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

August 12, 2021

Dear Recipient:

In accordance with provisions of the National Environmental Policy Act, we announce the availability for review of the Draft Environmental Assessment for Five Salmon Hatchery Programs in the Lake Washington Basin. The proposed action is approval of five salmon hatchery programs under Endangered Species Act Section 4(d) Limit 6. The hatchery programs are described in Hatchery Genetic Management Plans (HGMPs) prepared and submitted collectively by the Muckleshoot Indian Tribe and the Washington Department of Fish and Wildlife.

The hatchery programs produce fall-run Chinook salmon, coho salmon, and Sockeye salmon intended to contribute to the survival and recovery of Puget Sound Chinook salmon, provide information on exploitation rates, and support adult salmon returns to the Lake Washington basin. The hatchery programs would operate out of the Issaquah Creek Hatchery, Willow Creek Hatchery, Cedar Creek Hatchery and University of Washington Aquatic Research Facility (UWAF). Three of the four locations are currently in operation. Upgrades would be required at UWAF before fish are available for rearing.

The document is accessible electronically through following website at https://www.fisheries.noaa.gov/action/five-hatchery-programs-lake-washington-basin. Hard copies of the document may be obtained from the comment coordinator, Chanté Davis, at the contact information provided below.

Written comments may be submitted to NMFS via electronic mail or physical mail to the comment coordinator, during the public-comment period (the closing date for the public comment period is noted at the above website). When submitting comments, please include the identifier "Lake Washington hatchery programs" on the subject line.
Comment Coordinator: Chanté Davis

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Thank you in advance for your input and assistance in finalizing the Environmental Assessment.

Sincerely,

Barry A. Thom
Regional Administrator

Environmental Assessment

Lake Washington Basin Hatcheries

Lake Washington Basin

July 26, 2021

Lake Washington Basin Hatcheries
Draft Environmental Assessment

July 26, 2021

Lead Agency:	National Marine Fisheries Service, West Coast Region National Oceanic and Atmospheric Administration
Responsible Official:	Regional Administrator National Marine Fisheries Service

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Persons and Agencies Consulted

U.S. Fish and Wildlife Service (USFWS)

Washington Department of Fish and Wildlife (WDFW)

Muckleshoot Indian Tribe (MIT)

Suquamish Indian Tribe

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Acronym List

BKD	Bacterial kidney disease
BMP	Best management practice
BOD	Biochemical oxygen demand
CFS	Cubic feet per second
CWT	Coded-wire tag
DPS	Distinct Population Segment
EA	Environmental Assessment
EFH	Essential fish habitat
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FONSI	Finding of no significant impact
HCP	Habitat Conservation Plan
HGMP	Hatchery Genetics Management Plan
HOR	Hatchery-origin return
HSRG	Hatchery Scientific Review Group
IHN	Infectious hematopoietic necrosis
IHNV	Infectious hematopoietic necrosis virus
IVa	Viral hemorrhagic septicemia virus
LMA	Landsburg Mitigation Agreement
MIT	Muckleshoot Indian Tribe
MPG	Major population group
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOR	Natural-origin return
NPDES	National Pollutant Discharge Elimination System
NWFSC	Northwest Fisheries Science Center
NWSSC	Northwest Steelhead and Salmon Council
OHWM	Ordinary high-water mark
OMV	*Oncorhynchus masou* virus
PBF	Physical and biological feature

Acronym List

PBT	Parentage-based tagging
PFMC	Pacific Fishery Marine Council
PHOS	Proportion hatchery-origin spawners
PIT	Passive Integrated Transponder
PNI	Proportion natural influence
PNW VHSV	Pacific Northwest strain of viral hemorraghic septicemia virus
PSIT	Puget Sound Indian Tribes
PSSMP	Puget Sound Salmon Management Plan
PSTT	Puget Sound Treaty Tribes
RM&E	Research, monitoring, and evaluation
SIWG	Species Interaction Work Group
SPU	Seattle Public Utilities
SSE	Suquamish Seafood Enterprises
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UWARF	University of Washington Aquatic Research Facility
WDE	Washington Department of Ecology
WDFW	Washington Department of Fish and Wildlife
WWTIT	Western Washington Treaty Indian Tribes

1 Introduction

The National Marine Fisheries Service (NMFS) is the lead agency responsible for administering the Endangered Species Act (ESA) as it relates to listed salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*). Actions that may affect listed species are reviewed by NMFS under section 7, section 10, or section 4(d) of the ESA. Under section 4(d), the Secretary of Commerce issues regulations that are "necessary and advisable to provide for the conservation of such species." NMFS is considering authorizing under ESA section 4(d) the operation and maintenance of five hatchery programs in the Lake Washington Basin in Washington. Each program includes the collection and spawning of adult salmon, incubation of eggs, and rearing and release of juveniles as described in Hatchery and Genetic Management Plans (HGMPs). The 4(d) determination would affirm that the programs do not jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Determinations under Section 4(d) have no expiration date. Two of the proposed hatchery programs release fish listed as threatened under the ESA (Chinook Salmon (*O. tshawytscha*)) and three programs release fish that are not listed (Coho Salmon (*O. kisutch*) and Sockeye Salmon (*O. nerka*)). HGMPs for non-listed species are reviewed for ESA compliance to determine if program activities affect listed species. The five hatchery programs, including facility operations specific to these programs, under consideration and their operators are (Table 1-1):

- Issaquah Coho Hatchery, Washington Department of Fish and Wildlife (WDFW)
- University of Washington Aquatic Research Facility Coho Salmon (UWARF)
- Issaquah Fall Chinook Hatchery (WDFW)
- UWARF Fall Chinook Salmon
- Lake Washington Sockeye (WDFW and Seattle Public Utilities)

The Section 4(d) applications submitted to NMFS by WDFW and the Muckleshoot Indian Tribe (MIT) include HGMPs that outline the rearing and release of Coho Salmon, fall Chinook Salmon, and Sockeye Salmon using existing facilities and potential new acclimation sites (University of Washington 2018a, 2018b; WDFW 2019a, 2019b, 2019c). NMFS's section 4(d) determinations of the HGMPs constitute a Federal action that is subject to analysis as required by the National Environmental Policy Act (NEPA) and is the topic of this environmental assessment (EA) review.

NMFS is choosing to evaluate these programs as the Proposed Action in one NEPA analysis because many overlaps and links exist among the programs. All programs would be implemented during the same time and include the same or similar activities that lead to the release of Coho, fall Chinook, and Sockeye Salmon. This EA is being prepared using the 1978 CEQ NEPA Regulations. NEPA reviews initiated prior to the effective date of the 2020 CEQ regulations may be conducted using the 1978 version of the regulations. The effective date of the 2020 CEQ NEPA Regulations was September 14, 2020. This review began on August 6, 2019, and the agency has decided to proceed under the 1978 regulations.

The following activities are included in the HGMPs, and are described in more detail in Section 1.3, Description of the Proposed Action (Table 1-2):

- Broodstock collection, including methods and facility operations
- Identification, holding, and spawning of adult fish
- Egg incubation and rearing
- Marking of hatchery-origin juveniles

- Juvenile releases
- Adult management
- Research, monitoring, and evaluation (RM&E) to assess program performance

Table 1-1. Proposed Releases for the Five Hatchery Programs Included in this EA.

Program	Operator[1]	Funding Source	Releases[2,3]	Life Stage at Release
Issaquah Coho Hatchery	WDFW	State and Federal	Issaquah Creek = 750,000 Edmonds Net Pen = 25,000 North and Swamp Creeks = 80,000 Educational Projects = 340,000	Yearling Yearling Fry Fry
University of Washington Aquatic Research Facility Coho Salmon	UWARF	Not Determined	90,000	Subyearling (0-age smolts)
Issaquah Fall Chinook Hatchery	WDFW	State and Federal	6,000,000	Subyearling
University of Washington Aquatic Research Facility Chinook Salmon	UWARF	Federal (primarily)	180,000	Subyearling
Lake Washington Sockeye	WDFW	Seattle Public Utilities	31,000,000 - 34,000,000 < 780,000 – 2,000,000 < 40,000 – 1,000,000	Fry Subyearlings Yearlings

Sources: University of Washington (2018a, 2018b); Washington Department of Fish and Wildlife (2019a, 2019b, 2019c)

[1]WDFW = Washington Department of Fish and Wildlife; UWARF = University of Washington Aquatic Research Facility

[2]Future releases for the Lake Washington Sockeye program will be implemented in phases as described in Section 1.3.5, Lake Washington Sockeye, and Table 1-2.

[3]Additional information provided in Table 1-2.

1.1 Purpose and Need

NMFS' purpose for the proposed action is to evaluate the submitted HGMPs for the proposed hatchery programs for compliance under ESA Section 4(d), consistent with the agency's program for reviewing hatchery plans. The applicants and NMFS need the proposed action to promote sustainability of Puget Sound salmon by contributing to conserving the productivity, abundance, diversity, and distribution of listed species of salmon in Puget Sound. Proposed hatchery programs within this EA release fish listed as threatened (Chinook Salmon) and not listed (Coho and Sockeye Salmon). Under the ESA, NMFS will ensure it (1) is consistent with tribal treaty rights and the Federal government's trust and fiduciary responsibilities and (2) works collaboratively with co-managers (WDFW, MIT, Suquamish Indian Tribe) to protect and conserve ESA-listed species.

1.2 Project Area and Study Area

The Project Area is the geographic area where the HGMPs under consideration in the Proposed Action would take place (Figure 1-1). It includes the fish traps and collection sites, hatchery facilities, and release locations as described in the HGMPs (Section 1.3, Description of the Proposed Action). It also includes the broader area where direct and indirect impacts of the program operations could affect natural and human resources. As such, the Project Area includes parts of the Lake Washington Basin addressed in the HGMPs under consideration in the Proposed Action: Issaquah Creek, Lake Sammamish, and the Sammamish River Basin downstream of Issaquah Hatchery, the Cedar River downstream of Landsburg Dam and Cedar River Hatchery, Lake Washington, and Lake Union extending through the Lake

Washington Ship Canal to the Ballard Locks and Puget Sound (Figure 1-1). In general, for most affected resources, the EA considers impacts throughout the Project Area.

Discernable effects on salmon in the marine environment may extend throughout Puget Sound and the Strait of Juan de Fuca. The Project Area therefore also includes areas of the marine environment identified by NMFS (2014) as the South Puget Sound, North Puget Sound, and Strait of Juan de Fuca subregions (Figure 1-1).

The Study Area is a geographic area where particular resources are being evaluated more narrowly. Although the Project Area encompasses the full extent of project influence, the Study Area is specific to the resource being analyzed. For some resources the EA has identified a Study Area that is limited to the area immediately surrounding the project facilities where operations could have a direct effect on a particular resource. For other resources, such as salmon and steelhead, project operations could have wider reaching effects. The Study Area for each resource is described in Section 3, Affected Environment.

1.3 Description of the Proposed Action

The HGMPs identified in Section 1, Introduction, collectively describe the management of the Issaquah Coho, UWARF Coho Salmon, Issaquah Fall Chinook, UWARF Chinook Salmon, and Lake Washington Sockeye Salmon hatchery programs. The HGMPs are the subject of this EA and were submitted by the applicants (University of Washington 2018a, 2018b; WDFW 2019a, 2019b, 2019c). The proposed action will require the construction of new facilities; however, the scope of this EA does not include any future facility construction or expansion, or any increases in quantities of water withdrawals beyond existing permissible volumes.

1.3.1 Issaquah Coho Hatchery

The purpose of the Issaquah Hatchery Coho Salmon program is to produce Coho Salmon for sustainable fisheries (including those under the jurisdiction of the Magnuson/Stevens Act) and to facilitate exercise of Treaty Indian fishing right entitlements (U.S. v Washington). The program also provides educational opportunities through its Watershed Interpretative Center and supplies salmon eggs to schools and cooperative educational centers throughout the region. The two major program components are (1) the Issaquah Hatchery, and (2) the Northwest Steelhead and Salmon Council (NWSSC)-Laebugten Net Pens Program (Table 1-2). The Issaquah Program has released up to 450,000 yearlings annually, but the release goal of the proposed action would increase under the HGMPs to 750,000 yearlings. In addition, alternative release sites are being considered in the Lake Washington Basin.

1.3.2 University of Washington Aquatic Research Facility Coho Salmon

The purpose of the UWARF Coho Salmon program will be to support research programs (e.g., University of Washington faculty, research scientists, graduate students; MIT; WDFW; and other affiliated research organizations such as NOAA Fisheries and USGS-Western Fisheries Research Center) and to support educational activities for undergraduate and graduate students within the University of Washington, MIT members, other Tribes, and the general public. The intent of the research program will be to reduce genetic risk to natural populations and to maintain a gene pool that is separated from all natural populations (Table 1-2; Figure 1-1). The program is proposed to release up to 90,000 subyearling smolts at the UWARF. The hatchery stock in this program will be managed with a segregated broodstock management strategy with fish produced primarily for research purposes. The UWARF Coho Salmon program (previously named the Portage Bay Hatchery) produced about 80,000 hatchery subyearlings annually from 1950-2010 but is not producing fish currently. The program will be initiated with eggs or

juvenile Coho Salmon from the Issaquah Hatchery and in the event of a shortfall in production at the UWARF.

1.3.3 Issaquah Fall Chinook Hatchery

The purpose of the Issaquah Hatchery Chinook Salmon program (Table 1-2; Figure 1-1) is to produce Chinook Salmon for sustainable fisheries (including those under the jurisdiction of the Magnuson/Stevens Act) and to facilitate exercise of Treaty Indian fishing right entitlements (U.S. v Washington). The program produced an average of 1.97 million subyearling Chinook from 2004 through 2015 (WDFW 2019b). Production ranged from 1.47 million in 2015 to 2,36 million in 2006. The program also provides educational opportunities for the citizens of the area. Within the heavily urbanized and modified Lake Washington Basin, habitat loss and degradation severely limit natural salmon production and necessitate hatchery programs to facilitate exercise of tribal treaty obligations and provide fishing opportunities. Fish from the program are specifically included as part of the Puget Sound Chinook Salmon Evolutionarily Significant Unit (ESU), which is listed as Threatened under the ESA (76 FR 50448, August 15, 2011).

The program is proposed to release up to 6,000,000 subyearlings annually, with all releases occurring at Issaquah hatchery or further downstream in the Lake Washington Basin. Up to 180,000 subyearlings will be released at the UWARF. Releases of subyearlings at downstream locations in the Lake Washington Basin would include Issaquah Creek, Lake Washington Ship Canal, Sammamish Slough and tributaries, Kenmore boat ramp, and the 14th Street boat ramp (Table 1-2). A pilot study and evaluation are in progress for releases of Chinook Salmon at several of these downstream locations. Releases at these locations within the Lake Washington Basin would not result in any impacts that differ from those described in this EA.

The Issaquah Hatchery Chinook program will transition into a genetically-linked program when the minimum trigger is reached (Table 1-2). This will occur when the population of NORs in Issaquah Creek is expected to exceed 500 fish for a third straight year. This assumes the two preceding years had more than 500 adult natural-origin returns and that the current pre-season forecast also exceeds that trigger. Under this scenario, Issaquah Hatchery's goal will be to release 200,000 sub-yearling Chinook derived solely from natural origin parents. A higher trigger occurs when the NOR population exceeds 800 for three straight years. When this occurs, the only change is that the integrated production will be doubled to 400,000 sub-yearlings. If the specific trigger is not met at the 800 natural-origin adult Chinook salmon level, but meet the 500 natural-origin level, the integrated program would revert back to 200,000 sub-yearling Chinook salmon. If the specific trigger is not met at the 500 natural-origin adult Chinook salmon level the Issaquah Chinook salmon program revert back to running as a segregated program.

1.3.4 University of Washington Aquatic Research Facility Fall Chinook Salmon

The purpose of the UWARF Fall Chinook Salmon program will be to support regional research programs and staff and to support educational and outreach activities for the public. Similar to the UWARF Coho Salmon program, the UWARF Fall Chinook Salmon program will be managed with a segregated broodstock management strategy with fish produced primarily for research purposes with the intent of to reduce genetic risk to natural populations and to maintain a gene pool that is separated from all natural populations (Table 1-2; Figure 1-1). The UWARF Fall Chinook Salmon program (previously named the Portage Bay Hatchery) produced about 180,000 hatchery fingerlings from 1950-2010 but is not producing fish currently. The program is proposed to release up to 180,000 subyearlings at the UWARF. The program will be initiated with eggs or juvenile Chinook Salmon from the Issaquah Hatchery and in the event of a shortfall in production at the UWARF. Fish released from the UWARF program are not presently included within the Puget Sound Chinook Salmon ESU.

1.3.5 Lake Washington Sockeye

The purposes of the Lake Washington Sockeye program are to: 1) fully mitigate for the long-term effects of the Sockeye Salmon migration barrier created by the City of Seattle's Cedar River Diversion Facilities (Figure 1-1); 2) halt the decline in Sockeye Salmon to allow time to address the larger issues affecting Sockeye Salmon survival in the Lake Washington Basin; and 3) help provide for the persistence and rebuilding of healthy and harvestable runs of Sockeye Salmon (Section 1.4.6, Landsburg Mitigation Agreement; WDFW 2019c). Although the program has only released up to 18,000,000 fry annually in recent years (Table 1-2; WDFW 2019c), this is due to low escapement of Sockeye Salmon that are needed for broodstock. The co-managers propose two phases for the Lake Washington Sockeye Program. The phase 1 release would include up to 34,000,000 fed fry, 780,000 subyearlings, and 40,000 yearlings, with the total releases of all age life stages not exceeding 34 million juvenile sockeye salmon. Phase 2 would increase the release levels to up to 2,000,000 subyearlings and 1,000,000 yearlings, with the total releases of all age life stages not exceeding 34 million juvenile sockeye salmon. Egg transfers from outside the Lake Washington Basin may be considered if declining escapement prevents meeting egg take goals (Table 1-2). Eggs from outside the basin would be used only to make up for production shortfalls and would never exceed the 37 million eggs needed for release of 34 million Sockeye Salmon (WDFW 2019c). Any fish incubated and reared at Issaquah Hatchery would be transported to release locations.

1.4 Relationship to Other Plans, Regulations, Agreements, Laws, Secretarial Orders, and Executive Orders

Hatchery programs and fisheries managed by the co-managers operate under the provisions and obligations of a complex array of: treaties; federal court orders, statutes, and rules; legally binding agreements; executive orders; and state statutes and rules. It is the responsibility of the co-managers to ensure that hatchery programs and fisheries are managed in a manner consistent with these diverse obligations. Six examples are discussed briefly below.

1.4.1 Tribal Trust Responsibility under the Endangered Species Act

The United States government has a trust or special relationship with Tribes. The unique and distinctive political relationship between the United States and Tribes is defined by treaties, statutes, executive orders, judicial decisions, and agreements, and differentiates Tribes from other entities that deal with, or are affected by the Federal government.

Secretarial Order, *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA* (Secretarial Order) clarifies the responsibilities of the agencies when actions are taken under the ESA (USFWS and NMFS 1997). Specifically, the U.S. Fish and Wildlife Service (USFWS) and NMFS shall, among other things:

- Work directly with Tribes on a government-to-government basis to promote healthy ecosystems
- Recognize that tribal lands are not subject to the same controls as Federal public lands
- Assist Tribes in developing and expanding tribal programs so that healthy ecosystems are promoted and conservation restrictions are unnecessary
- Be sensitive to tribal culture, religion, and spirituality

NMFS considers the responsibilities described above when taking ESA actions such as making section 4(d) determinations associated with this EA. Furthermore, NMFS has specified that the statutory goals of the ESA and the federal trust responsibility to Tribes are complementary (Terry Garcia, U.S. Department of Commerce, letter sent to Ted Strong, Executive Director, Columbia River Inter-Tribal Fish Commission,

July 21, 1998, regarding federal trust responsibility). The federal trust responsibility is independent of the statutory duties and informs the way that statutory duties are implemented.

Table 1-2. Operations Overview for the Proposed Action in this EA.

Parameter	Issaquah Coho Hatchery (Issaquah)	Issaquah Coho Hatchery (NWSSC-Laebugten)	UWARF Coho Salmon	Issaquah Fall Chinook Hatchery	UWARF Fall Chinook Salmon	Lake Washington Sockeye
Adults						
Purpose	Integrated Harvest/Education	Segregated Harvest	Segregated Research/Education	Segregated/Integrated[1]	Segregated Research/Education	Integrated
Broodstock number and type (HOR vs. NOR)[2]	1,130 (10-20% NORs)	Included in 1,130	180 (100% HORs)	3,360[1]	180 (100% HORs)	24,000 (50% NORs)[3]
Collection location	Issaquah Creek[4]	Issaquah Creek[4]	Portage Bay, Issaquah Hatchery as appropriate	Issaquah Creek[4]	Portage Bay, Issaquah Hatchery as appropriate	Temporary weir on Cedar River at RM 1.7[5]; Seasonal weir on Bear Creek near mouth[6] Landsburg Dam fish ladder on Cedar River at RM 21.7; Ballard Locks in Lake Washington Ship Canal at RM 1.0; Issaquah Creek RM 3.0 Eggs from outside of the Lake Washington Basin[7]
Collection timing	October-December	October-December	September-December	September-December	September-October	September-November
Adult holding location	Issaquah Hatchery	Issaquah Hatchery	UWARF	Issaquah Hatchery	UWARF	Cedar River Hatchery
Adult spawning location	Issaquah Hatchery	Issaquah Hatchery	UWARF	Issaquah Hatchery	UWARF	Cedar River Hatchery
Incubation, Rearing, and Release						
Incubation location	Issaquah Hatchery	Issaquah Hatchery; Willow Creek Hatchery	UWARF	Issaquah Hatchery	UWARF	Cedar River Hatchery Issaquah Hatchery
Rearing location	Issaquah Creek; Cooperative and School programs UWARF	Willow Creek Hatchery	UWARF	Issaquah Hatchery UWARF	UWARF	Cedar River Hatchery Issaquah Hatchery UWARF

Parameter	Issaquah Coho Hatchery (Issaquah)	Issaquah Coho Hatchery (NWSSC-Laebugten)	UWARF Coho Salmon	Issaquah Fall Chinook Hatchery	UWARF Fall Chinook Salmon	Lake Washington Sockeye
Acclimation location	Issaquah Hatchery; Sammamish Slough and tributaries, downstream sites UWARF	Edmonds Net Pen	UWARF	Issaquah Hatchery; Sammamish Slough and tributaries, downstream sites UWARF	UWARF	--
Release locations	Issaquah Creek, Lake Washington Ship Canal, Sammamish Slough and tributaries, Kenmore boat ramp, Portage Bay, downstream sites	Puget Sound Puget Sound Independent Tributaries. North Creek Swamp Creek	Portage Bay	Issaquah Creek; Lake Washington ship canal; Portage Bay, Sammamish Slough and tributaries, Kenmore boat ramp, downstream sites	Portage Bay	Cedar River, Lake Washington, Lake Washington Ship Canal, Portage Bay, net pen(s)[8]
Release timing	March - June	Puget Sound = May-June; North Creek = April-June; Swamp Creek = April/May	April-June	April – June	May	Fry = Jan - May Subyearlings = May – Jun; Sep – Oct Yearlings = Apr - May

Parameter	Issaquah Coho Hatchery (Issaquah)	Issaquah Coho Hatchery (NWSSC-Laebugten)	UWARF Coho Salmon	Issaquah Fall Chinook Hatchery	UWARF Fall Chinook Salmon	Lake Washington Sockeye
Release number[9]	Issaquah Hatchery = 750,000 yearlings; Throughout Lake Washington= 340,000 fry	Edmonds Net Pen = 25,000 yearlings North Creek/Swamp Creek/Puget Sound Independent Tributaries = 80,000 fry	90,000 subyearling smolts	Issaquah Creek and Lake Washington basin = up to 6,000,000 subyearlings	180,000 subyearlings	**Phase 1:** ≤ 34,000,000 fry, ≤ 780,000 subyearlings, ≤ 40,000 yearlings **Phase 2:** ≤ 34,000,000 fry; ≤ 2,000,000 subyearlings; ≤ 1,000,000 yearlings
Mark[10]	Adipose fin clip = 100% of yearlings only;	Adipose fin clip = 100% of yearlings only	Adipose fin clip = 100%;	Adipose fin clip = 100%;	Adipose fin clip = 100%;	Otolith marking = 100%; Adipose fin clip = 100% of subyearlings and yearlings
Other						
Maximum surface water use by facility (cfs)[11]	Issaquah Hatchery = 36	Willow Creek Hatchery = 1	UWARF = 4.9	Issaquah Hatchery = 36	UWARF = 4.9	Cedar River Hatchery = 6.7
Maximum ground/springwater use by facility (cfs)	--	--	--	Issaquah Hatchery = 1.1	--	Cedar River Hatchery = 3.7 Issaquah Hatchery = 1.1
Maximum domestic water use by facility (cfs)	--	--	UWARF = 0.03	--	UWARF = 0.03	--

Parameter	Issaquah Coho Hatchery (Issaquah)	Issaquah Coho Hatchery (NWSSC-Laebugten)	UWARF Coho Salmon	Issaquah Fall Chinook Hatchery	UWARF Fall Chinook Salmon	Lake Washington Sockeye
Method of adult management	Adults collected above broodstock needs are released upstream for natural spawning; some may be outplanted to other Lake Washington Basin tributaries	--	--	Number and management origin of Chinook passed above the broodstock weir depends on number of available fish	--	All fish collected are used for broodstock
Within basin targeted fisheries	Yes	Yes	Yes	Yes[9]	Yes	Yes[12]

[1]The Issaquah Hatchery Fall Chinook program will transition into a genetically-linked program when the minimum trigger is reached. This would occur when the population of NORs in Issaquah Creek is expected to exceed 500 fish for a third straight year. This assumes the two preceding years had more than 500 adult natural-origin returns and that the current pre-season forecast also exceeds that trigger. Under this scenario, Issaquah Hatchery's goal will be to release 200,000 sub-yearling Chinook derived solely from natural-origin parents. A higher trigger occurs when the NOR population exceeds 800 for three straight years. When this occurs, the only change is that the integrated production will be doubled to 400,000 sub-yearlings.

[2]HOR = hatchery-origin returns, NOR = natural-origin returns, UWARF = University of Washington Aquatic Research Facility

[3]The co-managers expectation is that when adult Sockeye spawning escapement goals in the Cedar River are met, the long term expectation is that at least 50% of the fry entering Lake Washington will be naturally produced and at least 50% of the adults returning to the basin are from natural production. As adult sockeye spawning escapements fall below this goal, the fry entering Lake Washington will be increasingly dominated by hatchery origin recruits. At critically low run sizes of adult sockeye entering the Cedar River, up to the full spawning population will be targeted for broodstock collection.

[4] Eggs from hatcheries on the Green River and UWARF may be used to backfill a shortfall in egg take

[5]The Cedar River weir is going through the approval and permitting process before being considered permanent. The NMFS area office is evaluating this through a separate consultation.

[6]This weir would be used as a contingency plan for the collection of Sockeye during low sockeye salmon run sizes.

[7]Egg transfers from Baker Lake, Quinault River, Lake Wenatchee, Alaska, or the Upper Columbia River may be considered if declining escapement prevents meeting egg take goals

[8]The co-managers may consider using net pens to rear juvenile sockeye and hold adult salmon in the future. However, those options are not part of the action under consideration in this consultation.

[9] The planned total Chinook salmon releases in Lake Washington watershed would not exceed 6M; i.e., if the planned UW ARF release was 0.18M, the Issaquah Fall Chinook planned release would be 5.82M.

[10] Released fish may be implanted with a coded wire tag (CWT) in the future depending on research and/or Co-manager needs.

[11]CFS = cubic feet per second; it is assumed that maximum water use by facility will not increase with any production increases described for future phases.

