Draft Environmental Assessment

Impacts of NOAA's National Marine Fisheries Service Determination that 10 Hatchery Programs for Hood Canal Salmon and Steelhead, as Described in Hatchery and Genetic Management Plans, Satisfy the Endangered Species Act Section 4(d) Rule

Prepared by the
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ESU/DPS:	Puget Sound Chinook Salmon, Puget Sound Steelhead, Hood Canal Summer Chum Salmon
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Location of Proposed Activities:	Hood Canal, Washington
Activity Considered:	Endangered Species Act Section 4(d) Rule Determinations for Ten Hatchery and Genetic Management Plans

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1. PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1. Background

NOAA's National Marine Fisheries Service (NMFS) is the lead agency responsible for administering the Endangered Species Act (ESA) as it relates to listed salmon and steelhead. Actions that may affect listed species are reviewed by NMFS under section 7 or section 10 of the ESA or under section 4(d), which can be used to limit the application of take prohibitions described in section 9. NMFS issued a final rule pursuant to ESA section 4(d) (4(d) Rule), adopting regulations necessary and advisable to conserve threatened species (50 CFR 223.203). The 4(d) Rule applies the take prohibitions in section 9(a)(1) of the ESA to salmon and steelhead listed as threatened, and also sets forth specific circumstances when the prohibitions will not apply, known as 4(d) limits. NMFS declared under Limit 6 of the 4(d) Rule that section 9 take prohibitions would not apply to activities carried out under hatchery and genetic management plans (HGMPs) when NMFS determines that the HGMPs meet the requirements of Limit 6. The final decision on the hatchery plans will be made in separate ESA decision documents.

NMFS has received 10 HGMPs for hatchery programs[1] in the Hood Canal region of Puget Sound, Washington (Table 1). NMFS is choosing to evaluate the 10 HGMPs collectively because they overlap in geography and have potential effects on the same ESA-listed species, and therefore it is more efficient to bundle the reviews in this manner. Activities included in the HGMPs are:

- Broodstock collection
- Broodstock collection methods and facility operations
- Holding, identification, and spawning of adult fish
- Egg incubation and rearing
- Marking of hatchery-origin juveniles
- Juvenile releases
- Adult management
- Monitoring and evaluation to assess program performance

Table 1. HGMPs for Hood Canal salmon and steelhead hatchery programs.

Hatchery Program	Operator[1]	Program Purpose[2]	Date Submitted
Hamma Hamma Fall Chinook Supplementation	LLTK/HCSEG/ WDFW	Integrated Recovery	May 1, 2013

[1] In this document, NMFS makes a distinction between "program" – the actual set of activities carried out to achieve objectives for the given group of fish – and "HGMP" – the written plan describing the program. This distinction is useful, since the program causes the effects considered in this analysis, while the HGMP is the subject of NMFS' potential approval for compliance with the ESA.

Quilcene National Fish Hatchery Yearling Coho Salmon Production	USFWS	Segregated Harvest	July 15, 2013
Hood Canal Steelhead Supplementation	WDFW/LLTK	Integrated Recovery	November 28, 2012
Hoodsport Hatchery Fall Chinook	WDFW	Segregated Harvest	July 23, 2013
Hoodsport Hatchery Fall Chum	WDFW	Segregated Harvest	January 11, 2013
Hoodsport Hatchery Pink Salmon	WDFW	Segregated Harvest	July 15, 2013
Port Gamble Coho Net Pen	PGST	Segregated Harvest	February 28, 2013
Port Gamble Hatchery Fall Chum	PGST	Segregated Harvest	February 28, 2013
Quilcene Bay Coho Net Pen	ST	Segregated Harvest	September 18, 2013
Enetai Creek Hatchery Fall Chum	ST	Segregated Harvest	September 10, 2013

[1]LLTK = Long Live the Kings; HCSEG = Hood Canal Salmon Enhancement Group; WDFW = Washington Department of Fish and Wildlife; USFWS = United States Fish and Wildlife Service; PGST = Port Gamble S'Klallam Tribe; ST = Skokomish Tribe.

[2] The term "segregated" as used by the applicants is synonymous with the term "isolated". Both terms refer to hatchery programs designed to ensure no hatchery-origin returnees interact genetically with any natural-origin populations.

1.2. Description of the Proposed Action

Under the Proposed Action, NMFS would make a determination that the 10 submitted HGMPs meet the requirements of Limit 6 of the 4(d) Rule. These 10 HGMPs all cover programs operating in Hood Canal within the Puget Sound, Washington. One program rears listed steelhead (Hood Canal Steelhead Supplementation) and one rears listed Chinook salmon (Hamma Hamma Fall Chinook Salmon Supplementation) for integrated recovery, while the remaining eight rear non-listed Chinook, coho, fall chum, and pink salmon for segregated harvest. The Hamma Hamma Fall Chinook Salmon Supplementation Program is no longer in operation; the last collection of broodstock occurred in fall 2014 and the last juvenile release occurred in spring 2015. However, the applicants have asked NMFS to analyze the effects of this program as if it were still in operation, in case the applicants decide to resume this program in the future.

NMFS' determination would apply for as long as the programs operate consistent with their approved HGMPs or until such time that NMFS determines that environmental conditions have changed sufficiently that the analysis or the assumptions underlying the analysis are no longer valid. NMFS will then take appropriate steps described in the 4(d) Rule to ensure that any HGMP in question is altered or withdraw the limit.[2] It is this proposed determination of which NMFS is assessing the effects under the National Environmental Policy Act (NEPA).

[2] NMFS' regulations concerning the reinitiation of Endangered Species Act consultations are another mechanism that could bring about a new program review. See 50 C.F.R. 402.16.

1.3. Purpose of and Need for the Action

The purpose of the NEPA environmental assessment (EA) is to ensure that the hatchery programs as described in the 10 HGMPs comply with the requirements of the ESA, and are reviewed for potential approval under the ESA 4(d) Rule.

NMFS' need for the Proposed Action is to:

- Ensure the proposed hatchery programs comply with ESA requirements
- Meet NMFS' stewardship responsibilities toward preserving tribal treaty-reserved rights

The applicants' need for the Proposed Action is:

- Mitigate the effects of lost natural-origin fish production
- Aid in the recovery of ESA-listed Puget Sound Chinook salmon and steelhead
- Meet tribal fishery harvest allocations guaranteed through treaties, as affirmed in *U.S. v. Washington* (1974)
- Meet Pacific Salmon Treaty harvest sharing agreements with Canada
- Implement population monitoring activities in marine and fresh waters important for tracking the status of listed fish populations and the effects of the hatchery programs

1.4. Project Area

The project area is the geographic area where the Proposed Action would take place. It includes the places where fish would be spawned, incubated, reared, acclimated, or released under the proposed HGMPs (Figure 1). For this EA, our project area includes all the major rivers and creeks draining into and the marine waters of Hood Canal, along with the banks and riparian areas where facilities associated with the proposed action would occur. The effects of any additional programs (e.g. Skokomish) in the region will be assessed when those programs are ready for evaluation.

The analysis area is the geographic extent that is being evaluated for a particular resource. For some resources, the analysis area may be larger than the project area if the effects of the alternatives may occur outside the project area (e.g., Jefferson and Mason counties for the socioeconomic analysis). The analysis area for each resource is described in section 3, Affected Environment.

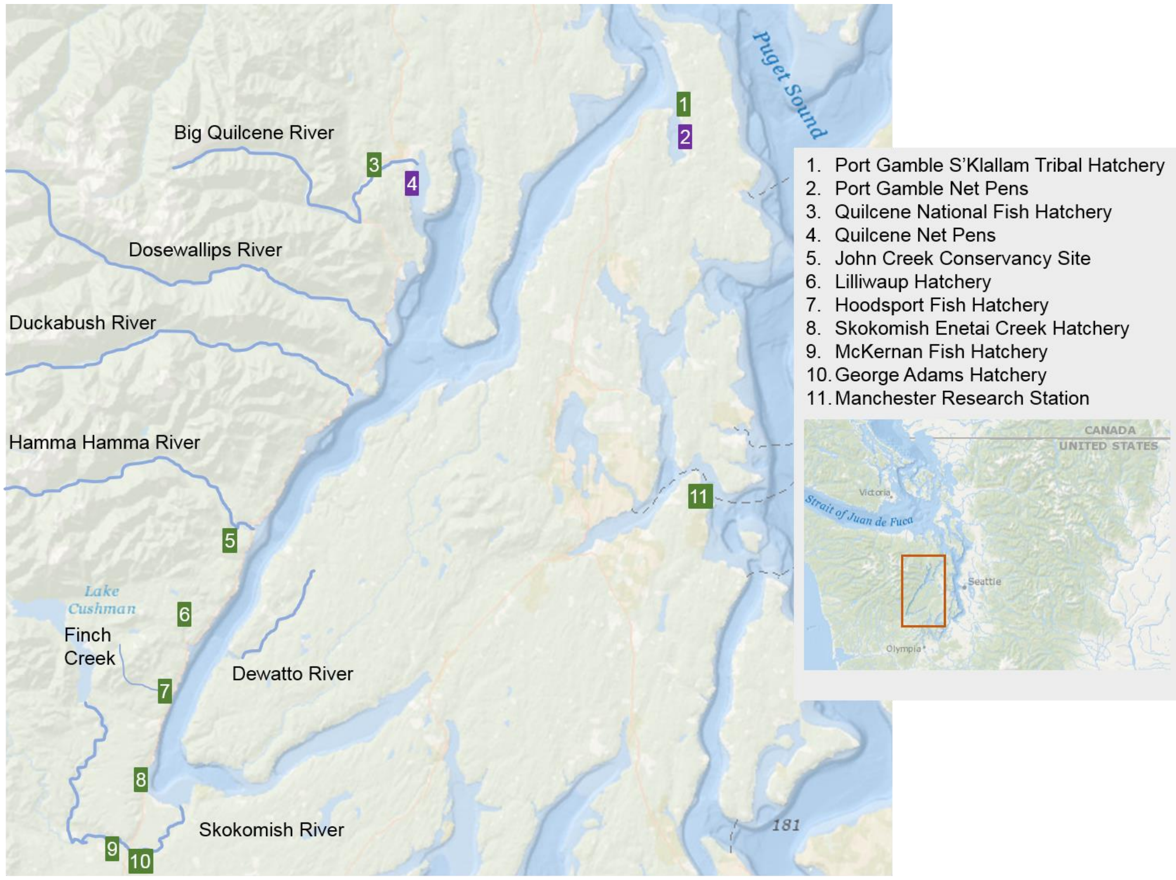

Figure 1. The Hood Canal region and associated hatchery facilities.

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

In addition to NEPA and ESA, other plans, regulations, agreements, treaties, laws, and Secretarial and Executive Orders also affect hatchery operations in the Hood Canal.

1.5.1. Clean Water Act

The Clean Water Act (33 USC 1251, 1977, as amended in 1987), administered by the U.S. Environmental Protection Agency and state water quality agencies, is the principal Federal legislation directed at protecting water quality. Each state implements and carries forth Federal provisions, as well as approves and reviews National Pollutant Discharge Elimination System applications, and establishes total maximum daily loads for rivers, lakes, and streams. The states are responsible for setting the water quality standards needed to support all beneficial uses, including protection of public health, recreational activities, aquatic life, and water supplies. The Washington State Water Pollution Control Act (Revised Code of Washington 90.48), designates the Washington Department of Ecology (Ecology) as the agency responsible for carrying out the provisions of the Federal Clean Water Act within Washington State. The agency is responsible for establishing water quality standards, making and enforcing water quality rules, and operating waste discharge permit programs. These regulations are described in Washington Administrative Code (WAC) 173. Hatchery operations are required to comply with the Clean Water Act.

1.5.2. Bald Eagle and Golden Eagle Protection Act

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

1.5.3. Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 USC 1361) as amended, establishes a national policy designated to protect and conserve all wild marine mammals and their habitats. This policy was established so as not to diminish such species or populations beyond the point at which they cease to be a significant functioning element in the ecosystem, nor to diminish such species below their optimum sustainable population. The MMPA prohibits, with certain exceptions, the take of marine mammals in United States waters and by United States citizens on the high seas, and the importation of marine mammals and marine mammal products into the United States. The term “take,” as defined by the MMPA, means to “harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.” The MMPA further defines harassment as “any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.” NMFS is responsible for reviewing Federal actions for compliance with the MMPA. Changes in salmon and steelhead production can indirectly affect marine mammals by altering the number of available prey.

1.5.4. Executive Order 12898

The objectives of Executive Order 12898 (1994), *Federal Actions to Address Environmental Justice in Minority and Low-income Populations*, include: (1) developing Federal agency implementation strategies; (2) identifying minority and low-income populations where proposed Federal actions could have disproportionately high and adverse human health and environmental effects; and (3) encouraging the participation of minority and low-income populations in the NEPA process. While there are many economic, social, and cultural elements that influence the viability and location of such populations and their communities, certainly the development, implementation, and enforcement of environmental laws, regulations, and policies can have impacts. Therefore, Federal agencies, including NMFS, must ensure fair treatment, equal protection, and meaningful involvement for minority populations and low-income populations as they develop and apply the laws under their jurisdiction. Changes in hatchery production may affect the available harvest and socioeconomic potential for minority and low-income populations.

1.5.5. Treaties of Point Elliot, Medicine Creek, and Point No Point

Beginning in the mid-1850s, the United States entered into a series of treaties with tribes in Puget Sound. The treaties were completed to secure the rights of the tribes to land and the use of natural resources in their historically inhabited areas, in exchange for the ceding of land to the United States for settlement by its citizens. These treaties secured the rights of tribes for taking fish at usual and accustomed grounds and stations in common with all citizens of the United States. Marine and freshwater areas of Puget Sound were affirmed as the *Usual and Accustomed Fishing Areas* for treaty tribes under *U.S. v. Washington* (1974). The Skokomish Tribe, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Lower Elwha Klallam Tribe are signatories to the Treaty of Point No Point, which is the lands settlement treaty between the United States government and the Native American tribes of the Strait of Juan de Fuca and Hood Canal regions (then the S'Klallam, the Chimakum, and the Skokomish tribes) in the recently-formed Washington Territory. The Treaty of Point No Point was signed on January 26, 1855, at Hahdskus – the Salish dialect name for Point No Point – on the northern tip of the Kitsap Peninsula.

1.5.6. *U.S. v. Washington*

U.S. v *Washington* (1974) is the Federal court proceeding that enforces and implements reserved treaty fishing rights with regards to salmon and steelhead returning to Puget Sound. Treaties that the Federal government signed with the tribes in the 1850s established these fishing rights and attendant access. In those treaties, the tribes agreed to allow the peaceful settlement of tribal lands in western Washington in exchange for their continued right to fish, gather shellfish, hunt, and exercise other sovereign rights. Under Phase II, the Federal District Court ensured tribes the rights to the protection of fish habitat subject to treaty catch and a right to the fish. Judge George Boldt decided that the tribes' fair and equitable share was 50 percent of all of the harvestable fish destined for the tribes' traditional fishing places. To aid in implementing the decisions of the court, the Puget Sound and Hood Canal Salmon Management Plans (1986; 1985) were created. Hatcheries in Puget Sound contribute to the salmon and steelhead fish available to fisheries in the management plans.

1.5.7. Secretarial Order 3206

Secretarial Order 3206, *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA*, issued by the secretaries of the Departments of Interior and Commerce, clarifies the responsibilities of the agencies, bureaus, and offices of the departments when actions taken under the ESA and its implementing regulations affect, or may affect, tribal lands, trust resources, or the exercise of tribal rights as they are defined in the Order (USFWS and NMFS 1997). Secretarial Order 3206 acknowledges the trust responsibility and treaty obligations of the United States toward tribes and tribal members, as well as its government-to-government relationship when corresponding with tribes. Under the Order, NMFS and the U.S. Fish and Wildlife Service (Services) "will carry out their responsibilities under the [ESA] in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the [Services], and that strives to ensure that tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation." Specifically, the Services 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

1.5.8. The Federal Trust Responsibility

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 statutes, executive orders, judicial decisions, and agreements and differentiates tribes from other entities that deal with, or are affected by the Federal government. Executive Order 13175 (2000), *Consultation and Coordination with Indian Tribal Governments*, states that the United States has recognized tribes as domestic dependent nations under its protection. The Federal government has enacted numerous statutes and promulgated numerous regulations that establish and define a trust relationship with the tribes. The relationship has been compared to one existing under common law trust, with the United States as trustee, the tribes or individuals as beneficiaries, and the property and natural resources of the United States as the trust corpus (Cohen et al. 1942). The trust responsibility has been interpreted to require Federal agencies to carry out their activities in a manner that is protective of tribal treaty rights. This policy is also reflected in the *Department of Commerce - American Indian and Alaska Native Policy* (March 30, 1995).

1.5.9. Washington State Endangered, Threatened, and Sensitive Species Act

This EA will consider the effects of hatchery programs and harvest actions on state endangered, threatened, and sensitive species. The State of Washington has species of concern listings (WDFW 2014b) that include all state endangered, threatened, sensitive, and candidate species (WAC 232-12-014 and 232-12-011). These species are managed by WDFW, as needed, to prevent them from becoming endangered, threatened, or sensitive. The criteria for listing and de-listing and the requirements for recovery and management plans for these species are provided in WAC 232-12-297. The state list is separate from the Federal ESA list; the state list includes species status relative to Washington state jurisdiction only. Critical wildlife habitats associated with state or federally listed species are also identified (WAC 222-16-080). Species listed under the state endangered, threatened, and sensitive species list are included in this EA if the Proposed Action or its alternatives may affect these species.

1.5.10. Hatchery and Fishery Reform Policy

WDFW's Hatchery and Fishery Reform Policy (C-3619) was adopted by the Washington Fish and Wildlife Commission in 2009 (WFWC) and supersedes the 1997 Wild Salmonid Policy (WDFW). Its purpose is to advance the conservation and recovery of wild salmon and steelhead by promoting and guiding the implementation of hatchery reform. The policy applies to state hatcheries and its intent is to improve hatchery effectiveness, ensure compatibility between hatchery production and salmon recovery plans and rebuilding programs, and support sustainable fisheries.

1.5.11. Tribal Policy Statement for Salmon Hatcheries in the Face of Treaty Rights at Risk

The Puget Sound Treaty Tribes' Tribal Policy Statement for Salmon Hatcheries in the Face of Treaty Rights at Risk (Grayum 2013) was submitted to NMFS and WDFW by the Tribes for the purpose of reaffirming "the role salmon and steelhead hatcheries play in implementing the treaty right to fish and in recovering salmon populations in the face of continuing loss of salmon habitat by degradation and climate change." The Policy acknowledges that State and federal governments historically developed and used hatcheries as a means of mitigating for the loss of habitat and natural production they had permitted. The Policy states that " As long as watersheds, the Salish Sea estuary, and the ocean are unable to maintain self-sustaining salmon populations in sufficient abundance, hatcheries will remain an integral and indispensable component of salmon management. Hatcheries are necessary for tribes to be able to harvest salmon in their traditional areas to carry out the promises of the treaties fully and meet the requirements of *United States vs. Washington* and *Hoh vs. Baldridge*."

