DRAFT SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

Supplemental Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Five Hatchery Programs for Elwha River Salmon and Steelhead as Described in Joint State-Tribal Hatchery and Genetic Management Plans and One Tribal Harvest Plan Satisfy the Endangered Species Act Section 4(d) Rule

Prepared by the
National Marine Fisheries Service, West Coast Region

In Cooperation with the
National Park Service, Olympic National Park
and
Bureau of Indian Affairs, Northwest Region

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Title of Environmental Review:	Supplemental Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Five Hatchery Programs for Elwha River Salmon and Steelhead as Described in Joint State-Tribal Hatchery and Genetic Management Plans and One Tribal Harvest Plan satisfy the Endangered Species Act Section 4(d) Rule
Distinct Population Segments:	Puget Sound Chinook Salmon, Puget Sound Steelhead, and Southern Pacific Eulachon
Responsible Agency and Official:	Barry Thom Deputy Regional Administrator National Marine Fisheries Service West Coast Region 7600 Sand Point Way N.E., Building 1 Seattle, WA 98115
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Legal Mandate:	Endangered Species Act of 1973, as amended and implemented – 50 CFR Part 223
Location of Proposed Activities:	Elwha River Basin, Washington
Activity Considered:	Endangered Species Act section 4(d) Rule determinations for five Hatchery Genetic Management Plans and one Tribal Harvest Plan

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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. With regard to hatchery programs described in Hatchery and Genetic Management Plans (HGMPs), NMFS declared under limit 6 of the 4(d) Rule that section 9 take prohibitions would not apply to activities carried out under those HGMPs when NMFS determines that the HGMPs meet the requirements of limit 6.

On August 1, 2012, NMFS received four HGMPs for hatchery programs in the Elwha River (LEFT 2012a; LEKT 2012b; LEKT 2012c; LEKT and WDFW 2012)[1]. On August 31, 2012, NMFS received one additional HGMP for hatchery programs in the Elwha River (WDFW 2012a). All five HGMPs were submitted pursuant to limit 6 of the 4(d) Rule. On August 27, 2012, The Lower Elwha Klallam Tribe submitted a tribal resource management plan for harvest (Tribal Harvest Plan) of Elwha River winter steelhead (LEKT 2012d). The Tribal Harvest Plan was submitted pursuant to the Tribal 4(d) Rule.

Table 1. Permit applications for Elwha River salmon and steelhead hatchery programs.

Hatchery Program	Operator
Lower Elwha Fish Hatchery Native Steelhead Program	Lower Elwha Klallam Tribe
Lower Elwha Fish Hatchery Coho Salmon Program	Lower Elwha Klallam Tribe
Elwha River Pink Salmon Odd and Even Year Preservation and Restoration Program	Lower Elwha Klallam Tribe and Washington Department of Wildlife
Lower Elwha Fish Hatchery Fall Chum Salmon Program	Lower Elwha Klallam Tribe
Elwha Channel Facility Summer/Fall Chinook Salmon Fingerling and Yearling Program	Washington Department of Wildlife
Harvest Management Plan for Elwha River Winter Steelhead	Lower Elwha Klallam Tribe

[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.

A Draft Environmental Assessment on the effects of the proposed plans was released for a 30-day public comment period on October 16, 2012 (77 FR 63294). The comment period for review of the Draft Environmental Assessment on the proposed plans expired on November 15, 2012. A Final Environmental Assessment and a Finding of No Significant Impact were completed by NMFS on December 11, 2012.

This Draft Supplemental Environmental Assessment is being prepared in response to the court order in Wild Fish Conservancy, et al. v. National Park Service, et al., NO. C12-5109 BHS (W.D. Wash.), wherein the court held that, in order to be legally sufficient, the Environmental Assessment should either analyze in detail an alternative involving reduced releases of hatchery smolts, or adequately explain why such an alternative is unreasonable. Specifically, the court expressed concern that the alternatives in the 2012 Final Environmental Assessment did not adequately consider whether smaller-sized hatchery programs would result in fewer impacts to naturally-spawning salmonid species. The court also raised questions about how the alternatives fit the purpose and need. These concerns are addressed by the inclusion of a reduced release alternative and by additional clarifications in this Draft Supplemental Environmental Assessment.

NMFS is evaluating the five HGMPs and the Tribal Harvest Plan collectively in one Environmental Assessment because they overlap in geography, were submitted to NMFS around the same time, and rely on a common approach based upon the Elwha River Fish Restoration Plan (Ward et al. 2008). The final decisions on the hatchery and harvest plans are pursuant to separate authorities and will be made in separate ESA decision documents.