[12]MIT has not opened tribal fishing since 1994 for Chinook Salmon, and since 2006 for Sockeye in Lake Washington

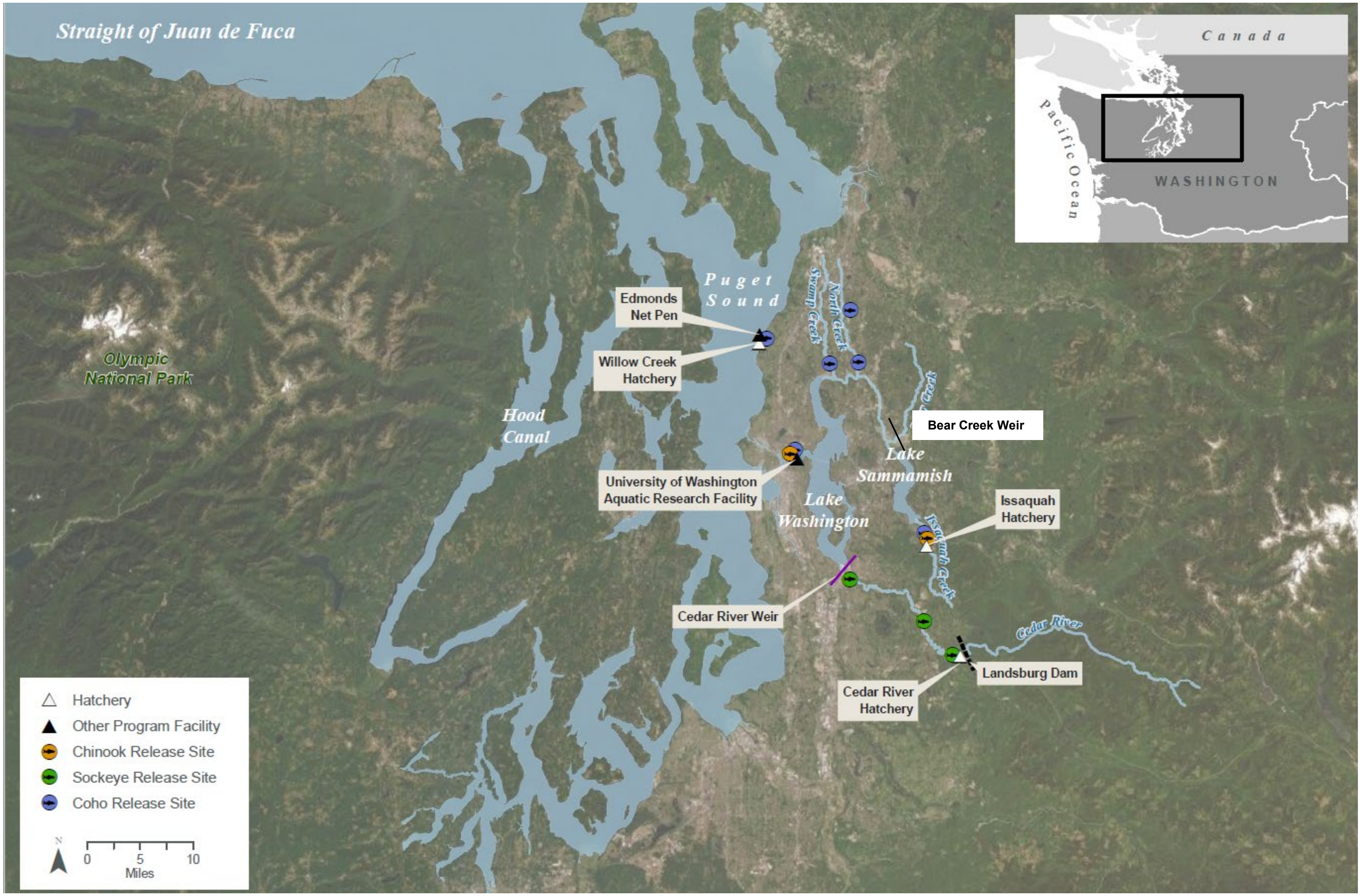

Figure 1-1. Hatchery Facilities and Release Sites for Programs Included in this EA.

1.4.2 U.S. v. Washington

The court in *U.S. v. Washington* (384 F. Supp. 312 [W.D. Wash. 1974], aff'd, 520 F.2d 676 [9th Cir. 1975]) reaffirmed the reserved right of American Indian Tribes in the State of Washington to act alongside the state as co-managers of salmon and other fish, and to continue harvesting them in accordance with the various treaties that the United States had signed with the Tribes (e.g., Medicine Creek, Quinault, Neah Bay, Point Elliott, and Point-No-Point Treaties). The Tribes of Washington had ceded their land to the United States but had reserved the right to fish as they had always done, including fishing at their traditional locations that were off the designated reservations. Because of this decision, fisheries in Puget Sound, including those supported by the five hatchery programs being reviewed within this EA, are governed by The Puget Sound Salmon Management Plan (PSSMP; WDFW 1985) and are jointly managed by the Puget Sound Treaty Tribes (PSTT) and WDFW under the continuing jurisdiction of U.S. v. Washington.

1.4.3 Puget Sound Salmon Management Plan

The Puget Sound Salmon Management Plan is the original guiding framework for jointly agreed management objectives, allocation of harvest, information exchange among the co-managers, and processes for negotiating annual harvest regimes in Puget Sound (WDFW 1985). At its inception, the PSSMP defined management units and regions of origin as the basis for harvest objectives and allocation and established maximum sustainable harvest and escapement as general objectives for all Puget Sound management units, including the Lake Washington Management Unit. In addition, the PSSMP envisioned the adaptive management process that motivated the Comprehensive Coho Management Plan and the Comprehensive Management Plan for Puget Sound Chinook.

1.4.4 Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component

The draft Puget Sound Chinook Harvest Management Plan (PSIT and WDFW 2017) aims to establish management guidelines for annual harvest regimes, as they affect Puget Sound Chinook Salmon, for a 10-year management time period. The ultimate goal of this plan is to promote rebuilding of natural Puget Sound Chinook Salmon, to the extent possible in light of habitat constraints, so that natural Chinook Salmon populations will be sufficiently abundant and resilient to perform their natural ecological function in freshwater and marine systems and provide related cultural values. The plan guides the implementation of fisheries in Washington, under the co-managers' jurisdiction, but also considers harvest impacts of other fisheries that impact Puget Sound Chinook Salmon, including those in Alaska and British Columbia, to assure that conservation objectives for Puget Sound management units are achieved. Within each watershed, Chinook Salmon hatchery programs also are coordinated with harvest goals and objectives to accord with Puget Sound Chinook Salmon recovery. Hatchery production is managed to achieve harvest and conservation objectives, recognizing the status of habitat, and potential for restoring habitat function in each watershed (NWIFC 2016).

1.4.5 Comprehensive Coho Management Plan

The Comprehensive Coho Management Plan (PSTT and WDFW 1998) establishes management guidelines for annual harvest regimes, as they affect Puget Sound Coho Salmon. The ultimate goal of this plan is to develop and implement improved Coho management approaches that support the maintenance and restoration of wild stocks in a manner that reflects the region's fisheries objectives (resource protection, allocation, and harvest stabilization), production constraints, and production opportunities. The plan provides recommended exploitations rates for some wild stocks, escapement thresholds that trigger

management actions, and monitoring requirements for Puget Sound Coho Salmon. The plan includes seven plan components, of which one is related to artificial production management. The plan also identifies Puget Sound management units and production regions, as defined by the PSSMP, in which the Coho hatchery programs being reviewed within this EA would be included in the mid-Puget Sound production region and the Lake Washington Management Unit.

1.4.6 Landsburg Mitigation Agreement

The Landsburg Mitigation Agreement (LMA) was signed in 2000 by the City of Seattle, USFWS, NMFS, and WDFW, with an original term of 49 years beyond the end of year 1. In the LMA, the City of Seattle is committed to "long-term measures to help restore anadromous fish runs and mitigate for the blockage at Landsburg Dam, including fish passage for coho, chinook, and steelhead; artificial production facilities as alternative mitigation to passage for sockeye; and habitat restoration below Landsburg Dam." The required mitigation measures included the construction of a hatchery designed to produce up to 34 million Sockeye Salmon fry annually and annual funding to operate and maintain the facilities over the term of the LMA. The mitigation measures were expected to provide and contribute to the potential for more regular sport and tribal harvest opportunities of the Lake Washington Sockeye Salmon fishery.

The specific primary objectives of the LMA are to (1) implement biologically sound, short and long term solutions that help provide for the recovery and persistence of healthy, harvestable runs of Sockeye, Coho, and Chinook Salmon and steelhead in the Cedar River; (2) maintain a safe, high quality drinking water supply; (3) implement restoration alternatives that have a high likelihood for success and that provide substantial value for target resources; (4) provide fish passage over the Landsburg Diversion Dam, consistent with water quality protection, that is coordinated with run recovery, biological need, water supply operations, and facility maintenance requirements; (5) coordinate with and support other compatible fish protection and restoration activities in the basin to maximize total benefits to fisheries resources within an ecosystem context; and (6) design restoration measures in a manner that satisfies any mitigation obligations the City of Seattle may have for the diversion facilities as defined by existing state and federal law and pursuant to City of Seattle ordinance and initiatives.

2 Description of Alternatives

Three alternatives are considered in this EA:

- Alternative 1, No Action: NMFS would not make ESA Section 4(d) determinations but programs would continue to operate as they currently are (Table 2-1) without ESA coverage.
- Alternative 2, Proposed Action: NMFS would make Section 4(d) determinations consistent with the HGMPs and programs would be operated as proposed in the HGMPs.
- Alternative 3, Program Termination: NMFS would not make Section 4(d) determinations and all five programs would terminate.

Under the 4(d) rule, NMFS evaluates the hatchery program's compliance with the ESA. Under NEPA, NMFS must also analyze the environmental effects of the hatchery programs on the human environment. NMFS is reviewing the effects of the proposed phased approach for the genetically-linked program for Chinook salmon at the Issaquah Hatchery. NMFS acknowledges that facilities to support the full release goal of 6 million juvenile Chinook Salmon and 750,000 juvenile coho salmon from the Issaquah Hatchery do not currently exist and will require several years to plan, fund, and construct (WDFW 2019a, 2019b). The proposed action will likely require the construction of new facilities; however, the scope of this EA does not include any future facility construction or expansion, or any increases in quantities of water withdrawals beyond existing permissible volumes.

The applicants are developing construction plans and will work with state and federal entities to determine specific permitting requirements. Any Finding of No Significant Impact (FONSI) that NMFS issues in support of the 4(d) analysis assumes that the co-managers will secure any local, state, or other federal agency permit that may be required for future expansion. These permits include, but are not limited to, water withdrawal rights, National Pollutant Discharge Elimination System permits, Clean Water Act Section 404, Rivers and Harbor Act Section 10, and Section 106 of the National Historic Preservation Act (NHPA).

2.1 Alternative 1, No Action

Under this alternative, NMFS would not make a Section 4(d) determination. For analysis purposes, NMFS has defined the No Action Alternative as the future conditions if the Proposed Action is not implemented. For the most part, this would result in the applicants continuing to operate those portions of the programs that are currently operating (Table 2-1), including RM&E (Section 2.1.1, Research Monitoring, and Evaluation) and O&M (Section 2.1.2, Operation and Maintenance). However, some program modifications are already planned and would be included in the No Action Alternative. This would include changing the Sockeye Salmon Weir on the Cedar River from seasonal to a permanent structure . The permanent weir on the Cedar River would allow collection of a substantial portion of the spawning population if needed when run sizes are critically low.

Table 2-1. Number of Fish Released under Each Alternative Evaluated in this EA

Program	Alternative 1, No Action	Alternative 2, Proposed Action	Alternative 3, Program Termination
Issaquah Coho Hatchery: Issaquah Creek Edmonds Net Pen North and Swamp Creeks Educational Projects	 450,000 yearlings 25,000 yearlings 80,000 fry >200,000 fry	 750,000 yearlings 25,000 yearlings 80,000 fry 340,000 fry	0
UWARF Coho Salmon	0	Up to 90,000 subyearlings	0
Issaquah Fall Chinook Hatchery	3,000,000 subyearlings	6,000,000 subyearlings	0
UWARF Fall Chinook Salmon	0	180,000 subyearlings	0
Lake Washington Sockeye	18,000,000 fry	Phase 1: ≤ 34,000,000 fry ≤ 780,000 subyearlings ≤ 40,000 yearlings Phase 2: ≤ 34,000,000 fry ≤ 2,000,000 subyearlings ≤ 1,000,000 yearlings	0

2.1.1 Research, Monitoring, and Evaluation

Surveying and sampling to assess program objectives and goals may increase the risk of injury and mortality to salmon that are the focus of the programs included in this EA, or that may be incidentally encountered. RM&E activities are either related directly to the hatchery programs described in this EA or may be for other programs in each watershed (Table 2-2). RM&E may include monitoring survival and growth within hatcheries and sampling outside of hatcheries, to assess the effects of hatchery fish on population, productivity, genetic diversity, run and spawn timing, spawning distribution, and age and size at maturity. This information may be collected from:

- Spawning ground surveys to assess distribution and origin (hatchery or natural) of spawners through marking (i.e., coded-wire tags [CWT] and adipose fin-clips)
- Adult trapping for broodstock collection, adult passage, and stock composition sampling
- Stock composition sampling (genetics, disease) to determine population age, sex, and size distribution
- Juvenile sampling in the hatchery to determine smoltification status, size distribution, and precocial maturation
- Smolt trapping using screw traps to determine emigration timing, and size of juveniles
- Passive integrated transponder (PIT) tagging to estimate the timing and relative abundance of outmigrating juvenile salmon at discrete esonified points along their route.

2.1.2 Operation and Maintenance

Most facilities used for operation of programs included in this EA divert surface water and return it to the diverted waterbody (minus any leakage and evaporation) a short distance downstream of the diversion

location. The Cedar River Hatchery also uses water from two unnamed springs for incubation and rearing, well water is currently used at the Issaquah Hatchery, and a test well is in place at the Cedar River Hatchery. Both surface and groundwater used at all facilities are withdrawn in accordance with state-issued water rights. Screens at all facilities drawing surface water accessible to anadromous fish comply with NMFS (2011) screening and passage criteria.

For additional information regarding facility water sources for each program, refer to Section 3.1, Water Quantity, Section 3.2, Water Quality, and to the HGMPs recently issued for each program (University of Washington 2018a, 2018b; WDFW 2019a, 2019b, 2019c). The Issaquah Coho and Fall Chinook Hatchery programs rear over 20,000 pounds of fish annually and therefore operate under applicable National Pollutant Discharge Elimination System (NPDES) general permits.

Several routine (and semi-routine) maintenance activities occur in or near waterbodies that could affect fish. These activities include sediment/gravel removal/relocation and debris removal from intake and/or outfall structures, pond cleaning, pump maintenance, and maintenance and stabilization of existing bank protection. All in-water maintenance activities considered routine (occurring on an annual basis) or semi-routine (occurring with regularity, but not necessarily on an annual basis) occur within existing structures or the footprint of areas that have already been affected. When maintenance activities occur within active stream channels, they are implemented with all necessary federal, state, and local permits and under the following conditions:

- In-water work:
    - Is done during the allowable freshwater work times established for each location, or complies with an approved variance of the allowable freshwater work times with WDFW, NMFS, and USFWS
    - Follows a pollution and erosion control plan that addresses equipment and materials storage sites, fueling operations, staging areas, cement mortars and bonding agents, hazardous materials, spill containment and notification, and debris management
    - Ceases if fish are observed in distress at any time because of the activities
    - Includes notification of NMFS staff
    - Is conducted using equipment retrofitted with vegetable-based synthetic fuel oil
- Equipment:
    - Is inspected daily, and is free of leaks before leaving the vehicle staging area
    - Is operated above ordinary high-water mark (OHWM) or in the dry whenever possible
    - Is sized correctly for the work to be performed and has approved oils/lubricants when working below the OHWM
    - Is staged and fueled in appropriate areas 150 feet from any waterbody
    - Is cleaned and free of vegetation before it is brought to the site and prior to removal from the Project Area

Table 2-2. RM&E Activities Associated with Each Hatchery Program.

Program	Adult	Juvenile
All	• Measure and examine for gender, tags, and marks • Recover CWTs as appropriate • Inspect adult broodstock for pathogens and parasites • Record numbers of adults returning to the hatchery, broodstock collected, and surplus returns • Collect annual run timing, age and sex composition data upon adult return • Annually sample and monitor adult salmon at Ballard Locks, in fisheries, in hatchery returns, and on spawning grounds • Monitor contribution of hatchery adult fish to fisheries and escapement	• Monitor survival metrics for all life stages in the hatchery from spawning to release – CWT and/or mark representative groups • Inspect hatchery fry/juveniles for pathogens and parasites • Monitor juvenile hatchery fish size, number, date of release and mass-mark quality •
Issaquah Coho Hatchery	• Divert and sort all upstream migrants for broodstock collection, passage upstream at the hatchery weir on Issaquah Creek, outplant to Lake Washington basin tributaries, or dispose of to the contracted fish buyer • Survey spawning grounds in Issaquah Creek and other Lake Washington tributaries used to track annual trends in population abundance and spatial distribution	• Mass mark (ad-clip) 100% of program fish
UWARF Coho Salmon	• Divert and sort all adults returning to the hatchery intake on Portage Bay for broodstock collection, monitoring, and/or evaluation	• Inspect off-station fish/eggs prior to transfer to hatchery for pathogens and parasites • Mass mark (ad-clip) 100% of program fish
Issaquah Fall Chinook Hatchery	• Divert and sort all upstream migrants for broodstock collection or passage upstream at the hatchery weir on Issaquah Creek • Dipnet adult Chinook out of the Ballard Locks ladder for broodstock collection feasibility evaluation	• Mass mark (ad-clip) 100% of program fish
UWARF Fall Chinook Salmon	• Divert and sort all adults returning to the hatchery intake on Portage Bay for broodstock collection, monitoring, and/or evaluation	• Inspect off-station fish/eggs prior to transfer to hatchery for pathogens and parasites • Mass mark (ad-clip) 100% of program fish

Program	Adult	Juvenile
Lake Washington Sockeye	• Survey spawning grounds in the Cedar River and some Lake Washington basin tributaries to track trends in abundance and spatial distribution. • Dipnet adult Sockeye out of the Ballard Locks ladder for broodstock collection feasibility evaluation and/or biosampling.	• Otolith mark 100% of all program fish • Annually monitor natural production and emigration via juvenile trapping near the mouth of the Cedar River

2.2 Alternative 2, Proposed Action

Under this alternative, NMFS would make ESA section 4(d) determinations for the five hatchery programs that would allow the programs to operate as described in Section 1.3, Description of the Proposed Action, Section 2.1.1, Research Monitoring, and Evaluation, and Section 2.1.2, Operation and Maintenance. However, new activities may be implemented in the near future as part each program (Table 2-1).

Depending on results of an ongoing study, part of the Coho Salmon releases into Issaquah Creek at Issaquah Hatchery may be moved to the Kenmore boat ramp in north Lake Washington, or the Lake Washington Ship Canal at RM 2.0 or RM 6.5. Also, in the near future, as part of the Issaquah Fall Chinook Hatchery program, releases may be split between Issaquah Creek and other locations within the Lake Washington basin.

The UWARF would resume production of Coho and Fall Chinook Salmon to support research programs and educational activities (Table 2-1). The UWARF (previously named the Portage Bay Hatchery) produced hatchery Coho Salmon and Chinook Salmon from 1950-2010 but is not currently producing fish.

In addition to increased releases described for the Lake Washington Sockeye Program (Table 2-1), subsequent phases of the program may include further revised strategies. Phase 1 would include releases of up to 780,000 subyearlings and 40,000 yearlings. Phase 2 would include the release of up to 1 million subyearlings in May and June, up to 1 million subyearlings in September and October, and up to 1,000,000 yearlings in April and May. Egg transfers from outside the Lake Washington Basin may be considered if declining escapement prevents meeting egg take goals (Table 1-2). Eggs from outside the basin would be used only to make up for production shortfalls and would never exceed the 37 million eggs needed for release of 34 million Sockeye Salmon (WDFW 2019c).

2.3 Alternative 3, Program Termination

Under this alternative, NMFS would determine that the five hatchery programs described for the No Action Alternative 1 and the Proposed Action Alternative 2 do not meet the criteria for 4(d) determinations and all actions related to those programs would be terminated. This termination would occur whether or not those actions may already have existing ESA authorizations. None of the five hatchery programs would operate under this alternative.

For purposes of analysis in this EA, NMFS assumes that most facilities would cease operation if programs were terminated. Reduced operations would continue at Issaquah Hatchery for a Kokanee program only.

2.4 Alternatives Considered but not Analyzed in Detail

The following alternatives were considered, but not analyzed in detail because the alternatives would not meet the purpose and need for the programs.

2.4.1 Hatchery Programs with Increased Production Levels

Under this alternative, NMFS would issue an ESA 4(d) determination for production levels associated with the five hatchery programs that are increased beyond the levels described in the HGMPs and in Section 2.2, Alternative 2, Proposed Action. This alternative is not analyzed in detail because broodstock and physical infrastructure would not be available for larger numbers than the maximum production described for Alternative 2. Moreover, Alternative 2 includes increases in production compared to present operations, so the information gained from comparing that to Alternative 1 can be expected to lend insight into the impacts of increasing production.

2.4.2 Hatchery Programs with Decreased Production Levels

While NMFS often looks at decreased production levels as an alternative, it is not an explicit requirement and is only utilized to provide additional information that cannot be ascertained from comparing the proposed program to a scenario without the program. In some other basins where natural-origin populations are more sensitive to the possibility of interactions with hatchery fish, it may be informative to size the program up and down to see how varying the intensity of those interactions affects risk to natural spawning populations. Here, however, the programs are relatively small and removed from interactions with sensitive populations. Thus, an alternative that further reduces production is not analyzed.

3 Affected Environment

This chapter describes current conditions for eight resources that may be affected by implementation of the EA alternatives:

- Water Quantity—Section 3.1
- Water Quality—Section 3.2
- Fish—Section 3.3
- Wildlife—Section 3.4
- Marine and Freshwater Habitat—Section 3.5
- Socioeconomics—Section 3.6
- Cultural Resources—Section 3.7
- Environmental Justice—Section 3.8

Internal scoping identified no other resources that would potentially be impacted by current operations, the Proposed Action, or other alternatives.

3.1 Water Quantity

The rivers or streams on which hatchery facilities included in this EA are located have been historically subjected to artificially altered flows. Flows in some streams have been annually depressed because of natural variability and human water use. Water diversions may substantially reduce flows in some stream reaches.

Hatchery programs can affect water quantity when groundwater from an aquifer is removed via a well or spring, or when surface water from a neighboring stream is removed for use in the hatchery facility (Table 3-1). The use of surface water for hatchery programs may reduce instream flow, sometimes leading to substantial reduction in stream flow between the water intake and discharge structures. Operation of adult holding tanks, egg incubation, juvenile fish rearing, and/or acclimation ponds affect water quantity. Surface water use is non-consumptive because, except for small amounts lost through leakage or evaporation, water that is diverted from a stream is discharged back to the stream after it circulates through the hatchery facility. Although springs are not directly replenished, spring water is also discharged after circulating through the facility, sometimes increasing a small amount of stream flow below the discharge point.

Three primary facilities have been used to support salmon programs in the Lake Washington Basin (Figure 1-1); the facilities use surface, well and/or spring water (Issaquah Hatchery, Willow Creek Hatchery, Cedar River Hatchery). The Edmonds net pens, located in Puget Sound, use only marine water (i.e. passive use associated with tidal flows). The UWARF (previously named the Portage Bay Hatchery) produced hatchery fish from 1950-2010 but is currently not producing fish. The Study Area for water quantity is limited to the stream reaches between intake and outfall for each facility, which range from 10 feet to approximately 3,960 feet in length (Table 3-1).

Water use for hatchery programs often fluctuates seasonally based on propagation needs, with the highest hatchery water demand often occurring in the spring when streamflow levels are highest. Prior to juvenile release in spring, hatcheries have more fish on hand, fish under propagation are at their largest size, and the need for rearing flows for fish health maintenance is greatest. Hatchery water withdrawal for fish rearing is often lowest in the late summer months (when river flows are also at their lowest) because fewer fish are on station after release.

Issaquah Hatchery and Cedar River Hatchery utilize multiple intakes for water supply. At Issaquah Hatchery all intakes are on Issaquah Creek and most water is gravity fed, but a lower intake requires pumping. Well water is also used. Cedar River Hatchery utilizes water from the Cedar River, two unnamed tributaries, from springs located across the river from the hatchery, and a test well is in place to supplement the spring water. Water from the Cedar River is diverted, and gravity fed from Landsburg Dam for adult holding. Water from the springs is pumped and piped over Landsburg Dam to the hatchery for incubation and rearing. The water rights for Landsburg dam are covered by Seattle Public Utility domestic water supply claim (SI 04730). Water from the unnamed tributaries is available as backup. At Willow Creek Hatchery, Willow Creek water is used to rear fish in fiberglass troughs and an asphalt pond.

Table 3-1. Surface Water Source and Use at Facilities Utilized by the Hatchery Programs in this EA

Program, Facility	Maximum Surface Water Use (cfs)	Surface Water Source	Discharge Location	Surface Water Diversion Distance (Feet)	Maximum Surface Water Use Relative to Stream Flow (%)
Issaquah Hatchery, Coho Salmon and Fall Chinook Salmon					
Issaquah Hatchery	36[1]	Issaquah Creek	Issaquah Creek	3,960[2]	50
Willow Creek Hatchery	1	Willow Creek	Willow Creek	10	100
Edmonds Net Pen	N/A	N/A	N/A	N/A	N/A
University of Washington Aquatic Research Facility, Coho Salmon and Fall Chinook Salmon[3]					
Aquatic Research Facility (1950 – 2010)	4.9	Lake Washington Ship Canal (Portage Bay)	Lake Washington Ship Canal (Portage Bay)	230	--
Lake Washington Sockeye Salmon					
Cedar River Hatchery	10.4	Cedar River = 4.5 cfs; Unnamed Streams = 2.2 cfs; Springs = 3.7 cfs	Cedar River	200[4]	1.5[4]

Sources: University of Washington (2018a, 2018b); Washington Department of Fish and Wildlife (2019a, 2019b, 2019c)
[1]Approximately 1.1 additional cubic feet per second (cfs) is available from a well source
[2]Upstream diversion
[3]The facility has not operated since 2010; it can treat approximately 0.03 cfs of City of Seattle domestic water for incubation use
[4]Cedar River diversion

3.2 Water Quality

The rivers or streams on which hatchery facilities included in this EA are located are considered impaired for one or more water quality parameter. Human-related activities that may affect water quality have included irrigation, livestock grazing, forest practices, and domestic water needs.

Hatchery programs can negatively affect water quality parameters. Water enters hatchery facilities used for fish production and receives various inputs (e.g., fish food, pharmaceuticals used for fish health) before returning as effluent to the natural environment. Effluent typically has elevated water temperature, ammonia, organic nitrogen, total phosphorus, biochemical oxygen demand (BOD), pH, and solids (WDE 1989; Kendra 1991; USEPA 2006). Nutrients discharged to natural waters from hatchery effluent may cause an increase in algal growth that may lead to increased fluctuations in dissolved oxygen and pH because of increased algal photosynthesis, respiration, and decay.

Discharge of hatchery effluents is regulated by USEPA under the Clean Water Act through NPDES permits (Table 3-2). In Washington, USEPA issues NPDES permits for federally owned facilities and permits on tribal lands but has delegated authority to issue other NPDES permits to the Washington Department of Ecology (WDE). Some facilities included in this EA are permitted to have limited pollutant discharges in accordance with NPDES permits whereas others do not need a NPDES permit because they release less than 20,000 pounds of fish per year and/or feed fish less than 5,000 pounds of fish feed within a month

A fecal coliform bacteria cleanup plan for Issaquah Creek was developed by WDE (2004). The plan notes that although salmon are not a source of fecal coliform bacteria and are not affected by fecal coliform bacteria, they may be affected by contaminants typically associated with some bacteria sources.

The Issaquah Hatchery has had NPDES permit violations for total suspended solid exceedances due to flooding that were not related to hatchery production (WDFW 2019a, WDFW 2019b). During extremely high water events, facilities may have exceeded the permit limits for effluent solids, usually because high flow volumes flushed influent solids through the system without allowing them to settle, or resuspended settled solids from the ponds. When facilities have adequately removed solids, hatchery discharges have rarely caused water quality violations (WDE 2015). Based on review of the Discharge Monitoring Reports (DMRs) received, WDE found that Issaquah hatchery complied with their permit conditions (pers com email Brodie and Ecology person).

Hatchery facilities are required to comply with applicable Federal, state, and tribal water quality and groundwater standards as well as federal and state regulations for safe storage, handling, and application of chemicals and feed. As noted in Section 1.3, Description of the Proposed Action, the proposed action and scope of this EA do not include any future facility construction or expansion, including the withdrawal of water quantities beyond existing permissible volumes. NMFS assumes that the applicants will secure additional state water rights, if required.

Table 3-2. Current Hatchery Program Facility NPDES Permit and Receiving Water Attributes

Program	Facility	Permit No.	Receiving Waters	Impairment Listings for Receiving Waters
Issaquah Coho (Issaquah)	Issaquah Hatchery	WAG13-3010	Issaquah Creek[2]	Dissolved Oxygen, Bacteria
Issaquah Coho (NWSSC-Laebugten)[1]	Willow Creek Hatchery	--	Willow Creek	--
Issaquah Fall Chinook Hatchery Program	Issaquah Hatchery	WAG13-3010	Issaquah Creek[2]	Dissolved Oxygen, Bacteria
Lake Washington Sockeye[3]	Cedar River Hatchery	--	Cedar River	Temperature

Sources: Washington Department of Ecology (2019); Washington Department of Fish and Wildlife (2019a, 2019b, 2019c)
[1] NPDES permits are not required because the facility produces less than 20,000 pounds of fish per year or distributes less than 5,000 pounds of feed at any one time
[2]The Issaquah Creek Basin Water Cleanup Plan (WDE 2004) was developed under the Clean Water Act and under an agreement between the WDE and the USEPA
[3]Cedar Creek Hatchery operates under a surface water right from Landsburg Dam and does not have an NPDES permit.

3.3 Fish

Hatchery fish from Puget Sound programs have the potential to interact with salmon, steelhead, and other fish species in the natural environment. Hatchery fish from Lake Washington hatchery programs may interact with fish during three different life phases: both yearling and subyearling smolts during emigration, as juveniles rearing in Lake Washington for Sockeye Salmon released as fry, and as adults upon return. The Study Area for fish therefore includes locations in Issaquah Creek, Willow Creek, the Cedar River, other streams in the Lake Washington Basin, and the Lake Washington Ship Canal where

hatchery fish are captured, reared, and released, all areas downstream from release sites to Puget Sound. The Study Area also includes marine areas of Puget Sound and the Strait of Juan de Fuca as described in Section 1.2, Project Area and Study Area (Figure 1-1).