1.5.12. Recovery Plans for Puget Sound Salmon and Steelhead

Federal recovery plans are in place for the ESA-listed Puget Sound Chinook Salmon (NMFS 2006; SSPS 2005) and Hood Canal Summer Chum Salmon ESUs (HCCC 2005a; NMFS 2007). In addition, a Summer Chum Conservation Initiative was developed to provide implementation guidance for the associated recovery plan (WDFW and PNPTT 2000). Broad partnerships of Federal, state, local, and tribal governments and community organizations collaborated in the development of the two recovery plans under Washington's Salmon Recovery Act. The comprehensive recovery plans include conservation goals and proposed habitat, hatchery, and harvest actions needed to achieve the conservation goals for the listed ESUs. Although listed in 2007, a recovery plan for the Puget Sound Steelhead DPS has not yet been completed.

1.5.13. Wilderness Act

The 1964 Wilderness Act directs Federal agencies to manage wilderness to preserve its wilderness character. Lands classified as wilderness through the Wilderness Act may be under the jurisdiction of the U.S. Forest Service, National Park Service, U.S. Fish and Wildlife Service, or the U.S. Bureau of Land Management. With some exceptions, the Wilderness Act prohibits motorized and mechanized vehicles, timber harvest, new grazing and mining activity, or any kind of development. In 1988, Congress designated 95 percent of the Olympic National Park as wilderness under the Wilderness Act. The Olympic Wilderness Area is under the jurisdiction of the National Park Service and a portion of Hood Canal and its tributaries is in the Wilderness Area.

1.5.14. Man and Biosphere Program

In 1976, Olympic National Park became an International Biosphere Reserve under the Man and Biosphere Program. The Man and Biosphere Program of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) was launched in 1971 to establish a scientific basis for the improvement of relationships between people and their environment. The Man and the Biosphere Program combines the natural and social sciences, economics, and education to; improve human livelihoods, ensure equitable sharing of benefits, and to safeguard natural and managed ecosystems. With this approach, UNESCO promotes innovative approaches to economic development that are socially and culturally appropriate, and environmentally sustainable (UNESCO et al. 2014a).

1.5.15. World Heritage Convention

In 1981, the Olympic National Park was designated as a World Heritage Site under the World Heritage Convention. Protection and management of World Heritage properties ensure the site's qualities are sustained or enhanced (UNESCO et al. 2012). These qualities include one of the largest temperate rainforests in the world, alpine meadows and glaciated mountain peaks. This complex ecosystem has produced areas of high diversity on the Pacific coast and its isolation has allowed the evolution of unique fur coloration in mammals, plant varieties, and trout subspecies (UNESCO et al. 2014b).

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Four alternatives are considered in this EA: (1) NMFS would not make a determination under the 4(d) Rule, (2) NMFS would make a determination that the submitted HGMPs meet the requirements of the 4(d) Rule, (3) NMFS would make a determination that the submitted HGMPs do not meet the requirements of the 4(d) Rule, and (4) the HGMPs would be revised and resubmitted with decreased production levels.

2.1. Alternative 1 (No Action) – Do Not Make a Determination under the 4(d) Rule

Under this alternative, NMFS would not make a determination under the 4(d) Rule. The applicants would continue to operate the 10 Hood Canal hatchery programs under current conditions and would not have ESA coverage. The eight segregated programs propagate Chinook, coho, fall chum, and pink salmon; the two integrated programs propagate ESA-listed Chinook salmon and steelhead. For further program details, see section 3. No new environmental protection or enhancement measures would be implemented.

Other potential outcomes might occur under this No-action Alternative. For example, the Tribes and WDFW could pursue other mechanisms for ESA coverage. However, NMFS's No-action Alternative represents NMFS's best estimate of what would happen in the absence of the proposed Federal action, which is a determination that the submitted plans meet the requirements of the 4(d) Rule.

2.2. Alternative 2 (Proposed Action/Preferred Alternative) – Make a Determination that the Submitted HGMPs Meet the Requirements of the 4(d) Rule

Under this alternative, NMFS would make a determination that the submitted HGMPs meet the requirements of the 4(d) Rule. The Hood Canal hatchery programs propagating Chinook, coho, fall chum and pink salmon and steelhead would be implemented as described in the 10 HGMPs (see section 3).

2.3. Alternative 3 − Make a Determination that the Submitted HGMPs Do Not Meet the Requirements of the 4(d) Rule

Under this alternative, NMFS would make a determination that the submitted HGMPs do not meet the requirements of the 4(d) Rule, and the Hood Canal hatchery programs would be terminated immediately. All salmon and steelhead currently being raised in hatchery facilities (i.e., Chinook, coho, fall chum, and pink salmon and steelhead) would be released or killed, and no broodstock would be collected.

NMFS does not expect this alternative to meet the applicants' purpose and need for action because substantial progress toward Chinook salmon and steelhead recovery in Hood Canal is unlikely under this alternative. Additionally, this alternative would not fulfill treaty-reserved fishing rights or provide fishing opportunities for citizens of Washington State. However, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios, including those that do not achieve all of the applicants' specific objectives.

2.4. Alternative 4 – The HGMPs would be Revised and Resubmitted with Decreased Production Levels

Under this alternative, NMFS would make a determination that the HGMPs, revised to reflect reduced production levels, meet the requirements of the 4(d) Rule. For analyses in this EA, production levels are reduced for 4 of the 10 programs where hatchery escapement substantially exceeds the broodstock collection goal stated in the HGMPs (Table 5 in section 3, Affected Environment). The objective of this scenario is to illustrate the likely effects of reducing the number of adults returning to the hatchery (after harvest) such that the broodstock goal is not substantially exceeded. Because broodstock goals are substantially exceeded for only the coho and pink salmon programs, these would be reduced by 25 and 78 percent, respectively (Table 2, Table 3). The reduction would occur by culling eggs, with an equal amount culled from each female to help prevent any decrease in genetic diversity. Reducing production to ensure broodstock goals are not substantially exceeded would likely reduce effects of hatchery fish on natural-origin fish.

Table 2. Comparison of pink salmon production under the four alternatives.

Alternative	Juvenile Release Numbers	Percent Survival[1]	Harvest	Hatchery Escapement	Broodstock
1	500,000	3.37	2689	14,884	920
2	500,000	3.37	2689	14,884	920
3	0	0	0	0	0
4[2]	110,000	3.37	2689	1,018	920

Source: (WDFW 2013b), also in Table 5

[1]Estimated by dividing the total adult run size by the total numbers of juveniles released for the same brood year.

[2]110, 000* 0.0337 = harvest + hatchery escapement. Harvest is subtracted to yield hatchery escapement. Reduction in release numbers is accomplished by culling eggs, rather than reducing broodstock collection, to maintain genetic diversity (see text).

Table 3. Comparison of coho salmon production under the four alternatives.

Alternative	Juvenile Release Numbers	Percent Survival[1]	Harvest[1]	Hatchery Escapement[1]	Broodstock
1	1 million	3.4	23,322	9,940	1,500
2	1 million	3.4	23,322	9,940	1,500
3	0	0	0	0	0
4[2]	750,000	3.4	23,322	2,178	1,500

Source: (Port Gamble S'Klallam Tribe 2013a; Skokomish Tribe 2013a; USFWS 2015), also in Table 5

[1]Mean weighted smolt to adult survival rate, mean harvest, and mean hatchery escapement were summed from the three coho HGMPs.

[2]750,000 * 0.034 = harvest + hatchery escapement. Harvest is subtracted to yield hatchery escapement. Reduction in release numbers is accomplished by culling eggs, rather than reducing broodstock collection, to maintain genetic diversity (see text).

2.5. Alternatives Considered but not Analyzed in Detail

2.5.1. Hatchery Programs for Listed Species Only

Under this alternative, NMFS would not make a determination that the proposed hatchery programs for non-listed species (fall chum, coho, and pink salmon and Hoodsport Chinook salmon) meet the requirements of the 4(d) Rule. For the purpose of this analysis, NMFS would treat this alternative as resulting in hatchery production of only Puget Sound Chinook salmon (Hamma Hamma program only) and Puget Sound steelhead as proposed in the HGMPs for those species. The eight HGMPs for the other species – fall Chinook, fall chum, coho, and pink salmon – would not be implemented, and the programs would be terminated. This alternative will not be analyzed in detail because the analysis of Alternative 1 and Alternative 2 will disclose the environmental effects of operating the hatchery programs for each of the species, and the analysis of Alternative 3 will disclose the environmental effects of terminating the hatchery programs.

2.5.2. Approve Proposed Hatchery Programs under Section 10 of the ESA

Under this alternative, NMFS would determine that the 10 hatchery programs as described in the HGMPs meet the requirements for either section 10(a)(1)(A) permits (for listed Chinook salmon and steelhead programs) or section 10(a)(1)(B) permits (for non-listed Chinook, coho, pink, and fall chum salmon programs). Under this alternative, the only change from the Proposed Action would be a difference in which process mechanism would be used to address ESA compliance for these hatchery programs. Consequently, this alternative would not be meaningfully different from the Proposed Action and will not be analyzed in detail.

2.5.3. Hatchery Programs with Increased Production Levels

Under this alternative, NMFS would make a determination that revised HGMPs with increased production levels meet the requirements of the 4(d) Rule. This alternative will not be analyzed in detail because substantially higher production levels may exceed hatchery facility fish rearing density limits. Thus, this alternative would not be expected to meet the applicant's purpose and need for action, because the proposed hatchery programs would release more than the number of juvenile salmon of each species identified by the tribal and State resource manager applicants, resulting in greater negative impacts.

2.5.4. Hatchery Programs with Decreased Production Levels

NMFS is considering a version of this alternative for analysis (see subsection 2.4, Alternative 4 – The HGMPs would be Revised and Resubmitted with Decreased Production Levels), but three other scenarios exist for reducing production levels:

- Escapement to the hatchery could be reduced by increasing harvest. However, this is likely not possible without also increasing impacts on incidentally-encountered listed fish, which would necessitate further discussion on the fisheries management regime and may require a new ESA consultation.
- A reduction in returning adults could also be achieved by rearing juvenile fish until near release stage, then destroying excess juveniles. However, the costs of rearing excess fish (e.g., feed, pathogen treatment) only for them to be destroyed before they can contribute to harvest is not economically practical for the applicants. In addition, the selection of juveniles for destruction would have to consider the preservation of the current genetic and phenotypic diversity of the hatchery fish.
- The number of adults collected could be decreased, but collecting fewer adults limits the available pool of fish from which to randomly choose broodstock. Over time, this may decrease genetic diversity and limit the effective population size, which is not an issue for the segregated programs.

In sum, there are numerous ways to devise a reduced production alternative, but there is more utility in NMFS choosing one version which is most likely to meet the purpose and need and analysis of which is likely to yield the most useful information. Alternative 4 represents that selection here.

3. AFFECTED ENVIRONMENT

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

- Water quantity—subsection 3.1
- Water quality—subsection 3.2
- Salmon and steelhead—subsection 3.3
- Other fish—subsection 3.4
- Wildlife—subsection 3.5
- Socioeconomics—subsection 3.6
- Cultural Resources—subsection 3.7
- Environmental Justice—subsection 3.8
- Human Health and Safety—subsection 3.9

Internal scoping identified no other resources that would potentially be impacted by the Proposed Action or alternatives. Current conditions include the operation of hatchery programs nearly identical to those described in the 10 HGMPs, because the HGMPs were largely developed through refinement of on-going programs. Production and operation details are included in Tables

Table 4Table 5. Each resource’s analysis area includes the project area as a minimum area, but may include locations beyond the project area if some of the effects of the EA’s alternatives on that resource would be expected to occur outside the immediate area of the proposed activities (subsection 1.4, Project Area).

Table 4. Integrated recovery program details under current conditions.

Program	Facility	Start Date	Broodstock Numbers	Broodstock Collection Method	Target Juvenile Release	Release River	Adult Release	Mark Percentage	Mean Adult Escapement
Hamma Hamma Fall Chinook	Johns Creek Conservancy Site; George Adams Hatchery	1995	30 pairs	Hook and line; Seine	95,000	Hamma Hamma	NA[1]	100	175 (2000-12)
Hood Canal Steelhead	Manchester Research Station; Lilliwaup, McKernan, and Quilcene Hatcheries	2007	62,802 eggs from redds	Hydraulic Suction	48,567 yearlings and 2-year olds	Dewatto, Duckabush, Skokomish	400-883	100	ID[1]

Sources: (Long Live the Kings et al. 2013; WDFW and LLTK 2012)

[1]NA = not applicable; ID = insufficient data

Table 5. Isolated harvest program details under current conditions. The value after the mean is the standard deviation, a measure that quantifies the amount of variability in the data set.

Species	Program	Start Date	Broodstock Numbers	Broodstock Collection Method	Mark Percentage	Target Juvenile Release	Release Location	Mean Adult Escapement	Mean Adults Harvested
Coho	Quilcene National Fish Hatchery Yearling Coho Salmon	1912	1500	Permanent Weir	100	400,000 yearlings	Big Quilcene River	8,251 ± 4,686 (1989-2008)	8,609 ± 5,654
	Port Gamble Coho Net Pen	1979	NA[1]	NA	100	400,000 yearlings	Port Gamble Bay	256 ± 47 (2000-10)	6,482 ± 3,545
	Quilcene Bay Coho Net Pen	1986	NA	NA	100	200,000 yearlings	Quilcene Bay	1,433 ± 1,518 (1988-2011)	8,231 ± 5,182

Fall Chinook-not in ESU	Hoodsport Hatchery Fall Chinook[2]	1953	2500	Removable Weir	100	3 million subyearlings; 120,000 yearlings	Finch Creek/Hood Canal Confluence	3,759 ± 1,153 (2001-13)	17,136 ± 9,624
Pink	Hoodsport Hatchery Pink Salmon[3]	1954	920	Removable Weir	0	500,000 fed fry	Finch Creek/Hood Canal Confluence	14,884 ± 9,369 (2007-11)	2,689 ± 2,407
Fall Chum	Hoodsport Hatchery Fall Chum[4]	1954	9000	Removable Weir	0	12 million fed fry	Finch Creek/Hood Canal Confluence	10,873 ± 7,207 (2008-11)	150,196 ± 89,486
	Port Gamble Hatchery Fall Chum	1976	1300	Weir	0	950,000 fed fry	Little Boston Creek	2,977 ± 2,210 (2000-10)	3,065 ± 3,065
	Skokomish Enetai Creek Hatchery Fall Chum	1976	3000	Weir	0	3.2 million fed fry	Enetai Creek	5,720 ± 4,073 (1988-2011)	17,238 ± 11,792

Sources: (Port Gamble S'Klallam Tribe 2013a; Port Gamble S'Klallam Tribe 2013b; Skokomish Tribe 2013a; Skokomish Tribe 2013b; USFWS 2015; WDFW 2013a; WDFW 2013b; WDFW 2014a; WDFW 2015b)

[1] NA = not applicable.

[2] Yearling Chinook salmon hatchery releases were reduced from 250,000 to 120,000 in 2006.

[3] Juvenile pink salmon release was reduced from 7 million to 1 million in 2000 and from 1 million to 500,000 fry in 2006; only data from 2007-2011 were used to estimate adult returns and harvest.

[4] 6.6 million fall chum fry originate from Hoodsport broodstock and are raised at Hoodsport Hatchery. The remaining 5.4 million fry are transferred from McKernan Hatchery to Hoodsport Hatchery a few months prior to their release. Annual juvenile releases were reduced from 15 to 12 million in 2005; only data from 2008-2011 were used to estimate adult returns and harvest

3.1. Water Quantity

The west side of Hood Canal includes the Big Quilcene, Hamma Hamma, Duckabush, and Dosewallips watersheds. In the Big Quilcene River, the City of Port Townsend operates a water diversion structure at river mile (RM) 9 and has rights to 30 cubic feet per second (cfs). The diverted water is used for the City's municipal needs and to supply water to the Port Townsend Paper Company (HCCC 2005a). In 2009, as a condition of a Special Use Permit (SUP), the US Forest Service, in consultation with National Marine Fisheries Service, conditioned the SUP with a requirement to maintain 27 cfs water flow below the Port Townsend water diversion if naturally available. The upper portions of the Hamma Hamma, Duckabush and Dosewallips watersheds are protected in National park or designated wilderness (34, 80 and 60 percent, respectively). In the Hamma Hamma River, 60 percent of the land is managed public forestland. The remaining land is private and is located in the lower portions of the watershed. Most of the floodplain area along the lower 1.5 miles is for agricultural and residential uses (WDFW and PNPTT 2000). In the Duckabush River, from RM 11.5 downstream, land use is predominantly managed for timber harvest, with some rural residential and urban commercial development in the lower 1.5 miles (Correa 2003). In the lower reaches of the Dosewallips River, pastureland, residential development, and clear-cut logging dominate land use. Dosewallips State Park occupies land on the south side of the river near the mouth, and the town of Brinnon is located to the north, within the floodplain delta area (WDFW and PNPTT 2000).

On the east side of Hood Canal, there has been a significant shift in the natural hydrologic regime of many watersheds, especially those undergoing urbanization. This is characterized by increases in peak flow frequency, duration, and magnitude due to increased stormwater runoff from lands that have been converted from native forest and wetlands to developed landscapes with impervious surfaces (HCCC 2005a).

The southern portion of Hood Canal is comprised of the Union and Skokomish Rivers. The dominant land use in the upper portions of the Union River, and its tributaries, is residential development, small farms, industrial forestry, and water storage/diversion. The town of Belfair is located directly east of the river mouth and subestuary. Three County owned bridge crossings, and several privately owned bridges prevent the river from migrating throughout its floodplain (WDFW and PNPTT 2000).

Two major features in the Skokomish system are Lakes Cushman and Kokanee. The area above Lake Cushman is mostly protected within the Olympic National Park. Below the reservoirs, land use is predominately forestry, with some residential and agriculture uses near the confluence with the South Fork (WDFW and PNPTT 2000). Since April 1999, Tacoma Power has released about 60 cfs downstream, allowing salmon and trout access to habitat in the lower North Fork

Skokomish River (NMFS 2004). Most of the drainage area in the South Fork and mainstem Skokomish River are in the Olympic National Forest, with private forestlands, agriculture, and residential uses in the lower watershed and along the mainstem. Stream flows are highly variable ranging from a low of 61 to a high of 8,110 cfs over the past year (August 2014-2015; South Fork Skokomish USGS gage 12060500). In addition, due to the filling of levees with sediment from logging operations, multiple, damaging floods occur almost annually in the Skokomish River lowlands (WDFW and PNPTT 2000).

