives would affect the overall trend in cumulative effects on environmental justice because the range of production levels under the alternatives would result in a small fraction of the total harvestable salmon and steelhead in the analysis area available to environmental justice communities.

5.6. Summary of Effects

Table 30 summarizes the combined effects of past, present, and reasonably foreseeable actions, other than the Proposed Action and alternatives (summarized above), affecting the environmental resources reviewed in this DEIS, affected by dams, forest management, climate change, land use and development, habitat restoration, hatchery production, and fisheries.

Table 31 summarizes the conclusions made above on the impacts of past, present, and reasonably foreseeable actions when combined with the impacts of the Proposed Action. Definitions for effects terms are the same as described in Subsection 3, Affected Environment, and Subsection 4, Environmental Consequences. The relative magnitude and direction of impacts is described using the following terms:

- Undetectable: The impact would not be detectable.
- Negligible: The impact would be at the lower levels of detection, and could be either positive or negative.
- Low: The impact would be slight, but detectable, and could be either positive or negative.
- Moderate: The impact would be readily apparent, and could be either positive or negative.
- High: The impact would be greatly positive or severely negative.

Table 31. Summary of effects of past, present, and reasonably foreseeable future actions on the affected resources evaluated in this DEIS.

Affected Resource	**Past Actions**	**Present Actions**	**Reasonable Foreseeable Future Actions**	**Past, Present, and Reasonably Foreseeable Future Actions**
Water Quantity	Negligible to low negative due to water withdrawals from human development	Negligible to low negative	Low negative	Low negative
Water Quality	Moderate	Moderate	Moderate	Moderate

Affected Resource	Past Actions	Present Actions	Reasonable Foreseeable Future Actions	Past, Present, and Reasonably Foreseeable Future Actions
Salmon and Steelhead and Their Habitat	Moderate to high negative due to land use and development, past fishery, hatcheries, and habitat management practices	Mixed (negligible to moderate negative, to low positive) due to ESA compliance and improved fishery, hatcheries, habitat management practices, and habitat restoration, depending on population	Mixed (moderate negative to low positive), depending on population	Mixed (moderate negative to low positive), depending on population
Other Fish and Their Habitats	Mixed (negligible to low negative, to negligible positive) depending on species, due to land use and development, past fishery, hatcheries, and habitat management practices	Mixed (negligible negative to negligible positive) depending on species	Negligible to low negative depending on species	Negligible to low negative depending on species
Wildlife	Mixed (negligible to low negative, to low positive) due to habitat degradation and hatchery-origin	Low positive	Negligible to low positive	Low positive

Affected Resource	Past Actions	Present Actions	Reasonable Foreseeable Future Actions	Past, Present, and Reasonably Foreseeable Future Actions
	salmon and steelhead as a food source			
Socioeconomics	Moderate positive from benefits to recreational fisheries and tribal fisheries, although some have been reduced in recent years as numbers of fish available to harvest have declined	Low positive due to declines in harvest opportunities	Low positive	Low positive
Environmental Justice	Low to moderate negative due to reductions in fish available for use by communities of concern and populations of concern such as treaty Indian tribes	Low negative to low positive	Negligible negative	Low negative

Table 32. Summary of the cumulative effects of Alternative 2, Proposed Action/Preferred Alternative.

Affected Resource	Baseline	Past, Present, and Reasonably Foreseeable Future Actions	Proposed Action	Cumulative Effects of the Proposed Action
Water Quantity	Mixed (negligible negative to negligible positive)	Low negative	Negligible negative	None
Water Quality	Moderate	Moderate	Moderate	Moderate
Salmon and Steelhead and Their Habitat	Mixed (negligible to moderate negative, to low positive) due to ESA compliance and improved fishery, hatchery, habitat management practices, and habitat restoration, depending on population	Mixed (moderate negative to low positive), depending on population	Negligible negative	None
Other Fish and Their Habitats	Mixed (negligible negative to negligible positive) depending on species	Negligible to low negative depending on species	Mixed (negligible negative to negligible positive) depending on species	None
Wildlife	Low negative	Low positive	Negligible positive	None
Socioeconomics	Moderate positive	Low positive	Moderate positive	None

Affected Resource	Baseline	Past, Present, and Reasonably Foreseeable Future Actions	Proposed Action	Cumulative Effects of the Proposed Action
Environmental Justice	Low negative to low positive	Low negative	Negligible positive	None

6. List of Persons and Agencies Contacted and Consulted

The following were consulted during the development and assessment described herein:

- Bonneville Power Administration
- Burns-Paiute Tribe
- Environmental Protection Agency
- Grande Ronde Tribe
- Oregon Department of Environmental Quality
- Oregon Department of Fish and Wildlife
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- U.S. Forest Service

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8. Distribution List

State Agencies

- Oregon Department of Environmental Quality
- Oregon Department of Fish and Wildlife

Federal Agencies

- Army Corps of Engineers
- Bonneville Power Administration
- Bureau of Land Management
- Environmental Protection Agency
- Forest Service

Native American Tribes in Oregon

- Burns Paiute Tribe
- Columbia River Inter-Tribal Fish Commission
- The Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians
- The Confederated Tribes of Grand Ronde
- Confederated Tribes of Siletz Indians
- Confederated Tribes of the Umatilla Indian Reservation
- Confederated Tribes of the Warm Springs Reservation of Oregon
- Coquille Indian Tribe
- Cow Creek Band of Umpqua Tribe of Indians
- The Klamath Tribe

Organizations and Associations

- Coastal Conservation Association
- Conservation Angler
- McKenzie River Flyfishers
- McKenzie River Guides Association
- Native Fish Society
- Northwest Sportfishing Industry Association
- Trout Unlimited

Individuals

(An extensive distribution list of individuals were notified by email that contained an electronic link to the DEIS.)

9. List of Preparers

Name/Professional Discipline	Affiliation	Education
Lance Kruzic, Fisheries Biologist NMFS Project Manager	NMFS	B.S. Fisheries Science, M.S. Fisheries Ecology
Chuck Peven, Fisheries Biologist	Peven Consulting, Inc.	B.S. and M.S. in Fisheries Science

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1 **11. APPENDIX A**

2 Table 1. List of the HGMPs and primary hatchery facility under consideration in this DEIS.

Hatchery Program	Hatchery Facility (primary)	HGMP Reference
North Santiam Spring Chinook Salmon	Marion Forks	ODFW 2016
South Santiam Spring Chinook Salmon	South Santiam	ODFW 2016
McKenzie Spring Chinook Salmon	McKenzie	ODFW 2016
Middle Fork Willamette Spring Chinook Salmon	Willamette	ODFW 2016
Upper Willamette Summer Steelhead	South Santiam	ODFW 2017; ODFW 2018
Upper Willamette Rainbow Trout	Leaburg, Roaring River, Desert Springs	ODFW 2005; ODFW 2017; 2018

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