The programs included in this EA have released less than 5 percent of the total hatchery production of Coho Salmon in Puget Sound and less than 10 percent of total Chinook Salmon production (NMFS 2014). Survival rates from release to adult return for programs included in this EA have been estimated at 4.3 percent for Coho Salmon yearlings (WDFW 2019a), and 0.55 percent for Chinook Salmon subyearlings (WDFW 2019b). Given the relatively small proportion of overall production by these programs, and the low survival rates of hatchery fish, releases of Coho Salmon and Chinook Salmon from hatcheries included in this EA have not likely had discernible effects in the marine environment beyond this Study Area. The Cedar River Hatchery program constitutes about 8 percent (average in release years 2011 through 2018) of total hatchery salmon production in Puget Sound, and a far smaller percentage of hatchery fish in marine areas beyond Puget Sound and the Strait of Juan de Fuca (because fish produced in other areas are also present). By weight, Sockeye Salmon fry releases constitute a far smaller proportion of hatchery releases since each Sockeye Salmon fry weighs less than one percent of weight of a yearling Coho Salmon smolt. Therefore, Sockeye Salmon from the Cedar River Hatchery program have not likely had discernable effects in the marine environment beyond the Study Area.

3.3.1 ESA-Listed Salmon and Steelhead

The ESA-listed salmon and steelhead populations spawning in the Study Area are part of the Puget Sound Chinook Salmon ESU (76 FR 50448, August 15, 2011), Hood Canal Summer-Run Chum Salmon ESU (76 FR 50448, August 15, 2011), and Puget Sound Steelhead Distinct Population Segment (DPS; 76 FR 50448, August 15, 2011). The NWFSC (2015) found that in general, biological risks have not substantively changed since the time of listing. Both natural-origin and hatchery-origin ESA-listed Chinook Salmon, Chum Salmon (*O. keta*), and steelhead may occur in the Study Area (NMFS 2014):

- Puget Sound Chinook Salmon ESU
    - Whidbey Basin (MPG)
    - Central/South Basin-Eastern MPG
        - Includes the Issaquah Fall Chinook Hatchery Program
        - Inclusion of the UWARF Chinook Salmon Program will be determined by NMFS
    - Strait of Georgia MPG
    - Whidbey Basin MPG
    - Strait of Juan de Fuca MPG
- Hood Canal Summer-Run Chum Salmon ESU
- Puget Sound Steelhead DPS
    - Central and South Puget Sound MPG
    - Northern Cascades MPG
    - Hood Canal and Strait of Juan de Fuca MPG

NMFS has ranked the Sammamish and Cedar River populations of Chinook Salmon as Tier 3 for salmon recovery planning purposes (75 Fed. Reg. 82208, December 29, 2010). Tier 1 Chinook Salmon populations are of primary importance for preservation, restoration, and ESU recovery and must be viable

for the entire ESU to attain recovery status (75 Fed. Reg. 82208, December 29, 2010; Ruckelshaus et al. 2002). Tier 2 populations are less important than Tier 1 populations for recovery to a low-extinction risk status, and Tier 3 populations are the least important, relatively speaking, for species-level recovery purposes. For ESA recovery planning purposes under the Puget Sound Salmon Recovery Plan (Shared Strategy for Puget Sound 2007), the equilibrium abundance targets roughly reflect the historical abundance potential for the Lake Washington Chinook Salmon populations. The Sammamish population has a planning range of 4,000-6,500 spawners, and the Cedar River population has a planning range of 8,200-13,000 spawners (NMFS 2006; Shared Strategy for Puget Sound 2007). Critical escapement thresholds, below which extinction risk increases substantially, are 200 fish for the Sammamish and Cedar River populations (NMFS 2000a).

The geometric mean number of naturally spawning Chinook Salmon (hatchery-origin and natural-origin fish) from 1999 to 2018 was 1,073 fish per year for the Sammamish population and 924 fish per year for the Cedar River population, with both populations in decline (NMFS 2021). Natural-origin Chinook Salmon contribute an average of 161 fish per year to the Sammamish population and 659 fish to the Cedar River population. Additional information on Chinook Salmon viability in the Lake Washington Basin can be found in Subsection 3.3.3.1, Population Viability.

3.3.2 Non-ESA-listed Salmon

Similar to populations listed under the ESA, some non-listed salmon migrate through and spawn in the Study Area. Although not listed as threatened or endangered, the Puget Sound/Strait of Georgia Coho Salmon ESU is currently a species of concern under the ESA (69 FR 19975, April 15, 2004). A species of concern is a species about which there are concerns regarding status and threats, but insufficient information is available to list the species under the ESA. Other non-listed species include Sockeye Salmon, Pink Salmon (*O. gorbuscha*), and unlisted populations of Chum Salmon:

- Puget Sound/Strait of Georgia Coho Salmon ESU
    - Includes the Issaquah Coho Hatchery Program
    - Includes the UWARF Coho Salmon Program
- Baker River Sockeye Salmon ESU
- Sockeye Salmon not part of any ESU
    - Includes all Sockeye Salmon in the Lake Washington Basin (originated from Baker River Sockeye Salmon)
- Puget Sound/Strait of Georgia Chum Salmon ESU
- Odd Year Pink Salmon ESU
- Even Year Pink Salmon ESU

The number of adult Coho Salmon returning to the Lake Washington Basin has averaged about 15,000 fish, with a high of 47,000 fish in 2000. The run size was about 8,000 fish in 2020 (WDFW 2020a). Most Coho Salmon return to Issaquah Creek. The number of adult Sockeye Salmon from 2010 through 2019 averaged approximately 84,000, ranging from a low of 17,411 in 2019 to a high of 182,731 in 2013 (WDFW 2020a). Run sizes from 1972 through 1990 averaged over 200,000 adults.

3.3.3 Ongoing Impacts of Hatchery Programs on Salmon and Steelhead

Hatchery programs can affect natural-origin salmon and steelhead and their habitat in a variety of ways (Table 3-3). Through the implementation of its ESA section 4(d) program for reviewing hatchery programs, NMFS has developed a comprehensive approach to assessing impacts/effects to ESA-listed salmonid species from hatchery program operations. The extent of effects (adverse or beneficial) on salmon and steelhead and their habitat depends on the design of hatchery programs, the condition of the habitat, and the status of the species, among other factors. The following subsections describe each hatchery effect pathway in more detail as they pertain to the five Lake Washington hatchery programs included in this EA.

Table 3-3 General Effects of Hatchery Programs on Natural-origin Salmon and Steelhead Resources

Pathway	Potential Effects
Population Viability	• Abundance: Preserve, increase, or decrease the abundance of a natural-origin fish population • Spatial Structure: Preserve, expand, or reduce the spatial structure of a natural-origin fish population • Genetic Diversity: Retain or homogenize within-population genetic diversity of a natural-origin fish population • Productivity: Maintain, increase, or decrease the productivity of a natural-origin fish population
Genetics	• Interbreeding with hatchery-origin fish can change the genetic character of the local populations. • Interbreeding with hatchery-origin fish may reduce the reproductive performance of local populations.
Masking[1]	• Hatchery-origin fish can increase the difficulty in determining the status of natural-origin component of a salmon population.
Competition and Predation	• Hatchery-origin fish can increase competition for food and space. • Hatchery-origin fish can prey on natural-origin fish.
Prey Enhancement	• Hatchery-origin fish can increase the number of prey for natural-origin fish.
Disease	• Concentrating rearing salmon in a hatchery facility can lead to an increased risk of pathogens and outbreaks. When hatchery-origin fish are released from hatchery facilities, they may increase the disease risk to natural-origin salmon and steelhead through pathogen transmission.
Nutrient Cycling	• Returning hatchery-origin adults can increase the amount of marine-derived nutrients in freshwater systems.
Facility Operations	• Hatchery facilities can reduce water quantity or quality in adjacent streams through water withdrawal and discharge. • Weirs for broodstock collection or to control the number of hatchery-origin 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 or increase predation or pre-spawn mortality o Alteration of streamflow o Alteration of streambed and riparian habitat o Alteration of the distribution of spawning within a population o Increased mortality or stress due to capture and handling o Impingement of downstream migrating fish o Forced downstream spawning by fish that do not pass through the weir • Increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries
RM&E	• Surveying and sampling to assess program objectives and goals may increase the risk of injury and mortality to salmon that are the focus of the actions, or that may be incidentally encountered. • RM&E will also provide information on the status of the natural population.

[1] Not applicable to programs in this EA because all of the Coho Salmon and Chinook Salmon are or would be adipose-fin clipped. The Lake Washington Sockeye Program utilizes otolith-marking to allow for future monitoring and evaluation and would also adipose-fin clip subyearlings and yearlings. Therefore, masking is unlikely to occur under any alternative for Coho, Chinook, and Sockeye Salmon.

3.3.3.1 Population Viability

Salmon and steelhead population viability is determined through a combination of four parameters including abundance, productivity, spatial structure, and genetic diversity. As part of NMFS' periodic reviews of the status of threatened and endangered species and planning for their recovery, NMFS defines population performance measures for these key parameters and then estimates the effects of hatchery programs at the population scale on the survival and recovery of an entire ESU or DPS. NMFS has established population viability criteria for three federally threatened ESUs or DPSs in the Study Area: Puget Sound Chinook Salmon ESU, Puget Sound Steelhead DPS, and Hood Canal Summer Run Chum ESU. This section provides a qualitative assessment of benefits to the viable salmonid population parameters for Chinook, Coho, and Sockeye Salmon from the current hatchery program in the Lake Washington Basin. The assessment is focused on abundance and productivity. Additional information on the viability of listed Puget Sound Chinook Salmon is available in the most recent 5-year review of their status (NWFSC 2015).

Hatchery programs considered in this EA do not produce Chum Salmon or steelhead; therefore, ongoing hatchery production has little to no effect on population viability for natural-origin individuals from the Puget Sound Steelhead DPS or the Hood Canal Summer Run Chum ESU.

The Issaquah Fall Chinook Salmon Hatchery program released an average of about 2 million subyearlings annually from 2004 through 2015, with a maximum goal of 3 million subyearlings. The program is operated as an integrated program but would run as a segregated program until NORs exceed 500 fish consistently (Section 1.3.3, Issaquah Fall Chinook Hatchery). The program supplements critically low natural-origin adult escapements to reduce the threat of extinction and facilitate monitoring of fisheries and population demographics (Section 3.3.1, ESA-Listed Salmon and Steelhead). As noted in Section 3.3.3.2, Genetics, only about 24 percent of the Sammamish population of Chinook Salmon have been of natural origin. Fish from the Issaquah Fall Chinook Hatchery Program have therefore contributed substantially to the population abundance.

Viable populations have an average productivity value of at least 1.0, meaning at least one adult returns for every natural spawner (Ruckelshaus et al. 2002). Based on current habitat conditions, the Sammamish population of Chinook Salmon is not viable (PSIT and WDFW 2017). Productivity in terms of recruits per spawner has been consistently poor, with no brood year from 1989-2009 having more than 0.7 recruits per spawner. Productivity has been variable for the Cedar River population, with an average value of 1.8 recruits per spawner. Productivity for the two populations is poorly correlated ($r = 0.25$).

All salmon hatchery programs have high egg-to-release survival objectives. The Issaquah Fall Chinook Salmon hatchery program averaged approximately 80 percent egg-to-subyearling release survival from 2004 through 2015 (WDFW 2019b). Consequently, the program has helped to improve viability through high survival rates during early life stages and particularly during life stages of concern because of poor habitat in the Sammamish Lake Basin for natural-origin Chinook Salmon.

Stochastic simulation analysis projects that natural-origin Sockeye Salmon will not persist in the Lake Washington under current conditions (WDFW 2018). The Cedar River Hatchery program released an average of about 7.5 million Sockeye Salmon fry annually from 2008 through 2015. The program operates as an integrated program to minimize differences between the genetic characteristics of hatchery- and natural-origin salmon. The sockeye hatchery program has been identified by the co-

managers as an important tool to maintain the population while other environmental stressors are addressed (WDFW 2019c).

NMFS has identified the Puget Sound/Strait of Georgia Coho Salmon ESU as a species of concern under the ESA (69 FR 19975, April 15, 2004). Based on field observations Feist et al. (2017) predicted adult mortality of Coho Salmon as high as 54 percent in watersheds in the Seattle metropolitan area and mortality rates that exceeded 40 percent in much of the Lake Washington Basin. Natural production in much of the basin is believed to be primarily maintained by releases of juveniles and planting of adults from the Issaquah Hatchery. For example, higher-than-average adult coho returns to Bellevue streams (especially Coal Creek) observed in 2016 and 2017 were likely a result of the hatchery coho adult out-planting that occurred in 2013 and 2014 (WDFW 2018b).

3.3.3.2 Genetics

Ongoing hatchery operations currently affect the genetic character of salmon and steelhead populations in the Study Area. Genetic effects may depend on the type of hatchery program being operated. Hatchery programs included in this EA are both integrated and segregated. Segregated programs use only hatchery-origin fish for broodstock, and are generally intended to support harvest, with few if any hatchery fish allowed to spawn naturally. This may result in greater domestication of the hatchery fish compared to integrated programs that use natural-origin broodstock to maintain genetic similarities with wild fish; therefore, a potential for negative effects exists if hatchery fish from segregated programs interbreed with natural fish on spawning grounds. Integrated programs are designed to supplement natural populations by using natural-origin broodstock to increase production. The purpose of integrated programs is often to allow for hatchery fish to spawn naturally to expand populations. While integrated broodstock pose less of a genetic risk to natural populations when spawning in rivers, there is still some risk. Descriptions of these effects can be found in the completed biological opinions prepared by NMFS for hatchery programs in Puget Sound (NMFS 2021).

Typical metrics used to describe the genetic risks of hatchery-origin spawners on the natural population are called proportionate natural influence (PNI) and percent hatchery-origin fish on the spawning grounds (pHOS). PNI is typically relied on to assess genetic impacts of an integrated program, while pHOS would be used to measure impacts from a segregated one. Assessment of outbreeding effects and hatchery-influenced selection occurs simultaneously using pHOS/PNI metrics. A low PNI value indicates that hatchery fish and the hatchery environment were having a greater influence (i.e., hatchery influence selection) on the naturally-spawning population than the natural environment. A PNI exceeding 0.5 indicates that natural selection outweighs hatchery-influenced selection (i.e., the use of natural-origin broodstock contributes to higher PNI). In other words, the use of more natural-origin broodstock equates to less genetic effects on natural-origin populations.

Regarding segregated programs, pHOS simply measures the (often unintended) spawning of hatchery fish with natural-origin populations. The Hatchery Scientific Review Group (HSRG) developed guidelines for allowable pHOS population levels, scaled by the population’s conservation importance. the HSRG recommends a maximum of 5 percent in primary populations, 10 percent for contributing populations, and “at a level required” to maintain sustaining populations (HSRG 2015). It is important to note that NMFS has not adopted HSRG guidelines but regards the HSRG’s genetic recommendations as important information to consider with other scientific information in evaluations of hatchery programs (NMFS 2011c, 2016e, 2016f) While NMFS evaluates each hatchery program, if a program meets HSRG standards, NMFS typically considers the risk levels acceptable.

The five hatchery programs included in this EA currently support (or previously supported) artificial production of Coho Salmon, fall Chinook Salmon, and Sockeye Salmon. Because no spring Chinook

Salmon, Chum Salmon, Pink Salmon, or steelhead are produced under any of these hatchery programs, they are not genetically affected through interbreeding. Therefore, only individuals from the Puget Sound Chinook Salmon ESU (ESA-threatened), Puget Sound/Strait of Georgia Coho Salmon ESU (ESA species of concern), and natural origin Sockeye Salmon (not part of an ESU) have been subject to genetic effects from the hatchery programs covered in this EA.

Issaquah Coho Hatchery Program

The Issaquah Coho Hatchery Program contains two sub-programs: (1) the Issaquah Program, and (2) the NWSSC-Laebugten Program. The Issaquah Program is an integrated program intended to provide sustainable recreational and tribal fisheries. Because the majority of naturally-spawning fish in the basin are of hatchery-origin, little genetic difference exists between the hatchery-origin and the natural-origin Coho Salmon in the basin (WDFW 2019a).

The NWSSC-Laebugten Program is operated as a segregated program to support non-tribal sport and commercial harvest. Formerly supplied from Marblemount Hatchery, Coho Salmon are now provided from the Issaquah Hatchery (WDFW 2019a). Although Coho Salmon on-station production at Issaquah Hatchery are managed as an integrated program, fish destined for transfers are not integrated (they are progeny of hatchery x hatchery crosses), and the NWSSC-Laebugten Coho Salmon production is currently managed as a segregated program. Regardless, no known genetic differences exist between hatchery-origin and natural-original Coho Salmon in the Study Area. Therefore, similar to the Issaquah Program, the NWSSC-Laebugten Program has had little potential to influence the genetics of naturally-spawning Coho Salmon in the Study Area.

University of Washington Aquatic Research Facility Hatchery Coho Salmon Program (1950-2010)

The UWARF Coho Salmon program operated for 60 years before it was discontinued in 2010. Under the proposed action, the program would be revitalized over the next 2 to 5 years (2019 to 2022; University of Washington 2018a). Prior to its discontinuation in 2010, the program was operated as a segregated hatchery program that supported regional research programs. The program was operated to maintain a genetically distinct population to reduce genetic and risks to natural populations and to maintain a gene pool that was separated from all natural populations (University of Washington 2018a).

Issaquah Fall Chinook Salmon Program

The Issaquah Fall Chinook Salmon Program has operated in the Lake Washington Basin in recent years has been an integrated program, which is intended to provide sustainable fisheries, including tribal and recreational harvest. The Puget Sound Chinook Salmon ESU is listed as threatened under the ESA, and fish from the Issaquah Fall Chinook Program are included in the ESA-listing. The Puget Sound Technical Recovery Team has delineated two historical populations of Chinook Salmon in the Lake Washington Basin: Sammamish River and Cedar River. Issaquah Creek is within the area of the Sammamish population. The Sammamish population is not essential for recovery of the Puget Sound Chinook ESU (PRA Tier 3), and the additional contribution of hatchery origin fish helps mitigate demographic risk (NMFS 2021). Despite the delineation and management of two populations in Lake Washington, Warheit and Bettles (2005) suggest that genetic differences between Sammamish River and Cedar River Chinook Salmon are small.

From 2005 through 2016 the Sammamish population averaged 1,331 (range 482-2,333) spawning adults; however, only about 24 percent (range 8 – 29 percent) of these were of natural origin (Figure 3-1; WDFW 2020b). Fish from the Issaquah Fall Chinook Hatchery Program have therefore constituted most of the population.

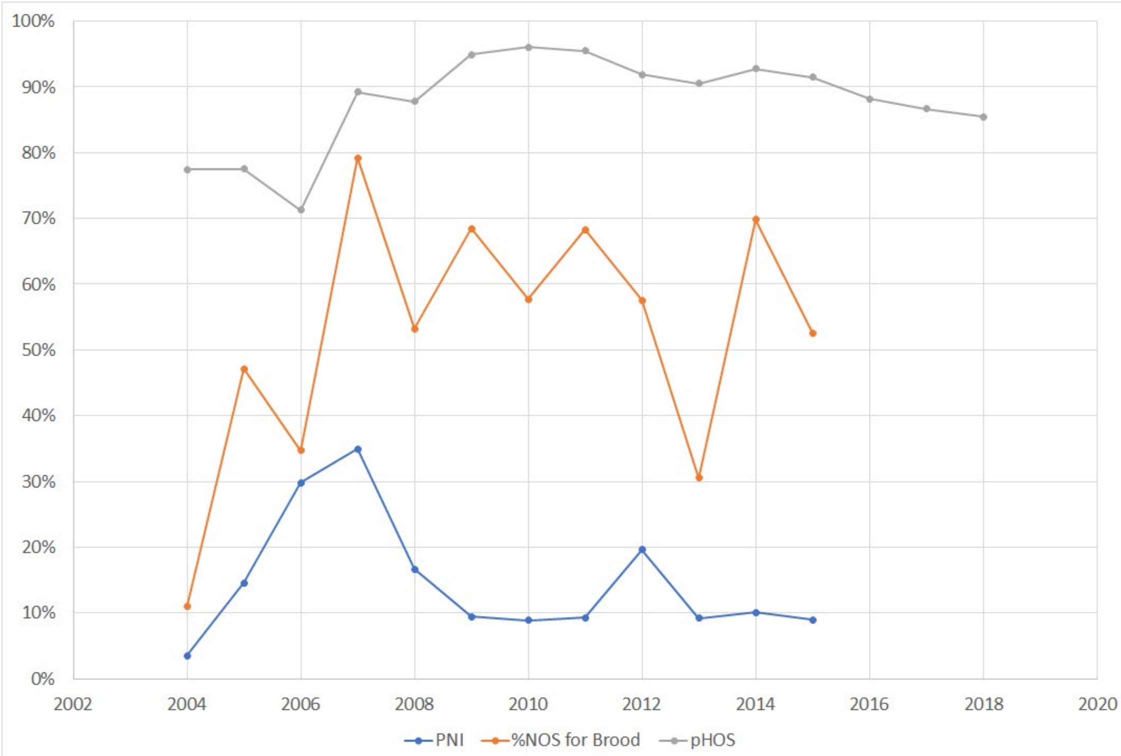

Figure 3-1. Proportion natural influence (PNI), percent natural origin spawners used in broodstock (pNOB) and proportion hatchery origin spawners (pHOS) reported for Sammamish River Chinook Salmon.

Broodstock has been randomly selected from all adult returns to the Issaquah Creek Hatchery fish ladder. Some hatchery-origin fish are not marked resulting in a percentage of the natural origin fish return that are unclipped hatchery origin fish. The mis-clip rate for Issaquah Hatchery is 2.9%; therefore, although the majority of broodstock is usually natural-origin fish (Figure 3-1), some unmarked hatchery-origin fish have been included. This has helped maintain the genetic similarities between hatchery and naturally-spawning fish and reduced the risk of divergence of these populations (HSRG 2004).

Shared Strategy for Puget Sound (2007) noted concern that straying of Chinook Salmon from Issaquah Creek Hatchery may affect the genetic diversity of Lake Washington Basin Chinook Salmon populations. Similar to pHOS, straying refers to hatchery fish returning to spawn somewhere other than the hatchery where they were intended to be removed from the river. However, WDFW (2019b) reported that from 2006 through 2010, strays to within-basin and out-of-basin spawning grounds, and to out-of-basin hatcheries totaled only 0.87 percent of all known adult returns from the Issaquah Fall Chinook Salmon Program. Anderson et al. (2013) found that the number of hatchery Chinook Salmon ascending the ladder at Landsburg Dam on the Cedar River generally decreased from 2003 through 2009, but still ranged from 17-30 percent from 2007 through 2009. It is likely (but not confirmed) that most of these fish were from the Issaquah Fall Chinook Salmon Program. The total number of hatchery fish ascending the ladder ranged from 25 fish in 2008 to 93 fish in 2007. If all hatchery Chinook Salmon at Landsburg Dam were from the Issaquah program, then stray rates to the dam from 2007 through 2009 would have ranged from 0.69 percent to 1.79 percent of total escapement, which is consistent with the overall stray rate estimate from 2006 through 2010 of 0.87 percent. In addition, the Cedar River upstream of the dam was not

accessible until modifications to the dam were completed in 2003; therefore, hatchery fish ascending the ladder seeded underutilized habitat.

University of Washington Aquatic Research Facility Fall Chinook Salmon Program (1950-2010)

The UWARF Fall Chinook Salmon Program has supported regional research programs as well as regional educational and outreach activities. Chinook Salmon produced from previous program releases have not been considered a viable population segment of the Puget Sound Chinook Salmon ESU and fish from the program have therefore not been part of the ESU.

Data from the Regional Mark Information System indicate that a total of 21 hatchery program CWTs were found in the Cedar River from the period 2000-2007, representing 10 different tag codes. The Cedar River-specific stray rate for the program hatchery tag codes in fish released from brood years 1997-2003 was 1.87 percent. Based on these data, roughly 2 percent of the total return of program Chinook Salmon strayed to the Cedar River and another 1 percent strayed to other basin tributaries (University of Washington 2018b). In addition, University of Washington hatchery Chinook Salmon had low stray rates, 0.93 percent, which resulted in the majority of the run returning to the facility (~ 90% average years 2000 - 2003) and decreasing competition within spawning grounds (RMIS 2020).

Lake Washington Sockeye Program

The Lake Washington Sockeye Program is operated as an integrated program intended to supplement natural production in the Study Area. Broodstock for the program have been collected from the Cedar River, at the Landsburg Dam, and beginning in 2021from the Ballard Locks. The origin of Sockeye Salmon in the Cedar River is believed to be from the Baker River in northern Washington State along with some transfers from Cultus Lake in British Columbia. NMFS does not consider the Cedar River stock to be part of a recognized ESU and the nearest Sockeye Salmon ESU is the Baker River ESU.

3.3.3.3 Competition and Predation

Ecological interactions between natural- and hatchery-origin fish may occur during the adult and juvenile life-history stages. Hatchery yearlings, subyearlings, and fry released into habitats where natural-origin juvenile salmon rear may compete with or prey on natural-origin fish. Hatchery-origin adults may also compete with natural-origin salmon for spawning sites and resources. The Species Interaction Work Group (SIWG) (1984) identified the potential risk of competition from hatchery-origin on natural-origin Chinook Salmon. The incidence of competition or predation between natural- and hatchery-origin fish under past and current operations has been influenced by a variety of factors including size of predators and prey, spatial and temporal overlap, and the number of fish released at any time. General information on competition risks from salmon hatchery programs to natural-origin salmon and steelhead, and the qualitative evaluation tool are presented in NMFS (2019b).

Interactions between Hatchery-Origin Juveniles and Natural-Origin Juveniles

In the Study Area, hatchery Coho Salmon fry, subyearlings, and yearlings are released April-June, fall Chinook Salmon subyearlings are released May-June, and Sockeye Salmon fry are released January-May. Fish released as fry may rear in fresh water for a substantial period; Sockeye Salmon fry remain in Lake Washington for one year or more (NMFS 1997). Coho Salmon subyearlings and yearlings and Fall Chinook Salmon subyearlings outmigrate soon after release. During these release, rearing, and outmigration periods, some natural-origin salmon juveniles are lost to competition and predation from hatchery-origin juveniles particularly when there is overlap in time and space (NMFS 2018a; 2018b). Daly et al. (2009) found that Coho Salmon and Chinook Salmon become more piscivorous as they enter

marine waters. All currently operating programs within this EA have managed fish size at release, release location, and release timing to minimize competition and predation from hatchery-origin juveniles.

Predation on some species by hatchery-origin juveniles is less likely than competition because of fish size. Some reports suggest that hatchery-origin fish can prey on fish one half their length (Pearsons and Fritts 1999; HSRG 2004), but other studies concluded hatchery-origin predators prefer fish one third or less their length (Hillman and Mullan 1989; Beauchamp 1990; Cannamela 1992). Thus, past predation by Coho Salmon hatchery yearlings may have been limited to fish less than about 2 inches because of the size hatchery Coho Salmon at release (Table 3-4). Mean size of fish consumed by hatchery fall Chinook Salmon has been even smaller. The average size of most natural-origin fish encountered by juvenile hatchery fish has therefore limited the effects of predation (NMFS 2018a). In addition, hatchery fish within this EA have been released downstream of significant ESA fish spawning sites and at time and fish size that fosters rapid downstream migration to the marine environment to minimize encounters with ESA listed fishes (University of Washington 2018a, 2018b; WDFW 2019a, 2019b; 2019c). Once in marine waters, salmon may begin feeding on fish prey at a smaller size than when in fresh water (Daly et al. 2009).

Table 3-4. Approximate Average Releases from Coho Salmon, Fall Chinook Salmon, and Sockeye Salmon Programs Included in this EA.

Program	Release Site	Fish Per Pound	Estimated Length (Inches)	Life Stage	Recent Annual Releases[1]
Issaquah Coho Hatchery	Issaquah Creek	17	5.5	Yearling	436,000
	North Creek	100-500	2.0-2.8	Fry	48,000
	Swamp Creek	500	2.0	Fry	20,000
	Edmonds, WA, Puget Sound	10	6.3	Yearling	27,000
University of Washington Aquatic Research Facility Coho Salmon[2]	Portage Bay, Lake Washington	30	4.7	Subyearling	83,000
Issaquah Fall Chinook Hatchery	Issaquah Creek	80-110	2.0-3.7	Subyearling	1,970,000
University of Washington Aquatic Research Facility Fall Chinook Salmon[2]	Portage Bay, Lake Washington	22	4.9	Subyearling	183,000
Lake Washington Sockeye	Cedar River	2,000	<2	Fry	9,355,000

Sources: University of Washington 2018a, 2018b; WDFW 2019a, 2019b, 2019c
[1] Historical release numbers may vary from those under the Proposed Action, but are representative of conditions expected under Alternative 1 of this EA
[2] Not operated since 2010

Residualism of Hatchery-Origin Juveniles

A proportion of the juveniles released from a hatchery may not migrate to the ocean but rather reside for some time near the release point. These non-migratory fish may directly compete for food and space with natural-origin juvenile salmonids of similar age. They also may prey on younger, smaller-sized juvenile salmonids. Although this behavior has been studied and observed most frequently in the case of hatchery steelhead, residualism has been reported as a potential issue for hatchery Chinook Salmon as well. Johnson et al. (2012) and Temple et al. (2012) found very low rates of residualism (less than 0.1 percent) for hatchery spring Chinook Salmon in the Yakima River.

The existing hatchery programs in this EA currently implement several actions to reduce the potential for residualism including:

- releasing hatchery smolts that are physiologically ready to migrate
- rearing hatchery fish to sufficient size that smoltification occurs in nearly the entire population
- releasing hatchery smolts below areas used by natural-origin juveniles, monitoring the incidence of potential non-migratory smolts (residuals) after release, and adjusting rearing strategies, release location and timing if substantial competition with naturally rearing juveniles is determined likely

For the Issaquah Coho program, yearling Coho Salmon are released from the Edmonds Net pen as close as possible to June 1, to encourage fish to remain in the vicinity and therefore maximize harvest opportunities within Puget Sound. Release of fish from pens directly into marine waters eliminates freshwater juvenile interaction (WDFW 2019a).