Hatchery programs can affect water quantity when they take water from a well (groundwater) or a neighboring tributary streams (surface water) to use in the hatchery facility. All water use is non-consumptive because, with the exception of small amounts lost through leakage or evaporation, water that is diverted from a river or taken from a well is discharged to the adjacent river or bay from which the water was appropriated after it circulates through the hatchery facility. When hatchery programs use groundwater, they may reduce the amount of water for other users in the same aquifer. When hatchery programs use surface water, they may lead to dewatering of the stream between the water intake and discharge structures. Dewatering may impact fish and wildlife if migration is impeded or lead to increased water temperatures. Generally, water intake and discharge structures are located as close together as possible to minimize the area of the stream that may be impacted by a water withdrawal.

In addition, surface water withdrawal for the hatchery program fluctuates seasonally, with the highest hatchery water withdrawal occurring in the spring months when seasonal flow levels are highest, and fish under propagation are at their largest size and need high rearing flows for fish health maintenance. Hatchery water withdrawal for fish rearing is lowest in the late summer months when river flows are at their lowest level.

Table 6. Water source and permitted maximum use by hatchery facility.

Facility	Surface Water (cfs)	Ground-water (cfs)	% Used for Hood Canal Programs	Surface Water Source	Average (min-max) % of Surface Water Diverted for Programs[2]	Estimated Max. Distance between hatchery intake and discharge (ft)
Quilcene National Fish Hatchery	65.2	0.8	100	Big Quilcene River; Penny Creek; Durdel Creek	Unknown (17-44)	1320
Port Gamble net pens	NA[1]	NA	NA	Port Gamble Bay	NA	NA
Quilcene net pens	NA	NA	NA	Quilcene Bay	NA	NA
Hoodsport Hatchery	18.9 fresh 3.6 salt	0.7	100	Finch Creek and Puget Sound	49 (16-100) NA	1600
Enetai Creek Hatchery	2.7	NA	100	Enetai Creek	Unknown (29-80)	500
Port Gamble Hatchery	1	NA	100	Little Boston Creek	Unknown (0-100)	450
Johns Creek Conservancy Site	1	NA	100	John Creek	100	20
McKernan Hatchery[3]	12.0	6.4	100	Weaver Creek	51 (0-93)	380
George Adams Hatchery[3]	23.8	6.4	100	Purdy Creek and Ellis Spring	60 (27-100)	1550
Lilliwaup Hatchery	2.2	NA	100	Beardsley and unnamed Creek	60-75	300
Manchester Research Station	0.6	0.1	100	Puget Sound	NA	NA

Sources: (Port Gamble S'Klallam Tribe 2013a; Port Gamble S'Klallam Tribe 2013b; Skokomish Tribe 2013a; Skokomish Tribe 2013b; USFWS 2015; WDFW 2013a; WDFW 2013b; WDFW 2014a)

[1] NA = not applicable; saltwater

[2] Hatchery water withdrawal proportions of total flows during low flow periods are worst-case estimates that are unlikely to be realized.

[3] Although the main programs associated with these facilities are not yet ready for evaluation, these facilities are included because they are used for rearing juveniles associated with programs included in this EA.

A water right permit is required for all groundwater withdrawal within Washington except those supporting single-family homes. All hatchery facilities have current water rights and all wells used by hatchery facilities supporting the Hood Canal hatchery programs are permitted by Ecology. Critical Groundwater Areas designed to protect aquifers with potentially insufficient supplies are not designated in Washington State.

3.2. Water Quality

As part of administering elements of the Clean Water Act, Ecology is required to assess water quality in all rivers, lakes, and marine waters within the state. These assessments are published in what are referred to as the 305(d) report and the 303(d) list (the numbers referring to the relevant sections of the original Clean Water Act text). The 305(d) report reviews the quality of all waters of the state. The 303(d) list identifies specific water bodies considered impaired, based on the number of exceedances of water quality criteria in a water body segment. In addition to those water bodies in Table 7 within the analysis area, the Skokomish, Duckabush, Dosewallips, and Dewatto Rivers and Hood Canal are on the 303(d) list (WDOE 2012). In some cases, it is unknown what is causing poor water quality in Hood Canal streams, but, in those areas where causes are identified, hatchery operations have not been identified as a cause of the impairment. The most common causes of impaired water quality within the Hood Canal region are those associated with development (Table 7).

Table 7. Water quality compliance and 303(d) listed water bodies.

Facility	Compliant with NPDES permit	Discharges Effluent into a 303(d) Listed Water Body	Impaired Parameters	Impairment Cause
Quilcene National Fish Hatchery	Yes	Yes, Big Quilcene River	Instream flow, fish and shellfish habitat, temperature	Timber harvest, residential development, roading, levee construction, and illegal dredging activities
Port Gamble Net Pens	NA	NA	NA	NA
Quilcene Net Pens	NA	NA	NA	NA
Hoodsport Fish Hatchery	Yes	No, Finch Creek	NA	NA
Skokomish Enetai Creek Hatchery	NA	No, Enetai Creek	NA	NA
Port Gamble S'Klallam Tribal Hatchery	NA	No, Little Boston Creek	NA	NA
John Creek Conservancy Site	NA	Yes, John Creek	Temperature, instream flow	unknown
McKernan Fish Hatchery	Yes	Yes, Weaver Creek	Bacteria	unknown
Lilliwaup Hatchery	NA	Yes, Lilliwaup Creek	Bacteria	unknown
Manchester Research Station	NA	Yes, Kitsap County, Puget Sound	Fish and shellfish habitat	Human-caused eutrophication

Source: (WDOE 2012); Accessed November 21, 2014.

The direct discharge of hatchery facility effluent is regulated by the Environmental Protection Agency (EPA) under the Clean Water Act through National Pollutant Discharge Elimination System (NPDES) permits. For hatchery discharges not located on Federal or tribal lands within Washington, the EPA has delegated its regulatory oversight to the State. Washington Department of Ecology is responsible for issuing and enforcing NPDES permits that ensure water quality standards for surface waters remain consistent with public health and enjoyment, and the propagation and protection of fish, shellfish, and wildlife (WAC 173-201A). NPDES permits are not needed for hatchery facilities that release less than 20,000 pounds of fish per year or use less than 5,000 pounds of fish feed per month. Regular monitoring occurs for total suspended solids, settleable solids, and chlorine. Monitoring of chemical effluent concentrations applied in the hatcheries for fish pathogen control is not required as part of the NPDES discharge permit. Chemical concentrations are assumed to be diluted to the levels indicated on the treatment label for the safe treatment of fish before being discharged. Additionally, Indian tribes may adopt their own water quality standards for permits on tribal lands (i.e., tribal wastewater plans). All hatchery facilities included in this EA are compliant with NPDES or produce a small enough number of fish that they do not require an NPDES permit. All hatchery effluent is passed through pollution abatement ponds to settle out uneaten food and fish waste before being discharged into receiving waters.

3.3. Salmon and Steelhead

Since 1999, NMFS has identified two salmon ESUs (Puget Sound Chinook Salmon and Hood Canal Summer Chum Salmon) and one steelhead DPS (Puget Sound Steelhead) in the analysis area that require protection under the ESA (70 FR 37160, NMFS 2005b; 72 FR 26722, NMFS & NOAA 2007). There are three additional non-listed salmon species in the analysis area (fall chum, pink, and coho salmon).

Critical habitat was designated for Puget Sound Chinook salmon and Hood Canal summer chum (70 FR 52630, NMFS 2005a) and has been proposed for Puget Sound steelhead (78 FR 2725, NMFS & NOAA 2013), but has not been described for fall chum salmon, pink salmon, or coho salmon. The designated and proposed critical habitats for each ESU include the Hood Canal region. Within these areas, NMFS identifies primary constituent elements, such as freshwater spawning and rearing sites as well as freshwater and estuarine migration corridors. Each element requires adequate water quantity and quality, forage, natural cover, and freedom from obstruction and excessive predation.

Hatchery programs can affect natural-origin salmon and steelhead and their habitat through a variety of effects (Table 8). However, the extent of effects (adverse or beneficial) 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 in more detail as they pertain to the Hood Canal hatchery programs.

Table 8. General mechanisms through which hatchery programs can affect natural-origin salmon and steelhead populations.

Effect	Description of Effect
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 the local populations.
Competition and Predation	• Hatchery-origin fish can increase competition for food and space. • Hatchery-origin fish can prey on natural-origin fish. • The presence of hatchery-origin fish can increase the number of other predators on natural-origin fish.
Prey Enhancement	• Hatchery-origin fish can increase the number of prey for natural-origin fish.
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 o Alteration of stream flow o Alteration of streambed and riparian habitat o Alteration of the distribution of spawning within a population o Increased mortality or stress due to capture and handling o Impingement of downstream migrating fish o Forced downstream spawning by fish that do not pass through the weir o Increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries
Masking	• Hatchery-origin fish can increase the difficulty in determining the status of the natural-origin component of a salmon or steelhead population.
Fisheries	• Fisheries targeting hatchery-origin fish impact natural-origin fish.
Disease	• Concentrating salmon and steelhead for rearing in a hatchery facility can lead to an increased risk of carrying 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.
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.
Nutrient Cycling	• Returning hatchery-origin adults can increase the amount of marine-derived nutrients in freshwater systems.

Effect	Description of Effect
Research, Monitoring, and Evaluation (RM&E)	• Surveying and sampling to assess program objectives and goals may increase the risk of injury and mortality to salmon and steelhead 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

3.3.1. Genetics

Hatchery fish can have a variety of genetic effects on natural population productivity and diversity when they interbreed with natural-origin fish. NMFS considers three major areas of genetic risks of hatchery programs: within-population diversity, outbreeding, and hatchery-influenced selection. Within-population genetic diversity is a general term for the quantity, variety and combinations of genetic material in a population (Busack and Currens 1995). Within-population diversity is gained through mutations or gene flow from other populations and is lost primarily due to genetic drift, a random loss of diversity due to population size.

Outbreeding effects are caused by gene flow from other populations. Gene flow occurs naturally among salmon and steelhead populations, a process referred to as straying (Quinn 1993; Quinn 1997). Natural straying serves a valuable function in preserving diversity that would otherwise be lost through genetic drift and in re-colonizing vacant habitat. Straying is considered a risk only when it occurs at unnatural levels or from unnatural sources. Gene flow from other populations can have two effects. It can increase genetic diversity (Ayllon et al. 2006), but it can also alter established allele frequencies (and co-adapted gene complexes) and reduce the population's level of adaptation, a phenomenon called outbreeding depression (Edmands 2007; McClelland and Naish 2007). In general, the greater the geographic separation between the source or origin of hatchery fish and the recipient natural population, the greater the genetic difference between the two populations (ICTRT 2007), and the greater potential for outbreeding depression.

Hatchery-influenced selection occurs when selection pressures imposed by hatchery spawning and rearing differ greatly from those imposed by the natural environment and causes genetic change that is passed on to natural populations through interbreeding with hatchery-origin fish, typically from the same population. These differing selection pressures can be a result of differences in environments or a consequence of protocols and practices used by a hatchery program. Hatchery selection can range from relaxation of selection that would normally occur in nature to inadvertent selection for different characteristics in the hatchery and natural environments, to intentional selection for desired characteristics (Waples 1999).

Genetic effects are only considered for the natural-origin fish of the same species as the propagated fish species. Interbreeding among different species of salmon does not occur.

Chinook salmon

Broodstock used to support both of the proposed Chinook salmon programs was derived from a non-local population within the ESU, Green River. Green-River-origin Chinook salmon are now localized (i.e., adapted) to the Hood Canal region. Any native Chinook salmon that comprised the mid-Hood Canal and Skokomish Chinook salmon populations are extirpated and were supplanted by the Green River-lineage fish. The Green River lineage fish are now considered to be the extant populations (Ruckelshaus et al. 2006). Thus, Chinook salmon from the Hamma Hamma Chinook Supplementation program and Hoodsport Hatchery are not genetically distinct from fish spawning naturally in Hood Canal, including the Hamma Hamma River (Jones 2006).

Long-term, hatchery-origin fish may have undergone hatchery-influenced selection. There is overlap in hatchery and natural-origin fish during natural spawning; the percentage of hatchery-origin spawners in the Hamma Hamma River has been ~57 percent (Downen 2015). In addition, straying from the Hoodsport Hatchery program outside of Finch Creek has typically been 1.9 (subyearling) and 5 (yearling) percent of the total adult returns (PSMFC 2015).

Steelhead

The steelhead supplementation program uses natural-origin eggs collected from redds to increase the likelihood that fish propagated in the program represent the genetic diversity of the native steelhead populations. However, the rearing of steelhead juveniles for one to two years in a hatchery environment has likely resulted in hatchery-influenced selection. Any hatchery-influenced selection that may have occurred could have been incorporated into the natural-origin steelhead populations because all hatchery-reared fish were allowed to spawn naturally to increase population abundance. However, any genes that would not have benefited the hatchery-reared fish in the natural environment would likely have been selected against and eliminated from the population.

Summer chum Salmon

Although fall chum salmon and summer chum salmon have different run times, they are the same species and could interbreed. Fall chum salmon have been propagated in Hood Canal since the 1950's(WDFW 2013a), which has likely led to some hatchery-influenced selection. Because fall chum salmon are unmarked it has been difficult to differentiate them from summer chum salmon, but the maintenance of two separate runs indicates that hybridization has not occurred. In addition, fall chum broodstock collection has only begun after October 15 since 2003, which is after the end of the summer chum run (NMFS 2002).

Fall Chum Salmon

The fall chum programs were all founded with broodstock native to Hood Canal. However, the culture of these fish in the hatchery since the 1950's (Port Gamble S'Klallam Tribe 2013b; Skokomish Tribe 2013b; WDFW 2013a) has likely led to some hatchery-influenced selection. Because fall chum are unmarked, it is difficult to assess the amount of hatchery-origin fish that may have strayed and spawned naturally, mixing with natural-origin fall chum populations. The risk of outbreeding depression on the natural-origin populations via straying has likely been decreased by rearing chum for their entire rearing cycle in the water body from which they are released.

Pink Salmon

Broodstock for the pink salmon program also originated from fish native to the Hood Canal region (WDFW 2013b). Selection of a localized broodstock has likely minimized genetic risks to natural pink salmon populations, but outbreeding depression of natural-origin pink salmon populations, due to interbreeding with stray hatchery-origin fish, may have occurred. The number of stray fish has likely been small as pink salmon are acclimated throughout their rearing cycle at the site of their release (Finch Creek).

Coho Salmon

Hatchery-origin coho salmon return to spawn about a month earlier (USFWS 2015) than natural-origin coho salmon populations (October versus November, Table 10), which has reduced the interbreeding potential between hatchery and natural fish. Selection for the earlier spawn timing as well as the exclusion of jacks from hatchery broodstock until 1992 has resulted in reduced genetic diversity of the hatchery-stock. However, this reduced diversity has not resulted in any deleterious phenotypic effects (Smith et al. 2007). Marking of coho salmon allows managers to assess stray rates. Fewer than one percent of the returning hatchery coho salmon have strayed to natural production areas outside of the Big Quilcene River annually from 2007-2013 (Pacific States Marine Fisheries Commission 2015). In addition, the use of a full-channel weir at Quilcene hatchery has resulted in complete control of fish passed upstream; 200-800 coho salmon adults are passed upstream annually to spawn naturally. However, no natural-origin population of coho is known to reside in the Big Quilcene River (USFWS 2015), further limiting potential overlap to de minimis levels.

3.3.2. Competition and Predation

Chinook Salmon

Together, the two Chinook salmon programs release over 3.25 million fish, of which the majority are subyearlings (

Table 4 and Table 5). The estimated average annual number of natural-origin Chinook salmon smolts reaching Hood Canal marine waters was 132,000 fish (WDFW 2014a). Because natural-origin Chinook salmon represent only about 4 percent of the juvenile Chinook salmon in Hood Canal, competition and predation by any hatchery-origin salmon or trout species is more likely to occur on a hatchery-origin Chinook salmon than a natural-origin Chinook salmon.

Subyearling Chinook salmon are unlikely to have preyed on natural-origin Chinook salmon juveniles because of similar sizes (Table 9). Of concern is the yearling Chinook program, which annually releases 120,000 smolts about 2.5 times larger in size than natural-origin Chinook salmon subyearlings (Table 9). Chamberlin et al. (2011) showed that 40 of the 41 tagged yearling Chinook salmon remained within Hood Canal for the entire duration of the study (~150 days), suggesting that a high proportion of yearling Chinook salmon residualize. In addition, a population reconstruction scenario suggested that several hundred thousand Chinook salmon age 1-3 reside in Puget Sound for most or all seasons of the year and could consume 6 to 59% of the 15-18 million juvenile Chinook salmon (Beauchamp and Duffy 2011). As residual yearling Chinook salmon continue to grow, natural-origin Chinook salmon smolts become more vulnerable to resident Chinook salmon predation. Hatchery-origin coho salmon and steelhead yearlings also have likely preyed on natural-origin Chinook salmon. However, coho smolts are thought to move out of the estuary and into the open ocean within a week and supplemented steelhead move out in about two weeks (Simenstad et al. 1982 in Fresh 2006; Moore et al. 2010). To decrease the risks of competition and predation to natural-origin Chinook salmon, hatchery-origin Chinook salmon, coho and steelhead are released from late April to June at seawater-ready stages after the majority of natural-origin Chinook salmon have emigrated seaward (Table 9). Because hatchery fall chum and pink salmon are released as fed-fry at a small size and migrate out of freshwater quickly (NMFS 2002), they are unlikely to have preyed on or competed with natural-origin Chinook salmon.

Natural-origin Chinook salmon adults may have competed with Hatchery-origin Chinook, coho, fall, chum, and pink salmon and steelhead for spawning sites. However, the Big Quilcene and Dewatto Rivers, as well as Enetai, Little Boston, and Finch Creeks, where fish from the Chinook, coho, pink and fall chum salmon programs are released, respectively, do not support Chinook salmon populations. Thus, only stray fish from these programs have posed a competition threat. This threat is likely small as stray rates from the Chinook salmon and coho programs are five percent or less annually (Section 3.3.1). The small size of the steelhead program (50,000 smolts) and their late run and spawn timing makes competition unlikely to have occurred. In addition, (NMFS 2014a) notes that adult competition risks are generally limited to interactions between hatchery-origin and natural-origin fish of the same species.

Steelhead

Hatchery-origin steelhead smolts are released as one- and two-year-olds at a size large enough to be capable of preying on natural-origin steelhead fry and parr (Table 9). Yearling hatchery-origin Chinook and coho salmon are also large enough to prey on natural-origin steelhead. However, the release of hatchery-origin steelhead, Chinook and coho salmon as seawater-ready smolts that rapidly leave freshwater likely decreased the risk of competition between hatchery-origin and natural-origin steelhead in freshwater. Hatchery-origin Chinook salmon are also released into Finch Creek, a small water body that does not support listed fish (WDFW 2014a). Chinook salmon that residualize in Hood Canal do pose a threat to larger steelhead smolts traveling through Hood Canal, but the annual release of yearling Chinook salmon is small (120,000). In addition, the residence time of coho salmon smolts in the estuary is uncertain and may have led to more predation on natural-origin steelhead than expected if residence time is lengthy (USFWS 2015). Because hatchery fall chum and pink salmon are released as fed-fry at a small size and migrate out of freshwater quickly (NMFS 2002), they are unlikely to have preyed on or competed with natural-origin steelhead.