1.2. Description of the Proposed Action

The Lower Elwha Klallam Tribe and the Washington Department of Fish and Wildlife (WDFW) have submitted to NMFS five jointly operated hatchery programs in the Elwha River Basin. The plans were submitted pursuant to limit 6 of the 4(d) Rule for the listed Puget Sound Chinook salmon evolutionarily significant unit (ESU) and listed Puget Sound steelhead distinct population segment (DPS). Two of the hatchery programs release ESA-listed Chinook salmon and steelhead, and three hatchery programs release non-ESA listed coho, fall chum, and pink salmon into the Elwha River watershed. All of the programs are currently operating for Elwha River salmon and steelhead conservation purposes, and all five hatchery programs raise fish native to the Elwha River Basin.

Under the Proposed Action, NMFS would make a determination that the submitted HGMPs meet the requirements of limit 6 of the 4(d) Rule. NMFS's determination would apply for the duration of the preservation and recolonization phases of fish restoration in the Elwha River Basin, as

defined in the HGMPs. These phases would encompass the periods during removal of the two Elwha River dams (Elwha Dam and Glines Canyon Dam), and for a period following that removal as river habitat, and the productivity of salmon and steelhead populations, recover from dam removal effects. Activities included in the plans are as follows:

- Broodstock collection at Elwha Channel Facility, Lower Elwha Fish Hatchery, Morse Creek Facility, and through opportunistic seining, gaffing, and gill-netting in the lower Elwha River (Table 2)
- Holding, identification, and spawning of adult fish at WDFW's Elwha Channel Facility and Lower Elwha Klallam Tribe's Lower Elwha Fish Hatchery (Table 2)
- Egg incubation and fish rearing at Hurd Creek, Sol Duc, Elwha Channel, and Morse Creek Facilities (Elwha Channel Facility program), Lower Elwha Fish Hatchery (all other species programs), and Manchester Research Station (captive broodstock pink salmon program) (Table 2)
- Release of up to 2.5 million subyearling and 200,000 yearling Chinook salmon from Elwha Channel Facility; 200,000 yearling Chinook salmon from Morse Creek Facility (Elwha genetic reserve program); and 175,000 steelhead, 425,000 coho salmon, 1,025,000 fall chum salmon, and 3,000,000 pink salmon from Lower Elwha Fish Hatchery (Table 2)
- Upstream transport and release of adult salmon and steelhead surplus to hatchery broodstock needs via truck
- Implementation of measures to minimize risks to listed fish species, including use of only native salmon and steelhead as broodstock, maintenance of effective breeding population sizes, and application of appropriate mating protocols to minimize genetic risks; release of smolts only, release of all juvenile fish into the lowest portion of the Elwha River, and release of juvenile fish at times that minimize interactions with juvenile natural-origin fish to minimize ecological risks; and, compliance with water withdrawal, screening, and effluent discharge permits to minimize facility operation risks
- Monitoring and evaluation activities to assess the performance of the programs in preserving and recolonizing native salmon and steelhead

Activities included in the HGMPs to meet conservation objectives for each of the native Elwha River salmon and steelhead populations, including broodstock collection methods and goals, juvenile fish release numbers by life stage, and juvenile fish release locations, were developed by the *United States* v. *Washington* salmon resource managers (Washington Department of Fish and Wildlife and the Lower Elwha Klallam Tribe), as guided by the Elwha Fish Restoration Plan and federal agency and independent scientific experts. In particular, proposed annual adult broodstock collection and juvenile salmon and steelhead release numbers were developed based

on the need to produce enough returning adult fish to preserve the abundance and genetic diversity of the remnant native populations during and for a period after dam removal. The proposed HGMPs were also sized to increase the number of adult fish spawning in the river, which will aid in the recolonizing of available healthy habitat and the restoration of naturally self-sustaining populations.

Table 2. Hatchery facilities associated with the proposed Elwha River watershed native salmon and steelhead population supportive breeding programs.

Activity	Facility	Location	Does Facility Exist under Baseline Conditions?	Is Facility Operated under Baseline Conditions?
Broodstock collection[1]	Elwha Channel Facility	River mile 3.5 on the Elwha River	Yes	Yes
	Lower Elwha Fish Hatchery	River mile 1.25 on the Elwha River	Yes	Yes
	Morse Creek Facility [1]	River mile 1.0 on Morse Creek	Yes	Yes
	Opportunistic seining, gaffing, and gill-netting[1]	Downstream of river mile 4.9 on the Elwha River	N/A	Yes
Spawning	Elwha Channel Facility	River mile 3.5 on the Elwha River	Yes	Yes
	Lower Elwha Fish Hatchery	River mile 1.25 on the Elwha River	Yes	Yes
	Morse Creek Facility [1]	River mile 1.0 Morse Creek	Yes	Yes
Incubation	Hurd Creek Hatchery	River mile 0.2 on Hurd Creek (a tributary to the Dungeness at river mile 2.8)	Yes	Yes
	Lower Elwha Hatchery	River mile 1.25 on the Elwha River	Yes	Yes
Rearing	Elwha Channel Facility	River mile 3.5 on the Elwha River	Yes	Yes
	Lower Elwha Fish Hatchery	River mile 1.25 on the Elwha River	Yes	Yes
	Morse Creek Facility	River mile 1.0 Morse Creek	Yes	Yes
	Sol Duc Hatchery	River mile 29 on the Sol Duc River	Yes	Yes
	Manchester Research Station	Manchester, Washington	Yes	Yes
Juvenile release	Elwha Channel Facility	River mile 3.5 on the Elwha River	Yes	Yes