Interactions with Naturally-Produced Progeny

Naturally spawning Coho, Fall Chinook, and Sockeye salmon originating from the hatchery programs included in this EA are likely to be less efficient at reproduction than their natural-origin counterparts (Christie et al. 2014). The progeny of hatchery-origin spawners may therefore compose a portion of the juvenile fish population. If rearing habitat is limited, the added abundance of hatchery progeny may result in a density-dependent response by natural-origin juveniles of decreasing growth or survival, earlier migration due to high densities, and potential exceedance of habitat capacity.

Interactions between Hatchery-Origin Adults and Natural-Origin Adults

Negative interactions between hatchery Coho, Chinook, and Sockeye salmon originating from the hatchery programs and other salmonids in the Study Area, such as displacement of natural fish from preferred habitats and interaction on spawning grounds between fish of natural and hatchery origin have been minimal due to differences in run-timing, holding, spawn timing, and spawning habitat preferences. Although most returning adults associated with the programs within the EA have been collected for broodstock, adult Coho and Chinook salmon that exceed broodstock needs at Issaquah Hatchery have been passed upstream. These fish seed otherwise unutilized habitat.

In the Cedar River, all Sockeye Salmon collected at the weir (RM 1.7) are removed from the river and used for broodstock. Landsburg Dam fish passage facility operations are included in the 2000 Cedar River Habitat Conservation Plan (HCP; City of Seattle 2000). Broodstock is also collected at Landsburg Dam (section 10 permit number 1235). Natural-origin and hatchery-origin Coho and Chinook salmon are passed above Landsburg Dam (Table 3-5). Potential temporal or geographic overlap of hatchery salmon with natural-origin salmon exists, and redd superimposition is possible. Considering the low number of hatchery and natural-origin salmon that have returned to spawn in the Cedar River (Table 3-5), redd superimposition has likely been low. Furthermore, steelhead have not been reported at the fish passage facility, therefore interaction above the dam would not be expected.

Table 3-5. Fish passage at Landsburg Dam.

Year	Chinook passed above Landsburg	Coho passed above Landsburg	Sockeye released downstream or taken to Cedar River Hatchery
2003	79	47	1001
2004	51	99	876
2005	69	170	1238
2006	182	190	2414
2007	397	142	831
2008	146	366	59
2009	138	679	236
2010	169	*	3706
2011	211	*	915
2012	278	1085	1359
2013	262	*	1327
2014	199	*	634
Totals	2181	2778	14596

Source: WDFW 2019c

3.3.3.4 Prey Enhancement

Upon release into the natural environment, hatchery-origin juveniles may become prey for natural origin salmon and steelhead and provide an additional food source (Table 3-4). Any resident adult fish can prey on hatchery-origin juveniles. Similarly, larger natural-origin juvenile fish can prey on hatchery-origin juveniles. Though the occurrence of predation by some species on hatchery-origin juveniles has likely been low because of fish size (Section 3.3.3.3, Competition and Predation), prey enhancement can occur for any fish species larger than the hatchery-origin juveniles. Sockeye Salmon are not piscivorous and therefore do not prey on hatchery-origin fish.

3.3.3.5 Diseases

Ongoing hatchery programs may introduce exotic pathogens and spread exotic and endemic pathogens into the natural environment. When a hatchery fish is infected in a hatchery facility, the pathogen can be amplified in the water column and among the other fish because hatchery fish are reared at higher densities and closer proximity than in the natural environment. Transmission of pathogens between infected hatchery fish and natural fish can occur indirectly through hatchery water effluent or directly if infected hatchery fish contact natural-origin fish after the hatchery fish are released into the natural environment.

Major diseases identified in salmonids from Puget Sound include Bacterial Kidney Disease (BKD) and Infectious Hematopoietic Necrosis (IHN), both of which are caused by pathogens endemic to the basin (bacterium *Renibacterium salmoninarum* and infectious hematopoietic necrosis virus (IHNV), respectively). Sockeye Salmon are particularly vulnerable to IHN (Lapatra 2011; Alaska Department of Fish and Game 2021), IHNV has no known treatment. Viral hemorrhagic septicemia virus (IVa), the Pacific Northwest Strain of IVa (PNW VHSV), *Oncorhynchus masou* virus (OMV), *Myxobolus cerebralis* (agent of whirling disease), and infectious salmon anemia virus are also of concern in Puget Sound (WDFW and WWTIT 2006),

To minimize the potential for disease transmission within and outside of each facility, hatchery operators have closely monitored for disease during all aspects of the production programs until fish are released. Adherence to several state, federal, and tribal fish health policies limits the disease risks associated with hatchery programs (USFWS 2004; WDFW and WWTIT 2006). These policies govern the transfer of fish, eggs, carcasses, and water to prevent the spread of exotic and endemic reportable pathogens. For all pathogens, both reportable and non-reportable, pathogen spread and amplification are minimized through regular monitoring, removing mortalities, and disinfecting all eggs. Vaccines may provide additional protection from certain pathogens when available. All of these actions have been implemented to prevent amplification and transmission of infectious diseases in the naturally spawning populations.

3.3.3.6 Nutrient Cycling

Salmon are important transporters of marine-derived nutrients into the freshwater and terrestrial systems through the decomposition of adult carcasses (Cederholm et al. 2000). During the time that salmon and steelhead live in marine environments, they consume food that contains nutrients found only in marine water (called marine-derived nutrients). After spawning and dying in freshwater spawning areas, salmon and steelhead (as well as carcasses resulting from hatchery operations that are manually placed in streams) decompose and release the marine-derived nutrients to the benefit of freshwater ecosystems (Cederholm et al. 2000).

The input of marine-derived nutrients such as phosphorus and nitrogen into streams is thought to enhance productivity of many nutrient-poor coastal streams and riparian vegetation communities (NMFS 2014). Phosphorous is one example of a marine-derived nutrient added to natural systems from salmonid carcasses. Estimating the quantity of phosphorous added to the natural environment from hatchery programs is one method to estimate nutrient transport. Increased phosphorus can benefit salmonids because phosphorus is typically a limiting nutrient for the growth of prey sources (e.g., *Daphnia* spp., a prey item for juvenile salmonids).

Hatchery-origin fish and eggs from the hatchery programs included in this EA have added an unknown amount of phosphorus annually into the environment, in addition to what is typically added to the system by natural-origin fish. The amount of phosphorous is difficult to estimate accurately because hatchery-origin returns are subjected to removal from harvest, broodstock collection, and gene flow management. Regardless, hatchery-origin fish increase phosphorous concentrations, which has likely compensated for some marine-derived nutrients lost from declining numbers of natural-origin fish.

3.3.3.7 Facility Operations

Water quantity and water quality are assessed as separate resources in Sections 3.1, Water Quantity, and 3.2, Water Quality. Therefore, the discussion of current facility operations in this subsection is limited to operation of weirs and traps for adult collection, water diversions, intake structures, and facility maintenance activities relative to their direct impacts on salmon and steelhead.

Adult Collection

The operation of adult collection facilities may delay salmon and steelhead migration and may lead to changes in spawning distribution. Operational guidelines and monitoring minimize delays to and impacts on fish. Traps are checked daily during peak migration periods at all collection facilities.

As presented in Section 1.3, Description of the Proposed Action (Table 1-2), adult Coho and fall Chinook Salmon are collected for broodstock at the Issaquah Creek Hatchery with additional natural-origin salmon potentially handled during broodstock collection efforts at the Ballard Locks. The UWARF Coho and fall Chinook Salmon programs have not operated since 2010. For the Lake Washington Sockeye Program,

broodstock is collected at a temporary weir on the Cedar River, Landsburg Dam and the Ballard Locks which could also result in the handling of additional natural-origin salmonids. Adult Sockeye Salmon are also received from the Landsburg Dam fish sorting facility which is covered by a separate Section 10 Permit (#1235). Hatchery-origin Chinook, Coho, and Sockeye salmon adults are collected for broodstock as part of these segregated program components but other natural-origin fish may also be encountered (Table 3-6). Such encounters may delay migration and cause stress or mortality during sorting, holding, and handling. Collected non-target species are typically returned upstream of collection sites on the same day they are captured. In the mid-Columbia River and Hood Canal, mortality of incidentally collected species has been low, ranging from near zero to a maximum of 3 percent (NMFS 2018a, 2018b).

Table 3-6. Average Annual Number of Natural-origin Salmon Trapped during Broodstock Collection for Programs included in this EA

Location	Years Included	Collection Period	Coho Salmon	Fall Chinook Salmon	Steelhead	Sockeye Salmon
Issaquah Hatchery	2004-2015	September-December	97	166	0	2
Ballard Locks	--	August-September	0	--[1]	0	--[3]
UWARF[2]	2002-2009	September-December	301	649	0	0
Cedar River	2007-2018	September-October	0	0	0	6,123

Sources: University of Washington 2018a, 2018b; WDFW 2019a, 2019b, 2019c
[1]Broodstock collection has occurred in the past and may occur in the future
[2]Not operated since 2010
[3]Broodstock collection occurred in 2021 and is likely to occur in the future

Water Diversions

As described in Section 3.1, Water Quantity, the diversion of surface water for hatchery programs reduces instream flow between the water intake and discharge structures. Flow reductions and dewatering may affect salmon and steelhead if migration is impeded or it leads to degraded habitat conditions (e.g., increased water temperatures, reduced pool availability). During low flow periods, habitat complexity may be reduced in some areas, but diversion reaches are not completely disconnected from flow.

Intake Screening

Impingement or entrainment during water intake by intakes, pumps, or screens has the potential to affect fish. Facilities are routinely observed for any signs that screens are not effectively excluding fish from intakes. Intake facilities at Issaquah Hatchery, Cedar River Hatchery meet current NMFS (2011) screening criteria. The intake at Willow Creek Hatchery is not required to meet NMFS criteria but was issued a hydraulic project approval by WDFW when it was built in 1985 (WDFW 2019a).

Effluent Discharge

Issaquah hatchery and associated programs are operated under NPDES permits for hatchery discharge, but Willow Creek does not need NPDES coverage because rearing levels are below permit minimums (Section 3.2, Water Quality). Facilities within this EA have discharged proportionally small volumes of

water with waste (predominantly biological waste) into their respective water bodies, which has resulted in temporary, low, or undetectable levels of contaminants.

Therapeutic chemicals used to control or eliminate pathogens (i.e., formaldehyde, sodium chloride, iodine, potassium permanganate, hydrogen peroxide, antibiotics), can also be present in hatchery effluent. However, these chemicals are not likely to be problematic for salmon and steelhead because they are quickly diluted beyond manufacturer’s instructions when added to the total effluent and again after discharge into the recipient waterbody. Therapeutants are also used periodically, and not constantly during hatchery rearing. Many therapeutants break down quickly in the water and/or are not likely to bioaccumulate in the environment (USEPA 2015). For example, formaldehyde readily biodegrades within 30 to 40 hours in stagnant waters. Similarly, potassium permanganate would reduce to compounds of low toxicity within minutes. Aquatic organisms are also capable of transforming formaldehyde through various metabolic pathways into nontoxic substances, preventing bioaccumulation in organisms (USEPA 2015).

Facility Maintenance Activities

HGMPs referenced in Section 1.3, Description of the Proposed Action, were prepared for each hatchery program and describe facility-specific maintenance activities that occur at each location (University of Washington 2018a, 2018b; WDFW 2019c; WDFW 2019a, 2019b). Routine preventative maintenance of hatchery facility structures is necessary for proper functionality.

For most facilities in anadromous waters, hatchery-related infrastructure (e.g., weirs and water source intakes) is located within salmon and steelhead migration and/or spawning habitat. Therefore, individual fish have been temporarily displaced from occupied habitats when personnel work in or near the river channel (e.g., clearing accumulated sediment at intakes). Hatchery maintenance activities may have displaced juvenile fish through instream activity or exposed them to brief pulses of sediment as activities occurred instream. When maintenance activities occur within water, they have been implemented using best management practices (BMPs) described in Section 2.1.2, Operation and Maintenance) and all permit requirements have been followed to minimize the potential indirect “take” associated with the operations of the hatchery facilities within this EA.

3.3.3.8 Research, Monitoring, and Evaluation

Although some hatchery programs have program-specific RM&E activities (Table 2-2), RM&E activities associated with other research programs have been conducted independent of hatchery operations. In other geographic areas, NMFS (2018a, 2018b) determined that the effects of ongoing program RM&E on natural-origin salmon and steelhead populations are unlikely to contribute to a decrease in the abundance, productivity, diversity, or spatial structure of the populations. RM&E activities directly related to hatchery programs have been implemented using well established methods and protocols (e.g., Galbreath et al 2008). Because the intent of RM&E for Lake Washington programs is to improve the understanding of salmonids., the information gained outweighs the risks to the populations, based on the small proportion of fish encountered. Incidental effects may result from tagging, such as injury to salmon and steelhead.

Collection of adults at traps delays individuals in their upstream migration and could alter spawning behaviors upon release. Individuals may also suffer stress or mortality during tagging, tissue sampling, or other monitoring efforts. Mortality from tagging is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish are released into the environment). Programs within this EA (e.g., Cedar River weir and fish trap) follow operational guidelines and protocols for how broodstock will be collected to minimize the impact on listed species migration and spawning activities (e.g., WDFW 2019c).

In other geographic areas, NMFS has developed general guidelines to reduce impacts when collecting listed adult and juvenile salmonids (NMFS 2000b, 2008a). Projects within this EA have followed performance standards and indicators for the use of artificial production in the Pacific Northwest (NPCC 2001). Additional monitoring principles for supplementation programs have been developed (Galbreath et al. 2008).

Ongoing spawning ground surveys may temporarily harass salmonids in surveyed reaches of the Study Area. At times, research involves observing adult fish, which are more sensitive to disturbance than juveniles. Salmonids exhibit avoidance behaviors likely in the range of normal predator and disturbance behaviors.

Individual salmon and steelhead are captured at rotary screw traps associated with juvenile outmigration monitoring for several hatchery programs. These ongoing collections may temporarily delay downstream migration and stress fish during handling (if required).

3.3.4 Other Fish Species

Hatchery fish from Lake Washington hatchery programs may interact with fish during three different life phases: both yearling and subyearling smolts during emigration, as juveniles rearing in Lake Washington for Sockeye Salmon released as fry, and as adults upon return. Smolts and adults are not likely to have a discernible effect beyond Puget Sound because fish from these programs are likely to have similar density-dependent interactions (e.g., competitive or predator/prey relationships) with other fish species, comparable to that discussed in Section 3.3.3, Ongoing Impacts of Hatchery Programs on Salmon and Steelhead). Many fish species found in the Study Area may have potential interactions with fish from the current programs (Table 3-7). These species include resident and anadromous forms of trout and lamprey, other species that are restricted to fresh water, and species that are found only in marine waters. Hatchery fish may compete for spawning sites or have redd superimposition with other salmonid species such as Coastal Cutthroat Trout and Kokanee. Fish from hatchery programs may prey on native species such as Longnose Dace which are widespread throughout the freshwater portions of the Study Area. Species such as Smallmouth Bass, Northern Pikeminnow, and Walleye are highly piscivorous; therefore, hatchery programs may provide a form of prey enhancement. Hatchery fish may also be preyed on to some extent by Bull Trout, Yellow Perch, Pacific Lamprey, and River Lamprey. Hatchery fish may also interact in the marine environment with rockfish species (*Sebastes spp.)*. However, none of these species is located exclusively in the analysis area, and the analysis area is generally a very small part of their total range. Risks to other species from salmon hatchery programs in the Lake Washington Basin are not considered further.

In addition to direct effects of predation and competition, hatchery fish may act as a buffer against predation on wild fish. Conversely, releases of hatchery fish may attract additional predators that prey on wild fish.

Current disease and nutrient effects on salmonid species (e.g., Cutthroat Trout) are likely to be similar to the effects discussed in Sections 3.3.3.5, Diseases, and 3.3.3.6, Nutrient Cycling. Diseases that pose particular risk to hatchery-origin salmonids (i.e., BKD and IHN) only affect salmonid species. Other diseases endemic to many fish species (e.g., freshwater ich, *Ichthyophthirius multifiliis*) may also be amplified in a hatchery to affect non-salmonid species. Salmonid species such as Cutthroat Trout and Kokanee may occur near existing hatchery facilities and release sites; however, disease and pathogen transmission are unlikely.

Table 3-7. Examples of Fish Species Other than Salmon or Steelhead that May Interact with Hatchery-origin Salmon in the Study Area

Species	Range in Puget Sound	Federal/State Listing Status	Prey	Competitor	Predator
Bull Trout (*Salvelinus confluentus*)	Some river systems and marine waters	Federal Threatened (64 FR 58909, November 1, 1999) Washington State species of concern	✓	✓	✓
Cutthroat Trout (*Oncorhynchus clarkii*)	Most streams and rivers	Not listed	✓	✓	✓
Kokanee (*O. nerka*)	Lakes	Federal species of concern (Lake Sammamish)		✓	
Pacific Lamprey (*Entosphenus tridentatus*)	Throughout marine waters and many river systems	Federal species of concern Washington State monitor	✓		✓
River Lamprey (*Lampetra ayresii*)	Most river systems	Federal species of concern Washington State candidate	✓		✓
Longnose Dace (*Rhinichythys cataractae*)	Most streams and rivers	Not listed	✓		
Smallmouth Bass (*Micropterus dolomieu*)	Lake Washington basin	Not listed			✓
Walleye (*Sander vitreus*)	Lake Washington basin	Not listed			✓
Northern pikeminnow (*Ptychocheilus oregonensis)*	Lake Washington basin	Not listed			✓
Yellow Perch (*Perca flavescens)*	Lake Washington basin	Not listed			✓

Fish species other than salmon or steelhead may also be affected by hatchery facility operation, similar to the effects discussed in Section 3.3.3.7, Facility Operations. Although many fish species may be incidentally collected during RM&E activities described in Section 3.3.3.8, Research, Monitoring, and Evaluation, general guidelines to reduce impacts on salmon and steelhead (NMFS 2000b, 2008a) also reduce effects on other species. In addition, specific risk aversion measures are developed in conjunction with monitoring and evaluation plans (WDFW 2019c; WDFW 2019a, 2019b). However, none of these species is located exclusively in the analysis area, and the analysis area is generally a very small part of their total range (NMFS 2014). Therefore, risks to these species from salmon hatchery programs in the Lake Washington Basin are not considered further.

3.4 Wildlife

The Study Area for wildlife is limited to the project area as described in Section 1.2, Project Area and Study Area. Some species of mammals and birds may potentially interact with salmon associated with the hatchery programs included in this EA (Table 3-8), primarily by acting as predators. Hatchery programs also have the potential to enhance nutrient availability, transfer pathogens or toxic contaminants outside the hatchery environment, or impede wildlife movement. Twelve wildlife species are federally listed as endangered or threatened under the ESA and/or Washington State within the study area. Many of these species consume salmon, which may benefit their survival and productivity. Increases or decreases in the abundance of juvenile and adult salmon associated with hatchery operations in the Lake Washington Basin may affect the viability of wildlife species that prey on them. The effects of salmon hatchery programs on wildlife species have generally been negligible, and wildlife species in the analysis area have continued to occupy their existing habitats in similar abundances and feed on a variety of prey, including salmon (NMFS 2019c). Therefore, risks to wildlife from salmon hatchery programs in the Lake Washington Basin (other than Southern Resident killer whale, Steller sea lion, California sea lion, harbor seal, and marbled murrelet) are not considered further.

Salmon distribution and abundance affects distribution and abundance of Southern Resident killer whales through effects on prey abundance and distribution. The whales primarily consume large Chinook Salmon from May to October, even when other salmon species are more abundant (Ford and Ellis 2006; Hanson et al. 2010). Southern Resident killer whales spend a large proportion of their time during these months in inland marine waters (Ford and Ellis 2006; Hauser et al. 2007). During this period, their diet consists of more than 83 percent Chinook Salmon and 14 to 15 percent other salmon species (Hanson et al. 2010). The primary prey of Southern Resident killer whales in inland marine waters during summer is adult Chinook Salmon, even when other salmon species are more abundant (Ford et al. 2016; Chasco et al, 2017a, 2017b). Based on preliminary results from genetic analysis of a limited number of samples collected during killer whale feeding events, Chinook Salmon are also important to Southern Resident killer whales in Puget Sound during the winter (PFMC 2020a). Adult Coho Salmon are important in the whales' diet in inland waters in late summer (Ford et al. 2016), whereas Chum Salmon are also important in the fall. Of all the Pacific salmon species, Chinook Salmon are the most calorie rich (O'Neill et al. 2014). Switching by the whales to less calorie-rich salmon species as prey may be due to reduced availability of Chinook Salmon at that time and area.

The heavy contaminant loads observed in Chinook salmon within Puget Sound waters (O'Neill et al. 2005; Cullon et al. 2009) have likely contributed to the contaminant loads in Southern Resident killer whales. Because both hatchery-origin and natural-origin fish reside within Puget Sound for similar periods and eat the same prey, they likely have similar contaminant loads.

An independent science panel acknowledged correlations between overall Chinook Salmon abundance and Southern Resident killer whale survival rates and fecundity (Ford et al. 2010; Ward et al. 2012). However, the panel cautioned against assuming that there is a simple linear causative relationship between Chinook Salmon abundance and the status of Southern Resident killer whales.

Southern Resident killer whales may not distinguish between hatchery-origin and natural-origin salmon (NMFS 2008b; Hanson et al. 2010). Adults returning from hatchery releases have partially compensated for declines in natural-origin salmon populations and may have benefitted Southern Resident killer whales (Myers 2011). Although Chinook Salmon and Chum Salmon are selected with much greater frequency than other prey species. Other salmon and steelhead are also prey items during specific times of the year. Thus, all species of hatchery-origin salmon and steelhead may contribute to the diet of Southern Resident killer whales but at much less frequency than would be expected based on their relative abundances (NMFS 2014).

Steller sea lions, California sea lions, and harbor seals are distributed throughout the Pacific coast of North America, and the study area is a very small part of their total range. All three species are protected under the Marine Mammal Protection Act. Abundance of the eastern stock of Steller sea lions has been gradually increasing since 1976 (Pitcher et al. 2007; COSEWIC 2012). Number of California sea lions has remained stable since 1990 (Jeffries et al. 2003), and the number of harbor seals has also stabilized since the early 1990's (Carretta et al. 2012).

Cederholm et al. (2000) state that Steller sea lions, California sea lions, and harbor seals have a recurrent relationship with salmon and steelhead; distribution of all three species is known to change in response to prey abundance and distribution, including that of salmon and steelhead. Similar to other species that forage on salmon and steelhead, foraging by Steller sea lions, California sea lions, and harbor seals is opportunistic, especially where fish congregate, such as in estuaries and at specific locations like the Ballard Locks in Seattle.

No direct evidence suggests that sea lions and seals are strongly dependent on salmon or steelhead, but they may opportunistically exploit particular species or populations of fish based on their availability. Steller sea lions forage for a variety of prey species (Fisheries and Oceans Canada 2010). Observations of California sea lions in the project area suggest that these opportunistic predators consume a wide range of fish and squid species, consistent with the local and seasonal availability of different prey species (Everitt et al. 1981; NMFS 1997). However, California sea lions used to be attracted to winter-run steelhead when they were present, out-migrating juvenile salmon, and adult Chinook Salmon, Coho Salmon and Sockeye Salmon at the Ballard Locks (NMFS 1997). Similar to California sea lions, the diet of harbor seals in the study area varies with season and the local availability of a wide range of mostly pelagic and demersal fish species. Lance et al. (2012) identified the major groups of harbor seal prey in northern Puget Sound as herring (year round), juvenile walleye pollock, sand lance, and anchovy (winter/spring), and adult salmon (late July to September). Although presence of juvenile and adult hatchery salmon at "bottlenecks" such as the Ballard Locks may result in temporary changes to the distribution of sea lions and seals because of their opportunistic feeding behavior, this opportunistic feeding combined with the small part of their range being in the study area has resulted in the Lake Washington hatchery programs having a small overall effect on these species and these effects are not considered further.

Fish-eating birds including marbled murrelets may prey on juvenile and adult salmon in both freshwater and marine habitats. However, marbled murrelets are found within 30 miles of the Pacific Coast from southern Alaska to California (McShane et al. 2004), and the study area is a very small part of their total range).In addition, marbled murrelets are opportunistic feeders with a diverse diet, Although juvenile salmon may be part of the diet in some areas, main fish prey is generally consists of small marine species such as Pacific Sand Lance (*Ammodytes hexapterus*), Northern Anchovy (*Engraulis mordax*), immature Pacific Herring (*Clupea harengus*), Capelin (*Mallotus villosus*), and smelt (Osmeridae) (McShane et al. 2004).The effects of Lake Washington salmon hatchery programs on marbled murrelets have therefore been minimal and are not considered further.

Table 3-8. Primary Wildlife Species that May Interact with Hatchery-origin Salmon or be Affected by Hatchery Operations in the Study Area

Species[1]	Range in relationship to Study Area	Federal/State Listing Status	Prey	Predator	Otherwise Affected by Operations
Mammals					
Southern Resident Killer Whale (*Orcinus orca*)	Throughout; occurs in inland marine deep-water habitats	Federally endangered; State endangered Endangered (70 Fed. Reg. 69903, November 18, 2005)		✓	
Steller Sea Lion (*Eumetopias jubatus*)	Throughout Puget Sound in marine deepwater and nearshore habitats	Federally protected under the Marine Mammal Protection Act; State threatened		✓	
California Sea Lion (*Zalophus californianus*)	Nearshore and deeper water inland marine waters	Federally protected under the Marine Mammal Protection Act		✓	
Harbor Seal (*Phoca vitulina*)	Nearshore and deeper water inland marine waters	Federally protected under the Marine Mammal Protection Act		✓	
Birds					
Marbled Murrelet (*Brachyramphus marmoratus*)	Federally threatened	Federally threatened (57 Fed. Reg. 45328, October 1, 1992) State threatened		✓	

The transfer of toxic contaminants and/or pathogens to wildlife associated with the ongoing hatchery programs is unlikely to contribute to their current presence/load in wildlife due to the regulation of hatchery operations through NPDES Water Quality General permits and the applicants' fish health policies (USFWS 2004; NWIFC and WDFW 2006). Heavy contaminant loads in Puget Sound Chinook Salmon (acquired during the time Chinook Salmon are present in the relatively urbanized and contaminated waters of Puget Sound) likely contribute to contaminant loads in Southern Resident killer whales, because the main prey source for the whales is Chinook Salmon during some months of the year.

The presence of hatchery-origin salmon and steelhead carcasses has likely provided a benefit to local wildlife as a nutrient source. Weirs and traps used for collection of fish may have impeded wildlife movement or may have benefited wildlife by restricting fish migration and subsequently enhancing predation efficiency. The three programs currently operating utilize passive methods of predator control (i.e., fences around facilities, netting over holding ponds, monofilament line to deter avian predators).

3.5 Marine and Freshwater Habitat

3.5.1 Critical Habitat

Critical habitat is 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. Critical habitat is designated in the Study Area for:

- Puget Sound Chinook Salmon ESU
- Hood Canal Summer-Run Chum Salmon ESU
- Puget Sound Steelhead DPS
- Bull Trout
- Georgia Basin Bocaccio DPS
- Georgia Basin Yelloweye Rockfish DPS
- Southern Resident Killer Whale DPS
- Marbled murrelet

NMFS specifically excluded the entirety of the Sammamish River and Lake Sammamish basins from designation as critical habitat because the economic benefits of no designation outweighed the conservation benefits of a critical habitat designation (NMFS 2005). With regard to all excluded areas, NMFS (2005) stated "We have concluded that exclusion of any of these areas alone or of all areas in combination, would not significantly impede conservation of the Puget Sound Chinook ESU."

Within designated critical habitat, NMFS or the USFWS identifies physical and biological features (PBFs) essential for conservation of the species. PBFs for listed salmon and steelhead include freshwater spawning and rearing sites, freshwater migration corridors, estuarine and nearshore marine areas free of obstruction and excessive predation, and offshore marine areas with conditions supporting growth and maturation. Nine PBFs have been developed for Bull Trout, focusing on water quality and quantity, habitat quality and complexity, prey base, and low levels on nonnative predators. PBFs for Georgia Basin Bocaccio and Yelloweye Rockfish (*Sebastes ruberrimus*) include benthic habitats (deeper than 98 ft) for adult Bocaccio and adult and juvenile Yelloweye Rockfish, and nearshore habitats for juvenile Bocaccio that include quantity, quality, and availability of prey species, the type and amount of structure and rugosity that supports feeding opportunities and predator avoidance, and water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities. PBFs for Southern Resident killer whales include water quality to support growth and development, prey species of sufficient quantity, quality, and availability to support growth, reproduction, and development, and passage conditions to allow for migration, resting, and foraging. PBFs for marbled murrelets include individual trees with potential nesting platforms and forested areas within 0.5 miles of individual trees with potential nesting platforms.