Competition with adults from the proposed programs for spawning sites is unlikely to have been a concern steelhead return to freshwater and spawn much later than salmon species (Table 10). Competition with hatchery-origin steelhead has likely occurred, but the programs releases are small (50,000 smolts) likely resulting in far fewer adults at return. In addition, the purpose of the steelhead program is to supplement the natural-origin population, with hatchery-origin steelhead intended to spawn naturally. In this case, the threat of any competition is outweighed by the benefit of increased abundance of natural-origin steelhead.

Summer chum salmon

Natural-origin summer chum fry are vulnerable to predation from yearling Chinook and coho salmon and steelhead, and may compete with subyearling Chinook, fall chum, and pink salmon released from the programs. However, NMFS (2002), restricted releases of hatchery-origin fish until after the peak in summer chum salmon juvenile outmigration (March), which reduced ecological effects. However, any residual fish from these programs may have preyed on natural-origin summer chum salmon.

Spawning site competition with natural-origin summer chum salmon is limited to the lowest reaches of natal streams because summer chum salmon typically spawn in these areas soon after freshwater entry (Tynan 1997). Based on run and spawn timing, only hatchery-origin Chinook and pink salmon are likely to overlap temporally with summer chum salmon. However, the majority of hatchery Chinook salmon and all the pink salmon are released into Finch Creek, where summer chum do not occur (WDFW 2013b; WDFW 2014a). Thus, the main overlap has been with Chinook salmon in the Hamma Hamma River, but Chinook salmon spawn farther up in the river than summer chum, limiting spatial overlap (Tynan 1997).

Fall Chum

The release of fall chum (~16 million from 3 programs) and pink salmon (~500,000 from 1 program) as fed fry means they may have competed with natural-origin fall chum salmon. The release of yearling steelhead, Chinook and coho salmon has posed a predation threat. However, all hatchery fish are released after the natural-origin fall chum have emigrated seaward (Table 9). In addition, all of the fall chum salmon fed fry are released directly into the marine waters of Hood Canal, which has further limited competition in freshwater.

Spawning site competition between natural-origin fall chum and hatchery-origin fish is likely to have occurred only with hatchery fall chum and coho salmon based on run and spawn timing (Table 10). However, this competition has likely been minimal because hatchery coho salmon originate only from the Big Quilcene River, which only has about 3 miles of accessible spawning habitat for both species (including habitat above the weir).

Pink Salmon

For ecological effects on juvenile pink salmon see above discussion on juvenile fall chum.

Adult spawning site competition is most likely to have occurred with hatchery Chinook and pink salmon. This has been minimized by the majority of releases of these two hatchery species into one location, Finch Creek. Chinook salmon are also larger fish and would likely have had different spawning space requirements than pink salmon.

Coho salmon

Natural-origin coho salmon have most likely competed with hatchery steelhead, Chinook, and coho salmon because of their similar size (Table 9). The yearling steelhead and Chinook salmon programs are relatively small in scale (releasing 170,000 fish annually) limiting interaction, but the three coho salmon programs have released approximately 1 million yearlings annually. However, coho salmon migrate from freshwater within hours of release, limiting the potential for freshwater competition and predation (USFWS 2015). In addition, there is only one freshwater release site, the Big Quilcene River. Yearling Chinook and coho salmon and steelhead that residualize may also have competed with or preyed on natural-origin coho salmon.

Competition for spawning space may have occurred among natural-origin coho and hatchery coho and fall chum salmon based on spawn timing overlap between these two species (Table 10). Effects of hatchery coho on natural coho have been limited because hatchery coho return and spawn a month earlier than natural-origin coho (USFWS 2015). Interactions with fall chum have also likely been limited because chum from the three programs originate in small creeks that are unlikely to have supported listed fish and thus may not support natural-origin coho (Port Gamble S'Klallam Tribe 2013b; Skokomish Tribe 2013b; WDFW 2013a).

Table 9. Estimated size and freshwater occurrence/release for natural and hatchery juvenile salmonids.

Species (Origin)	Life Stage	Estimated Size (mm fl)	Occurrence/Release Timing
Chinook salmon (wild)	Fry	< 45	January-April
Chinook salmon (wild)	Parr	45-110	April-February
Chinook salmon (wild)	Yearling	76-156	February-May
Chinook salmon (hatchery)	Sub-yearling	88-97	late April-mid June
Chinook salmon (hatchery)	Yearling	190-220	late April-mid May
Steelhead (wild)	Fry	< 40	May-October
Steelhead (wild)	Parr	50-150	October-mid May
Steelhead (wild)	Smolt	159-235	February-June
Steelhead (hatchery)	Smolt	100-170	mid April-mid May
Steelhead (hatchery)	Adult	< 254	February-May
Coho (wild)	Fry	< 60	March-May
Coho (wild)	Parr	60-85	May-April
Coho (wild)	Yearling	90-115	late April-May
Coho (hatchery)	Yearling	75-90	late April-May
Fall Chum (wild)	Fry	< 50	February-May
Fall Chum (hatchery)	Fry	50-53	April
Summer Chum (wild)	Fry	37-41	December-early April
Pink (wild)	Fry	32-43	March-April
Pink (hatchery)	Fry	50-53	April-May

Sources: (Hard et al. 1996; Kinsel and Zimmerman 2011; Myers et al. 2015; Piper et al. 1986; Topping and Zimmerman 2013; WDFW and PNPTT 2000; Weinheimer et al. 2011; Weitkamp et al. 1995).

Table 10. Timing of adult return and spawning.

Species	Freshwater Entry	Spawn Timing
Chinook salmon (fall)	July to October	Peaks in mid-October (hatchery); August (natural)
Coho salmon	August to mid-November	October (hatchery); November to mid-January (natural)
Steelhead trout (winter)	December to May	February to June
Pink salmon (odd-year)	Early August to October	September to October; peak in mid-October
Chum salmon (summer)	Early August to September	Late August to October

Chum salmon (fall)	Early October to Early January	Late October to January

Source: WDFW and WWTIT (1994)

3.3.3. Prey Enhancement

The co-managers currently release a total of about 147 million juvenile salmon and steelhead into Puget Sound freshwater and marine areas each year. This total includes 46.1 million Chinook salmon, 14.6 million coho salmon, 44.5 million fall chum salmon, 4.5 million pink salmon, 35.1 million sockeye salmon, and 1.8 million steelhead (NMFS 2014). The combined contribution of the 10 proposed hatchery programs to the Hood Canal region results in about 20.8 million salmon and steelhead, or 14 percent of the total salmon and steelhead releases into Puget Sound on an annual basis. Fall chum salmon comprise the largest portion of this amount with approximately 16 million fry. Thus, hatchery releases may provide a substantial prey resource for natural-origin salmon and steelhead.

3.3.4. Facility Operations

Because water quantity and water quality are assessed as separate resources, our discussion of the effects of facility operations on salmon and steelhead in this section is restricted to water intake structures and the operation of weirs and smolt traps. There are potential effects on salmon and steelhead from water intake structures, as only the Quilcene National Fish Hatchery and McKernan Hatchery meet NMFS screening criteria (NMFS 2011a). However, an unscreened intake is also used during emergencies at the Quilcene National Fish Hatchery. Although natural-origin salmon and steelhead populations are not present at Finch, Enetai, and Little Boston Creeks, fish may stray into these small creeks. The two net-pen programs for coho salmon rely on passive tidal flow for rearing, and effects regarding water intake structures are not applicable for those two programs.

Weirs are used for collecting broodstock for 6 out of 10 proposed programs and are checked daily. The removable Hoodsport hatchery weir is located on a small Hood Canal tributary and operates from July through January of each year. The weirs for the other two fall chum programs on Little Boston and Enetai Creeks are permanent. The Quilcene National Fish Hatchery weir is also permanent, spans the entire Big Quilcene River and, up until 2013, was electrified. Hatchery personnel open the sliding gates periodically from September through December on the fish ladder to allow some coho salmon (~200-800) and all steelhead to pass upstream. From January 1 through July, the gates for the ladder are opened continuously to allow upstream passage of any steelhead (USFWS 2015). In addition, during this time, river flows may be high enough to allow passage of fish over the weir (Correa 2002). See Table 8 for a summary of the effects of weirs on salmon and steelhead.

The collection of eyed eggs for the steelhead program using a hydraulic suction device could potentially have affected other salmon and trout species. Collection required that researchers walk in the stream to the redd, which could have trampled redds of other species. However, the late run- and spawn-timing of steelhead compared with salmon species limited trampling (Table 14). In addition, researchers are trained in redd appearance for all salmon and steelhead species (WDFW and LLTK 2012), making trampling unlikely to occur.

Removable smolt traps are used periodically for assessing juvenile outmigration on the Hamma Hamma, Skokomish, Dewatto, Big Quilcene, and Duckabush Rivers. The potential effects on natural-origin salmon and steelhead caught in the traps can range from impeding their movement to death, with mortality occurring for a small portion of those fish that are trapped. The potential effects are minimized by daily trap checks during operation. In addition, traps typically have caught less than 5 percent of outmigrating juveniles, although in some years this could be as high as 30 percent (Weinheimer et al. 2011).

3.3.5. Masking

Masking occurs when unmarked hatchery-origin salmon and steelhead are included with population estimates of natural-origin fish, resulting in an overestimation of the count of natural-origin fish. Marking (i.e., adipose fin clip, coded-wire tag) allows hatchery-origin fish to be distinguished from natural-origin fish. All of the Chinook and coho salmon as well as steelhead are marked to allow for the differentiation of program fish from natural-origin fish as juveniles, in fisheries, and upon adult return. Mass marking allows for monitoring of hatchery fish stray rates to natural spawning areas, program performance in meeting juvenile to adult fish survival goals, and, where applicable, natural spawning population supplementation objectives. However, coho salmon passed above the Quilcene National Fish Hatchery in the Big Quilcene River produce progeny that are not marked (USFWS 2015). Fall chum and pink salmon are also unmarked, and these fish straying to naturally spawning areas may have decreased certainty in evaluating natural population status and spawning composition. However, the comanagers are considering otolith marking for certain chum programs (Adrian Spidle, NWIFC, personal communication).

3.3.6. Fisheries

Within Hood Canal, recreational and treaty and non-treaty commercial fisheries exist for non-listed species (i.e., Hoodsport Hatchery Chinook, pink, coho, and fall chum salmon) produced through the programs. These fisheries may incidentally affect natural-origin Chinook and summer chum salmon and steelhead. Although the eight segregated programs produce fish for harvest, these programs are not the sole producers of fish for the fisheries.

There are no fisheries directed on listed summer chum salmon. There are also no fisheries directed on adult Chinook salmon or steelhead associated with the Hamma Hamma Supplementation Program or Hood Canal Steelhead Supplementation Program. However, Puget Sound Chinook salmon harvest management is based on a weak-stock approach, with the mid-Hood Canal population representing one of the stocks with abundance criteria that decide annual harvest management, which may limit fisheries when mid-Hood Canal population abundances are low. The Hamma Hamma program propagates fish from the mid-Hood Canal population, thereby helping maintain population levels more conducive to harvest implementation.

NMFS determined (NMFS 2001; NMFS 2014b) that implementing and enforcing the harvest components of the resource management plans for summer chum and Chinook salmon (Bureau of Indian Affairs 2014; WDFW and PNPTT 2000) would have little measurable effect on the listed populations.

3.3.7. Disease

For all programs, the applicants' fish health policies govern how fish health is managed within a hatchery and throughout the state of Washington by controlling the movement of fish, fish eggs, and water. Fish are monitored regularly and treated as needed during their hatchery residence (NWIFC and WDFW 2006; USFWS 2004). However, the passage of coho salmon adults that may potentially carry fish pathogens above the Quilcene National Fish Hatchery in the Big Quilcene River could have increased the number and types of pathogens entering the hatchery. Water withdrawn through the river intake is untreated, and its use may have resulted in an increased incidence of epizootics in hatchery coho salmon. Passage of coho salmon may have increased the risk of pathogen transmission to natural-origin fish.

3.3.8. Population Viability

Because Puget Sound fall chum, pink, and coho salmon ESUs are unlisted, population viability criteria for these ESUs have not been determined (60 FR 51928, NMFS & NOAA 1995; 63 FR 11774, NMFS & NOAA 1998; 75 FR 38776, NMFS & NOAA 2010). As part of recovery planning, population viability criteria have been established for the listed threatened Puget Sound Chinook Salmon and Hood Canal Summer Chum Salmon ESUs, and the Puget Sound Steelhead DPS.

There are two populations in the Hood Canal biogeographical region and both the Skokomish River and mid-Hood Canal Chinook salmon populations need to be restored to a low extinction risk status for recovery and delisting of the ESU (NMFS 2006; SSPS 2005). The mid-Hood

Canal Chinook population, which includes Chinook salmon in the Hamma Hamma, Dosewallips, and Duckabush Rivers, is one of 22 populations of Chinook salmon in the Puget Sound Chinook Salmon ESU. Because Chinook salmon are not a native species in Finch Creek, and there is no associated natural-origin population, Hoodsport Hatchery fall Chinook salmon originating from non-local Green River stock transfers are not included in the ESU (Jones 2006).

The abundance of Chinook salmon from 2000 to 2012 for the mid-Hood Canal population has ranged from 30 to 438 and averaged 175 fish (Long Live the Kings et al. 2013), below the critical level (200 returning adults) recommended by McElhany et al. (2000). Productivity was two recruits per spawner from 2002-2006 (Ford 2011). The integrated hatchery program on the Hamma Hamma River has supported the majority of mid-Hood Canal adult returns, with an average escapement to the river of 134 adults ranging from 16 in 2002 to 403 in 2012. On average, hatchery-origin fish account for over 57 percent of the total natural spawning population in the Hamma Hamma River each year (Downen 2015). This high proportion of hatchery fish spawning naturally reflects the supplementation purpose of the proposed Hamma Hamma program, which is to increase the spawning abundance of the mid-Hood Canal Chinook salmon population. Natural spawning escapement for the Skokomish River population, which includes hatchery-origin fall Chinook propagated at George Adams Hatchery and used as broodstock for the Hamma Hamma program, has averaged 1,422 fish (1999-2013; Bishop 2013) and is above both the critical and rebuilding levels of 452 and 1,160 fish, respectively, that were established for recovery planning purposes. Productivity for the Skokomish population was 0.93 recruits per spawner from 2002-2006 (Ford 2011).

Winter-run steelhead in Hood Canal are included in the Hood Canal and Strait of Juan de Fuca major population group of the Puget Sound Steelhead DPS (Myers et al. 2015). This major population group is one of three major population groups included in the DPS. According to NMFS DPS viability criteria, at least 40 percent of the demographically independent populations in each major population group must be viable for delisting of the DPS (Hard et al. 2015). The Hood Canal and Strait of Juan de Fuca major population group is comprised of eight demographically independent populations, with four of those populations originating from the Hood Canal region. All of these populations are below the intrinsic potential (IP) abundance estimated from the amount and condition of habitat currently available to each population (Table 11). The Hood Canal Steelhead Supplementation program is likely to improve population viability. Indeed, abundance was shown to increase through a similar steelhead supplementation program in the Hamma Hamma River (Berejikian et al. 2008).

Table 11. Hood Canal steelhead demographically independent populations (DIP).

DIP	Primary Tributaries	2000-11 Mean Escapement/Range (Numbers of Fish)	IP Estimate (Numbers of Fish)
East Hood Canal	Dewatto River, Big Beef and Anderson Creeks	34/13-92 (Dewatto)	1270-2540
South Hood Canal	Tahuya and Union Rivers	156/58-269	2985-5970
Skokomish River	Skokomish River	309/132-567	10030-20060
West Hood Canal	Hamma Hamma, Duckabush, Dosewallips and Quilcene Rivers	205/99-358	3608-7216

Source: (Hard et al. 2015; Myers et al. 2015; WDFW and LLTK 2012)

The geometric mean in spawner abundance of summer chum in Hood Canal has increased compared to what it was at the time of listing: 13,903 (2005-2009) versus 7,224 (1995-1999), but remains below the minimum viable population abundance goal of 24,700. The Hood Canal summer chum salmon population also has a recruit/spawner ratio of 2.02 (2002-2006), which exceeds the replacement rate of one and suggests a continued increase in abundance. Assessment of diversity has been variable, but is currently higher (1.98, 2005-2009) than at the time of listing (1.06, 1995-9; Ford 2011).

3.3.9. Nutrient Cycling

Salmon and steelhead are important transporters of marine-derived nutrients into the freshwater and terrestrial systems through the decomposition of fish carcasses (Cederholm et al. 2000). The decreased abundance of natural-origin salmon and steelhead likely translates into a reduction of nutrient cycling between marine, freshwater, and terrestrial ecosystems. The propagation of hatchery-origin fish increased nutrient cycling compared to what the remaining natural-origin fish supplied, to the extent that hatchery-origin adults are allowed to move into, or are released as spawners or carcasses in, areas where their carcasses will provide nutrition for juvenile salmonids or their prey items. The contribution of the segregated harvest programs to nutrient cycling is limited because any surplus hatchery fish not used as broodstock are either sold or donated and are not passed upstream or distributed in the watershed as carcasses. The one exception is the Quilcene National Fish Hatchery coho program, which passes ~200-800 adult coho salmon upstream to spawn naturally in the Big Quilcene River each year.

3.3.10. Research, Monitoring and Evaluation

In addition to assessing proposed program performance by measuring escapement, harvest contribution, stray rates and spawning (Section 3), the Hood Canal steelhead supplementation program conducted additional research to improve our understanding of steelhead life history, genetics, and movement:

- Redd counts to estimate spawner abundance
- Outmigrant juvenile collection to estimate production
- Use of telemetry-tagged outmigrants to estimate ocean survival and migration
- Sampling of natural- and hatchery-reared adults and juveniles for genetic analysis of heterozygosity, loss of rare alleles or change in allele frequencies
- Sampling of natural- and hatchery-reared adults and juveniles for determining contribution of resident populations to smolts with an anadromous life history

This increased sampling confers benefits through identification of the status and trends for Puget Sound steelhead DPS populations in the Hood Canal region. However, sampling does cause some adverse effects on fish. Each year, up to 840 parr and 300 resident rainbow trout juveniles were collected and sampled. Some unintentional mortality may have occurred due to the implantation of telemetry tags and from the collection of scales for genetic sampling. Of the 840 parr, up to 300 were intentionally lethally sampled for collection of otoliths to assess life history type.

3.4. Other Fish Species

Many fish species in the Hood Canal region have a relationship with salmon and steelhead as prey, predators, or competitors (Table 12). Due to the piscivorous nature of many fishes, this ecological relationship may change over the course of each fishes' lifetime. For example, juvenile salmon may serve as prey for larger rockfish, but salmon adults are likely to become predators of smaller rockfish. All of these fish species have a range that includes the Hood Canal Region of Puget Sound, but none are located exclusively in the Hood Canal region. In addition to Chinook and summer chum salmon and steelhead, six other fish species listed under the ESA may occur in Hood Canal: Pacific eulachon, bull trout, the southern DPS of green sturgeon, and Puget Sound/Georgia Basin Boccacio, Canary rockfish, and Yelloweye rockfish (Table 12).

The primary risk from the hatchery programs on green and white sturgeon is the potential of being incidentally intercepted in fisheries targeting salmon (NMFS 2014a). Rockfish and other salmon and trout species (e.g., bull trout) may also be incidentally caught in salmon fisheries (NMFS 2014a). More detailed information on the relationship between salmon and steelhead and other fish can be found in sections 3.2.13 to 3.2.18 of NMFS (2014a).

Table 12. Other fish species in the analysis area that may interact with Hood Canal region salmon and steelhead.

Species	Range	Federal/State Listing Status	Relationship		
			Prey	Competitor	Predator
Freshwater					
Pacific and Western brook lamprey	Coastal rivers and streams, Columbia River basin	Federal species of concern; state monitored species	√	√	√
Sculpin	Widespread	None		√	√
Pacific Eulachon	Coast and lower Columbia River basin	Federal threatened species; state candidate species	√	√	
Longfin smelt	Puget Sound	None	√	√	
Minnows	Widespread	None	√		
Salish Sucker	Puget Sound	State monitor species	√		
Green and White Sturgeon	Coastal rivers	Green: Southern DPS is a Federal threatened species; northern DPS is a Federal species of concern			√ (salmon carcasses)
Three-spine stickleback	Widespread	None	√	√	
Eastern brook trout	Widespread	None	√	√	√
Rainbow trout (resident)	Widespread	None	√	√	√
Kokanee	Widespread	None	√	√	√
Bull Trout	Widespread	Federal threatened species	√	√	√
Dolly Varden	Coast	Federal candidate species	√	√	√
Cutthroat trout	Widespread	None	√	√	√
Marine					
Rockfish	Rocky reef habitats in Puget Sound	Several species are federally and/or State listed[1]	√	√	√
Forage fish	Puget Sound, Strait of Georgia	Georgia basin DPS Pacific herring is a Federal species of concern and a state candidate species	√	√	√

Sources: (NMFS 2014a; Wydoski and Whitney 1979)

[1]Georgia Basin bocaccio DPS (*Sebastes paucispinis*) - Federally listed as endangered and state candidate species; Georgia Basin yelloweye rockfish DPS (*S. ruberrimus*) and Georgia Basin canary rockfish DPS (*S. pinniger*) -Federally listed as threatened and state candidate species; black, brown, china, copper, green-striped, quillback, red-stripe, tiger, and widow rockfish.

3.5. Wildlife

Hatchery facilities and hatchery-origin salmon and steelhead may affect wildlife by transferring toxic contaminants and/or pathogens outside the hatchery environment, altering water quality and/or quantity, impeding wildlife movement, enhancing nutrient availability, and acting as either predators or prey. The transfer of toxic contaminants and/or pathogens to wildlife associated with the hatchery programs is unlikely to contribute to their presence/load in wildlife due to the regulation of hatchery operations through the NPDES permit and the applicants' fish health policies (NMFS 2014a; NWIFC and WDFW 2006; USFWS 2004). Weirs and traps used for collection of fish may impede wildlife movement and/or benefit wildlife by restricting migration of fish and thereby enhancing predation efficiency. The presence of hatchery-origin salmon and steelhead carcasses likely provides a benefit to local wildlife as a nutrient source. Live fish serve as both a prey source (e.g., for mammals and birds including killer whales and bald and golden eagles) and a predator (e.g., on amphibians and invertebrates). For more detail on predator-prey interactions with salmon and steelhead in the analysis area, please see section 3.5 in NMFS (2014a).

3.6. Socioeconomics

Socioeconomics is defined as the study of the relationship between economics and social interactions with affected regions, communities, and user groups. In addition to providing fish for harvest, hatchery programs directly affect socioeconomic conditions in the regions where the hatchery facilities operate. Hatchery facilities provide employment opportunities and procure goods and services for hatchery operations. Annual operation of the Hood Canal hatchery programs contributes approximately $2.17 million and 21 full-time jobs to the regional economy (Long Live the Kings et al. 2013; Port Gamble S'Klallam Tribe 2013a; Port Gamble S'Klallam Tribe 2013b; Skokomish Tribe 2013a; Skokomish Tribe 2013b; USFWS 2015; WDFW 2013a; WDFW 2013b; WDFW 2014a; WDFW and LLTK 2012). Harvest of fish produced by the eight segregated programs included in this analysis is worth an estimated 2.6 million dollars (Table 13).

Table 13. Estimated commercial harvest value of fish produced by the Hood Canal hatchery programs.

Salmon Species	Average Poundage[1]	Income Impacts per Pound ($)[1]	Average Harvest[2] (number of fish)	Estimated Value ($)
Chinook	12.9	2.56	17, 136	565,899
Fall Chum	10.1	1.63	107,913	1,776,571
Coho	5.6	2.04	20,531[3]	234,546
Pink	3.9	1.63	2,689[3]	17,094

[1] Source: SEIS for the Puget Sound Harvest Management Plan, Appendix D (Table D-2).
[2] These values are based on run reconstructions by species for each hatchery program; see Table 5 for sources.
[3] Harvest values are calculated by taking the average of the sum of all relevant programs for each year.

Fisheries for hatchery fish contribute to local economies through the purchase of supplies such as fishing gear, camping equipment, consumables, and fuel at local businesses. All of these expenditures would be expected to support local businesses. Anglers would also be expected to contribute to the economy through outfitter/guide/charter fees. In 2014, approximately 14,000 recreational fishing licenses were purchased in Jefferson and Mason Counties, translating to values ranging from $500,000 and 1.2 million dollars to the regional economy depending on the proportion of residents and non-residents. Commercial salmon fishermen hold approximately 520 active licenses as of 2014 and contribute approximately $18,200 a year in license renewal fees (WDFW Public Disclosure Office). Across both Jefferson and Mason Counties, the commercial and recreational fishing industries (both treaty and non-treaty) totaled approximately 6.4 million dollars in personal income and contributed 188 jobs (Table 14). The average (2002-2006) gross economic value of salmon post-landing (i.e., fish buyers) brought to Jefferson and Mason Counties was $920,000 and $90,000 respectively. The proposed hatchery programs contribute fish for both harvest sectors, with the exception of the integrated Chinook salmon and steelhead programs, but in conjunction with other hatchery programs within all of Puget Sound. Thus, the eight segregated programs would be responsible for only a portion of the values in Table 14.

Table 14. Estimated (2002-2006) personal income and jobs (part- and full-time) from the commercial and recreational (both treaty and non-treaty) industry in Hood Canal counties.

	Commercial		Recreational	
County	**Personal Income**	**Jobs**	**Personal Income**	**Jobs**
Jefferson	$1,977,397	58	$2,946,776	87
Mason	$192,938	7	$1,054,472	36

Source: (Table 3.3-9, NMFS 2014a)

3.7. Cultural Resources

Salmon fishing has been a focus for tribal economies, cultures, lifestyles, and identities for over 1,000 years. Beyond generating jobs and income for contemporary commercial tribal fishers, salmon are regularly eaten by individuals and families, and are served at gatherings of elders at traditional dinners and other ceremonies. To Indian tribes, salmon are a core symbol of tribal and individual identity. The survival and well-being of salmon are seen as inextricably linked to the survival and well-being of Indian people and their cultures. Salmon evoke sharing, gifts from nature, responsibility to the resource, and connection to the land and the water. Puget Sound treaty tribes use salmon in various ways, including personal and family consumption, informal and formal distribution, and community sharing and ceremonial uses. Salmon are strongly associated with the use and knowledge of water, appropriate harvesting techniques, and traditional processing techniques and facilitate the transfer of tribal fishing culture to young tribal members (NMFS 2014a).

The Skokomish, Port Gamble S'Klallam, Jamestown S'Klallam, and Lower Elwha Klallam Tribes have Usual and Accustomed Fishing Areas within the Hood Canal region. For the Skokomish tribe, these areas include all the waterways of Hood Canal and Hood Canal itself (Lane Ph.D. 1973). Although the Tribes historically hunted sea mammals, waterfowl, and land animals in addition to gathering mollusks and vegetables for food, fishing was the most important food gathering technique. Of the fish harvested, salmon and steelhead were considered the most important. The First Salmon Ceremony highlights this importance as the first "crooked-jawed" salmon each year is cooked and eaten by every member of the tribe and the bones are used in a ritual to ensure the return of salmon the following year (Lane Ph.D. 1973).

3.8. Environmental Justice

Section 3.4 of the Puget Sound Draft EIS (NMFS 2014a) identifies three environmental justice user groups and communities of concern in the Hood Canal region: Mason County, commercial fishers in Mason County, and Native American Tribes. Analysis of commercial and recreational fisher minority percentage and income level indicated that commercial fishers at Shelton Port within Mason County are a user group of concern. Mason County was also considered a community of concern based on exceedance of the American Indian minority threshold. EPA guidance (1998) regarding environmental justice extends beyond use of statistical thresholds to explicitly consider environmental justice effects on Native American Tribes. The presence of the Skokomish, Port Gamble S'Klallam, Jamestown S'Klallam, and Lower Elwha Klallam Tribes within the analysis area necessitates consideration of the effects of the proposed action on ecological, cultural, human health, economic, or social impacts when those impacts are interrelated to impacts on the natural or physical environment.

3.9. Human Health and Safety

Section 3.7 in NMFS (2014a), briefly summarized here, discusses potential risks to human health from hatchery facility operations including common chemicals used and safe handling, potential toxic contaminants in hatchery-origin fish, and potential pathogens transmitted from handling hatchery-origin fish. Compliance with safety programs, rules and regulations, and the use of personal protective equipment limits the spread of pathogens and the potential risk to human health, but accidental skin contact and needle-stick injuries involving infected fish are potential human health risks for hatchery personnel. In addition, the minimal use of therapeutics in the United States and application of therapeutics in compliance with manufacturers' directions further limits the risk hatcheries pose to human health and the environment, leading to a negligible effect on this resource. However, locally high concentrations could occur depending on the nature of the receiving environment if therapeutics are needed to control or prevent a disease outbreak. Another risk to human health is contaminant exposure through consumption.

This risk is directly associated with the frequency of consuming fish, regardless of whether fish are of hatchery or natural origin; people who eat more fish are at higher risk of contaminant exposure (U.S. Environmental Protection Agency (EPA) 1999; Washington Department of Ecology (Ecology) 2013).

4. ENVIRONMENTAL CONSEQUENCES

This chapter provides an analysis of the direct and indirect environmental effects associated with the alternatives on the nine resource categories. The effects of Alternative 1 are described relative to current conditions (see section 3). The effects of the other alternatives are described relative to Alternative 1 (No Action). Where applicable, NMFS describes the relative magnitude of impacts 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.

The aspects of critical habitat as defined by the ESA that may be affected include (1) adequate water quantity and quality, and (2) freedom from excessive predation. Potential effects on critical habitat as defined by the ESA are analyzed in this EA in the broader discussion of impacts on habitat (subsections 4.1, Water Quantity; 4.2, Water Quality; 4.3, Salmon and Steelhead; 4.4, Other Fish Species; and 4.5, Wildlife).

4.1. Water Quantity

Table 15. Summary of change in effects on water quantity relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Resource	Alternative 1 No Action	Effects of Alternative Relative to No Action		
		2	3	4
Water Quantity	Low-adverse	No change	Low-beneficial	No change

Under Alternative 1 (No Action), the Hood Canal hatchery programs would have the same production levels as under current conditions. Thus, the same amount of water would be used as under current conditions resulting in no change in the amount of water among the hatchery facilities' water intake and discharge structures, or the amount of water in the aquifer. Because water use is non-consumptive and limited by permits, but in some cases substantial amounts of water are being diverted for hatchery purposes (e.g., Hoodsport Hatchery, Liliwaup Hatchery), the effects on water quantity are low and adverse.

Under Alternative 2, the Hood Canal hatchery production levels would remain unchanged and would utilize the same amount of water for the same purposes as Alternative 1, resulting in no change in water quantity effects described in Alternative 1.

Under Alternative 3, the Hood Canal hatchery programs would be terminated immediately. These changes would reduce the short- and long-term potential for impacts on fish and wildlife as a result of stream dewatering relative to Alternative 1, leading to an increase in the amount of water flowing through the pertinent reaches. Because the water withdrawn under Alternative 1 typically leaves a majority of the water in the stream and returns it only a short distance downstream (Table 6), the resulting effect on fish and wildlife would be low and beneficial. In addition, less well and groundwater would be used, which may increase the amount of water available for other aquifer users in the Hood Canal region relative to Alternative 1.

Under Alternative 4, reductions in coho and pink salmon production may reduce the short- and long-term potential effects on fish and wildlife as a result of stream dewatering relative to Alternative 1. In addition, less well and groundwater may be used, which may increase the amount of water available for other aquifer users in the Hood Canal region. However, both facilities would still rear fish, and, in the case of Hoodsport hatchery, where pink salmon are reared, any reductions in water quantity would be minimal compared to the amount of water needed for the larger Chinook and chum salmon production programs relative to Alternative 1. Thus, while adverse water quantity effects may decrease, they likely will still have a low adverse effect.

4.2. Water Quality

Table 16. Summary of change in effects on water quality relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Resource	Alternative 1 No Action	Effects of Alternative Relative to No Action 2	3	4
Water Quality	Low-adverse	No change	Undetectable	No change

Under Alternative 1 (No Action), the Hood Canal hatchery programs would have the same production levels as under current conditions, so there would be no expected change in the discharge of ammonia, nutrients (e.g., nitrogen), biological oxygen demand, pH, suspended solid levels, antibiotics, fungicides, disinfectants, steroid hormones, pathogens, anesthetics, pesticides, and herbicides into the Hood Canal analysis area annually. However, over time, the small amounts of nutrients and chemicals discharged could accumulate in the environment. The amount of accumulation would depend on the life expectancy of each substance and the uptake of those substances by biological organisms. The potential for additonla nutrients and chemicals in the effluent is minimized by compliance with the NPDES permit and fish health policies, but the potential accumulation in the environment results in a low adverse effect.

Under Alternative 2, the Hood Canal hatchery programs would have the same production level and practices, resulting in no expected change in water quality relative to Alternative 1.

Under Alternative 3, all programs would be terminated immediately, reducing nutrient and chemical discharge over the short and long term. Because the Hoodsport, Enetai Creek, Quilcene and Port Gamble hatcheries are solely producing fish for Hood Canal, and all the HGMPs applicable to these four facilities are included, these facilities would close eliminating any discharge concerns and potentially improving water quality in Hood Canal and its tributaries. The remaining facilities that rear fish for the Hood Canal programs are either small in scale (e.g., Lilliwaup Hatchery) or will be analyzed in future NEPA documents (e.g., George Adams and McKernan Hatcheries). Thus, the effect on water quality is decreased to undetectable relative to Alternative 1.

Under Alternative 4, the production of fewer coho and pink salmon may reduce the discharge of chemicals and nutrients relative to Alternative 1. However, because all the hatchery facilities and programs would still be in operation, the adverse effects would still be low.

4.3. Salmon and Steelhead

Table 8 lists the various pathways through which the hatchery programs could affect natural-origin salmon and steelhead populations in the Hood Canal. In this section, we compare hatchery program effects under each alternative on natural salmon and steelhead populations in the analysis area.

4.3.1. Genetics

Table 17. Summary of change in genetic effects on natural-origin salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Species	Alternative 1 No Action	Effects of Alternative Relative to No Action 2	3	4
Puget Sound Chinook Salmon	Low-adverse	No change	Negligible-adverse	No change
Puget Sound Steelhead	Negligible-adverse	No change	Undetectable	No change
Hood Canal Summer Chum Salmon	Undetectable	No change	No change	No change

Fall Chum	Low-adverse	No change	Negligible-adverse	No change
Pink Salmon	Low-adverse	No change	Negligible-adverse	No change
Coho Salmon	Low-adverse	No change	Negligible-adverse	No change

Under Alternative 1, the hatchery programs would be operated the same as under current conditions. Therefore, there would be no change in genetic effects of the hatchery programs relative to current conditions. Over time, genetic effects of hatchery programs may be cumulative and result in lowered fitness in the natural environment. These fitness reductions may not be reversible. The effects on:

- Natural-origin Chinook salmon are low adverse because they are genetically indistinguishable from the hatchery populations of Chinook salmon. However, interbreeding with hatchery Chinook salmon could introduce hatchery-influenced selection that may result in lowered fitness.
- Natural-origin steelhead are negligible and adverse because although steelhead are reared in the hatchery, only natural-origin eggs are used as broodstock. This allows for mate choice by the parents, which may offset the negative effects of hatchery rearing, including reduced fecundity and survival in the natural environment. This approach also represents a larger portion of the gene pool than a conventional hatchery program that collects broodstock (Berejikian et al. 2008).
- Natural-origin summer chum salmon are undetectable because they are a different species than those propagated by the programs and have different spatial and temporal spawning requirements than fall chum, making interbreeding very unlikely to occur
- Natural-origin fall chum salmon are low adverse because the fall chum salmon hatchery programs are in small creeks that are unlikely to support natural-origin populations. The programs are also located close to the confluence of Hood Canal, limiting the likelihood that returning adults of these programs would spawn in areas used by natural-origin fish leading to a low adverse effect because of potential straying.
- Natural-origin pink salmon are low adverse because the one pink salmon program is located in Finch Creek, which is unlikely to support a natural-origin population of pink salmon (Hoodsport HGMP). In addition, hatchery pink salmon are acclimated on and released into Hood Canal saltwater leading to a low potential straying risk.
- Natural-origin coho salmon are low adverse because spawning is separated temporally from hatchery coho salmon, which return a month earlier than natural-origin coho salmon. In addition, only a limited number (200-800 annually) are allowed to spawn naturally and a native, naturally-reproducing coho population is not known to exist in the Big Quilcene River (USFWS 2015) However, there is still a risk of interbreeding between hatchery fish and a very small proportion of the earliest-returning natural-origin fish, but no indication to date of any adverse effect on the natural population .

Under Alternative 2, the operation of the Hood Canal hatchery programs would be the same as under Alternative 1. Therefore, there would be no change in genetic effects of the hatchery programs relative to Alternative 1.

Under Alternative 3, the Hood Canal hatchery programs would be terminated immediately. Consequently, this Alternative would reduce the short- and eliminate the long-term genetic effects caused by the proposed hatchery programs. Because hatchery fish released from the programs would continue to return for the next four to five years, but no new fish would be released, the effects would decrease to negligible adverse for most species, undetectable for steelhead, and no change for summer chum salmon relative to Alternative 1.