Ongoing direct effects on critical habitat for listed salmon, steelhead, and Bull Trout result from facility operation (e.g., water diversion and effluent discharge), maintenance (e.g., instream sediment removal), and the presence of hatchery program-related weirs and water withdrawal structures. Hatchery programs such as those included in this EA can also affect critical habitat for Bull Trout by influencing abundance of prey species. Genetic and ecological interactions between hatchery-reared fish and fish in the natural environment also contribute to minor degradation of critical habitat, particularly as related to rearing habitat. Three hatchery programs are currently operated to minimize effects on critical habitat (Section 3.3.3.7, Facility Operations). In general, water withdrawals are small enough in scale that changes in flow are low, and measurable impacts on critical habitat do not occur. Minor modifications to channel habitat by construction and operation of weirs or maintenance actions results in short-term water quality impairments. However, impacts on water quality are typically short-lived, and do not currently alter the function or usability of critical habitat once turbidity subsides.

Hatchery programs such as those included in this EA can affect critical habitat for Georgia Basin Bocaccio and Yelloweye Rockfish, and Southern Resident killer whales by influencing abundance of prey species. As described in Section 3.4, Wildlife, salmon distribution and abundance affect distribution and abundance of Southern Resident killer whales through effects on prey abundance and distribution.

Operations of ongoing hatchery programs are unlikely to affect critical habitat for marbled murrelets through removal of trees with potential nesting platforms. Existence of hatchery facilities has not affected presence of nearby forested areas.

3.5.2 Essential Fish Habitat

Essential fish habitat (EFH) is defined under the Magnuson-Stevens Act as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Coho, Chinook, and Pink Salmon have designated EFH in the Study Area, and NMFS recognizes the need to consider EFH to minimize risks from hatchery operations, and genetic and ecological interactions of hatchery-origin fish with natural-origin fish (PFMC and NMFS 2014).

All facilities that support hatchery programs included in this EA currently operate and/or release juvenile hatchery fish into Pacific Salmon EFH. Ongoing direct effects on EFH are similar to those described for critical habitat for listed salmon and steelhead in Section 3.5.1, Critical Habitat. Effects result primarily from facility operation, maintenance, and the presence of weirs and water withdrawal structures.

3.6 Socioeconomics

Socioeconomics is defined as the study of the relationship between economics and social interactions with affected regions, communities, and user groups. Hatchery programs affect economic conditions by providing fish for commercial and recreational fishing opportunities, employment, and economic opportunities through hatchery operations. Hatchery-related spending affects the economy in the community surrounding the hatchery, and those economic impacts can extend outward, having a wider regional effect. The Study Area for socioeconomics includes Puget Sound and the Strait of Juan de Fuca, which is identified as the Puget Sound Region and includes the South Puget Sound, North Puget Sound, and Strait of Juan de Fuca socioeconomic subregions (NMFS 2014).

One important impact hatchery programs can have on social economics is through tribal and nontribal commercial and recreational fisheries that target hatchery fish. Changes in hatchery production levels can create beneficial or adverse effects on harvests, which affect the industries and communities that depend on them. The hatchery programs assessed in this EA release fish within the Southern Puget Sound socioeconomic subregion (NMFS 2014); however, fish migrate and are harvested throughout the South Puget Sound, North Puget Sound, and Strait of Juan de Fuca subregions. Effects on fisheries beyond the Puget Sound Region are not likely to be discernable. Based on information provided in NMFS (2019c), production from the Issaquah Hatchery contributes approximately 3 percent of total Coho Salmon and 6 percent of the total Chinook Salmon releases within the Study Area, and the Lake Washington Sockeye Program releases almost all of the Sockeye Salmon in the Study Area.

Tribal and non-tribal commercial fisheries occur throughout the Study Area, in both marine and freshwater environments. Tribal salmon fishing is distributed in space and time throughout all marine waters and major rivers of Puget Sound, but occurs within defined usual and accustomed areas for each Tribe. Commercial catch (both Tribal and non-Tribal) in Puget Sound from 2015 through 2019 was approximately 54 percent Chum Salmon, 17 percent Pink Salmon, 13 percent Sockeye Salmon, 10 percent Coho Salmon, and 6 percent Chinook Salmon (PFMC 2020b).

Chinook Salmon hatcheries have historically contributed substantially to freshwater fisheries; however, because of low abundance (Section 3.3.1, ESA-Listed Salmon and Steelhead), tribal fisheries for Chinook Salmon in the Lake Washington Basin have been closed since 1994, except for occasional fisheries on surplus hatchery fish in Lake Sammamish (WDFW 2019b). Directed tribal fisheries and sport harvest in Lake Washington for Sockeye Salmon have been closed since 2006 (NMFS 2019c).

NMFS (2019c) noted that indicators of economic conditions include ex-vessel values to commercial fishermen, trip-related expenditures by recreational fishermen, hatchery program expenditures, and direct and indirect employment and personal income associated with hatchery operations and affected fisheries. For example, in 2015, the average price per pound for Chinook Salmon, Coho Salmon, and Sockeye Salmon within the Study Area was $2.44, $0.99, and $1.40 respectively (NMFS 2019c, Appendix B, Table B-13) while the average weight per fish was 10.8 lb., 6.4 lb., and 4.6 lb. (NMFS 2019c, Appendix B, Table B-12). NMFS (2019c) also indicated that the estimated spending per recreational fishing trip was approximately $176 in 2015.

Hatcheries also contribute positively to the regional economy through full-time employees tasked with managing hatchery facilities and annual budgets that support hatchery operations. The Issaquah Hatchery and the Cedar Creek Hatchery currently support 2.6 and 3.0 full-time employees with annual budgets of $380,000 and $320,000. The state of Washington estimates that as of January 2020, there are about 1.43 million jobs in King County (King County Profile), so 5.6 employees at these hatcheries does not have a noticeable economic impact on the region. Of note, the economic impact of hatchery spending on jobs is broader than employment just at the hatcheries because these jobs include indirect employment opportunities in the community that provide goods and services related to hatchery operations and personnel.

In addition to providing fisheries and employment, fish hatcheries in the urban environment can have social value through providing public tours and school programs that offer education about salmon and the environment in general. In addition to hosting hundreds of thousands of visitors each year (including an estimated 150,000 during the annual Salmon Days Festival), Issaquah Hatchery has a docent program that conducts educational tours at the hatchery, provides in-classroom presentations, and supplies online curriculum for at home learning. The program welcomes tens of thousands of young students to the hatchery each year, primarily in fall when adult salmon are returning to the hatchery. The educational program focuses on the role of the hatchery in protecting salmon and how attendees can become a salmon steward in the community. Although not as focused on education as Issaquah Hatchery, Cedar River Hatchery also uses volunteer naturalists to teach visitors about salmon.

In addition to its educational value, Issaquah Hatchery appears to meet criteria for the National Register of Historic Places. The property is located in a potential historic district, and the property potentially contributes to a historic district (https://wisaard.dahp.wa.gov/Resource/42739/PropertyInventory/52549).

3.7 Cultural Resources

Salmon fishing has been central to the existence of Tribes in the Pacific Northwest for thousands of years. Beyond the generation of jobs and income for commercial tribal fisherman, salmon are regularly eaten by individuals and families and served at tribal community gatherings. As with other Pacific Northwest Tribes, Puget Sound Tribes depend on salmon for subsistence purposes and attach great cultural importance to salmon for ceremonial purposes. Tribes of Puget Sound share a passionate concern for the future of salmon runs in the region because of their importance to tribal culture, history, and economic subsistence. Salmon harvested for ceremonial and subsistence purposes are important to maintaining cultural viability, and provide a valuable food resource, among other traditional foods, in tribal ceremonies (NMFS 2014).

As discussed in Section 1.4.2, *U.S. v Washington*, five treaties were ratified by the United States and Washington Tribes. The Puget Sound Treaty Tribes with fishing rights are entitled to up to 50 percent of the available harvest at usual and accustomed grounds and stations. Present day tribal reservations may encompass a fraction of a Tribe's previously occupied territory; therefore, Tribes have the exclusive right of taking fish at all usual and accustomed places in accordance with applicable treaties. The Northwest

Indian Fisheries Commission (NWIFC) was created following the 1974 *U.S. v. Washington* ruling to support the Tribes co-managing fisheries in the region. The PSTT coordinate management policies through the NWIFC and the organization provides fisheries technical services to its member Tribes. NWIFC Tribes work together to achieve accomplishments and milestones to protect tribal treaty fishing rights, salmon, and the watersheds where fish live.

Treaty Tribes include the Hoh, Jamestown S'Klallam, Lower Elwha Klallam, Lummi, Makah, Muckleshoot, Nisqually, Nooksack, Port Gamble S'Klallam, Puyallup, Quileute, Quinault, Sauk-Suiattle, Skokomish, Squaxin Island, Stillaguamish, Suquamish, Swinomish, Tulalip, and Upper Skagit Indian Tribes. This EA focuses primarily on the Muckleshoot Tribe and the Suquamish Tribe because of their proximity to facilities included in this EA and their co-manager responsibility for salmon populations in the Lake Washington Basin.

3.7.1 Muckleshoot Indian Tribe

The MIT is a federally recognized tribe whose members comprise descendants of the Duwamish and Upper Puyallup people who inhabited the Central Puget Sound for thousands of years prior to non-Indian settlement (NWIFC 2016). Like many other Tribes in western Washington, Muckleshoot ancestors depended on fish and other animal and plant resources and traveled to harvest these resources. The MIT Reservation is near Auburn, Washington, approximately 15 miles northeast of Tacoma and 35 miles southeast of Seattle. The MIT co-manages fisheries resources within the study area, partnering with the state, federal, and other tribal entities. The *U.S. v. Washington* affirmed the United States' recognition of the MIT as a political successor to Duwamish bands on the Treaty of Point Elliot, and delineated certain of the Tribe's treaty-time usual and accustomed fishing areas. The MIT, in addition to performing its work as a co-manager of the fisheries resources, operates and funds: numerous hatchery programs; habitat restoration projects; and other efforts and programs established to revive the area's salmon populations.

Salmon hatchery programs in the Lake Washington basin will be managed in cooperation with the MIT. The MIT works closely with WFDW and others to boost salmon production and survival within its U&A so that harvest opportunities are restored.

3.7.2 Suquamish Indian Tribe

The Suquamish Indian Tribe are descendants of Lushootseed-speaking Tribes that inhabited the Puget Sound area for thousands of years. The Tribe historically relied on the abundance of natural resources such as salmon for primary food sources and used canoes and fishing baskets to aid with harvest. The traditional territory of Lushootseed-speaking Tribes covered a large part of what is now western Washington, from near present-day Bellingham south to Olympia, Washington, and from the Cascade Mountains west to Hood Canal.

The Suquamish Indian Tribe continues to live in the place of their ancestors and utilize the traditional life practices on the Port Madison Indian Reservation. The Suquamish Indian Tribe manages salmon habitat recovery efforts and enhancement programs to revive weak salmon populations. The Tribe also manages the Suquamish Seafood Enterprises (SSE), which is a fully-chartered business of the Tribe. Proceeds of the business enterprise help benefit the Tribe and support the local economy on the Suquamish Indian Tribe reservation.

3.8 Environmental Justice

In 1994, the President issued Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. Environmental justice is defined 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.” 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. Environmental justice analysis leads to a determination of whether high and adverse human health or environment effects of a program would be disproportionately borne by minority or low-income populations, often referred to as the environmental justice communities of concern. Changes in hatchery production, such as changes to the five hatchery programs in this EA, have the potential to affect the extent of fish harvest available for subsistence and economic purposes for minority or low-income populations.

The analysis area for environmental justice includes minority and low-income communities that may be affected directly, indirectly, or cumulatively by implementing the project alternatives and is the same as for socioeconomics (Section 3.6, Socioeconomics) and includes the geographic area where the Proposed Action (Section 1.2, Project Area and Study Area) would occur.

For the analysis of environmental justice effects, minority and low-income communities of concern were identified by comparing demographic data for counties in which physical hatchery facilities are located with a statewide reference. The three environmental justice metrics used to determine if a county is considered a minority community of concern are (1) percentage of county residents that are non-white, (2) percentage that are Indian, and (3) percentage that are Hispanic. The metric for determining if a county is a low-income community of concern is based on the poverty rate and per capita income. Counties were determined to be minority or low-income communities of concern if the level in any category (percent minority, poverty rate, or income) exceeded the applicable data in the statewide reference area.

Issaquah and Cedar River hatcheries are located in King County, and Willow Creek Hatchery is located in Snohomish County (Figure 1-1). Both counties were evaluated for their metrics of populations of concern (Table 3-9). Snohomish County does not meet the thresholds for environmental justice community of concern, but in King County, the percent of the population being non-white exceeds the statewide average. Neither county had per capita income lower than or poverty rates higher than the statewide reference. The environmental justice effect of the hatchery programs in the Lake Washington Basin to the people in King County is represented by the economic and cultural value of the salmon harvested.

Table 3-9. Summary of Environmental Justice Communities Analysis

State, County	Total Population	Percent Non-White	Percent Indian	Percent Hispanic	Poverty Rate	Per Capita Income
Washington State	7,169,967	30.2	1.1	12.3	12.2	$34,869
King County	2,118,119	38.6	0.5	9.5	10.2	$46,316
Snohomish County	771,904	28.8	0.8	9.8	8.8	$35,737

Source: U.S. Census Bureau (2017)

All treaty Tribes with federally recognized treaty fishing rights have an interest in fishery management in Puget Sound and qualify as environmental justice groups. Through treaties, the United States made commitments to protect Tribes’ rights to take fish. These rights are of cultural and societal importance to Tribes; thus, impacts to commercial, subsistence, and recreational harvest opportunities are examined for any effect on tribal and low-income harvest. All Tribes identified in Section 3.7, Cultural Resources, are considered an environmental justice community and, accordingly, tribal effects are a specific focus of the environmental justice analysis. Although individual Tribes may not meet traditional environmental justice analysis thresholds for minority or low income populations, they are regarded as affected communities for

environmental justice purposes, as defined by USEPA guidance; guidance regarding environmental justice extends beyond statistical threshold analyses to consider explicit environmental effects on Tribes (USEPA 1998).

4 Environmental Consequences

This chapter describes the analysis of the direct and indirect environmental effects associated with the alternatives on the eight resource categories. The effects on resources from other general factors (e.g., climate change, development, habitat restoration, hatchery production, and fisheries) are described in Chapter 5, Cumulative Effects. The relative magnitudes of impacts are 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.

If not undetectable, then effects may be either adverse or beneficial. Adverse is defined as harmful or unfavorable relative to a benchmark condition. Beneficial is defined as favorable or advantageous relative to a benchmark condition. The effects of Alternative 1, No Action, are described in terms of how current conditions (Chapter 3, Affected Environment) are likely to appear in the future under continued implementation of the three ongoing in this EA. The effects of other alternatives are described relative to Alternative 1.

Alternative 2, the Proposed Action, would differ from Alternative 1 (No Action) in a number of ways (Table 2-1). Hatchery production would increase for currently operating programs, and the UWARF programs would resume operations for the first time since 2010. New acclimation and release sites may also be utilized for some programs. The effects of increases in production would differ for some resources than the effects of current operations.

4.1 Water Quantity

The overall effect on water quantity from hatchery programs would be negligible-adverse under Alternative 1 and low-adverse under Alternative 2 (Table 4-1). Relative to Alternative 1, effects would be negligible-beneficial under Alternative 3.

Table 4-1. Summary of Effects on Water Quantity

Resource	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Water Quantity	Negligible-adverse	Low-adverse	Negligible-beneficial

4.1.1 Alternative 1, No Action

Under Alternative 1, the Issaquah hatchery programs and the Lake Washington Sockeye Salmon program would continue current operations and would continue to use stream, well, and spring water as previously described (Section 3.1, Water Quantity). No stream reaches have been dewatered to the extent that migration and rearing of listed natural-origin fish have been impaired and there has been no net loss of river or tributary flow volume. Overall, the hatchery programs under Alternative 1 would likely have a negligible-adverse effect on water quantity.

4.1.2 Alternative 2, Proposed Action

Under Alternative 2, all five hatchery programs would operate as described in the HGMPs, except for planned changes to acclimation and release sites for some of the programs, and potential releases of Sockeye Salmon subyearlings and yearlings rather than just fry. Proposed increases in production may result in increases in the amount of water required at new release sites not yet identified for Issaquah hatchery. However, as noted in Section 1.3, Description of the Proposed Action, the proposed action does not include any future facility construction or expansion, including the withdrawal of water quantities beyond existing permissible volumes. To meet water quantity requirements, programs would need to secure additional water rights or utilize existing facilities more efficiently. The revitalization of UWARF programs would utilize surface water from Portage Bay on Lake Washington or dechlorinated domestic water from the City of Seattle. Therefore, this alternative would have a low-adverse effect on water quantity rather than the negligible-adverse effect of Alternative 1.

4.1.3 Alternative 3, Program Termination

With termination of all hatchery programs under Alternative 3, all facilities would likely cease operations entirely, other than reduced operation at Issaquah Hatchery for a Kokanee program. Closure of these facilities would preclude the need for water withdrawals. Alternative 3 would therefore have a negligible-beneficial effect on water quantity compared to Alternative 1.

4.2 Water Quality

The overall effect on water quantity from the hatchery programs would be negligible-adverse under Alternative 1, and low-adverse under Alternative 2 (Table 4-2). Relative to Alternative 1, effects would be negligible-beneficial under Alternative 3.

Table 4-2. Summary of Effects on Water Quality

Resource	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Water Quality	Negligible-adverse	Low-adverse	Negligible-beneficial

4.2.1 Alternative 1, No Action

Under Alternative 1, the Issaquah hatchery programs and the Lake Washington Sockeye Salmon program would continue current operations. No change in the discharge water temperature, ammonia, organic nitrogen, total phosphorus, BOD, pH, and solids in receiving waters would be expected. Temporary and minor effects on sedimentation and dissolved gas supersaturation from adult collection and juvenile release activities also would be expected to remain similar to current conditions. Discharge at Issaquah Hatchery and the Cedar River Hatchery are managed under NPDES permits (Table 3-2). Production at Willow Creek Hatchery is low enough that a permit is not required. The pollutant loads associated with the Issaquah Hatchery and Cedar River Hatchery have been permitted with conditions and waste-load allocations that protect the water quality of receiving waters. Currently, Issaquah Hatchery and Cedar River Hatchery comply with NPDES discharge permits (Section 3.2, Water Quality).

NMFS believes effluent currently has had a negligible impact on salmon and steelhead in the Study Area (NMFS 2018a). NEPA analyses of hatchery programs in Puget Sound river basins have found that effects on water quality are not substantial (NMFS 2019a, 2019c). Under Alternative 1, effluent discharged by hatchery facilities would be expected to continue contributing similar levels of pollutants to receiving

waters, and periodic effluent permit-limit exceedances such as total suspended solid exceedances due to flooding may occur but these exceedances are not related to hatchery production and therefore a facility may remain in compliance. As NPDES permits are renewed, hatchery facilities would be required to comply with effluent limits that reflect current technologies and watershed conditions. Overall, Alternative 1 is expected to have a negligible-adverse effect on water quality.

4.2.2 Alternative 2, Proposed Action

Under Alternative 2, all five hatchery programs would operate as described in the HGMPs, except for planned changes to acclimation and release sites for some of the programs and potential releases of Sockeye Salmon subyearlings and yearlings rather than just fry. Proposed increases in production would likely result in increases in the amount of effluent discharged. As NPDES permits are renewed within Alternative 2, hatchery facilities would be required to comply with effluent limits that reflect current technologies and watershed conditions, likely maintaining insignificant effects on water quality despite increases in the amount of effluent discharged. Revitalization of the UWARF programs would also result in increased effluent, although proposed production at the University of Washington Hatchery is low enough that permits would not be required. Because of the increased effluent, this alternative would have a low-adverse effect on water quality rather than the negligible-adverse effect of Alternative 1.

4.2.3 Alternative 3, Program Termination

With immediate termination of all hatchery programs under Alternative 3, all facilities would likely cease operations entirely, other than reduced operation at Issaquah Hatchery for a Kokanee program. Closing the hatcheries would result in a small reduction in heat, nutrients, BOD, sediment, therapeutics (e.g., antibiotics), fungicides, disinfectants, steroid hormones, anesthetics, pesticides, herbicides, and pathogens discharged to receiving waters, and would therefore result in a small improvement in water quality.

Discontinuing broodstock collection and juvenile releases may eliminate temporary stream bottom and shoreline disturbances and effects on dissolved gas. However, the temporary and small-scale nature of sediment disturbance from broodstock collection and juvenile releases would likely result in a small difference in sediment loading. Overall, Alternative 3 would have a negligible-beneficial effect on water quality compared to Alternative 1.

4.3 Fish

4.3.1 Salmon and Steelhead

4.3.1.1 Population Viability

As discussed in Section 3.3.3.1, Population Viability, the discussion herein is limited to Chinook, Coho, and Sockeye salmon. Chinook Salmon hatchery programs considered in this EA would have no effect on population viability for the Puget Sound Steelhead DPS or the Hood Canal Summer-Run Chum ESU. Similarly, Coho Salmon and Sockeye Salmon programs considered in this EA would have no effect on population viability for the Puget Sound Chinook Salmon ESU, Puget Sound Steelhead DPS, or Hood Canal Summer-Run Chum ESU. Effects on population viability consider abundance, productivity, spatial structure, and diversity. As noted in Section, 3.3.3.1, Population Viability, the assessment focuses on abundance and productivity, although future release methods may also affect spatial structure. Effects from same-species hatchery programs (i.e., conspecifics) are summarized below (Table 4-3).

Table 4-3. Summary of Population Viability Effects of Chinook Salmon Hatchery Programs on Natural-origin Chinook Salmon from the Puget Sound Chinook Salmon ESU.

ESU	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Puget Sound Chinook Salmon ESU	Low-beneficial	Same as Alternative 1	Moderate-adverse
Coho Salmon	Low-beneficial	Same as Alternative 1	Low-adverse
Sockeye Salmon	Low-beneficial	Moderate-beneficial	Moderate-adverse

Alternative 1, No Action

Under Alternative 1, the Issaquah Fall Chinook Hatchery Program would release the same number of juveniles as under current operations. The program would continue to be integrated, would allow hatchery-origin fish to spawn naturally, and would increase abundance. Effects on productivity and diversity are unknown; however, the increase in abundance and potential increase in spatial structure would provide a benefit to population viability. As noted previously, the program would likely continue to provide the vast majority of spawning fish in the Sammamish population (Section 3.3.3.1, Population Viability), continuing to support the survival of the population. Moreover, the spatial structure would potentially be maintained or enhanced through the use of volitional release methods that may enhance fidelity and encourage hatchery-origin adults to return to rivers into which they are released.

Regardless of whether hatchery fish are intended to spawn naturally or not, hatchery programs would increase genetic risks to natural-origin fish from hatchery-influenced selection. Further, if hatchery and natural-origin fish interbreed in the natural environment, productivity could be negatively affected compared to production by two natural-origin parents. Genetic risks would be present, but supplementing abundance of the Sammamish population through an integrated program would result in an overall effect of low-beneficial. Similar benefits are projected for the Coho and Sockeye salmon hatchery programs.

Alternative 2, Proposed Action

Under Alternative 2, production of the Issaquah Fall Chinook Hatchery Program would increase and the UWARF program would resume production. The Issaquah program would initially change from the recent integrated program to a segregated program because of the low number of NORs (Section 1.3.3, Issaquah Fall Chinook Hatchery). When NORs reach 500 fish, the integrated component of the Issaquah program would be initiated. Fish from the segregated UWARF program (Table 1-2) would not be intended to contribute to natural population abundance, and both within-basin and out-of-basin stray rates have been low for the Issaquah program (WDFW 2019b; Section 3.3.3.2, Genetics).

The Issaquah Fall Chinook Hatchery Program would likely continue to provide the vast majority of spawning fish in the Sammamish population (Section 3.3.3.1, Population Viability), continuing to support the survival of the population. Like Alternative 1, spatial structure would potentially be maintained or enhanced through the use of volitional release methods that may enhance fidelity and encourage hatchery-origin adults to return to rivers into which they are released. Based on the importance of the Issaquah program to population viability, and the historically low level of interactions between the previous UWARF program and listed populations, future program implementation is expected to have a low-beneficial effect on individuals from the Puget Sound Chinook Salmon ESU, primarily to the Sammamish population.

Increases in the number of releases from the Issaquah Coho program would have similar benefits to Coho Salmon. Larger increases in the number of Sockeye Salmon released would result in the effects on

Sockeye Salmon population viability being moderate-beneficial. This would be true even if eggs are transferred from outside the Lake Washington Basin because the population is derived from fish originating outside the basin. Eggs from outside the basin would be used only to make up for production shortfalls and would never exceed the 37 million eggs needed for release of 34 million Sockeye Salmon (WDFW 2019c).

Alternative 3, Program Termination

With immediate termination of fall Chinook Salmon hatchery programs under Alternative 3, hatchery-origin fish that have already been released would continue to be removed if encountered through another program, but the removal would not take place at the levels described in the HGMPs. Returning adults from previous releases for the integrated Issaquah Hatchery program would contribute to abundance for only a short period, and genetic risks from these programs would cease.

With program termination, the Issaquah Fall Chinook Hatchery Program would no longer support the Sammamish population. Because the vast majority of spawners in the population have been from the program (Section 3.3.3.1, Population Viability), population viability may decline, at least in the short term, which may place the population at a higher risk of decline. Although program termination removes genetic risks, the higher risk of decline of the Sammamish population because of program termination would result in an overall effect on population viability of moderate-adverse.

Similarly, the elimination of the Issaquah Coho program would contribute to further declines and extirpation of Coho Salmon from much of the Lake Washington Basin, resulting in low-adverse effects. Elimination of the Lake Washington Sockeye program would hasten the extirpation of Sockeye Salmon in the Cedar River resulting in a moderate-adverse effect.

4.3.1.2 Genetics

As discussed in Subsection 3.3.3.2, Genetics, natural-origin fish from the Puget Sound Chinook Salmon ESU (ESA-threatened) and Puget Sound/Strait of Georgia Coho Salmon ESU (not listed) have the potential to be genetically affected by hatchery programs in the Lake Washington Basin (Table 4-4). Sockeye Salmon in the Lake Washington basin are not part of a recognized ESU; however, natural-origin individuals could be genetically affected through interbreeding with Sockeye Salmon from the Lake Washington Sockeye Program.

Table 4-4. Summary of Effects on Coho, Chinook, and Sockeye Salmon Genetics

Species	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Puget Sound/Strait of Georgia Coho Salmon	Low-adverse	Same as Alternative 1	Low-beneficial
Puget Sound Chinook Salmon	Low-adverse	Moderate-adverse	Low-beneficial
Sockeye Salmon (individuals in Puget Sound fishery)	Negligible-adverse	Same as Alternative 1	Negligible-beneficial

Coho Salmon

Alternative 1, No Action

Under Alternative 1, the Issaquah Coho Hatchery Program poses genetic risks to natural-origin Coho Salmon from the non-listed Puget Sound/Strait of Georgia ESU. Because the majority of naturally-

spawning Coho Salmon in the basin are from the integrated hatchery program, little genetic difference exists between the hatchery-origin and the natural-origin Coho Salmon in the basin (WDFW 2019a). Puget Sound/Strait of Georgia Coho Salmon are not ESA-listed. Therefore, the Coho Hatchery Program has not affected the genetics of any listed Coho Salmon populations.

The NWSSC-Laebugten component of the Issaquah Coho Hatchery Program would remain segregated, and broodstock would consist of hatchery adults. For the Issaquah component of the program, broodstock would continue to be randomly selected from all adult returns to the Issaquah Hatchery trap. By selecting adults randomly from all returns, unmarked fish that are progeny of naturally-spawning hatchery fish are also integrated into the broodstock. This is to keep the hatchery and naturally-spawning fish genetically similar and reduce the risk of divergence of these populations (HSRG 2004). Despite this, both proposed hatchery programs as currently operated pose genetic risks (e.g., domestication) to natural-origin Coho Salmon from the Puget Sound/Strait of Georgia ESU, primarily because of stray hatchery fish spawning with natural-origin fish. Similar to the Issaquah Program, the NWSSC-Laebugten Program has had little potential to influence the genetics of naturally-spawning Coho Salmon in the Study Area. Therefore, overall, continuation of the programs under Alternative 1 would result in genetic effects on naturally-spawning Coho Salmon that are low-adverse.

Alternative 2, Proposed Action

Under Alternative 2, the Issaquah Hatchery program would increase production of yearlings by 300,000 and fry for educational activities by 140,000 (Table 2-1), but the genetic similarities between hatchery-produced and naturally-produced Coho Salmon in the Lake Washington Basin would limit any increased adverse effects on natural Coho Salmon genetics. The UWARF Coho Salmon Program operated for 60 years before it was discontinued in 2010. Under Alternative 2 the program would be resumed and would release up to 90,000 subyearlings from the Issaquah Program into Portage Bay on Lake Washington. Hatchery managers anticipate that hatchery stock for this program would be operated as a segregated stock to reduce genetic risks to natural populations and maintain a gene pool that is separated from all natural populations (HSRG 2015).

For the initial introduction out of Issaquah Hatchery, eggs would be collected from over the full run timing given the relatively small size of the founding program to increase genetic variation and reduce any genetic bottleneck effects (i.e., decreased future genetic diversity due to a sharp reduction in population size). Coho Salmon spawners from the hatchery stock would be selected by phenotype for delayed adult return timing, resulting in some temporal separation between UWARF, Issaquah Hatchery, and naturally produced Coho Salmon in the Lake Washington Basin. Based upon past program operations, the lack of genetic differentiation between program and natural-origin Coho Salmon in the Study Area, and the small number of strays resulting from the relatively small number of releases proposed under the revitalized program, genetic effects on naturally-produced Coho Salmon would be negligible. Therefore, Alternative 2 would have the same overall low-adverse effect as Alternative 1.

Alternative 3, Program Termination

With immediate termination of the Coho Salmon hatchery programs under Alternative 3, hatchery-origin fish that have already been released would return to the Lake Washington Basin for 2 or 3 years and continue to be removed if encountered through harvest or nearby hatchery programs. Hatchery-influenced selection would decrease as the hatchery-origin adults cease to return.

Elimination of hatchery programs would have a low-beneficial effect on Puget Sound/Strait of Georgia Coho Salmon genetics compared to Alternative 1. Although These programs are intended to contribute to genetic diversity, hatchery-origin production in the natural environment is generally considered adverse

and elimination of hatchery programs would have a low-beneficial effect on the genetics of natural-origin Coho Salmon from the Puget Sound/Strait of Georgia ESU in the Study Area compared to Alternative 1.

Chinook Salmon

Alternative 1, No Action

Under Alternative 1, the Issaquah Fall Chinook Hatchery Program as currently operated poses genetic risks to natural-origin Chinook Salmon from the Puget Sound Chinook Salmon ESU. The program would continue to operate as an integrated program, using natural-origin adults returning to the Issaquah Hatchery to maintain genetic similarities with wild fish from the basin. Any negative genetic effects on natural-origin Chinook Salmon would be similar to existing impacts to within-population genetic diversity and hatchery-influenced selection because current operations, including use of natural-origin fish as broodstock, would continue. PNI in the Sammamish population is < 10 percent and the proportion of hatchery-origin spawners (pHOS) interbreeding with the natural-origin fish is > 50 percent. This in-basin broodstock collection approach should continue to result in low stray rates (WDFW 2019b; Section 3.3.3.2, Genetics). Furthermore, the program would likely continue to provide the vast majority of spawning fish in the Sammamish population (Section 3.3.3.2, Genetics), continuing to support the survival of the population. Because over 75 percent of the naturally-spawning population is from the hatchery program (the population is primarily a result of hatchery operations), genetic differences between hatchery and natural-origin fish are small and therefore the continued hatchery program poses a low genetic risk to the receiving populations. This would limit the overall effects of genetic risks to natural-origin fish to low-adverse. Although hatchery fish would continue to stray to the Cedar River as documented by Anderson (2013), the proportion of hatchery fish ascending the ladder at Landsburg Dam has generally decreased and would likely continue to do so as the habitat upstream from the dam is colonized and the number of NORs increases.

Alternative 2, Proposed Action

Under Alternative 2, the Issaquah Hatchery program would increase production, and would change in the near term from an integrated program to a segregated program. As described in Section 1.3.3, Issaquah Fall Chinook Hatchery, use of natural broodstock for an integrated component would begin when unclipped returns reach 500 fish. The integrated component would increase in size when unclipped returns reach 800 fish.

Stray rates should remain as low as past rates, as described in Section 3.3.3.2, Genetics; however, with increased production, the number of strays into the nearby Cedar River may increase compared to Alternative 1. WDFW (2019b) reported the overall stray rate from 2006-10 to be 0.87%, and the estimated stray rate onto Cedar River spawning grounds is estimated to be 0.12%. Increased production and resulting adult returns may increase the potential effects on natural Chinook Salmon genetics in the Cedar River, as evidenced by an increased proportion of hatchery-origin spawners interbreeding with the natural-origin fish (pHOS >45 percent).

Negative genetic effects on natural-origin Chinook Salmon within the Sammamish population would be similar to or reduced from existing conditions because the Issaquah Program would initially be segregated. No natural-origin fish would be used for broodstock; therefore, effects would be limited to hatchery-origin fish interacting with natural-origin fish on the spawning grounds. Furthermore, the program would likely continue to provide the vast majority of spawning fish in the Sammamish population (Section 3.3.3.2, Genetics). The eventual step-wise return to an integrated program with gradual pNOB increases (Section 1.3.3, Issaquah Fall Chinook Hatchery) would serve to help decrease genetic risks by

keeping the hatchery and naturally-spawning fish genetically similar and reducing the risk of divergence of these populations (HSRG 2004).

The UWARF Fall Chinook Program would maintain a genetically distinct hatchery population (HSRG 2015). Based on the historically low amount of interaction between the previous UWARF program and listed populations, due to low stray rates and high facility return rates (Section 3.3.3.2, Genetics), future program implementation is expected to have a low-adverse effect on individuals from the Puget Sound ESU. Implementation of the program under this alternative would also reduce the need to use naturally-produced Chinook Salmon for research purposes. Because of the overall increase in production and the potential increase in the number of strays that could increase pHOS in the Cedar River, this alternative would result in a moderate-adverse effect compared to the low-adverse effect of Alternative 1.

Alternative 3, Program Termination

With immediate termination of the hatchery programs under Alternative 3, hatchery-origin fish that have already been released would return to the Lake Washington Basin for 4 or 5 years and continue to be removed if encountered through harvest or nearby hatchery programs. Hatchery-influenced selection would decrease as the hatchery-origin adults cease to return.

Elimination of hatchery programs would have a low-beneficial effect on Puget Sound Chinook Salmon ESU genetics compared to Alternative 1. The Issaquah program is part of the Puget Sound Chinook Salmon ESU and contributes to genetic diversity by supplementing the locally-adapted population. With program termination, the Issaquah Fall Chinook Hatchery Program would no longer contribute to the Sammamish population. Because the vast majority of spawners in the Sammamish population have been from the Issaquah Fall Chinook Hatchery Program (Section 3.3.3.2, Genetics), genetic diversity may decline. However, program termination would eliminate strays into the Cedar River. Approximately 17-30 percent of Chinook Salmon ascending the ladder at Landsburg Dam have been hatchery fish; therefore, eliminating these fish should result in decreasing the pHOS to under 30 percent.

Because hatchery-origin production in the natural environment is considered adverse, elimination of the hatchery programs would have beneficial effect on natural origin Chinook Salmon genetics. However, because of the potential negative effects that program elimination would have on the genetic diversity of the Sammamish population, the effect would be limited to low-beneficial.

Sockeye Salmon

Alternative 1, No Action

Under Alternative 1, the Lake Washington Sockeye program, which uses broodstock from the Cedar River, poses genetic risks to natural-origin Sockeye Salmon in the Study Area. Because most naturally-spawning Sockeye Salmon in the Study Area are of hatchery lineage, and in recent years from the Lake Washington Sockeye program, little, if any, genetic differences exist between the hatchery-origin and the natural-origin Sockeye Salmon in the basin. Under this alternative, the program would continue to integrate hatchery- and natural-origin spawning segments of the Cedar River spawning population to minimize domestication and other hatchery-related genetic effects. The integrated nature of the program therefore also minimizes negative genetic effects on the natural-origin population from hatchery-origin spawning in the Study Area.

Because no ESA-listed Sockeye Salmon populations occur in proximity to the Study Area, the program has no genetic effects on listed populations. Regardless, although this program is intended to contribute to natural production and abundance in the Study Area, hatchery-origin production in the natural environment is generally considered to have adverse genetic impacts, through straying and continued

interbreeding, to the non-listed natural population. Therefore, continuation of the program would have a negligible-adverse effect on natural-origin Sockeye Salmon in the Study Area.

Alternative 2, Proposed Action

Under Alternative 2, the Lake Washington Sockeye program would increase production, and may eventually release subyearlings and yearlings in addition to fry, but the genetic similarities between hatchery-produced and naturally-produced Sockeye Salmon in the Lake Washington Basin would limit any increased effects on natural Sockeye Salmon genetics. Egg transfers from outside the Lake Washington Basin would have limited effects on natural Sockeye Salmon genetics because Sockeye Salmon in the Study Area are of hatchery-origin and therefore we would not assign any risk to interactions between hatchery- and natural-origin individuals. In addition, recent findings indicate that the genetic composition of restored Sockeye Salmon populations may reflect diverse rather than just local sources (Quinn et al. 2021), which would mean that using fish from outside the basin would not be inconsistent with past practices or species status. Therefore, this alternative would have the same, negligible-adverse effect as Alternative 1.

Alternative 3, Program Termination

With immediate termination of the Lake Washington Sockeye Program under Alternative 3, hatchery-origin fish that have already been released would return to the Lake Washington Basin for 1 to 4 years and continue to be removed if encountered through harvest or nearby hatchery programs. Hatchery-influenced selection would decrease as the hatchery-origin adults cease to return.

The Lake Washington Sockeye program is a supplementation program intended to mitigate for long-term effects that have led to natural abundance declines in the basin. However, because hatchery-origin production in the natural environment is generally considered to increase the risk of adverse genetic impacts, elimination of this hatchery program would have a negligible-beneficial effect on the genetics of natural-origin Sockeye Salmon in the Study Area compared to Alternative 1.

4.3.1.3 Competition and Predation

The overall competition and predation effects from hatchery-origin Coho Salmon, Chinook Salmon, and Sockeye Salmon on natural-origin salmon and steelhead would be moderate-adverse or undetectable under Alternative 1 and moderate-adverse or undetectable under Alternative 2 (Table 4-5). Relative to Alternative 1, effects would be moderate-beneficial or undetectable under Alternative 3.

Table 4-5. Summary of Effects on Natural-origin Salmon and Steelhead from Competition and Predation with Hatchery-origin Fish

Species	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Coho Salmon	Moderate-adverse	Moderate-adverse	Moderate-beneficial
Chinook Salmon	Moderate-adverse	Moderate-adverse	Moderate-beneficial
Sockeye Salmon	Moderate-adverse	Moderate-adverse	Moderate-beneficial
Chum Salmon	Undetectable	Undetectable	Undetectable
Pink Salmon	Undetectable	Undetectable	Undetectable
Steelhead	Moderate-adverse	Moderate-adverse	Moderate-beneficial

Alternative 1, No Action

Competition and predation effects from the Issaquah programs and the Lake Washington Sockeye program would be moderate-adverse for natural-origin populations of Coho Salmon, Chinook Salmon, Sockeye Salmon, and steelhead in the Lake Washington Basin. All programs within this EA manage fish size at release, release location, and release timing to minimize competition and predation from hatchery-origin juveniles. Hatchery Chinook and Coho Salmon smolts migrate out of the Study Area soon after release; however, the relatively large size of the programs and number of releases would result in continued competition with and predation on other salmonids. Sockeye Salmon migrate into Lake Washington, may spend a year or more rearing, but occupy deeper habitat than other salmonids in the Lake (Section 3.3.3.3, Competition and Predation). Chum Salmon and Pink Salmon are unlikely to encounter released hatchery juveniles included in this EA and are therefore unlikely to be affected in any detectable manner.

Adults from the hatchery programs included in this EA may compete for spawning sites and potentially superimpose natural-origin Chinook Salmon, Coho Salmon, and Sockeye Salmon redds in the Study Area. Impacts of hatchery-origin adults competing with natural-origin adults in the Study Area would continue to be moderate due to differences in run-timing, holding, spawn timing, and spawning habitat preferences.

Alternative 2, Proposed Action

Under Alternative 2, production would be increased, and the UWARF programs would be resumed, resulting in potential increases in the effects of competition and predation on natural-origin salmon and steelhead. Sockeye salmon released as subyearlings would likely still rear in Lake Washington until ready to migrate, creating an opportunity for competition and predation impacts where they co-occur with natural populations. Although larger, Sockeye Salmon released as yearlings would be expected to migrate to marine water more quickly because juveniles migrate after one or two years in freshwater (WDFW 2020c), and therefore would have fewer interactions with natural origin fish. This would remain true regardless of the origin of Sockeye Salmon eggs. The production of Chinook Salmon and Coho Salmon, and the shift in production of Sockeye Salmon to include subyearlings, would result in this alternative having a moderate-adverse effect on Coho Salmon, Chinook Salmon, Sockeye Salmon, and steelhead.

Alternative 3, Program Termination

With the complete termination of hatchery programs under Alternative 3, all facilities would likely cease operations entirely, other than reduced operation at Issaquah Hatchery for a Kokanee program. Because there would be a reduction in the overall Coho Salmon, Chinook Salmon, and Sockeye Salmon hatchery production, and a subsequent reduction in juveniles released and returning adults in the Study Area over time, the hatchery programs' competitive and predatory effects would eventually subside. The effects would therefore be moderate-beneficial to Coho Salmon, Chinook Salmon, Sockeye Salmon, and steelhead relative to Alternative 1.

4.3.1.4 Prey Enhancement

The hatchery programs in this EA currently implement or propose to implement a number of actions (e.g., managing fish size at release, release location, and release timing to minimize competition and predation from hatchery-origin juveniles) to reduce the potential interaction between hatchery and natural-origin salmon. Steelhead are the only species likely to be present and feeding as adults when hatchery fish are released from all programs; however, juvenile salmon may prey upon smaller juvenile salmon released from hatcheries (Section 3.3.3.4, Prey Enhancement). The effects of prey enhancement are therefore analyzed for all species other than Sockeye Salmon because Sockeye Salmon are not piscivorous (Table 4-6).

Table 4-6. Summary of Prey Enhancement Effects

Species	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Coho Salmon	Undetectable	Low-beneficial	Low-adverse
Chinook Salmon	Undetectable	Low-beneficial	Low-adverse
Chum Salmon	Undetectable	Undetectable	Undetectable
Pink Salmon	Undetectable	Undetectable	Undetectable
Steelhead	Negligible-beneficial	Low-beneficial	Negligible-adverse

Alternative 1, No Action

Under Alternative 1, the Issaquah hatchery programs and the Lake Washington Sockeye program would operate as under current conditions. No change would therefore be expected in the prey enhancement effects from the hatchery programs compared to those described in Section 3.3.3.3, Prey Enhancement. Upon release into the natural environment, hatchery-origin juveniles may become prey for natural origin salmon and steelhead and provide an additional food source. Although juvenile Coho Salmon and Chinook Salmon may consume small hatchery fish, the effects would be undetectable. Chum Salmon and Pink Salmon do not occur in the Lake Washington Basin; any effect of prey enhancement in marine waters would also be undetectable for these species. The overall effects of providing potential prey for juvenile and adult steelhead would be negligible-beneficial.

Alternative 2, Proposed Action

Under Alternative 2, production would be increased, and the UWARF programs would be resumed, resulting in potential increases in juvenile salmon as available prey. This alternative would have low-beneficial effects compared to Alternative 1 for Coho Salmon, Chinook Salmon, and steelhead.

Alternative 3, Program Termination

Under Alternative 3, no program-related juvenile salmonids would be available as a prey source, though potential salmonid predators are long lived and predation on NORs is likely to increase. Therefore, this alternative would have a low-adverse effect on Coho Salmon and Chinook Salmon, and a negligible-adverse effect on steelhead compared to Alternative 1.

4.3.1.5 Diseases

The overall disease effects from hatchery-origin Coho Salmon, Chinook Salmon, and Sockeye Salmon on natural-origin salmon and steelhead would be negligible-adverse or undetectable under Alternative 1, and low-adverse or undetectable under Alternative 2. Relative to Alternative 1, effects would be negligible-beneficial or undetectable under Alternative 3 (Table 4-7).

Table 4-7. Summary of Disease Effects on Salmon and Steelhead

Species	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Coho Salmon	Negligible-adverse	Low-adverse	Negligible-beneficial
Chinook Salmon	Negligible-adverse	Low-adverse	Negligible-beneficial
Sockeye Salmon	Negligible-adverse	Low-adverse	Negligible-beneficial
Chum Salmon	Undetectable	Undetectable	Undetectable
Pink Salmon	Undetectable	Undetectable	Undetectable
Steelhead	Negligible-adverse	Low-adverse	Negligible-beneficial

Alternative 1, No Action

Under Alternative 1, the Issaquah Hatchery programs and the Lake Washington Sockeye program would be operated with the same disease management protocols as current conditions, so no change in disease effects on other salmon and steelhead species would be expected. Although pathogens can be passed to natural-origin salmon and steelhead that occupy rivers near hatchery facilities, several factors reduce the likelihood of disease and pathogen transmission between hatchery and natural fish. First, the proportion of facility surface water withdrawal and subsequent discharge at most sites represents only a portion of the total streamflow (Section 3.1, Water Quantity). This reduces, via dilution, the potential for transmission of pathogens from effluent. Second, smolt release strategies typically promote distribution of hatchery fish throughout the system and rapid outmigration (including Sockeye Salmon that migrate out of the Cedar River and into Lake Washington to rear), which reduces the concentration of hatchery-released fish, and therefore, the potential for a diseased hatchery fish to encounter natural-origin salmon or steelhead. Chum Salmon and Pink Salmon are unlikely to encounter released hatchery juveniles included in this EA and are therefore unlikely to be affected in any detectable manner. Finally, standard fish health protocols minimize the potential for disease and pathogen effects on natural-origin salmon and steelhead (NMFS 2018a, 2018b). Because few major outbreaks have occurred for any of the programs and management protocols have limited the extent and duration of any outbreaks, production of all salmon and steelhead discussed here would have a negligible-adverse effect.

Alternative 2, Proposed Action

Under Alternative 2, production would be increased, and the UWARF programs would be resumed, increasing the potential for interaction and therefore disease transmission between hatchery and natural-

origin salmon and steelhead. Although release strategies and rapid outmigration would help to minimize interactions, the increased potential for interaction because of increased densities would result in a low-adverse effect rather than the negligible-adverse effect of Alternative 1. Although Sockeye Salmon are particularly vulnerable to IHN (Lapatra 2011; Alaska Department of Fish and Game 2021), the effect of this vulnerability would not change if eggs were transferred from outside the Lake Washington Basin.

Alternative 3, Program Termination

Given the quantity of smolts that would be eliminated from the Study Area, terminated production under Alternative 3 would result in a negligible-beneficial effect on the potential for pathogen transmission to natural-origin fish associated with the hatchery programs compared to Alternative 1.

4.3.1.6 Nutrient Cycling

The overall effects of nutrient contribution in the form of marine-derived nutrients on natural-origin salmon and steelhead would be negligible-beneficial or undetectable under Alternative 1 and low-beneficial or undetectable under Alternative 2 (Table 4-8). Relative to Alternative 1, effects would be negligible-adverse or undetectable under Alternative 3.

Table 4-8. Summary of Nutrient Cycling Effects on Salmon and Steelhead

Species	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Coho Salmon	Negligible-beneficial	Low-beneficial	Negligible-adverse
Chinook Salmon	Negligible-beneficial	Low-beneficial	Negligible-adverse
Sockeye Salmon	Negligible-beneficial	Low-beneficial	Negligible-adverse
Chum Salmon	Undetectable	Undetectable	Undetectable
Pink Salmon	Undetectable	Undetectable	Undetectable
Steelhead	Negligible-beneficial	Low-beneficial	Negligible-adverse

Alternative 1, No Action

Under Alternative 1, the Issaquah programs and the Lake Washington Sockeye Program would continue to operate as under current conditions. NMFS therefore expects nutrient cycling effects to remain the same as current conditions. Because some hatchery-origin fish from all programs die in the Lake Washington Basin, the programs would provide a negligible-beneficial effect for Coho Salmon, Chinook Salmon, Sockeye Salmon, and steelhead in the Lake Washington Basin through nutrient cycling. Chum Salmon and Pink Salmon are not present in the basin and are therefore unlikely to be affected in any detectable manner. The number of hatchery-origin fish allowed to spawn naturally is undetermined because the number would depend on how many natural-origin fish are on the spawning ground. However, a portion of hatchery-origin adult returns would be expected to spawn naturally and thereby contribute nutrients to the environment. Over time, returning hatchery fish that spawn naturally could contribute to marine-derived nutrients in the Study Area, increasing the overall benefit to the system.

Alternative 2, Proposed Action

Under Alternative 2, production would increase, and the UWARF programs would resume, increasing the potential for nutrient cycling. Therefore, this alternative would have a low-beneficial effect rather than the negligible-beneficial effect of Alternative 1.

Alternative 3, Program Termination

Cessation of all program releases under Alternative 3 would reduce the quantity of adult returns. Hatchery-origin yearlings and subyearlings released prior to program termination would return to the Study Area for 4 or 5 years and continue to contribute to nutrient cycling at reduced levels. Over time, hatchery-origin adults from the project programs would no longer return to the Study Area, and marine-based nutrient contribution attributed to program adults would cease. This alternative would therefore have a negligible-adverse effect compared to Alternative 1.

4.3.1.7 Facility Operations

The overall effects of facility operations on natural-origin salmon and steelhead would be low-adverse or undetectable under Alternative 1 and Alternative 2. Relative to Alternative 1, effects would be low-beneficial or undetectable under Alternative 3 (Table 4-9), depending on the species considered.

Table 4-9. Summary of Facility Effects on Salmon and Steelhead

Species	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Coho Salmon	Low-adverse	Same as Alternative 1	Low-beneficial
Chinook Salmon	Low-adverse	Same as Alternative 1	Low-beneficial
Sockeye Salmon	Low-adverse	Same as Alternative 1	Low-beneficial
Chum Salmon	Undetectable	Undetectable	Undetectable
Pink Salmon	Undetectable	Undetectable	Undetectable
Steelhead	Low-adverse	Same as Alternative 1	Low-beneficial

Alternative 1, No Action

Under Alternative 1, the Issaquah Hatchery programs and the Lake Washington Sockeye Program would generally be operated the same as under current conditions with no change in effects on salmon and steelhead from current conditions, including adult collection, surface water diversion, effluent discharge, and routine instream maintenance activities. Exceptions would include conversion of the weir on the Cedar River from seasonal to permanent, and seasonal placement of a weir near the mouth of Bear Creek to collect adult Sockeye Salmon (Section 2.1, No Action).

The intake facilities may affect Chinook Salmon and steelhead more than other species because of their wider distribution throughout the Study Area which may increase the probability of encountering intakes. However, despite this increased probability, effects on Coho Salmon, Chinook Salmon, Sockeye Salmon, and steelhead would all be low-adverse. Chum Salmon and Pink Salmon are unlikely to encounter facilities included in this EA; therefore, effects on both species would be undetectable. Effects on salmon and steelhead in the Study Area are low because the program facilities minimize any impediment to fish movement as discussed in Section 3.3.3.7, Facility Operations. Further, all facilities comply with current anadromous salmonid passage facility design criteria and guidelines (NMFS 2011). These criteria require the mesh or slot size in the screening material and the approach velocity of water toward the intake screening, meet standards that reduce the risk of both entrainment and impingement of listed juvenile salmonids. Moreover, facilities are routinely observed for any sign that screens are not effectively excluding fish from intakes. Surface water withdrawals would not change; therefore, effects of water withdrawals and associated habitat degradation in diversion reaches assessed in Section 4.1, Water Quantity, are assumed into the future under Alternative 1.

Weirs, ladders, and traps operated for Chinook, Sockeye, and Coho Salmon broodstock collection would continue to operate, and potentially capture both natural- and hatchery-origin salmon and steelhead. Catches may increase because the weir on the Cedar River would be permanent. Broodstock collection timing would be similar under Alternative 1 as under current operations, and broodstock collection for each facility would have the greatest effect on species that overlap in run timing (primarily Coho, Chinook, and Sockeye Salmon). For Sockeye Salmon broodstock collection, the permanent weir on the Cedar River is in review, and it would allow collection later in the season which could extend the potential capture period of natural- and hatchery-origin salmon and steelhead. This would potentially allow collection of the full spawning population, if necessary, during times of critically low abundance. Collection of adult Chinook salmon and sockeye salmon (initiated in 2021) at the Ballard Locks has the potential to contribute to population viability by reducing enroute mortality to natural spawning areas or hatcheries, Effects from weirs and traps would range from migratory delay to mortality through stress from handling.

The spatial distribution of juvenile and adult salmon and steelhead likely would not be affected by weir operation because weirs are designed to allow juvenile passage, and natural-origin adults are passed upstream when not required for broodstock. Traps are checked daily and nontarget fish are removed and passed upstream.

Broodstock collection will have a low-adverse effect on Chinook, Coho, and Sockeye Salmon under Alternative 1. Chum and Pink Salmon are unlikely to encounter facilities included in this EA; therefore, effects on Chum and Pink Salmon would be undetectable.

Operations would continue to include BMPs that limit the type, timing, and magnitude of allowable instream activities. In general, BMPs would limit effects to short-term, sublethal effects such as fish displacement, and/or startling of fish, and would not result in any deviation beyond normal fish behavioral responses to environmental disturbances. Therefore, routine maintenance activities would not result in harm, harassment, or mortality of salmon and steelhead.

Alternative 2, Proposed Action

Under Alternative 2, the Issaquah hatchery programs and the Lake Washington Sockeye Salmon program would increase production, and the UWARF programs would resume production. Most facility operations would be similar to those described for Alternative 1 and use BMPs as described above. The weir on Cedar Creek would be operated to facilitate collection of enough returning adults to meet production needs. However, because of operation details and BMPs described above, this alternative would have the same, low-adverse effect as Alternative 1 for Coho Salmon, Chinook Salmon, Sockeye Salmon, and steelhead, and undetectable effects on Chum Salmon and Pink Salmon.

Alternative 3, Program Termination

With the complete termination of hatchery programs under Alternative 3, existing facilities would no longer be used to support these programs. The frequency at which salmon and steelhead are encountered would be less and the likelihood of migratory delay or mortality would be reduced, resulting in a low-beneficial effect on most salmon and steelhead compared to Alternative 1.

4.3.1.8 Research, Monitoring, and Evaluation

The overall effects of research, monitoring, and evaluation activities on natural-origin salmon and steelhead would range from negligible-adverse to undetectable under Alternative 1 and Alternative 2 and would range from negligible-beneficial to undetectable under Alternative 3, depending on the species considered (Table 4-10).

Table 4-10. Summary of RM&E Effects on Salmon and Steelhead

Species	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Coho Salmon	Negligible-adverse	Same as Alternative 1	Negligible-beneficial
Chinook Salmon	Negligible-adverse	Same as Alternative 1	Negligible-beneficial
Sockeye Salmon	Negligible-adverse	Same as Alternative 1	Negligible-beneficial
Chum Salmon	Undetectable	Undetectable	Undetectable
Pink Salmon	Undetectable	Undetectable	Undetectable
Steelhead	Negligible-adverse	Same as Alternative 1	Negligible-beneficial

Alternative 1, No Action

Under Alternative 1, RM&E activities currently part of the hatchery programs would be operated the same as under current conditions, so no change in effects on salmon and steelhead would be expected. Spawning ground surveys would continue to be performed during salmon and steelhead surveys, screw traps would continue to be operated the same as under current conditions, and juvenile fish sampling, tagging, and monitoring (e.g., electrofishing, snorkel surveys) would be performed the same way as under current conditions (Section 3.3.3.8, Research, Monitoring, and Evaluation). The effects of juvenile fish sampling would be minimized because smolt traps would have a negligible effect on migration. All salmon and steelhead species in the Lake Washington Basin are likely to be affected in a similar fashion, with the effects ranging from migratory delay to stress from handling (Section 3.3.3.8, Research, Monitoring, and Evaluation), leading to a negligible-adverse effect. Because smolt traps are checked daily, non-target fish can be removed on a daily basis, though handling may cause stress or injury to the fish. Considering the absence of Chum Salmon and Pink Salmon from the Lake Washington Basin, the potential for effects on these species would be undetectable.

Alternative 2, Proposed Action

Under Alternative 2, even with increased production and resumption of the UWARF programs, RM&E would be the same as under Alternative 1, except for changes related to possible changes to release sites for the Issaquah Coho Hatchery Program, with no change in effects on salmon and steelhead. Therefore, this alternative would also have the same, negligible-adverse effect as Alternative 1 for Coho Salmon, Chinook Salmon, Sockeye Salmon, and steelhead, and undetectable effects on Chum Salmon and Pink Salmon. Relative to how RM&E effects are likely to appear in the future, the effect would be the same as that of Alternative 1.

Alternative 3, Program Termination

With the termination of hatchery programs under Alternative 3, surveys would presumably continue until all adults from terminated programs have returned. Future surveys and smolt trapping would be reduced in duration and frequency until all program-related RM&E is discontinued. RM&E used to inform natural monitoring objectives would continue to operate. Therefore, RM&E effects would be negligible-beneficial for salmon and steelhead in the Study Area because of reduced effort associated with program-related RM&E. Considering the low number or absence of Chum Salmon and Pink Salmon in the Lake Washington Basin, the potential for effects on these species would be undetectable.

4.3.2 Other Fish Species

This subsection discusses the effects of the alternatives on other fish species. As described in Section 3.3.4, Other Fish Species, the analysis focuses on a small number of species that may have the highest degree of interactions with hatchery-origin salmon. The overall effect on fish species other than salmon and steelhead would range from negligible-adverse to negligible-beneficial under Alternative 1, and from low-adverse to low beneficial under Alternative 2 (Table 4-11). Effects would range from negligible-beneficial to negligible-adverse under Alternative 3.

Table 4-11. Summary of Effects on Fish Species other than Salmon or Steelhead

Metric	Alternative 1 – No Action	Alternative 2 – Proposed Action	Alternative 3 - Program Termination
Competition and Predation	Negligible-adverse	Low-adverse	Negligible-beneficial
Prey Enhancement	Negligible-beneficial	Low-beneficial	Negligible-adverse
Diseases	Negligible-adverse	Same as Alternative 1	Negligible-beneficial
Nutrient Cycling	Negligible-beneficial	Low-beneficial	Negligible-adverse
Facility Operations	Negligible-adverse	Same as Alternative 1	Negligible-beneficial
Research Monitoring and Evaluation	Negligible-adverse	Same as Alternative 1	Negligible-beneficial

4.3.2.1 Alternative 1, No Action

Because production of Coho Salmon, Chinook Salmon, Sockeye Salmon, and therefore the estimated number of adult recruits under Alternative 1 would not change compared to current conditions, no change in effects on other fish species is expected. Competition and predation effects would continue to be negligible-adverse for many fish species in the Study Area, especially for salmonid species such as Coastal Cutthroat Trout and Kokanee that may compete for spawning grounds or experience redd superimposition with hatchery-origin salmonids (Section 3.3.3, Ongoing Effects of Hatchery Programs on Salmon and Steelhead). Effects on other fish species would likely be less than effects on natural-origin salmon and steelhead (Section 4.3.1.3, Competition and Predation) because of differences in spawn timing, location, and habitat preference. Predation by hatchery fish on native species such as Longnose Dace would also continue.