Under Alternative 4, the reduction in the number of hatchery coho and pink salmon in the analysis area would reduce the potential for genetic effects on natural-origin salmon and steelhead relative to Alternative 1. Despite this reduction, the effect would remain low adverse, similar to Alternative 1, because hatchery fish of each species would still be produced in addition to those already residing in the system.

4.3.2. Competition and Predation

Table 18. Summary of change in ecological effects on natural-origin salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Species	Alternative 1 No Action	Effects of Alternative Relative to No Action 2	3	4
Puget Sound Chinook Salmon	Medium-adverse	No change	Negligible-adverse	No change
Puget Sound Steelhead	Medium-adverse	No change	Negligible-adverse	No change
Hood Canal Summer Chum Salmon	Negligible-adverse	No change	Negligible-adverse	No change
Fall Chum	Low-adverse	No change	Negligible-adverse	No change
Pink Salmon	Low-adverse	No change	Negligible-adverse	No change
Coho Salmon	Low-adverse	No change	Negligible-adverse	No change

Under Alternative 1, the hatchery programs would be operated the same as under current conditions. Therefore, there would be no change in competition and predation effects relative to current conditions annually. Over time, these effects could compound, leading to fewer natural-origin fish, and genetic diversity may be altered if certain genotypes/phenotypes of fish are preyed upon and competed with over others. The effects on:

- Natural-origin Chinook salmon are medium adverse due to competition with and predation by hatchery yearling steelhead, coho salmon, and un-listed Chinook salmon. Any yearlings that residualize would also pose a predation risk, although Chinook salmon appear to have the longest residence time and thus would pose the highest risk (Section

3.3.2) There is also likely some spawning site competition with hatchery Chinook salmon due to similar site requirements.

- Natural-origin steelhead are medium adverse due to competition and predation with hatchery yearling steelhead, coho salmon, and unlisted Chinook salmon. Any yearlings that residualize would also pose a predation risk. Spawning site competition may occur with hatchery steelhead, but is unlikely for other species due to temporal separation in spawning times.
- Natural-origin summer chum salmon are negligible adverse because measures are currently applied through the hatchery programs to delay the timing of hatchery salmon and steelhead releases to minimize ecological interactions, and their spawn timing is separated spatially and temporally from the other species
- Natural-origin fall chum salmon are low adverse because hatchery fish are unlikely to compete or prey on natural-origin fall chum salmon due to the delay in releases until natural-origin fish have emigrated. However, returning hatchery-origin fall chum and coho salmon are likely to compete with natural-origin fall chum for spawning sites. For coho salmon, this is limited because hatchery coho salmon return a month earlier and only originate from one river, the Big Quilcene.
- Natural-origin pink salmon are low adverse because hatchery fish are unlikely to compete with or prey on natural-origin pink salmon due to the delay in hatchery releases until natural-origin fish have emigrated. Returning hatchery-origin adults are unlikely to compete with natural-origin fall chum, coho, and pink salmon adults for spawning sites due to the placement of the hatcheries in small creeks with no natural-origin fish populations.
- Coho salmon are low adverse because they may be preyed upon by hatchery-origin yearlings and compete with space for subyearlings, and because they may potentially compete for spawning space with all other species of salmon and steelhead

Under Alternative 2, the operation of the Hood Canal hatchery programs would be the same as under Alternative 1, resulting in no change in competition and predation effects on natural-origin salmon and steelhead relative to Alternative 1.

Under Alternative 3, the Hood Canal hatchery programs would be terminated immediately. Consequently, no hatchery fish would be released to compete with or prey on natural-origin fish. However, adults would continue to return for the next four to five years, leading to some spawning site composition and redd superimposition. Relative to Alternative 1, the effects on natural-origin fish would be negligible-adverse for all species.

Under Alternative 4, the decreased production of pink and coho salmon would most likely reduce competition and predation by pink and coho salmon on natural-origin fish of all species, and reduce the amount of hatchery-origin prey relative to Alternative 1. However, this change may also result in increased predation on natural-origin fish of all species by the yearling Chinook salmon and steelhead to compensate for the loss in pink and coho salmon prey. Thus, there is no change in effects relative to Alternative 1 because the benefit associated with reductions in competition and predation by coho and pink salmon is offset by the loss in prey and the potential increased predation by Chinook salmon and steelhead.

4.3.3. Prey Enhancement

Table 19. Summary of change in prey enhancement effects on natural-origin salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

	Alternative 1	**Effects of Alternative Relative to No Action**		
Species	**No Action**	**2**	**3**	**4**
Puget Sound Chinook Salmon	Medium-beneficial	No change	Medium-adverse	No change
Puget Sound Steelhead	Negligible-beneficial	No change	Negligible-adverse	No change
Hood Canal Summer Chum Salmon	Undetectable	No change	No change	No change
Fall Chum	Medium-beneficial	No change	Medium-adverse	No change
Pink Salmon	Low-beneficial	No change	Low-adverse	Negligible-beneficial
Coho Salmon	Low-beneficial	No change	Low-adverse	Negligible-beneficial

Under Alternative 1, the hatchery programs would be operated the same as under current conditions. Therefore, there would be an increase in prey enhancement relative to current conditions as the release of fish would follow the values in

Table 4 and Table 5 each year. The effects of the programs on:

- Chinook and fall chum salmon are medium beneficial because they release large numbers of juveniles of those species
- Steelhead are negligible beneficial because fewer than 50,000 fish are released
- Hood Canal summer chum are undetectable because no summer chum are propagated and they are unlikely to prey on hatchery fish due to the small size of summer chum salmon at emigration to the sea
- Coho and pink salmon are low beneficial because the programs release a million fish or fewer of these species

Under Alternative 2, the hatchery programs would be operated similar to Alternative 1, resulting in no change in prey enhancement relative to Alternative 1.

Under Alternative 3, the immediate termination of the hatchery programs would eliminate any prey enhancement benefit. Thus, prey enhancement adverse effects are medium (Chinook and fall chum salmon), low (pink and coho salmon) or negligible relative to Alternative 1. Summer chum salmon are expected to be unaffected due to their small size at emigration to the sea.

Under Alternative 4, decreased production of pink and coho salmon would reduce the available prey by approximately 700,000. This would result in no change relative to Alternative 1 for Chinook salmon, steelhead, and summer chum salmon, but would reduce the effects of coho and pink salmon to negligible beneficial relative to Alternative 1.

4.3.4. Facility Operations

Table 20. Summary of change in facility operation effects on natural-origin salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Species	Alternative 1 No Action	Effects of Alternative Relative to No Action 2	3	4
Puget Sound Chinook Salmon	Low-adverse	No change	Low-beneficial	No change
Puget Sound Steelhead	Low-adverse	No change	Low-beneficial	No change
Hood Canal Summer Chum Salmon	Low-adverse	No change	Low-beneficial	No change
Fall Chum	Low-adverse	No change	Low-beneficial	No change
Pink Salmon	Low-adverse	No change	Low-beneficial	No change
Coho Salmon	Low-adverse	No change	Low-beneficial	No change

Under Alternative 1, the hatchery programs would be operated the same as under current conditions. Therefore, there would be no change in facility operations relative to current conditions. Because not all of the facilities comply with screening criteria (i.e., Hoodsport, Port

Gamble, and Enetai Creek Hatcheries), there is some potential for fish to be harmed by the hatchery intake. Even though Finch Creek, Little Boston Creek, and Enetai Creek do not support any listed fish populations due to their small size, listed fish could migrate into those areas. In addition, the adverse effects of weirs and smolt traps are minimized by checking traps daily, releasing any fish not intended for broodstock, and typically encountering only a small portion (less than 5 percent) of outmigrating juveniles. Thus, the potential for adverse facility operation effects is low for all the species included in Table 20.

Under Alternative 2, the hatchery programs would be operated similar to Alternative 1. Thus, there would be no change in facility operation effects relative to Alternative 1.

Under Alternative 3, the immediate termination of the hatchery programs would eliminate the associated facility operations. Thus, there would be no use of weirs, water intake structures, or smolt traps, leading to a low beneficial effect relative to Alternative 1.

Under Alternative 4, decreased production of coho and pink salmon would likely result in no change for weir, smolt trap, and water intake operations as they would still be needed to maintain the program regardless of size. Thus, there would be no change in facility operation effects relative to Alternative 1.

4.3.5. Masking

Table 21. Summary of change in masking effects on salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Species	Alternative 1 No Action	Effects of Alternative Relative to No Action		
		2	3	4
Puget Sound Chinook Salmon	Undetectable	No change	No change	No change
Puget Sound Steelhead	Undetectable	No change	No change	No change
Hood Canal Summer Chum Salmon	Medium-adverse	No change	Medium-beneficial	No change
Fall Chum	Medium-adverse	No change	Medium-beneficial	No change
Pink Salmon	Low-adverse	No change	Low-beneficial	No change
Coho Salmon	Low-adverse	No change	Low-beneficial	No change

Under Alternative 1, although the hatchery programs would be operated identically to current conditions, there would be an increased adverse masking effect due to the continued release of unmarked fish into the future. The program effects on masking of:

- Chinook salmon and steelhead would be undetectable because all hatchery programs producing these species mark 100 percent of the fish
- Summer and fall chum salmon are medium-adverse because fall chum are not marked,

masking the actual numbers of natural-origin fish of both runs, and releases for this species are large (~16 million)

- Pink salmon are low adverse because they are not marked, but their release numbers are considerably smaller than fall chum salmon (500,000) and only occur every other year
- Coho salmon are low adverse because, even though all released coho salmon are marked, the progeny of the hatchery-origin fish Quilcene National Fish Hatchery passed upstream are not marked and could mask the status of natural coho salmon populations

Under Alternative 2, the hatchery programs would be operated similar to Alternative 1, resulting in no masking effect changes relative to Alternative 1.

Under Alternative 3, the immediate termination of the Hood Canal hatchery programs would reduce the effects of masking relative to Alternative 1 as all fish after the last adults return in four to five years would be of natural-origin. This would result in a medium beneficial effect for natural-origin summer and fall chum salmon and a low beneficial effect for natural-origin pink and coho salmon relative to Alternative 1. There would be no change in effects on Chinook salmon and steelhead.

Under Alternative 4, the reduction of coho and pink salmon production would reduce masking effects relative to Alternative 1 for pink and coho salmon. Fewer unmarked hatchery pink and coho salmon would be released overall. However, the upstream passage of hatchery coho salmon would likely remain at the same level and unmarked pink salmon would still be released, resulting in no change in effect relative to Alternative 1. There would be no change in masking effects for the remaining species because production levels for Chinook and fall chum salmon and steelhead are the same as for Alternative 1.

4.3.6. Fisheries

Table 22. Summary of change in fisheries' effects on natural-origin salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Species	Alternative 1 No Action	Effects of Alternative Relative to No Action 2	3	4
Puget Sound Chinook Salmon	Low-adverse	No change	Negligible-adverse	No change
Puget Sound Steelhead	Low-adverse	No change	Negligible-adverse	No change
Hood Canal Summer Chum Salmon	Low-adverse	No change	Negligible-adverse	No change
Fall Chum	Low-adverse	No change	Negligible-adverse	No change
Pink Salmon	Low-adverse	No change	Negligible-adverse	No change
Coho Salmon	Low-adverse	No change	Negligible-adverse	No change

Under Alternative 1, although the hatchery programs would be operated identically to current conditions, there would be an increase in fisheries effects associated with the hatchery programs relative to current conditions due to the continued operation of the fisheries into the future. Fisheries effects because of the hatchery programs are:

- Low adverse for Chinook and summer chum salmon and steelhead because there are no fisheries associated with the Hamma Hamma Chinook salmon or steelhead programs and none of the programs rear summer chum salmon. Fisheries for other reared species such as coho and fall chum salmon can also incidentally take Chinook and summer chum salmon and steelhead. However, incidental take is regulated to a known low level (NMFS 2001; NMFS 2011b).
- Low adverse for fall chum, pink, and coho salmon because fisheries for these species target both hatchery- and natural origin fish. In addition, these species can be taken incidentally in the fisheries for Puget Sound Chinook salmon. However, the applicants regulate and agree to fisheries for all species in Puget Sound, which limits the number of fish harvested in accordance with the estimated number of fish available (WDFW 2015a).

Under Alternative 2, the hatchery programs would be operated similar to Alternative 1. Thus, there would be no change in fisheries effects relative to Alternative 1.

Under Alternative 3, the immediate termination of the Hood Canal hatchery programs would reduce fisheries effects relative to Alternative 1 after the most recent juvenile fish return as adults in four to five years. Effects would not be eliminated because these proposed programs are not the sole producers of fish for the fisheries. The effects on Chinook and summer chum salmon and steelhead would be negligible adverse because no hatchery fish from these proposed Hood Canal programs would exist to support the fisheries, restricting harvest. The effects on natural-origin coho, fall chum, and pink salmon may increase because the hatchery-origin fish no longer shield natural-origin fish. However, it is likely that fisheries would become more restrictive to account for the decrease in fish abundance, resulting in a negligible-adverse effect.

Under Alternative 4, there would be no change in fisheries effects relative to Alternative 1 as both the coho and pink salmon fisheries would still occur. Although the number of each species available to the fishery would be reduced, it is unlikely that this reduction would restrict harvest to a level that warrants a change in effect to negligible.

4.3.7. Disease

Table 23. Summary of change in disease effects on natural-origin salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

	Alternative 1	Effects of Alternative Relative to No Action

Species	No Action	2	3	4
Puget Sound Chinook Salmon	Negligible-adverse	No change	Negligible-beneficial	Negligible-beneficial
Puget Sound Steelhead	Negligible-adverse	No change	Negligible-beneficial	Negligible-beneficial
Hood Canal Summer Chum Salmon	Negligible-adverse	No change	Negligible-beneficial	Negligible-beneficial
Fall Chum	Negligible-adverse	No change	Negligible-beneficial	Negligible-beneficial
Pink Salmon	Negligible-adverse	No change	Negligible-beneficial	Negligible-beneficial
Coho Salmon	Low-adverse	No change	Negligible-beneficial	Negligible-beneficial

Under Alternative 1, although the hatchery programs would be operated identically to current conditions, there would be an increase in disease effects associated with the hatchery programs relative to current conditions, due to the continued operation of the programs into the future. Because strict fish health policies are in place to control the spread of pathogens, disease effects are negligible adverse for all hatchery programs except for the low adverse effect associated with the Quilcene National Fish Hatchery Yearling Coho program, which passes coho salmon above the hatchery intake. If these coho are carrying any pathogens, these could be transmitted to the hatchery water supply and lead to an outbreak in hatchery fish. Infected hatchery fish could then amplify pathogen levels in the Big Quilcene River, increasing the infection risk to natural-origin fish.

Under Alternative 2, the hatchery programs would be operated similar to Alternative 1. There would be no change in disease effects relative to Alternative 1.

Under Alternative 3, the immediate termination of the Hood Canal hatchery programs would likely reduce disease effects to negligible beneficial relative to Alternative 1 as no hatchery fish would be available after the last adults return in four to five years for pathogen transmission.

Under Alternative 4, the decreased production of coho and pink salmon would likely indirectly reduce disease effects through the reduction of available hosts in Hood Canal. Reduced hatchery rearing densities will also likely reduce the chance of a disease outbreak during hatchery residence relative to Alternative 1, resulting in a negligible-beneficial effect for all species.

4.3.8. Population Viability

Table 24. Summary of change in population viability of natural-origin salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

	Alternative 1	Effects of Alternative Relative to No Action		
Species	No Action	2	3	4
Puget Sound Chinook Salmon	Medium-beneficial	No change	Medium-adverse	No change
Puget Sound Steelhead	Medium-beneficial	No change	Medium-adverse	No change

Hood Canal Summer Chum Salmon	Undetectable	No change	No change	No change
Fall Chum	Low-adverse	No change	Low-beneficial	No change
Pink Salmon	Low-adverse	No change	Low-beneficial	Negligible-adverse
Coho Salmon	Low-adverse	No change	Low-beneficial	Negligible-adverse

Under Alternative 1, the hatchery programs would be operated identically to current conditions, but over time, there would be changes in population viability associated with the hatchery programs relative to current conditions. The effects of the hatchery programs on population viability for:

- Chinook salmon and steelhead are likely to increase through increased abundance. For both integrated programs, potential increases in abundance outweigh the genetic risks of supplementing the natural populations with fish reared in a hatchery. However, fish that have some hatchery influence may be less fit than natural-origin fish and could reduce the productivity of natural-origin fish. Over time, we anticipate that other viability factors such as genetic diversity and spatial structure will increase as natural-origin returns increase, leading to a medium beneficial effect.
- Summer chum salmon population viability are undetectable because none of these hatchery programs rear summer chum salmon.
- Pink, fall chum, and coho salmon are low adverse, through straying of fish that have undergone hatchery-influenced selection and interbreeding with natural populations. This could potentially decrease genetic diversity and productivity of the natural-origin populations.

Under Alternative 2, the hatchery programs would be operated similar to Alternative 1, resulting in no change in population viability relative to Alternative 1.

Under Alternative 3, the immediate termination of the Hood Canal hatchery programs would reduce population viability for the integrated Chinook salmon and steelhead programs, but may increase population viability for fall chum, pink salmon, and coho salmon. Because the mid-Hood Canal Chinook salmon population is considered at high risk of extinction and has low abundance relative to population viability targets, by eliminating the only recovery program designed to aid this population, Alternative 3 would reduce abundance and any long-term viability benefits (e.g., increased spatial structure) relative to Alternative 1, increasing extinction risk. This results in a medium adverse effect relative to Alternative 1. Elimination of the steelhead supplementation program would also eliminate the only active efforts to increase steelhead abundance and long-term viability benefits for the entire Puget Sound Steelhead DPS, increasing extinction risk relative to Alternative 1. In contrast, the elimination of the segregated pink, fall chum, and coho salmon programs may improve the population viability of natural-origin populations by eliminating genetic risks and maintaining the genetic diversity of the natural populations, resulting in a low beneficial effect. There is no change in population viability for summer chum salmon because this species is not propagated by any of the proposed hatchery programs.

Under Alternative 4, decreased production of pink and coho salmon may decrease effects on population viability to a negligible adverse level relative to Alternative 1, as fewer fish would be released to interbreed with natural-origin fish in a manner that could impact productivity. Because no reductions are made to the other hatchery programs, population viability for the other species would be similar to Alternative 1.

4.3.9. Nutrient Cycling

Table 25. Summary of change in nutrient cycling on natural-origin salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Species	Alternative 1 No Action	Effects of Alternative Relative to No Action		
		2	3	4
Puget Sound Chinook Salmon	Low-beneficial	No change	Low-adverse	No change
Puget Sound Steelhead	Low-beneficial	No change	Low-adverse	No change
Hood Canal Summer Chum Salmon	Low-beneficial	No change	Low-adverse	No change
Fall Chum	Low-beneficial	No change	Low-adverse	No change
Pink Salmon	Low-beneficial	No change	Low-adverse	No change
Coho Salmon	Low-beneficial	No change	Low-adverse	No change

Under Alternative 1, the hatchery programs would be operated identically to current conditions, but over time, there would be an increase in nutrient cycling associated with the continued production of hatchery fish by the hatchery programs relative to current conditions. The effects of nutrient cycling are low beneficial for all species because some (Chinook salmon) or all (steelhead) of the fish from the integrated programs are intended to spawn naturally. Surplus hatchery fish from the segregated programs are typically sold or donated and not passed upstream limiting their nutrient cycling benefits to strays. The exception is coho salmon because Quilcene National Fish hatchery passes some fish upstream annually (~200-800).