Prey enhancement related to hatchery production of salmon and steelhead would continue to have a negligible-beneficial effect on fish species in the Study Area that could prey on yearlings, subyearlings, and fry from the hatchery programs, though no fish species relies solely on salmon for prey. Available juvenile salmon prey would continue and predation on hatchery-origin juvenile salmon would continue. Predation on hatchery-origin salmon by Pacific Lamprey and River Lamprey would also likely continue, as would the potential for hatchery salmon to buffer Pacific Lamprey from predation by marine mammals.

Diseases that are endemic to many fish species would continue to have a negligible-adverse effect on fish species in the Study Area, though such incidences in the natural environment are not likely to be amplified by current ongoing hatchery programs. Diseases that pose particular risk to hatchery-origin salmonids (i.e., BKD and IHN) only affect salmonid species. Although other salmonid species such as Coastal Cutthroat Trout and Kokanee have the potential to occur near existing hatchery facilities and release sites, several factors such as the relatively low volume of discharge, smolt release strategies, and

fish health protocols would continue to reduce the likelihood of disease and pathogen transmission between hatchery fish and other salmonids.

Most fish species in the Study Area would continue to benefit negligibly from nutrient cycling of carcasses from hatchery-origin fish through having enhanced nutrients available to their prey sources. Naturally spawning fish of hatchery origin or nutrient enhancement derived from fish spawned in hatcheries would continue to contribute to increased nutrient cycling in the natural environment.

Facility operations would continue to have negligible-adverse effects because program facilities minimize any impediment to fish movement as discussed in Section 3.3.3.7, Facility Operations. Upstream migration may be delayed slightly for fish trapped at collection facilities. As described in Section 4.3.1.7, Facility Operations, the weir on the Cedar River would become permanent, and a seasonal weir would be placed near the mouth of Bear Creek. Handling and potential for injury could increase. Effects of water diversions, intakes, effluent discharge, and maintenance activities would remain unchanged.

RM&E activities would continue to have a negligible-adverse effect on fish species other than salmon and steelhead. Individuals would continue to be incidentally collected in traps and during surveys and may suffer increased stress and minimal mortality. However, guidelines to reduce impacts on salmon and steelhead (NMFS 2008a) would continue to reduce effects on other species.

4.3.2.2 Alternative 2, Proposed Action

Under Alternative 2, the Issaquah hatchery programs and the Lake Washington Sockeye Salmon program would increase production, and the UWARF programs would resume production. The increased production could increase the effects of competition and predation to low-adverse because of increased numbers of hatchery-origin salmon in the environment but could also increase the effects of prey enhancement to low-beneficial for the same reason.

Because of the practices described above, the potential effect of disease transmission would continue to be negligible-adverse, even with potentially large increases in production (e.g., Sockeye Salmon). Release strategies, rapid outmigration, and minimal habitat overlap between hatchery fish from these programs and fish species other than salmon and steelhead, would contribute to minimizing interactions and limiting effects.

The increased number of returning adults could increase the potential for nutrient cycling, resulting in a low-beneficial effect. For Sockeye Salmon, the program species with the highest potential increase, increased effects of nutrient cycling would be most pronounced for freshwater fish species however minimal habitat overlap within the freshwater environment would limit these effects.

Because of operation details and BMPs described in Section 4.3.1.7, Facility Operations, and in Section 4.3.1.8, Research, Monitoring, and Evaluation, effects would continue to be negligible-adverse, even with increased production, in particular for the Sockeye Salmon program.

4.3.2.3 Alternative 3, Program Termination

With the complete termination of hatchery programs under Alternative 3, facilities would not be used for these programs, and all but Issaquah Creek Hatchery may close completely. Operations at Issaquah Creek Hatchery would be limited to production of Kokanee. Termination of the hatchery programs would reduce competition with and predation on other fish species, leading to an overall negligible-beneficial effect on other fish species relative to Alternative 1.

The programs would not release yearlings, subyearlings, or fry, eliminating one source of prey for some fish in the Study Area. This could result in a negligible-adverse effect on other fish species relative to Alternative 1.

Termination of hatchery programs would eliminate the risk of hatchery-related disease amplification to salmonids other than salmon and steelhead. Complete cessation of hatchery production would therefore contribute to a negligible-beneficial effect on other fish species relative to Alternative 1.

Over time, as salmon from terminated programs no longer return to the Study Area, hatchery-origin adults from the programs would no longer contribute to nutrient cycling. Some hatchery-origin fish would successfully spawn in the natural environment, and therefore, add to future generations that would contribute to nutrient cycling. However, complete cessation of anadromous salmon hatchery production, and corresponding reduced intake of nutrients through prey sources, would contribute to a negligible-adverse effect on other fish species relative to Alternative 1.

As previously noted, operations at most facilities may cease entirely under Alternative 3. Issaquah Hatchery would operate with reduced intake and effluent discharge because of reduced production. Changes to or cessation of operations would contribute to a negligible-beneficial effect on other fish species relative to Alternative 1.

RM&E would eventually terminate for these programs under Alternative 3. Complete cessation of hatchery-related RM&E activities would contribute to a negligible-beneficial effect on other fish species relative to Alternative 1.

4.4 Wildlife

The overall effect on wildlife at the population level would range from low-beneficial to low-adverse under Alternative 1 and from medium-beneficial to medium-adverse under Alternative 2. Effects would range from low-adverse to low-beneficial under Alternative 3 (Table 4-12).

Table 4-12. Summary of Effects on Wildlife

Metric	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 - Program Termination
Prey Enhancement	Low-beneficial	Medium-beneficial	Low-adverse
Contaminants	Low-adverse	Medium-adverse	Low-beneficial
Nutrient Cycling	Negligible-beneficial	Low-beneficial	Negligible-adverse
Facility Operations	Negligible-adverse	Same as Alternative 1	Negligible-beneficial

4.4.1 Alternative 1, No Action

Because production of juvenile salmon and the estimated number of adult recruits under Alternative 1 would not change compared to current conditions, prey enhancement related to hatchery production of salmon and steelhead would continue to have a low-beneficial effect on wildlife species in the Study Area, though few wildlife species rely primarily on hatchery-origin salmon juveniles or adults. Adults returning from hatchery releases would continue to partially compensate for declines in natural-origin salmon populations and therefore continue to benefit Southern Resident killer whales.

Toxic contaminants found in hatchery-origin salmon and steelhead are unlikely to affect most wildlife species in the Study Area. However, the heavy contaminant loads observed in Chinook Salmon within Puget Sound waters (O’Neill et al. 2005; Cullon et al. 2009) would likely continue to contribute to the contaminant loads in Southern Resident killer whales. Toxic contaminants would therefore continue to have a low-adverse effect on wildlife species in the Study Area. The effect is low because the Issaquah Chinook Salmon program constitutes a small proportion of the Chinook Salmon available in Puget Sound.

Most wildlife species in the Study Area (e.g., stream invertebrates, mammals, and birds) would continue to receive a negligible benefit from nutrient cycling of carcasses from hatchery-origin fish, either directly or indirectly. Naturally spawning fish of hatchery origin would continue to contribute to increased nutrient cycling in the natural environment.

Program facilities would continue to have negligible-adverse effects because only passive methods (i.e., netting and fencing around facilities) are used to deter predators such as great blue herons and river otters at facilities. Program facilities minimize impediments to wildlife movement, and staff members who can remove non target species would be present at weirs and traps during trapping operations and routine maintenance activities. Handling levels and potential for injury would remain unchanged from current conditions.

Operation and maintenance at the hatcheries, weirs, and release locations may cause temporary effects on wildlife, including various species of birds, because of human presence and temporary elevated noise. Noise-sensitive wildlife are anticipated to temporarily relocate to adjacent habitats, which are abundant near some program facilities (e.g., Cedar River Hatchery); however, most facilities are in urban environments that are characterized by human presence and elevated noise levels. Effects from temporarily elevated noises are anticipated to remain unchanged from current conditions because no change in operation is proposed that would change the level of noise.

4.4.2 Alternative 2, Proposed Action

Under Alternative 2, the hatchery programs would be the same as described in the HGMPs, including increased production and the resumption of the UWARF programs. The increased production could increase the amount of available prey to wildlife species such as Southern Resident killer whales, increasing the effect to medium-beneficial. Contaminant levels in Chinook Salmon are not likely to change in the near future; therefore, the increased production and resulting increases in adult fish available would likely increase contaminant loading in Southern Resident killer whales. The effect would therefore be medium-adverse. The increased number of returning adults could increase the potential for nutrient cycling through increased prey availability and from fish spawning and dying in streams, resulting in a low-beneficial effect. Because of operation details and BMPs described in Section 4.3.1.7, Facility Operations, effects would continue to be negligible-adverse, even with increased production.

4.4.3 Alternative 3, Program Termination

With the complete termination of hatchery programs under Alternative 3, facilities would not be used for these programs, and all but Issaquah Creek Hatchery may close completely. Operations at Issaquah Creek Hatchery would be limited to production of Kokanee. Termination of the hatchery programs would reduce the prey base for some wildlife species. This would be particularly important to Southern Resident killer whales that rely heavily on Chinook Salmon as a food source. Because Chinook Salmon from the Issaquah program constitutes a small proportion of the Chinook Salmon available in Puget Sound, the overall effect would be low-adverse.

Termination of hatchery programs would reduce the number of adult salmon in the Study Area. This would reduce the number of Chinook Salmon with heavy contaminant levels, and therefore decrease contaminant loading in Southern Resident killer whales. Complete cessation of hatchery production would therefore contribute to a low-beneficial effect on wildlife relative to Alternative 1.

Over time, as salmon from terminated programs no longer return to the Study Area, hatchery-origin adults from the programs would no longer contribute to nutrient cycling. Some hatchery-origin fish would successfully spawn in the natural environment, and therefore, contribute to future generations that would contribute to nutrient cycling. However, complete cessation of hatchery production and corresponding

reduced intake of nutrients through prey sources would contribute to a negligible-adverse effect on wildlife species relative to Alternative 1.

As previously noted, operations at most facilities may cease entirely under Alternative 3. Issaquah Hatchery would operate with reduced intake and effluent discharge because of reduced production. Changes to or cessation of operations would contribute to a negligible-beneficial effect on wildlife species relative to Alternative 1.

4.5 Marine and Freshwater Habitat

The overall effects of the alternatives on critical habitat and EFH vary depending upon species (Table 4-13). Chinook Salmon are the only species with both designated critical habitat and EFH in the Study Area. The National Marine Fisheries Service (NMFS) specifically excluded the entirety of the Sammamish River and Lake Sammamish basins from designation as critical habitat because the economic benefits of no designation outweighed the conservation benefits of a critical habitat designation (NMFS 2005). Depending on the species, effects range from low-adverse to low-beneficial for Alternative 1 and Alternative 2. Relative to Alternative 1, effects range low-beneficial to low-adverse for Alternative 3.

Table 4-13. Summary of Program Effects on Critical Habitat and EFH for Chinook and Coho Salmon

Species	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 – Program Termination
Species with Both Critical Habitat and Essential Fish Habitat			
Chinook Salmon	Low-adverse	Same as Alternative 1	Low-beneficial
Species with Critical Habitat Only			
Chum Salmon	Undetectable	Undetectable	Undetectable
Steelhead	Low-adverse	Same as Alternative 1	Low-beneficial
Bull Trout	Negligible-adverse	Negligible-beneficial	Negligible-beneficial
Georgia Basin Bocaccio	Negligible-beneficial	Same as Alternative 1	Negligible-adverse
Georgia Basin Yelloweye Rockfish	Negligible-beneficial	Same as Alternative 1	Negligible-adverse
Southern Resident Killer Whale	Low-Beneficial	Same as Alternative 1	Low-adverse
Marbled Murrelet	Undetectable	Undetectable	Undetectable
Species with Essential Fish Habitat Only			
Coho Salmon	Low-adverse	Same as Alternative 1	Low-beneficial
Pink Salmon	Low-adverse	Same as Alternative 1	Low-beneficial

4.5.1 Alternative 1, No Action

Under Alternative 1, the Issaquah Hatchery programs and the Lake Washington Sockeye Program would be operated the same as under current conditions, with no change in water use or juvenile release strategies. Therefore, NMFS expects no change in effects on critical habitat or EFH compared to current conditions.

Alternative 1 would result in a low-adverse effect on critical habitat and EFH for Chinook Salmon, critical habitat for steelhead, and EFH for Coho Salmon and Pink Salmon through hatchery operations and

existence of associated structures (e.g., weirs, water withdrawal structures, effluent, and operations and maintenance affecting complex channels and floodplain habitat, thermal refugia, and spawning habitat, and through genetic and ecological interactions of hatchery-origin fish with natural-origin fish in the natural environment. Any effects on Chum Salmon critical habitat from the existence or operation of hatcheries considered in this EA would be undetectable because no critical habitat is designated in the Lake Washington Basin. Although the hatchery programs may enhance the prey base for Bull Trout, the overall effect would be negligible-adverse because of operation effects described for Chinook Salmon and steelhead. Effects on critical habitat for Georgia Basin Bocaccio and Yelloweye Rockfish would be negligible-beneficial through availability of prey species. Similarly, effects on critical habitat for Southern Resident killer whales would be low-beneficial because of availability of adult hatchery fish, especially Chinook Salmon, as prey species. Continuation of ongoing hatchery programs would have no detectable effect on critical habitat for marbled murrelets.

4.5.2 Alternative 2, Proposed Action

Under Alternative 2, water use would increase because of increased production by the Issaquah hatchery programs and the Lake Washington Sockeye Salmon program, and because of resumption of the UWARF programs (Section 4.1, Water Quantity). However, as noted in Section 1.3, Description of the Proposed Action, the proposed action does not include any future facility construction or expansion, including the withdrawal of water quantities beyond existing permissible volumes. To meet water quantity requirements, programs would need to secure additional water rights or utilize existing facilities more efficiently. Because changes would be minimal relative to the amount of water available, effects on critical habitat and EFH would the same as described for Alternative 1. Therefore, this alternative would have the same range of effects as Alternative 1. One exception is critical habitat for Bull Trout. The increase in prey would result in an overall negligible-beneficial effect.

4.5.3 Alternative 3, Program Termination

With the complete termination of hatchery programs under Alternative 3, existing facilities would no longer be used to support these programs. The frequency at which salmon and Bull Trout are encountered would be less and the likelihood of migratory delay or mortality reduced, resulting in a low-beneficial effect on critical habitat and EFH for Chinook Salmon, critical habitat for steelhead and Bull Trout, and EFH for Coho Salmon and Pink Salmon compared to Alternative 1. Any effects on Chum Salmon critical habitat would be undetectable because no critical habitat is designated in the Lake Washington Basin. Effects on critical habitat for Georgia Basin Bocaccio and Yelloweye Rockfish would be negligible-adverse through decreased availability of prey species. Effects on critical habitat for Southern Resident killer whales would be low-adverse because of decreased availability of adult hatchery fish, especially Chinook Salmon, as prey species. Termination of hatchery programs would have no detectable effect on critical habitat for marbled murrelets.

4.6 Socioeconomics

The overall effect on socioeconomics would be moderate-beneficial under Alternative 1 and high-beneficial under Alternative 2 (Table 4-14). Relative to Alternative 1, effects would be moderate-adverse under Alternative 3.

Table 4-14. Summary of Effects on Socioeconomics

Resource	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 - Program Termination
Socioeconomics	Moderate-beneficial	High-beneficial	Moderate-adverse

The Issaquah Hatchery appears to meet criteria for the National Register of Historic Places, is located in a potential historic district, and potentially contributes to a historic district. However, as discussed in Chapter 2, Description of Alternatives, construction, or expansion are not part of the proposed action. Therefore, the proposed action has no potential to cause effects on historic properties.

4.6.1 Alternative 1, No Action

Under Alternative 1, the Issaquah Hatchery programs and the Lake Washington Sockeye Program would operate in a similar manner as under current conditions. Selective fisheries would continue to provide fishing opportunities while also protecting natural-origin fish. Value of commercial and recreational fisheries plus baseline hatchery operations would therefore remain the same. It is unlikely that fisheries for Chinook Salmon and Sockeye Salmon would resume within the Lake Washington Basin.

Continued hatchery operations in an urban area would continue to provide education and outreach opportunities, particularly at Issaquah Hatchery, which would continue to provide opportunities for school programs and education about salmon. Although the Issaquah programs produce low proportions of the Chinook Salmon and Coho Salmon in the Study Area, and few Sockeye Salmon are harvested, the combination of fishing contributions to the regional economy and public education contributions would lead to a moderate-beneficial effect.

4.6.2 Alternative 2, Proposed Action

Under Alternative 2, hatchery production would increase and the UWARF programs would resume production. Within 3-5 years after implementation, if survival rates of hatchery fish are maintained or increased, then increased production could increase the number of returning adults, and therefore opportunities for both commercial and recreation fisheries. Increased production would also increase baseline hatchery operations, particularly at the UWARF. Increased production would be expected to increase the potential contribution to the regional economy. In addition, new hatchery jobs would be created in association with the UWARF Chinook and Coho Salmon programs and as well as expanded production within Phase 3 of the Issaquah Fall Chinook and Lake Washington Sockeye Salmon programs. Continued hatchery operations in an urban area would continue to provide education and outreach opportunities similar to those described for Alternative 1. Increased contributions of fishing to the regional economy, combined with public education contributions would have a high-beneficial effect compared to Alternative 1.

4.6.3 Alternative 3, Program Termination

Under Alternative 3, hatchery programs described would no longer contribute to harvest-related expenditures, jobs, or operational expenses for the regional economy, though fisheries targeting fish from other programs would continue. Most facilities would likely cease operations, causing hatchery-related expenditures, jobs, and operational expenses to be eliminated. Furthermore, ceasing hatchery operations would result in the termination of public education opportunities at these urban facilities. This alternative

would therefore have a moderate-adverse effect compared to Alternative 1 because of reduced expenditures, jobs, operational expenses, and public education opportunities.

4.7 Cultural Resources

The overall effect on cultural resources would be negligible-beneficial under Alternative 1 and moderate-beneficial under Alternative 2 (Table 4-15). Relative to Alternative 1, effects would be high-adverse under Alternative 3.

Table 4-15. Summary of Effects on Cultural Resources

Resource	Alternative 1 - No Action	Alternative 2 – Proposed Action	Alternative 3 - Program Termination
Cultural Resources	Negligible-beneficial	Moderate-beneficial	High-adverse

4.7.1 Alternative 1, No Action

Under Alternative 1, the Issaquah Hatchery programs and the Lake Washington Sockeye Program would be generally operated as under current conditions, and the abundance of salmon would be similar to that under current conditions (Section 3.3.1, ESA-Listed Salmon and Steelhead). Because conservation programs currently in place (e.g., those described in Section 1.4, Relationship to Other Plans, Regulations, Agreements, Laws, Secretarial Orders, and Executive Orders) could increase salmon abundance and productivity, Tribes might eventually harvest more hatchery-origin fish within the management guidelines developed by Puget Sound co-managers, as well as benefit from increased natural production through non-selective fisheries (fisheries in which both marked and unmarked fish may be retained). However, existing practices, including hatchery programs, have not resulted in directed tribal fisheries within the Lake Washington Basin for Chinook Salmon since 1994, or for Sockeye Salmon since 2006. No recreational salmon fishing is currently allowed in the Lake Washington Ship Canal, the Sammamish River, Issaquah Creek, or the Cedar River. Tribes benefit from the long-term existence of salmon populations, and recent levels of production have provided some benefit. Slight increases in hatchery releases relative to recent years would continue or increase this benefit; however, the lack of salmon available to fisheries in the Lake Washington Basin would result in the effect of Alternative 1 being only negligible-beneficial.

4.7.2 Alternative 2, Proposed Action

Under Alternative 2, hatchery programs would be operated as described in Section 2.2, Alternative 2, Proposed Action, including increased production and resumption of the UWARF programs. If survival rates of hatchery fish are maintained or increased, the result would be an increase in the abundance of salmon, which could lead to potential re-openings of tribal fisheries. Therefore, this alternative would have a moderate-beneficial effect compared to Alternative 1.

4.7.3 Alternative 3, Program Termination

Under Alternative 3, hatchery programs would no longer contribute to tribal fisheries or to the abundance and productivity of salmon in the Study Area. There would be no fishing for salmon by MIT and non-tribal fishers in the Lake Washington Basin, and tribal and non-tribal fisheries in the Study Area would be severely reduced. Most facilities would cease operations because they are dedicated specifically to the programs considered in the Proposed Action. Because tribal and non-tribal fisheries would be severely reduced, this alternative would have a high-adverse effect compared to Alternative 1.

4.8 Environmental Justice

This section determines if there would be disproportionately high and adverse human health or environmental effects from the salmon hatchery programs under the alternatives on minority and low-income environmental justice populations. In Section 3.8, Environmental Justice, Tribes were identified as an environmental justice population. Section 3.8, Environmental Justice, also identifies the non-white communities of King County as potential environmental justice groups. However, the data and information available are insufficient to evaluate whether these King County groups or communities would be uniquely affected by salmon hatchery programs in the Lake Washington Basin, and they are not further analyzed.

The analysis of environmental justice effects is different from the analysis of effects on the other resources in Chapter 4, Environmental Consequences. The analysis first determines whether effects on the resources analyzed in the EA are adverse under any alternative, and if so, whether such adverse effects would be disproportionately high to the identified environmental justice populations. Effects of the alternatives on water quantity, water quality, fish, wildlife, and marine and freshwater habitat would not affect environmental justice populations or communities. However, effects under the alternatives on socioeconomics and cultural resources important to Tribes may affect environmental justice populations. Although commercial fishing is currently not permitted for Chinook Salmon or Sockeye Salmon due to the low numbers of fish returning to the Lake Washington Basin and fisheries for Coho Salmon vary annually depending on forecasted return levels of hatchery-origin and natural-origin fish, it is assumed that commercial and/or recreational fishing may occur in the future and hatchery-origin salmon could be harvested as part of these fisheries. Consequently, the analysis in this subsection assumes the potential for future commercial and recreational fishing.

As described in Section 3.6, Socioeconomics, harvest of fish for ceremonial and subsistence use provides important cultural resource values to Tribes. In addition, the Lake Washington Basin hatcheries provide salmon that contribute to socioeconomic benefits from tribal commercial fisheries and associated personal income.

4.8.1 Alternative 1, No Action

Effects on cultural resources important to Tribes would continue to be only negligibly beneficial under Alternative 1. The Issaquah Hatchery programs and the Lake Washington Sockeye Program would continue to provide economic opportunities (Section 4.6, Socioeconomics) and fish of cultural importance to Tribes (Section 4.7, Cultural Resources). Production levels would remain similar to those of the recent past. These production levels have not resulted in fisheries for Chinook Salmon or Sockeye Salmon in the Lake Washington Basin since 1994 and 2006 respectively. As a result, tribal commercial fishing and tribal hatchery employment would be the same as under existing conditions. This effect would not be disproportionate because all commercial and recreational fishermen, as well as Tribes, would be equally affected.

4.8.2 Alternative 2, Proposed Action

Under Alternative 2, hatchery programs would increase production and the UWARF programs would be resumed. The resulting potential increase in the number of salmon available could result in more fish available for tribal harvest. Tribal commercial fishing and tribal hatchery employment may increase relative to current conditions, so no adverse effects on socioeconomics would occur. Similarly, no adverse effects on cultural resources important to Tribes would result under Alternative 2.

4.8.3 Alternative 3, Program Termination

Under Alternative 3, the salmon hatchery programs would be terminated, and no hatchery-origin salmon would be produced in the Lake Washington Basin. Socioeconomic effects on Tribes include those from the potential for future tribal commercial fisheries for fish returning to the Lake Washington Basin and operation and employment from hatcheries. Although termination of salmon hatchery production under Alternative 3 would decrease harvest opportunities and result in an adverse effect, this decrease would not be disproportionate because all commercial and recreational fishermen, as well as Tribes, would be equally affected. Furthermore, the existing salmon hatchery programs in the Lake Washington Basin are operated by WDFW; therefore, the loss of hatchery employment would not result in a disproportionate effect on Tribes.

The loss of hatchery-origin fish would result in an adverse effect on tribal cultural resources, specifically to their unique ceremonial and subsistence uses. Given the importance of salmon to Tribes and given that this importance is not similar among other populations, these adverse effects would be high and disproportionate. This disproportionate effect cannot be quantified, as no metric can be attributed to the value of this resource to Tribes.

5 Cumulative Effects

Cumulative effects were assessed by combining the effects of each alternative with the effects of other past, present, and reasonably foreseeable future actions that are impacting or will impact the same resources potentially affected by each alternative. Actions are included only if they are tangible and specific, and if effects overlap temporally and geographically with the Proposed Action.

5.1 Past, Present, and Reasonably Foreseeable Actions

The effects of past and present actions on resources potentially affected by the Proposed Action are recognized as current conditions described in Chapter 3, Affected Environment. Historical development of the Lake Washington watershed and Puget Sound for electrical power, drinking water, flood control, navigation, and agricultural needs influenced the existing condition of resources in the study areas. This development, along with other factors such as historic harvest, has led to implementation of management and recovery actions, including numerous hatchery programs.

The expected impacts of the alternatives on all of the resources are described in Chapter 4, Environmental Consequences. However, Chapter 4 does not account for other future foreseeable actions. Reasonably foreseeable future actions with the potential to have cumulative effects with the alternatives described in this EA include climate change, development, habitat restoration, hatchery production, and fisheries. The following subsections describe the reasonably foreseeable actions and conditions related to these factors.

5.1.1 Geographic and Temporal Scales

The geographic area included in the cumulative effects analysis for this EA includes the portions of the Lake Washington Basin and Puget Sound defined in Section 1.2, Project Area and Study Area. The Project Area includes locations immediately adjacent to hatchery facilities, acclimation sites, and weir locations. The scope of the action considered in this EA includes the rearing and release of Coho, chinook, and Sockeye Salmon in the Lake Washington Basin. Adult collection, rearing, and release activities would occur in localized areas only; the associated direct and indirect effects of these activities would occur to varying degrees in the Project Area and larger study areas, depending on the affected resource, as analyzed in Chapter 4, Environmental Consequences.

Available knowledge and research abilities are insufficient to discern the role and contribution of the Proposed Action to density dependent interactions affecting salmon and steelhead growth and survival in the marine environment beyond Puget Sound. NMFS generally concluded the influence of density-dependent interactions on growth and survival is likely small enough compared with the effects of large scale and regional environmental conditions that effects of the Proposed Action in the Study Area may contribute to effects outside the Study Area, but this contribution would not be meaningful or discernible outside the Study Area. Although hatchery production on a scale many times larger than the Proposed Action may affect salmon survival at sea, the degree of impact or level of influence is not yet understood or predictable, nor is there evidence that hatchery programs of the size being evaluated in this EA have effects in the ocean. Thus, neither direct nor indirect impacts of the programs on the human environment outside the Study Area are expected.

Although direct and indirect effects of the Proposed Action are not expected to be measurable outside the Study Area, it is important to consider how effects of certain activities outside the Study Area may or may not interact with the Proposed Action to exacerbate impacts on resources. Potential cumulative effects

are analyzed below, as is how these effects might correspond with the cumulative effects of hatchery programs in Puget Sound (NMFS 2014).

ESA Section 4(d) authorizations do not have a specified time limit. NMFS reviews annual reports provided by applicants, and authorizations may be modified when warranted by NMFS. Climate change is expected to continue to occur over the long term. Thus, the analysis of resource effects reflects shorter-term effects in relation to the scale of climate change. Localized future actions (e.g., urbanizing developments) have a greater potential to impose immediate, substantial cumulative effects on resources when combined with the direct and indirect effects analyzed in Chapter 4, Environmental Consequences.

5.1.2 Climate Change

The Project Area is in the Pacific Northwest where the effects of climate change are affecting hydrologic patterns and water temperatures. Climate change impacts to the regional hydrologic cycle and ESA-listed salmon and steelhead populations, as well as their habitats, have been evaluated extensively (ISAB 2007; Karl et al. 2009; USBR 2016). Evidence of climate change includes increased average annual air and water temperatures over the past century. Ford (2011) summarized expected climate changes in the coming years as leading to a high certainty of some physical and chemical changes:

- Increased air temperature
- Reduced winter and spring snowpack
- Reduced summer stream flow
- Earlier spring peak flow
- Higher sea level
- Higher ocean temperatures
- Increased ocean acidity

According to the Independent Scientific Advisory Board (ISAB), average annual temperatures in the Northwest increased by approximately 1.8°F since 1900, or about 50 percent more than the global average evaluated over the same period of time (ISAB 2007). The latest climate models project a warming of 0.2°F to 1.1°F per decade over the next century.

In general, warming air temperature in winter and spring will lead to more precipitation falling as rain, rather than snow. At elevations along the transient snow zone, even a small amount of warming in winter may cause substantial shifts in the accumulated rainfall versus snowfall during the cool months (October through March); alternatively, locations at higher elevations typically experience winter temperatures far below freezing, so a slight increase in temperature may not initiate a shift from snow to rain (ISAB 2007). In watersheds that historically develop a seasonal snowpack, warmer temperatures will likely reduce snowpack depth and cause a temporal shift in snowmelt runoff.