Under Alternative 2, the hatchery programs would be operated the same as under Alternative 1, resulting in no change in nutrient cycling relative to Alternative 1.

Under Alternative 3, the immediate termination of the Hood Canal hatchery programs would eliminate any nutrient contribution from hatchery fish, resulting in an elimination of the hatchery programs' beneficial effect described in Alternative 1. This would lead to a low adverse effect relative to Alternative 1.

Under Alternative 4, the decreased production of coho and pink salmon would result in no change in the effects of nutrient cycling relative to Alternative 1, because fish from the reduced programs would not typically have moved into natural production areas, so their loss would not represent a reduction in nutrients transported upstream. Despite the decrease in numbers, adult management plans are unlikely to change. Although reductions could lead to smaller numbers of fish that stray into other river systems, there is unlikely to be a measurable difference from the proposed production levels.

4.3.10. Research, Monitoring and Evaluation

Table 26. Summary of change in RM&E effects on natural-origin salmon and steelhead relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Species	Alternative 1 No Action	Effects of Alternative Relative to No Action 2	3	4
Puget Sound Chinook Salmon	Negligible-adverse	No change	Low-adverse	No change
Puget Sound Steelhead	Low-adverse	No change	Medium-adverse	No change
Hood Canal Summer Chum Salmon	Negligible-adverse	No change	Low-adverse	No change
Fall Chum	Negligible-adverse	No change	Low-adverse	No change
Pink Salmon	Negligible-adverse	No change	Low-adverse	No change
Coho Salmon	Negligible-adverse	No change	Low-adverse	No change

Under Alternative 1, the hatchery programs would be operated identical to current conditions, but RM&E effects would continue to increase on natural-origin salmon and steelhead over time. A negligible adverse effect was assessed for all species except steelhead, based on the potential for interference with spawning and rearing of natural-origin fish during spawning and outmigrant surveys. A low adverse RM&E effect was assessed for Puget Sound steelhead because additional research (e.g., redd surveys, genetic sampling) was proposed for the Hood Canal Steelhead Supplementation program. However, this research is ending in 2023, after which effects on steelhead would decrease to negligible adverse.

Under Alternative 2, the hatchery programs would be operated the same as under Alternative 1, resulting in no change in RM&E effects relative to Alternative 1.

Under Alternative 3, the immediate termination of the Hood Canal hatchery programs would eliminate the need to conduct RM&E, thereby eliminating adverse effects of the RM&E activities, but would also eliminate the beneficial effect. This increases the severity of the adverse effects to medium (steelhead) and low (other species), because the information gained on natural populations from conducting RM&E would be lost.

Under Alternative 4, the decreased production of coho and pink salmon would result in no change in RM&E effects on natural-origin populations relative to Alternative 1 because both the pink and coho salmon programs would still need RM&E to evaluate the remaining released fish.

4.4. Other Fish Species

Table 27. Summary of change in effects on other fish species relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Resource	Effects	Alternative 1	Effects of Alternative Relative to No Action 2	3	4
Other Fish Species	Competition	Low-adverse	No change	Low-beneficial	Negligible-adverse
	Predation	Low-adverse	No change	Low-beneficial	Negligible-adverse
	Prey enhancement	Low-beneficial	No change	Low-adverse	Negligible-beneficial
	Facilities	Low-adverse	No change	Low-beneficial	Negligible-adverse
	Fisheries	Low-adverse	No change	Low-beneficial	Negligible-adverse
	Disease	Low-adverse	No change	Low-beneficial	Negligible-adverse
	Nutrient cycling	Low-beneficial	No change	Low-adverse	Negligible-beneficial

Under Alternative 1, the hatchery programs would be operated identical to current conditions, but the hatchery effects on other fish species would increase relative to current conditions with the continued operation of the hatchery programs. The effects of competition, predation, and prey enhancement are low adverse (competition and predation) and low beneficial (prey enhancement) because salmon and steelhead are not the only prey/predators/competitors of any of the other fish. Facility effects are also low adverse because any other fish encountered would be released. Fisheries' effects on other fish species are low adverse because the gear used is not suitable for many of the other fish species, except for sturgeon. Disease effects are also low adverse because many pathogens found in hatcheries are specific for salmon and steelhead. Nutrient cycling effects are low beneficial because hatchery fish are likely to contribute nutrients to the system after spawning.

Under Alternative 2, the operation of the Hood Canal hatchery programs would be the same as under Alternative 1, resulting in no change in effects on other fish species relative to Alternative 1.

Under Alternative 3, the Hood Canal hatchery programs would be terminated immediately. Consequently, the total number of salmon and steelhead available to other fish species as prey and for nutrient cycling would decrease to low adverse relative to Alternative 1. However, the adverse effects of operating the hatchery facilities and fisheries, along with salmon and steelhead as potential predators, competitors, and sources of disease for other fish species would be eliminated resulting in low beneficial effects relative to Alternative 1.

Under Alternative 4, decreased pink and coho salmon production would cause the same reduction in effects as Alternative 3, but the reduction is unlikely to be as severe (i.e., negligible).

4.5. Wildlife

Table 28. Summary of change in effects on wildlife relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Resource	Effect	Alternative 1 No Action	Effects of Alternative Relative to No Action 2	3	4
Wildlife	Facility operations	Negligible-adverse	No change	Negligible-beneficial	No change
	Prey enhancement	Low-beneficial	No change	Low-adverse	No change
	Competition	Negligible-adverse	No change	Low-adverse	No change
	Predation	Negligible-adverse	No change	Low-adverse	No change
	Nutrient cycling	Low-beneficial	No change	Low-adverse	No change
	Disease	Negligible-adverse	No change	Negligible-beneficial	No change

Under Alternative 1, the Hood Canal hatchery programs would be operated the same as current conditions, but the effects on wildlife relative to current conditions would increase along with continued program operation. Competition and predation are negligible adverse as hatchery salmon and steelhead are more likely to be prey for most wildlife. Facility operations are also negligible adverse as only passive methods are used to deter predators at hatchery facilities. In addition, disease effects are negligible adverse because many pathogens found in hatcheries are specific for salmon and steelhead. Prey enhancement and nutrient cycling have a low beneficial effect because about 20.8 million fish are released into Hood Canal from these programs. This is only about 14 percent of the total number of hatchery salmon and steelhead released into Puget Sound. In addition, wildlife predators typically do not rely solely on salmon and steelhead as a prey source.

Under Alternative 2, the operation of the Hood Canal hatchery programs would be the same as under Alternative 1, resulting in no change in effects on wildlife relative to Alternative 1.

Under Alternative 3, the Hood Canal hatchery programs would be terminated immediately. Consequently, Alternative 3 would eliminate the effects of facility operations on wildlife, including disease/toxin risks, leading to a negligible-beneficial effect relative to Alternative 1. Disease risks to wildlife would also be reduced to a negligible-beneficial effect relative to

Alternative 1. In addition, this alternative would reduce hatchery salmon and steelhead prey for wildlife (including killer whales, bald eagles, and golden eagles), resulting in a low adverse effect relative to Alternative 1. This alternative may also increase competition for wildlife species with shared food preferences, such as gulls and cormorants and may shift predation pressure to other wildlife species such as frogs to compensate for the loss in salmon leading to a low adverse effect relative to Alternative 1. Terminating these hatchery programs will reduce nutrient exchange among the marine, freshwater, and terrestrial ecosystems in four to five years after the last adults return and would lead to a low adverse effect relative to Alternative 1.

Under Alternative 4, decreased production of coho and pink salmon would reduce prey availability but only by about 3.4 percent, resulting in no change in effect. Nutrient cycling, disease/toxin risks, and predation on wildlife by coho and pink salmon would also be reduced. Similar to Alternative 3, competition among wildlife species that prey on salmon may increase with the decrease in salmon prey. Because the pink and coho programs would continue to operate, facility operation effects under this alternative would likely result in no change relative to Alternative 1. For all of these effects on wildlife, although some will likely be reduced, the reduction is not enough to warrant a change in effects level relative to Alternative 1.

4.6. Socioeconomics

Table 29. Summary of change in effects on socioeconomics relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Resource	Alternative 1 No Action	Effects of Alternative Relative to No Action 2	3	4
Socioeconomics	Medium-beneficial	No change	Medium-adverse	Low-beneficial

Under Alternative 1, the hatchery programs would be operated the same as under current conditions, but there would be an increase in employment opportunities or the local procurement of goods and services for hatchery operations over time. Thus, the contribution of over 6.4 million dollars and 188 jobs to the regional economy leads to a medium beneficial effect of these hatchery programs.

Under Alternative 2, the operation of the Hood Canal hatchery programs would be the same as under Alternative 1, with no change in employment opportunities or the local procurement of goods and services for hatchery operations.

Under Alternative 3, the Hood Canal hatchery programs would be terminated immediately. Operation of the hatchery programs would no longer contribute jobs or operational expenses to the regional economy. Fish available for harvest would be reduced in four to five years after the last adults return, potentially leading to a reduction in the income of commercial fishermen. Indirect effects include the elimination of excess hatchery fish for contract buyers and a potential decline in the purchase of fishing-related supplies leading to a medium adverse effect.

Under Alternative 4, coho and pink salmon production by the Hood Canal hatchery programs would be reduced by about 3.4 percent, with no expected change in employment. Reduced fish production may have effects on income to the region through reduced harvest and fishing opportunity resulting from fewer returning adult fish. However, the reductions in the programs were designed to eliminate excess returns to the hatchery, not to limit harvest. Therefore, harvest opportunities would remain intact, but the reduction in excess hatchery fish will decrease the fish available for purchase by contract buyers, leading to a low beneficial effect.

4.7. Cultural Resources

Table 30. Summary of change in effects on cultural resources relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Resource	Alternative 1 No Action	Effects of Alternative Relative to No Action 2	3	4
Cultural Resources	Medium-beneficial	No change	Medium-adverse	Low-adverse

Under Alternative 1, the survival and well-being of salmon would improve relative to current conditions. This would be expected to improve the well-being of the Tribes through the long-term potential for Hood Canal salmon and steelhead to contribute meaningfully to the Tribes' fisheries in their Usual and Accustomed Fishing Areas, culture, and nutritional health leading to a medium beneficial effect.

Under Alternative 2, the operation of the Hood Canal hatchery programs would be the same as for Alternative 1, resulting in no change in effects on cultural resources relative to Alternative 1.

Under Alternative 3, the immediate termination of the Hood Canal hatchery programs would reduce the number of salmon and steelhead utilizing the Tribes' Usual and Accustomed Fishing Areas, and the Tribes' access to salmon and steelhead for cultural practices in four to five years after the last adults return. Immediate termination would also be expected to reduce the nutritional well-being of the Tribes, especially elders who depend on surplus fish as a source of fresh salmon, resulting in a medium adverse effect relative to Alternative 1.

Under Alternative 4, a reduction in coho and pink salmon would reduce the number of harvestable fish returning to the Tribes' Usual and Accustomed Fishing Areas, but this is intended to reduce the return of excess hatchery fish not being taken in either tribal or non-tribal fisheries. However, this would also reduce the number of surplus fish available to the tribes for food banks. If the viability of stocks limiting fisheries in Hood Canal (mid-Hood Canal Chinook salmon) improves, fisheries on other salmon and steelhead stocks for harvest, such as coho salmon, that otherwise could increase would not have the harvestable fish available. Therefore, cultural resources, in the form of surplus fish for food banks would be substantially impacted in the near term, and would suffer in the longer term, along with the loss of harvest opportunity due to the absence of the hatchery-produced harvestable fish, resulting in a low adverse effect relative to Alternative 1.

4.8. Environmental Justice

Table 31. Summary of change in effects on environmental justice relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

	Alternative 1	Effects of Alternative Relative to No Action		
Resource	**No Action**	**2**	**3**	**4**
Environmental Justice	Medium-beneficial	No change	Medium-adverse	Low-adverse

Under Alternative 1, the hatchery programs would be operated the same as under current conditions. Over time, the hatchery fish would continue to be available to Tribes for harvest and the four programs operated by the Tribes (e.g., Port Gamble Hatchery fall chum, Enetai Creek fall chum, Port Gamble coho net pens and Quilcene Bay coho net pens) would continue to provide jobs and personal income, resulting in a medium beneficial effect.

Under Alternative 2, the operation of the hatchery programs would be similar to Alternative 1 and would result in similar increases in harvestable fish cumulatively over time as well as the maintenance of jobs and personal income. Thus, there would be no change in effects on environmental justice relative to Alternative 1.

Under Alternative 3, the termination of the Hood Canal hatchery programs would result in a small increase in the amount of surface and ground water that would be available to environmental justice communities. Termination would also result in a reduction in the number of fish available to the Tribes' for ceremonial and other cultural practices as well as the potential nutritional benefits in four to five years after the last adults return. In addition, the employment and economic benefits to the community associated with the hatchery programs would be lost, resulting in a medium adverse effect.

Under Alternative 4, commercial fishers in Mason County are unlikely to be affected because the reductions in pink and coho salmon are in response to an excess of hatchery fish. The impacts on tribal communities depends on how reductions in the coho salmon programs are implemented, as there is no tribal fishery for pink salmon. It is unlikely that water quality or water quantity would change, as all three programs would still operate. However, the co-managers may decide to discontinue the operation of one of the net pen programs, reducing job opportunity and some operational costs that could affect the Tribes. Because reductions in the coho program were intended to minimize excess fish returning to Quilcene National Fish Hatchery, it is likely reductions would occur to the Quilcene program. However, the reduction in surplus fish could affect the availability of fish for tribal food banks, leading to a low adverse effect on environmental justice relative to Alternative 1.

4.9. Human Health and Safety

Table 32. Summary of change in effects on human health and safety relative to Alternative 1 (No Action). Alternative 2 is the agency preferred alternative.

Resource	Alternative 1 No Action	Effects of Alternative Relative to No Action		
		2	3	4
Human Health and Safety	Low-adverse	No change	Low-beneficial	No change

Under Alternative 1, the hatchery programs would be operated the same as under current conditions, but effects on human health and safety would be expected to increase over time due to the continued use and discharge of chemicals from the hatchery programs, which may accumulate in the environment. Although consumption of hatchery fish may increase health risks for consumers of fish, hatchery fish are likely to continue to serve as a source of food for humans. In addition, because the NPDES permit does not specifically monitor for therapeutics associated with treatment of fish diseases to ensure dilution to manufacturer recommendations, this resource is assigned a low adverse effect.

Under Alternative 2, the operation of the hatchery programs would be the same as under Alternative 1, resulting in no change in effects on human health and safety.

Under Alternative 3, the Hood Canal hatchery programs would be terminated, reducing any potentially harmful effects associated with hatchery operations on human health and safety in four to five years after the last adults return. While the reduction in hatchery fish would reduce health risk related to hatchery operations for consumers of fish, the number of fish available for consumption would decrease. We assume that, for reasons given in 4.8, other sources of food, including fish, exist, so we consider the reduction in harmful effects from hatchery practices to outweigh the loss of salmon-based nutrition in the local area. Thus, the effects are low beneficial relative to Alternative 1.

Under Alternative 4, a reduction in the production of pink and coho salmon may result in a reduction in the amount of therapeutics used to manage fish diseases and the risk associated with consuming hatchery fish. This would lead to a reduction in the potentially harmful effects to human health and safety, but likely not enough to change the effect level relative to Alternative 1. This is because all programs would continue to operate and would therefore continue to use therapeutics.

5. CUMULATIVE EFFECTS

5.1. Introduction

The National Environmental Policy Act defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). Council on Environmental Quality (CEQ) guidelines recognize that it is not practical to analyze the cumulative effects of an action from every conceivable perspective, but rather, the intent is to focus on those effects that are truly meaningful. In other words, if several separate actions have been taken or are intended to be taken within the same geographic area, all of the relevant actions together (cumulatively) need to be reviewed, to determine whether the actions *together* could have a significant impact on the human environment. Past, present, and reasonably foreseeable future actions include those that are Federal and non-Federal. For this EA analysis, they also include those that are hatchery-related (e.g., hatchery production levels) and non-hatchery related (e.g., human development).

The cumulative effects of a Proposed Action can be represented as an equation:

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

The CEQ provides an 11-step process for cumulative effects analyses that is woven into the larger NEPA process and into documents supporting a Federal action (CEQ 1997) (Table 33). Other subsections of this EA are relevant as support for this cumulative effects analysis.

Table 33. CEQ cumulative effects analysis process and documentation within this EA.

		Steps in the Process	Location within this EA
Scoping	1	Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals	Subsections 1.1, 1.2, 1.3, 5.2, 5.3, 5.4, 5.5, and 5.6
	2	Establish the geographic scope for the analysis	Subsections 1.4, 1.5, and 5.1.1

		Steps in the Process	Location within this EA
	3	Establish the time frame for the analysis	Subsection 5.1.1
	4	Identify other actions affecting the resources, ecosystems, and human communities of concern	Chapter 5
Describing the Affected Environment	5	Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stresses	Chapter 3
	6	Characterize the stresses affecting these resources, ecosystems, and human communities and relations to regulatory thresholds	
	7	Define a baseline condition for the resources, ecosystems and human communities	
Determining the Environmental Consequences	8	Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities	Chapter 3, Chapter 4, and Subsections 5.2, 5.3, 5.4, 5.5, and 5.6
	9	Determine the magnitude and significance of cumulative effects	Subsections 5.2, 5.3, 5.4, 5.5, and 5.6
	10	Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects	Chapter 2
	11	Monitor the cumulative impacts of the selected alternatives and apply adaptive management	Subsections 1.5, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.3, 2.4.1, 4.3, and Chapter 5

Chapter 3, Affected Environment, describes the existing conditions for each resource and reflects the effects of past actions and present condition. Chapter 4, Environmental Consequences, evaluates the direct and indirect effects of the alternatives on each resource's existing conditions. This chapter considers the cumulative effects of each alternative in the context of past actions, present conditions, and reasonably foreseeable future actions and conditions.

5.1.1 Geographic and Temporal Scales

The cumulative effects analysis area is Puget Sound, which includes the freshwater tributaries to Hood Canal and areas adjacent to the hatchery facilities (Subsection 1.4, Action Area). NMFS considered whether the ocean should be included in the broad analysis area, but the effects analysis was unable to detect or measure effects of the Proposed Action beyond Puget Sound. 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 Pacific Ocean. NMFS' general conclusion is that the influence of density-dependent interactions on growth and survival is likely small compared with the effects of large scale and regional environmental conditions. While there is evidence that hatchery production, on a scale many times larger than the Proposed Action, can affect salmon survival at sea, the degree of impact or level of influence is not yet understood or predictable, nor is there any evidence that programs of this size have effects in the ocean. Thus, direct, indirect, and cumulative impacts of the programs on the human environment outside Puget Sound are not expected.