Reduction in snowpack depth is attributed to both warming surface air temperatures and reduction of precipitation falling as snow (ISAB 2007). Annual snowpack measurements taken throughout the region on April 1 are considered a prime indicator of natural water storage available as runoff during the warmer months of the year. These measurements indicate a substantial snowpack reduction across the Pacific Northwest (Karl et al. 2009). In general, declines in the Pacific Northwest snowpack are projected to continue over this century, varying with latitude, elevation, and proximity to the coastal regions.

Flow timing has shifted over the past 50 years, with the peak spring runoff shifting from a few days earlier in some places to as much as 25 to 30 days earlier in others (Karl et al. 2009). Throughout the region, shifts in timing and magnitude of snowmelt runoff increase the winter flood risk and summer drought risk

in more sensitive watersheds. Increased winter temperatures and reduced snowpack would likely increase winter runoff, causing peak flows along rivers and large streams to increase and diminished runoff earlier in the season (ISAB 2007). Reductions in warm season (April through September) runoff in the region are expected to reach approximately 10 percent by mid-century (Karl et al. 2009). Impacts caused by shifts in flow timing range from lower stream flows to drought in the warmer months (June through September; ISAB 2007).

5.1.3 Development

Human population growth in the Puget Sound area is expected to continue over the next 15 years (Puget Sound Regional Council 2013), which will result in increased demand for housing, transportation, food, water, energy, and commerce. These needs will result in changes to existing land uses because of increases in residential and commercial development and roads, increases in impervious surfaces, conversions of private agricultural and forested lands to developed uses, increases in use of non-native species and increased potential for invasive species, and redevelopment and infill of existing developed lands. Development will continue to affect the natural resources in the cumulative effects Study Area.

5.1.4 Habitat Restoration

Because of concern about the need to protect and restore Chinook Salmon habitat and to maintain local control over recovery decisions and implementation, 27 local governments in the Lake Washington Basin, including King and Snohomish counties and 25 cities, signed an agreement in 2001 to jointly fund the development of the Lake Washington/ Cedar/Sammamish Watershed Chinook Salmon Conservation Plan. The plan was updated in 2017 with new information, and includes refined strategies and goals for the future, including habitat goals for 2025 and 2055 (Lake Washington/Cedar/Sammamish Watershed Salmon Recovery Council 2017). The plan also includes lists of site-specific habitat projects. In addition to this plan, a large portion of the upper Cedar River watershed is the municipal drinking water supply for the City of Seattle and is managed under a Habitat Conservation Plan (HCP).

It is anticipated that past contributors to habitat restoration will continue to be active in the Lake Washington Basin. The types of habitat restoration projects to be implemented in the future are likely to be similar to those implemented since the Chinook Salmon Conservation Plan was first developed in 2005. Projects will work toward the goals of re-connecting floodplains, improving riparian habitat, increasing wood volume, and increasing stream canopy cover to help reduce water temperatures.

5.1.5 Hatchery Production

The type and extent of salmon and steelhead hatchery programs other than those considered under the alternatives and the numbers of fish released in the cumulative effects analysis area will likely change over time in response to new information and evolving management objectives. Although it is possible that some hatchery programs in Puget Sound may reduce production in the future, it is likely that some programs may increase production to increase the prey base for Southern Resident killer whales, provide additional harvest benefits, mitigate for new habitat degradation and climate change, or to bolster abundance temporarily while habitat is restored. In general, effects of such changes on natural-origin salmon and steelhead (e.g., genetic effects and competition and predation risks) would be reduced for those species listed under the ESA. For example, effects on natural-origin Chinook salmon and steelhead are 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. New conservation programs for the Lake Washington Basin may be proposed in the future to bolster natural-origin populations. Assuming future compliance with the ESA and continued implementation and/or expansion of conservation hatchery programs, such hatchery programs would be a benefit to help increase the size of salmon and steelhead populations in the future.

5.1.6 Fisheries

Fisheries that harvest salmonids in the study area will likely change over time in response to new information and revised management objectives. Such fisheries include those in the Lake Washington Basin and adjacent marine catch areas where hatchery-origin salmon produced by hatchery programs in freshwater are also harvested. These fisheries have provided for tribal and non-tribal commercial fisheries and non-tribal recreational fisheries, as well as for tribal ceremonial and subsistence uses. However, due to conservation concerns, no commercial fisheries currently target adult Chinook Salmon or Sockeye Salmon in the Lake Washington Basin.

Effects on ESA-listed natural-origin Chinook Salmon and steelhead from fisheries are expected to decrease over time to the extent that fisheries management programs continue to be reviewed and approved by NMFS. Fisheries management program compliance with conservation provisions of the ESA will help 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 fisheries effects on listed salmon and steelhead may occur through changes in harvest areas or timing of fisheries or changes in types of harvest methods used. To the extent that improvements in the status of listed salmon and steelhead populations occur, potential future fisheries may be considered. Potential future fisheries could include the resumption of commercial fisheries for Chinook Salmon and Sockeye Salmon in the Lake Washington Basin.

A 10-year Chinook Salmon harvest resource management plan (PSIT and WDFW 2017) is intended to provide guidance for implementing fisheries in Washington through 2029. In addition, annual pre-season planning will occur to develop a fishing regime (i.e., set exploitation rate ceilings for each management unit) that meets the guidance provided in the resource management plan.

5.2 Impacts Analysis

This subsection discusses the effects on resources assessed in Chapter 4, Environmental Consequences, when considered cumulatively with the alternatives and the past, present, and reasonably foreseeable future actions described above.

5.2.1 Water Quantity

Successful operation of hatcheries included in this EA depends primarily on a constant supply of high quality surface water that, after use in hatchery facilities, is discharged to adjacent receiving environments. Under existing conditions, the salmon hatchery programs in the Lake Washington Basin have had a negligible adverse effect on water quantity (Section 4.1, Water Quantity). The direct and indirect effects of the alternatives on water quantity would result in a negligible adverse effect under Alternative 1 (No Action), a low adverse effect under Alternative 2 (Proposed Action) and a negligible beneficial effect compared to Alternative 1 under Alternative 3 (Termination). Climate change and development are expected to affect water quantity by changing seasonality and magnitude of flows. If available water decreases to levels below those required for hatchery programs, then hatchery production would be reduced or even terminated if necessary. Although existing regulations are intended to help protect water quantity from effects related to future development, the effectiveness of these regulations

over time is likely to vary. Future habitat restoration may improve water quantity (such as helping to decrease water diversions and protect aquifers and recharge areas).

5.2.2 Water Quality

Under existing conditions, the salmon hatchery programs in the Lake Washington Basin have had a negligible adverse effect on water quality (Subsection 4.2, Water Quality). The direct and indirect effects of the alternatives on water quantity would result in a negligible adverse effect under Alternative 1 (No Action), a low adverse effect under Alternative 2 (Proposed Action) and a negligible beneficial effect compared to Alternative 1 under Alternative 3 (Termination). Climate change and development are expected to affect water quality by increasing water temperatures, and the presence of toxic chemicals and other pollutants in stormwater runoff. Although existing regulations are intended to help protect water quality from effects related to future development, the effectiveness of these regulations over time is likely to vary. Future habitat restoration would likely improve water quality (such as helping to decrease water temperatures through shading, and decreased sedimentation).

As discussed in Subsection 5.1.5, Hatchery Production, changes in hatchery programs other than those considered under the alternatives may occur over time. Water quality would be protected from changes in production within the existing programs, or from new programs, by compliance with NPDES permits where applicable. Salmon and steelhead fisheries would not be expected to affect water quality because fishing activities, other than the potential for unintentional and generally minor oil and gas leakage from motor boat use, do not result in the release of any contaminants into the aquatic environment.

Overall, climate change, development, and hatchery production are likely to impair water quality more than is described in Subsection 4.2, Water Quality. These effects may be offset to some extent by habitat restoration; however, these habitat actions may not fully, or even partially, mitigate for the impacts of climate change and development on water quality. When combined with effects under Alternative 3, the negative trends of cumulative effects on water quality would be reduced because of the termination of hatchery salmon production in the Lake Washington Basin. Effects under Alternative 1 and Alternative 2 would continue to contribute to the adverse trends on water quality due to the production of hatchery-origin salmon. Nevertheless, the overall negative trends in water quality resulting from the cumulative effects of climate change, development, habitat restoration, hatchery production, and fisheries would be similar under all alternatives because increased stream temperatures caused by climate change and development, and degraded water quality caused by development would occur regardless of alternative and would outweigh any adverse effects on water quality caused by hatchery operations.

5.2.3 Salmon and Steelhead

As described in Subsection 4.3.1, Salmon and Steelhead, depending on the species affected, the hatchery programs under Alternative 1 (No Action) would have negligible to moderate adverse effects on natural-origin salmon and steelhead due to genetics, competition and predation, disease transfer risks, facility operations, and RM&E. Alternative 2 (Proposed Action) would have negligible adverse to moderate adverse effects on these resources. Effects on prey enhancement, population viability, and nutrient enhancement would be negligible beneficial to low beneficial under Alternative 1 and low beneficial under Alternative 2. Under Alternative 3 (Termination), all positive and negative effects would be eliminated compared to Alternative 1, which may place Chinook Salmon populations at a higher risk of decline in population viability.

Salmon and steelhead abundance naturally alternate 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). Current run sizes of salmon and steelhead are much lower than historical

run sizes in Puget Sound (Lackey et. al. 2006). Thus, cumulative effects on salmon and steelhead may be greater than the direct and indirect effects of each alternative as analyzed in Subsection 4.3.1, Salmon and Steelhead.

Climate change and development may reduce fish habitat and result in increased competition and predation compared to that described Subsection 4.3.1, Salmon and Steelhead. Issaquah Creek and the Cedar River flow through highly urbanized areas, and this is unlikely to change in the future. Continuing development results in environmental effects such as reduced forested area, sedimentation, impervious surface water runoff to streams, changes in stream flow because of increased consumptive uses, shoreline armoring, barriers to fish passage, and other types of changes that would continue to affect hatchery-origin and natural-origin salmon and steelhead (Quinn 2010). Consequently, development may continue to contribute to habitat degradation in the Lake Washington. Although habitat may be improved through restoration efforts, climate change and development may result in short- and long-term losses of habitat quality and quantity. Reductions in habitat may increase competition and predation risks within and among salmon and steelhead. In contrast, improved habitat conditions and increased food sources for salmon and steelhead (from habitat restoration), may ameliorate competition and predation risks, particularly in the context of other environmental threats that may impede salmon and steelhead recovery.

Climate change and development have the potential to exacerbate genetic risks to salmon and steelhead. For example, small salmon and steelhead population sizes can be further reduced to critical levels by the effects of climate change and development, posing genetic risks to within-population diversity. Furthermore, climate change and development may result in habitat changes that affect the way groups of fish are adapted to be genetically similar or different from each other. These habitat changes may include the extent to which water of suitable volume and temperature exists for adult salmon and steelhead to reach spawning areas. They may also affect patterns of straying in natural-origin and hatchery-origin fish, which may affect genetic diversity that prevents fish from being able to adapt to changing environmental conditions, and thus persist over time.

Climate change and development in the cumulative effects Study Area may reduce the abundance and productivity of natural-origin salmon and steelhead because of mechanisms such as:

- Increased mortality of salmon and steelhead because of more frequent and seasonally different flood flows, changed thermal regime during incubation, and lower disease resistance,
- Higher metabolic demands on fish because of warmer winter temperatures, which may also contribute to lower survival in winter if food is limiting, and
- Increased predator activity because of warmer winter temperatures, which can also contribute to lower winter survival.

Similarly, climate change and development may also impact the spatial structure and diversity of natural origin salmon and steelhead compared to direct and indirect conditions described in Subsection 4.3.1, Salmon and Steelhead. It is anticipated that cumulative adverse effects of climate change and development on overall viability of natural origin salmon and steelhead species in terms of individual abundance, productivity, spatial structure, and diversity parameters would occur over the next 15 years and beyond.

After spawning naturally, salmon and steelhead carcasses decompose in streams and thus return nutrients from the ocean to freshwater habitat. Hatchery-origin carcasses resulting from hatchery operations are also placed in streams to increase marine-derived nutrients in aquatic habitat. To the extent fewer natural-origin adult salmon and steelhead spawn in the future because of climate change and development, the relative importance of marine-derived nutrient contributions from hatchery-origin fish may be greater than described in Subsection 4.3.1, Salmon and Steelhead. Increased natural

production of salmon and steelhead from habitat restoration actions may mitigate for these potential cumulative effects, but it is unlikely that habitat restoration could fully mitigate for the combined negative effects of climate change and development in the cumulative effects Study Area.

Under all alternatives, effects on salmon from climate change and development are expected to be similar, because development would impact fish habitat and life history stages under each alternative in the same manner. Salmon hatchery production levels would not change the effects of climate change and development on aquatic habitat conditions (e.g., changes in sedimentation and stormwater runoff from impervious surfaces); however, the effects of Alternative 1 and Alternative 2, may partially offset some climate change and development effects on salmon populations compared to Alternative 3, which would terminate all the salmon hatchery programs in the Lake Washington Basin. For example, salmon reared in a hatchery would not be exposed to mortality resulting from more frequent peak flows that are projected to occur with climate change, or from increased sedimentation that is projected to occur with development.

Habitat restoration efforts described in Subsection 5.1.4, Habitat Restoration, are anticipated to occur in the cumulative effects analysis area in the future, and although difficult to quantify, potential benefits are expected to occur in localized areas. Benefits from habitat restoration are expected to affect salmon and steelhead survival and abundance similarly under all alternatives. Examples of such benefits may include increased habitat quality for foraging and spawning, improved water quality for fish survival, and increased fish passage through culverts to previously blocked habitat. However, these actions may not fully mitigate for the impacts of climate change and development on fish and their associated habitats. In part, this is because climate change and development will likely continue to occur over time and affect aquatic habitat, while habitat restoration is less certain under all alternatives due to its dependence on funding. Benefits from habitat restoration are expected to affect salmon and steelhead survival and abundance similarly under all alternatives.

The negative effects on natural-origin salmon and steelhead from future salmon and steelhead hatchery releases in Puget Sound are expected to decrease over time, especially for listed species, as hatchery programs are reviewed and approved under the ESA (Subsection 5.1.5, Hatchery Production). For example, reduction of genetic risks may occur through application of new research results that lead to improved BMPs, increased use of integrated hatchery programs, and reductions in production levels, where appropriate. Over time, changes like these would also be expected to reduce the ecological risks of competition and predation because BMPs would increase the efficiency of hatchery operations, and reduced production would decrease the potential for encounters between hatchery-and natural-origin fish in migration, rearing, and spawning areas. However, in general, continued hatchery releases within the cumulative effects analysis area would adversely affect continued long-term viability of natural-origin salmon and steelhead.

Risks posed by hatchery facilities and operations include genetic, survival, disease, straying, competition, predation, water quality and quantity, and barrier risks. These risks are based on hatchery facility design, operation, and maintenance. In the long term, some local climate change effects from hatchery facilities and their operation may occur to salmon and steelhead (e.g., flood damage to hatchery infrastructure and operations [e.g., roads], disruption of water flow resulting in difficulty in attracting broodstock, and increased flow-related siltation that could smother egg incubation trays. However, these effects would be localized and temporary and would not likely affect salmon and steelhead in the short term or over the entire cumulative effects Study Area.

As described in Subsection 5.1.5, Fisheries, management of Washington State's fisheries resources is expected to continue into the indefinite future and would change over time, based on pre-season forecasts of fisheries returns, such that harvest meets resource conservation needs, meets sustainable

fisheries goals, and assures all parties are afforded their allotted harvest opportunity. WDFW and Puget Sound treaty Tribes conduct pre-season planning each year for salmon and steelhead fisheries in Puget Sound and its tributaries, and all available information is considered. Adverse effects of fisheries on ESA-listed natural-origin salmon and steelhead are expected to decrease over time to the extent that fisheries management programs continue to be revised by WDFW and Puget Sound treaty Tribes and reviewed and approved by NMFS. 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. Effects on salmon and steelhead from fisheries are expected to be similar for each alternative, because management and planning would take different release numbers and expected adult returns into account.

In summary, effects from climate change and development would likely continue to degrade aquatic habitat over time, and abundance and productivity of natural-origin salmon and steelhead populations may be reduced relative to existing conditions considered in Section 4.3.1, Salmon and Steelhead. Hatchery-origin salmon and steelhead may be similarly affected. Habitat restoration and associated (mostly localized) benefits to salmon and steelhead would be expected to continue but may not fully mitigate for all habitat degradation. In addition, effects on abundance and productivity of ESA-listed natural-origin salmon and steelhead from changes in hatchery production and fisheries would be expected to continue but may decrease over time. Under all alternatives, the negative trend in cumulative adverse effects on salmon and steelhead would not be substantially affected. Alternative 3 would add to the negative trend of cumulative effects on salmon due to the loss of hatchery-origin salmon from the Lake Washington Basin and the higher risk of declines in the viability of the natural-origin Chinook populations. In contrast, Alternative 1 and Alternative 2 would partially offset the negative trend of cumulative effects on salmon and steelhead due to the availability of salmon from the hatchery programs in the Lake Washington Basin.

5.2.4 Other Fish Species

As described in Subsection 4.3.2, Other Fish Species, the hatchery programs under Alternative 1 (No Action) would have negligible adverse effects on other fish species due to competition and predation, disease transfer risks, facility operations, and RM&E. Alternative 2 (Proposed Action) would have negligible adverse to low adverse effects on these resources. Effects on prey enhancement and nutrient cycling would be negligible beneficial under Alternative 1 and low beneficial under Alternative 2. Under Alternative 3 (Termination), all positive and negative effects would be eliminated compared to Alternative 1.

Effects from climate change, development, and fisheries would likely result in negative trends for other fish species, whereas habitat restoration and hatchery production in Puget Sound would partially offset this trend. As discussed in Subsection 5.1.4, Habitat Restoration, the extent to which habitat restoration actions may mitigate impacts from climate change and development is difficult to predict. These actions may not fully mitigate for the effects of climate change and development. Changes in overall hatchery programs within Puget Sound over time may also affect other fish species. For example, reductions in hatchery production or terminations of hatchery programs may decrease the prey base available for piscivorous fish species, whereas increases in production may increase the prey base, but could also increase the effects of competition with and predation on other salmonids such as Cutthroat Trout.

On balance, Alternative 3 would not provide any offset to the negative trend of cumulative effects on other fish species due to the termination of hatchery-origin salmon from the Lake Washington Basin. Alternative 3 would also reduce the potential prey base for piscivorous fish species. In contrast, Alternative 1 and Alternative 2 may partially offset the negative trend of cumulative effects due to the availability of hatchery-origin salmon as prey.

5.2.5 Wildlife

As described in Section 4.5, Wildlife, the hatchery programs under Alternative 1 (No Action) would have negligible to low adverse effects on wildlife due to contaminants and facility operations. Alternative 2 (Proposed Action) would have negligible to moderate effects on these resources. Effects on prey enhancement and nutrient cycling would be negligible beneficial to low beneficial under Alternative 1 and low beneficial to moderate beneficial under Alternative 2. Under Alternative 3 (Termination), all positive and negative effects would be eliminated compared to Alternative 1. Effect determinations are focused primarily on killer whales because Chinook Salmon are a high-priority component of the prey base for Southern Resident killer whales.

Because climate change and development in the cumulative effects Study Area may reduce the abundance and productivity of salmon and steelhead populations, the total number of salmon and steelhead available as prey to wildlife may be lower than that considered in Subsection 4.5, Wildlife. The potential benefits of habitat restoration actions within the cumulative effects analysis area may not fully, or even partially, mitigate for the effects of climate change and development on salmon and steelhead abundance. Reduced abundance of salmon and steelhead would also decrease the number of carcasses available to wildlife for scavenging. Effects would be most detrimental to wildlife species that have a strong relationship with salmon and steelhead, including Southern Resident killer whales Cumulative effects to these species may include changes in distribution in response to changes in the distribution of their food supply, decreases in abundance, and decreases in reproductive success compared to that described in Subsection 4.5, Wildlife.

As discussed in Subsection 5.1.5, Hatchery Production, and Subsection 5.1.6, Fisheries, changes in hatchery programs and fisheries may occur over time. For example, reductions in hatchery production or terminations of hatchery programs in Puget Sound would contribute to the decrease in the prey base available for Southern Resident killer whales, whereas increases in hatchery production of Chinook Salmon could help increase Southern Resident killer whales' prey base, depending on smolt to adult survival rates (changes in survival rates could affect adult returns as much as changes in production). Fisheries may affect the extent that Southern Resident killer whales have access to salmon and steelhead as prey. Consequently, the trend in cumulative effects on the total number of salmon and steelhead available as prey to Southern Resident killer whale may increase or decrease from existing conditions.

Effects from climate change, development, habitat restoration, hatchery production, and fisheries would likely affect Southern Resident killer whales. The overall trend in cumulative effects on Southern Resident killer whales has been negative, as reflected in their declining abundance. If smolt to adult survival rates are maintained or increased, then contributions of the alternatives to overall cumulative effects on Southern Resident killer whales would be meaningful because hatchery-produced Chinook Salmon are a high-priority component of the diet. Alternative 3 would contribute to the negative trend of cumulative effects on Southern Resident killer whales due to the loss of hatchery-origin Chinook Salmon from the Lake Washington Basin and the higher risk of declines in the viability of the natural-origin population. In contrast, Alternative 1 and Alternative 2 could partially offset the negative trend of cumulative effects on Southern Resident killer whale due to the availability of hatchery-origin Chinook Salmon from the Lake Washington Basin hatchery programs.

5.2.6 Marine and Freshwater Habitat

As described in Section 4.5, Marine and Freshwater Habitat, depending on the species affected, the hatchery programs under Alternative 1 (No Action) would have low adverse to low beneficial effects on critical and essential habitat due primarily to hatchery operations and associated structures (adverse),

and increased prey availability (beneficial). Alternative 2 (Proposed Action) would have a similar range of effects on these resources. Under Alternative 3 (Termination), all positive and negative effects would be eliminated compared to Alternative 1.

Climate change and development may make it more difficult to protect the physical components of critical and essential habitat. Habitat restoration actions may not fully mitigate for these cumulative effects. Thus, cumulative effects on salmon and steelhead may be greater than the direct and indirect effects of each alternative as analyzed in Section 4.5, Marine and Freshwater Habitat.

Under all alternatives, effects on marine and freshwater habitat from climate change and development are expected to be similar, because development would impact habitat under each alternative in the same manner. Salmon hatchery production levels would not change the effects of climate change and development on aquatic habitat conditions; however, the effects of Alternative 1 and Alternative 2 may partially offset some climate change and development effects on critical habitat through increased prey availability for some species

Habitat restoration efforts described in Subsection 5.1.4, Habitat Restoration, are anticipated to occur in the cumulative effects analysis area in the future, and although difficult to quantify, potential benefits are expected to occur in localized areas. Benefits from habitat restoration are expected to affect freshwater habitat similarly under all alternatives. However, these actions may not fully mitigate for the impacts of climate change and development. Benefits from habitat restoration are expected to affect salmon and steelhead survival and abundance similarly under all alternatives.

In summary, effects from climate change and development would likely continue to degrade aquatic habitat over time, and condition of marine and fresh water habitat may be reduced relative to existing conditions considered in Section 4.5, Marine and Freshwater Habitat. Habitat restoration would be expected to continue but may not fully mitigate for all habitat degradation. Under all alternatives, the negative trend in cumulative adverse effects on habitat would not be substantially affected. Alternative 3 would add to the negative trend of cumulative effects on due to the loss of hatchery-origin prey for some species. In contrast, Alternative 1 and Alternative 2 would partially offset the negative trend of cumulative effects on critical habitat due to the availability of hatchery-origin prey.

5.2.7 Socioeconomics

Under existing conditions, the salmon hatchery programs in the Lake Washington Basin have had a moderate beneficial effect on socioeconomics (Subsection 4.6, Socioeconomics). The direct and indirect effects of the alternatives on socioeconomics would result in a moderate beneficial effect under Alternative 1 (No Action), a high beneficial effect under Alternative 2 (Proposed Action) and a moderate adverse effect compared to Alternative 1 under Alternative 3 (Termination).

Climate change and development may reduce the number of salmon and steelhead available for harvest over time. Habitat restoration actions may not fully mitigate for these cumulative effects. Changes in fisheries may also occur over time, which could alter the direction and magnitude of socioeconomic effects provided by hatchery production of salmon and steelhead. Reductions in the number of salmon and steelhead available for harvest over time reduces the income earned through commercial fisheries, and the number of salmon and steelhead exported to outside economies relative to conditions considered in Section 4.7, Socioeconomics. If abundance of salmon and steelhead decreases as a result of future climate change combined with development in the cumulative effects Study Area, then the benefit of commercial fisheries may be lower than described in Section 4.6, Socioeconomics, unless prices increase as a result of reduced supply.

If fewer fish are available for harvest and more restrictions are in place (e.g., reduced bag limits and fishing seasons), fewer recreational fishermen may be willing to pay for the opportunity to fish or travel to the area to fish. As a result, cumulative effects on gross and net economic values for recreational fishermen may lead to values lower than those considered in Subsection 4.7, Socioeconomics, as well as lead to decreased economic benefits to local communities from those considered in Subsection 4.7, Socioeconomics.

Climate change and development are unlikely to affect the education and outreach opportunities provided by hatcheries in the urban setting unless the reduction in abundance of salmon reaches a point at which educational opportunities are limited. Changes in hatchery production may affect education and outreach opportunities through increased or decreased opportunities to observe returning fish.

Overall, effects from climate change and development would likely adversely affect socioeconomic resources by decreasing the number of salmon and steelhead available for harvest and reducing associated expenditures and economic values relative to existing conditions described in Section 3.7, Socioeconomics. Reductions may also occur in the number of salmon and steelhead available to tribal members for subsistence use. It is possible that reduced numbers could also reduce the opportunities for education and outreach at the urban hatcheries. Alternative 3 would not exacerbate the negative trend of cumulative effects on socioeconomics due to the termination of hatchery employment and expenditures, as well as the abundance of hatchery-origin and natural-origin salmon from the Lake Washington Basin available for future harvest. In contrast, Alternative 1 and Alternative 2 would partially offset the negative trend of cumulative effects on socioeconomics due to the availability of salmon from the hatchery programs for harvest, maintenance of or increase in the abundance of natural- origin salmon, and the contribution to hatchery employment and related expenditures.

5.2.8 Cultural Resources

As described in Section 4.7, Cultural Resources, the salmon hatchery programs in the Lake Washington Basin have had a negligible beneficial effect on cultural resources. The direct and indirect effects of the alternatives on cultural resources would remain negligible adverse under Alternative 1 (No Action) but would be moderate beneficial under Alternative 2 (Proposed Action) and high adverse under Alternative 3 (Termination).

As described in Section 5.2.7, Socioeconomics, climate change and development may reduce the number of salmon and steelhead available for harvest over time, and habitat restoration actions may not fully mitigate for these cumulative effects. Even under existing conditions, no directed tribal fisheries within have occurred in the Lake Washington Basin for Chinook Salmon since 1994, or for Sockeye Salmon since 2006. If abundance of salmon and steelhead decreases further as a result of future climate change combined with development in the cumulative effects Study Area, then the potential benefit of increased production may be lower than described in Section 4.7, Cultural Resources.

Overall, effects from climate change and development would likely adversely affect cultural resources by decreasing the number of salmon and steelhead available for harvest relative to existing conditions described in Section 3.7, Cultural Resources. Reductions may also occur in the number of salmon and steelhead available to tribal members for subsistence use. Alternative 3 would exacerbate the negative trend of cumulative effects on cultural resources due to the termination of hatchery production. In contrast, Alternative 2 could partially offset the negative trend of cumulative effects on cultural resources if increased production results in more opportunities for tribal harvest.

5.2.9 Environmental Justice

As discussed in Section 4.9, Environmental Justice, high and disproportionate adverse effects were identified for cultural resources, specifically related to the importance of salmon to Tribes, under Alternative 1 (No Action) and Alternative 3 (Termination). Such high and disproportionate adverse effects would not occur under Alternative 2 (Proposed Action) because of possibilities for increased availability of salmon to Tribes relative to existing conditions.

As described in Subsection 5.2.3, Salmon and Steelhead, and Subsection 5.2.8, Cultural Resources, the overall effects from climate change, development, habitat restoration, and fisheries would likely continue to decrease the number of salmon and steelhead available to Tribes. Distribution of surplus fish from hatchery programs is dependent on fish availability and at least indirectly affected by levels of hatchery production and harvest policies. Cumulative effects including climate change and development may lead to fewer salmon being available. A decrease in harvest may also affect further adversely affect tribal salmon fishing revenues and tribal fishing employment. Similarly, cumulative effects may lead to less harvest and less net revenue for non-tribal user groups.

When considering effects of the alternatives in addition to those from climate change, development, habitat restoration, and fisheries, the adverse cumulative effects would be high and disproportionate for cultural resources under Alternative 1 and Alternative 3 due to the lack of increase, or the loss of hatchery production. These adverse cumulative effects may not occur to the same magnitude under Alternative 2 because increased hatchery production partially offset decreases in salmon and steelhead from climate change, development, habitat restoration, and fisheries. Hatchery production under Alternative 2 would contribute to the abundance of salmon available to Tribes.

6 Agencies Consulted

U.S. Fish and Wildlife Service (USFWS)

Washington Department of Fish and Wildlife (WDFW)

Muckleshoot Indian Tribe (MIT)

Suquamish Indian Tribe

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