The scope of the action considered here includes the rearing and release of hatchery salmon and steelhead in Hood Canal. Adult collection, rearing, and release activities would occur in localized areas only; associated direct and indirect effects of these activities are analyzed in Section 4, Environmental Consequences. Cumulative effects within the analysis area are analyzed below.

The direct, indirect, and cumulative reviews address potential effects in the entire analysis area, although adult collection, rearing, and release activities would occur in localized areas only. The HGMPs would be in effect after the associated ESA 4(d) determinations are signed, and would remain in effect until the applicants replace or retract them, or until NMFS determines that the plans are no longer effective. There would be periodic reviews of these HGMPs by NMFS every 5 years, and the plans would be modified when warranted by NMFS as specified in the approval of the plans.

5.2. Climate Change

The changing climate is becoming recognized as a long-term trend that is occurring throughout the world. Changes to biological organisms and their habitats are likely to include shifts in timing of life history events, changes in growth and development rates, changes in habitat and ecosystem structure, and rise in sea level and increased flooding (Johannessen and Macdonald 2009; Littell et al. 2009). The most heavily affected ecosystems and human activities along the Pacific coast are likely to be near areas having high human population densities, and the continental shelves off Oregon and Washington (Halpern et al. 2009). Within the Pacific Northwest, Ford (2011) summarized expected climate changes in the coming years as leading to the following physical and chemical changes (certainty of occurring is in parentheses):

- Increased air temperature (high certainty)
- Increased winter precipitation (low certainty)
- Decreased summer precipitation (low certainty)
- Decreased winter and spring snowpack (high certainty)
- Decreased summer stream flow (high certainty)
- Earlier spring peak flow (high certainty)
- Increased flood frequency and intensity (moderate certainty)

- Increased summer stream temperatures (moderate certainty)
- Increased sea level (high certainty)
- Increased ocean temperatures (high certainty)
- Intensified upwelling (moderate certainty)
- Delayed spring transition (moderate certainty)
- Increased ocean acidity (high certainty)

Hamlet (2011) notes that climate changes will have multiple effects in the Pacific Northwest, including:

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

5.3. Development

Future human population growth in the Seattle area is expected to continue over the next 15 years (Puget Sound Regional Council 2013). Although the rate of urban sprawl has been decreasing compared to increases in the late 1900s (Puget Sound Regional Council 2012), development will increase demand for housing, transportation, food, water, energy, and commerce. These needs will result in changes to existing land use through:

- 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
- Redevelopment and infill of existing developed lands
- Increases in shipping to provide food and supplies
- Increases in withdrawals of fresh water
- Increases in energy demands

To help protect environmental resources in the cumulative effects analysis area from potential future development effects, the United States has the Federal Environmental Protection Agency and Federal laws, regulations, and policies that are designed to conserve air, water, and land resources. Regulatory processes involve agency review, approval, and permitting of development actions. Regulatory examples include the Federal Endangered Species Act and the Navigable Waters regulations of the Clean Water Act.

In addition to Federal laws and processes, state and provincial laws, regulations, and guidelines will help limit the effects of future commercial, industrial, and residential development on natural ecosystems. In Washington State, various habitat conservation plans (HCPs) have been implemented, such as the Washington Department of Natural Resources (DNR) Forest Practices HCP (Washington Department of Natural Resources (DNR) 2005), and other HCPs are in development (e.g., DNR Aquatic Lands HCP and WDFW Wildlife Areas HCP). These plans will provide long-term, landscape-based protection of federally listed and non-listed species considered at risk of extinction in Washington's private and state forested lands. Other state laws, regulations, and guidance include the Washington State Environmental Policy Act, and its Endangered, Threatened, and Sensitive Species Act as described in Subsection 1.7.3, State Guidance and Regulations. A law unique to the State of Washington is the Growth Management Act (Chapter 36.70A Revised Code of Washington), which requires local land-use planning and development of regulations, including identification and protection of critical areas from future development.

In Washington, local land-use laws, regulations, and policies will also help protect the natural environment from future development effects. For example, the Puget Sound Regional Council (PSRC) developed Vision 2040 to identify goals that support preservation and restoration of the natural environment ongoing with development through multicounty policies that address environmental stewardship (Puget Sound Regional Council 2009). Vision 2040 is a growth management, environmental, economic, and transportation strategy for central Puget Sound. These objectives also include preserving open space, focusing on sustainable development, and planning for a comprehensive green space strategy. Other local policies and initiatives by counties and municipalities include designation of areas best suited for future development, such as local sensitive areas acts and shoreline protection acts.

In summary, Federal, state, and local laws, regulations, and policies will be applied with the intent to better enforce environmental protection for proposed future project developments. These laws, regulations, and policies include processes for public input, agency reviews, mitigation measures, permitting, and monitoring. The intent of these processes is to help ensure that development projects will occur in a manner that protects sensitive natural resources. The environmental goals and objectives of these processes are aimed at protecting ecosystems from activities that are regulated; however, not all activities are regulated to the same extent (e.g., large developments tend to be regulated more than smaller developments). Further, it is uncertain if such processes can successfully meet all environmental goals and objectives. Thus, although Federal, state, and local laws, regulations, policies, and guidelines are in place to protect environmental resources from future development effects, there will continue to be some cumulative environmental degradation in the future from development, albeit likely to a lesser extent than has occurred historically when environmental regulatory protections did not exist or were not comprehensive and collaborative.

5.4. Habitat Restoration

To counterbalance the human-induced changes that will affect biodiversity in the cumulative effects analysis area, future funding for environmental restoration efforts will continue to improve the sustainability of the ecosystem (Puget Sound Regional Council 2009). United States Federal agencies and organizations are expected to continue to support habitat protection and restoration initiatives/processes in Puget Sound, including projects such as the Puget Sound Nearshore Ecosystem Restoration Project (Puget Sound Nearshore Ecosystem Restoration Partnership 2013). The Puget Sound Partnership (formerly the Shared Strategy for Puget Sound) is a collaborative initiative that will continue efforts to recover the Puget Sound ecosystem (including listed salmon, steelhead, and other species) with the support of NMFS, U.S. Fish and Wildlife Service, Washington State, Puget Sound tribes, local governments, and key non-governmental organizations. In addition, implementation of salmon recovery plans in Puget Sound (HCCC 2005a; NMFS 2006; NMFS 2007; SSPS 2005) will continue to recover salmon and steelhead and the habitats on which they depend in Puget Sound. It is expected that NMFS will continue to provide funding for habitat restoration initiatives through the Pacific Coastal Salmon Recovery Fund (NMFS 2011c). Despite these initiatives, a recent review of the implementation of the Puget Sound Chinook salmon recovery plan (Judge 2011) found that habitat continues to decline and current habitat protection tools need improvement.

It is expected that Washington State will continue to support habitat restoration through actions similar to recent support efforts. In addition to cooperative partnerships with Federal agencies as described above, Ecology (2012) reserves funding for cleanups of toxics in Puget Sound. Although receiving substantial Federal support, the Puget Sound Partnership is a state agency that was created to lead the recovery of the Puget Sound ecosystem (Puget Sound Partnership 2010). The agency created, and is overseeing implementation of, a roadmap to a healthy Puget Sound. Objectives include prioritizing cleanup and improvement projects; coordinating Federal, state, local, tribal, and private resources; and ensuring that all agencies and funding partners are working cooperatively. Washington State also created the Salmon Recovery Funding Board, which administers Federal and Washington State funds to protect and restore salmon and steelhead habitat. Priorities for recovering the Puget Sound ecosystem include reducing land development pressure on ecologically important and sensitive areas, protecting and restoring floodplain function, and protecting and recovering salmon and freshwater resources (Puget

Sound Partnership 2012). In marine and freshwater areas, development will continue to be encouraged away from ecologically important and sensitive nearshore areas and estuaries, and efforts will be made to reduce sources of pollution into Puget Sound (including storm water runoff). Approaches will be used to help preserve the natural functions of the ecosystem and support sustainable economic growth. Local community efforts, such as smaller community habitat restoration and protection efforts, will help protect sensitive areas in Puget Sound.

5.5. Hatchery Production

It is likely that the type and extent of salmon and steelhead hatchery programs and the numbers of fish released in the analysis area will change over time. Although adverse effects will continue, these changes are likely to reduce effects from current levels to natural-origin salmon and steelhead such as genetic effects, competition and predation that are described in Subsection 3.3, especially for those species that are listed under the ESA (NMFS 2014a; NMFS 2014c). For example, effects to natural-origin salmon and steelhead would be expected to decrease from current levels 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, but will likely not be completely eliminated. Where needed, reductions in effects on listed salmon and steelhead may occur through changes in:

- Times and locations of fish releases to reduce risks of competition and predation
- Management of overlap in hatchery- and natural-origin spawners to meet gene flow objectives
- Decreased use of isolated hatchery programs
- Increased use of integrated hatchery programs for conservation purposes
- Incorporation of new research results and improved best management practices for hatchery operations
- Decreased production levels
- Termination of programs

Similar changes would be expected for non-listed species as well, motivated by the desire to avoid species from becoming listed. For steelhead, under WDFW's Statewide Steelhead Management Plan (WDFW 2008), Wild Steelhead Management Zones (or wild stock gene banks) are in the process of being identified and implemented in at least three Puget Sound watersheds to promote the recovery of steelhead populations (see http://wdfw.wa.gov/conservation/fisheries/steelhead/gene_bank/). In those watersheds, to protect natural-origin steelhead from the effects of steelhead hatchery programs, releases of hatchery-origin steelhead would not occur.

5.6. Fisheries

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

5.7. Cumulative Effects by Resource

Provided below is an analysis of the cumulative effects for each resource analyzed in this EA.

5.7.1. Water Quantity and Quality

Successful operation of hatcheries depends on a constant supply of high quality surface, spring, or groundwater that, after use in hatchery facilities, is discharged to adjacent receiving environments. Climate change and development are expected to affect water quality by increasing water temperatures and pollutant concentrations and affect water quantity by changing seasonality and magnitude of river flows. Although existing regulations are intended to help protect water quality and quantity from effects related to future development, such as the US Navy's 2012 purchase of a large easement from the Washington Department of Natural Resources to limit development in Hood Canal (Washington State of Natural Resoures 2013), the effectiveness of these regulations over time is likely to vary. Thus, water quality and water quantity are likely to be impaired to an additional degree when other factors are considered. Future habitat restoration would likely improve water quality and quantity such as helping to decrease water temperatures through shading, sedimentation, and water diversions. In Hood Canal, specific projects are aimed at improving both the Big Quilcene and Skokomish Rivers through the removal of dikes, excess sediment and fish barriers, for example (State of Washington Department of Ecology 2011). Because the hatchery programs included in the proposed action non-consumptively use water and monitor pollutants, the proposed action results in no change on water quantity and quality compared to current conditions when added to the other cumulative effects in the analysis area.

5.7.2. Salmon and Steelhead

Salmon and steelhead abundance naturally alternates between high and low levels on large temporal and spatial patterns that may last centuries and on more complex ecological scales than can be easily observed (Rogers et al. 2013). The effects of climate change on salmon and steelhead are described in general in ISAB (2007), and would vary among species and among species' life history stages. Effects of climate change may affect every species and life history type of salmon and steelhead in the cumulative effects analysis area (Glick et al. 2007; Mantua et al. 2009). Climate change, particularly changes in streamflow and water temperatures, would likely impact hatchery- and natural-origin salmon and steelhead life stages in various ways as summarized in Table 34.

Table 34. Examples of potential impacts of climate change by salmon and steelhead life stage under all alternatives.

Life Stage	Effects
Egg	• Increased water temperatures and decreased flows during spawning migrations would increase pre-spawn mortality and reduce egg deposition for some species. • Increased maintenance metabolism would lead to smaller fry. • Faster embryonic development would lead to earlier hatching. • Increased mortality for some species because of more frequent winter flood flows. • Lower flows would decrease access to or availability of spawning areas.
Spring and Summer Rearing	• Faster yolk utilization may lead to early emergence. • Smaller fry are expected to have lower survival rates. • Growth rates would be slower if food is limited or temperature increases exceed optimal levels. • Growth could increase where food is available, and temperatures are below stressful levels. • Lower flows would decrease habitat capacity. • Sea level rise would eliminate or diminish the tidal wetland capacity.
Overwinter Rearing	• Smaller size at start of winter is expected to result in lower winter survival. • Mortality would increase because of more frequent floods. • Warmer winter temperatures would lead to higher metabolic demands, which may decrease winter survival if food is limited, or increase winter survival if growth and size are enhanced. • Warmer winters may increase predator activity/hunger, which can decrease winter survival.
Out-Migration	• Earlier snowmelt and warmer temperatures may cause earlier emigration to the estuary and ocean either during favorable upwelling conditions, or prior to the period of favorable ocean upwelling. • Increased predation risk in the mainstem because of higher consumption rates by predators at the elevated spring water temperatures.
Adult	• Increased water temperatures may delay fish migration. • Increased water temperature may also lead to more frequent disease outbreaks as fish become stressed and crowded.

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

Previous and new developments associated with the increase in the human population (e.g., residential), accidental discharges of hazardous materials (e.g., oil), and the potential for landowner and developer noncompliance with regulations continue to affect aquatic habitat used by salmon and steelhead (Puget Sound Action Team 2007). These developments result in environmental effects such as land conversion, sedimentation, increased imperviousness of surfaces (increasing water runoff to streams), changes in stream flow because of increased consumptive uses, channelization in lower river areas, and barriers to fish passage (Quinn 2010). These environmental effects would continue to affect salmon and steelhead, especially those species that reside in lower river areas (such as floodplains and estuaries) because that is where development tends to be concentrated.

Although regulatory changes for increased environmental protection (such as local critical areas ordinances), monitoring, and enforcement have helped reduce impacts, development and fisheries may continue to reduce salmon and steelhead habitat and contribute to salmon and steelhead mortality.

Restoration of habitat will improve salmon and steelhead habitat, with particular benefits to localized freshwater and estuarine environments where the activities occur. Restoration efforts in Quilcene Bay, the Dosewallips and Duckabush estuaries, and the Skokomish River are ongoing (HCCC 2005b; State of Washington Department of Ecology 2011). As a result, habitat restoration would be expected to improve fish survival in local areas (Puget Sound Action Team 2007), at least partially off-setting losses of habitat to development.

Hatcheries in Puget Sound are designed to support fisheries, offset developmental impacts, and/or conserve native populations. Thus, hatcheries may also be used as a tool to offset climate change impacts. However, hatcheries can also pose a number of risks to natural populations. As NMFS continues to evaluate programs under the ESA, we anticipate that the number and degree of risks will decrease over time. Thus, the proposed action has no change compared to current conditions on salmon and steelhead when added to the other cumulative effects in the analysis area.

5.7.3. Other Fish Species

Similar to salmon and steelhead, other fish species require and use a diversity of habitats. Other fish species may also be affected by climate change and development because of the potential for loss or degradation of aquatic habitat or the inability to adapt to changing conditions. In addition, climate change and development may attract non-native aquatic plants that can out-compete native aquatic plants that provide important habitat to native fish (Patrick et al. 2012). Fisheries may also adversely affect other fish species through bycatch or a decrease in salmon and steelhead prey. The proposed hatchery programs may also lead to decreases in other fish species through predation and competition for the more limited habitat. However, habitat restoration actions may help mitigate impacts from climate change and development, and the hatchery programs will provide a prey source for some fish species. Thus, the proposed action has no change compared to current conditions on other fish species when added to the other cumulative effects in the analysis area.

5.7.4. Wildlife

Climate change, development, and fisheries in the cumulative effects analysis area may reduce the abundance and productivity of salmon and steelhead populations. Consequently, the total number of salmon and steelhead available as prey to wildlife may decrease, but the use of hatcheries is likely to buffer against abundance reductions to some extent. Effects would be greatest on wildlife species that prey on salmon and steelhead and may include changes in distribution in response to changes in the location of their food supply, decreases in abundance, and decreases in reproductive success. Effects on wildlife species that are competitors or prey for salmon and steelhead may benefit from the reduced abundance of salmon and steelhead associated with climate change, development, and fisheries. In addition, habitat restoration is likely to improve habitat for wildlife and may lead to increased wildlife abundance. Thus, the proposed action has no change compared to current conditions on wildlife when added to the other cumulative effects in the analysis area.

5.7.5. Socioeconomics

Climate change and development actions may reduce the number of salmon and steelhead available for harvest over time. This may reduce angler expenditure and economic output or could shift angler effort to other areas. Although habitat restoration is likely to improve habitat for salmon and steelhead and along with hatcheries, may help mitigate the effects of climate change and development, the potential benefits of habitat restoration actions within the cumulative effects analysis area from the proposed action are expected to result in no change from current conditions.

5.7.6. Cultural Resources

Climate change and development actions may reduce the number of salmon and steelhead available for harvest over time. This may reduce the number of salmon and steelhead available to tribal members for food, ceremonial purposes and as a part of their tribal identity. This reduction in salmon and steelhead may also increase tribal reliance on other consumer goods. Although habitat restoration is likely to improve habitat for salmon and steelhead and may help mitigate the effects of climate change and development, the potential benefits of habitat restoration actions within the cumulative effects analysis area are difficult to quantify. The adverse effects of climate change and development will also be mitigated by hatcheries, which will likely ensure that some salmon and steelhead remain in the Tribes’ Usual and Accustomed Fishing Areas. Thus, the proposed action has no change compared to current conditions when added to the other cumulative effects in the analysis area.

5.7.7. Environmental Justice

Climate change and development actions may reduce the number of salmon and steelhead available for harvest over time, which may reduce fishing opportunity in the analysis area. Although habitat restoration is likely to improve habitat for salmon and steelhead and may mitigate the effects of climate change and development, the potential benefits of habitat restoration actions within the cumulative effects analysis area are difficult to quantify. However, hatcheries are also likely to help mitigate the adverse effects of climate change and development. Thus, it is expected that our proposed action will result in no change compared to current conditions in addition to the other cumulative effects for Environmental Justice.

5.7.8. Human Health and Safety

Climate change, and especially development, may negatively affect human health and safety. Hatcheries do pose some potential low adverse effects on human health and safety through the release of chemicals and therapeutics through the hatchery effluent. It is likely that with increased development, increased pollution will occur that could potentially affect human health and safety, increasing susceptibility of humans to chemical exposures, but likely masking any effects of the hatchery chemicals and therapeutics. Thus, the proposed action has no change compared to current conditions when added to other cumulative effects within the analysis area.

6. Persons and Agencies Consulted

Port Gamble S'Klallam Tribe
Skokomish Tribe
Jamestown S'Klallam Tribe
Lower Elwha Klallam Tribe
Washington Department of Fish and Wildlife
U.S. Fish and Wildlife Service

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