Activity	Facility	Location	Does Facility Exist under Baseline Conditions?	Is Facility Operated under Baseline Conditions?
	Lower Elwha Fish Hatchery	River mile 1.25 on the Elwha River	Yes	Yes
	Morse Creek Facility	River mile 1.0 Morse Creek	Yes	Yes
Adult release	Elwha River mainstem and tributary areas	Elwha River watershed upstream of river mile 4.9	N/A	Yes
Monitoring and evaluation	Elwha Channel Facility	River mile 3.5 on the Elwha River	Yes	Yes
	Lower Elwha Fish Hatchery	River mile 1.25 on the Elwha River	Yes	Yes
	Watershed areas accessible to natural salmon and steelhead migration, spawning and rearing	Elwha River watershed areas from river mile 0 through river mile 45 plus its tributaries	N/A	N/A

[1] Broodstock collection actions associated with the five hatchery programs were previously evaluated and authorized by NMFS through separate ESA consultations with the National Park Service addressing dam deconstruction effects on listed fish. Broodstock collection actions required to implement the Chinook salmon and steelhead hatchery plans were required as terms and conditions to limit the effects of take resulting from the release of stored sediments behind the dams.
N/A = Not applicable.

A Tribal Harvest Plan has been submitted by the Lower Elwha Klallam Tribe for harvest of hatchery-origin steelhead in the Elwha River Basin. The Tribal Harvest Plan would guide management of steelhead fisheries in the Elwha River. Harvest of Elwha steelhead outside of the Elwha River, e.g., in coastal marine salmon fisheries in British Columbia or Washington, or in the Strait of Juan de Fuca or elsewhere in Puget Sound, is not regulated by the Tribal Harvest Plan. Under the Tribal Harvest Plan, the Tribal early-timed fisheries directed at non-native, hatchery-origin steelhead (i.e., Chambers Creek fish) would continue in the lower 5 miles of the Elwha River through the 2013-2014 fishing season when the last non-native steelhead adults are expected to return. After the 2013-2014 steelhead fishing season, a moratorium on all Elwha River tribal fisheries would be in effect, and the Lower Elwha Klallam Tribe would stop fishing in the Elwha River Basin until 2018. At that point, the Tribe proposes to initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on native stock, hatchery-origin fish if the late-timed natural-origin steelhead abundance is projected to exceed 300 fish. Beginning January of 2020 and later, if the natural-origin component of the steelhead population exceeds 500 fish, the Lower Elwha Klallam Tribe would scale up their fishery to target 200 to 300 hatchery-origin steelhead.

1.3. Purpose of and Need for the Action

The purpose of the Proposed Action is to ensure that the hatchery programs operated by the Lower Elwha Klallam Tribe and WDFW for the production of Chinook salmon, steelhead, coho salmon, fall chum salmon, and pink salmon as described in the five HGMPs and the Tribal Harvest Plan comply with the requirements of the ESA, and are reviewed for potential approval under the ESA 4(d) Rule.

NMFS's need for the Proposed Action is two-fold:

- Ensure the proposed hatchery programs and harvest plan comply with the requirements of the ESA
- Meet NMFS's tribal treaty rights stewardship responsibilities

The applicants' need for the Proposed Action is five-fold:

- Preserve and assist in the recolonization of all native salmon and steelhead populations in the Elwha River Basin during and after the removal of two dams
- Ensure substantial progress towards fish restoration in the Elwha River within a 20- to 30-year time frame
- Fulfill treaty-reserved fishing rights on steelhead[2] and Chinook, pink, chum, and coho salmon as the populations recover
- Provide fishing opportunities for citizens of Washington State as the populations recover
- Use existing hatchery facilities to meet the recovery objectives for the Elwha River

1.4. Action Area

The action area (or project area) is the geographic area where the Proposed Action would take place. It includes the places where Elwha River fish would be spawned, incubated, reared, acclimated, released, or harvested under the proposed hatchery and tribal harvest plans (Figure 1). The following facilities would be used by the Elwha River hatchery programs:

- Elwha Channel Facility (river mile 3.5 on Elwha River)
- Lower Elwha Fish Hatchery (river mile 1.25 on Elwha River)
- Morse Creek Facility (river mile 1.0 on Morse Creek)
- Elwha River mainstem weir (river mile 3.7 on the Elwha River)

[2] The proposed Tribal Harvest Plan (LEKT 2012d) for native stock hatchery-origin steelhead takes into account the status of the total adult return of native Elwha River steelhead in its current depressed condition, and the need for the population to recover. As such, steelhead harvests under the Tribal Harvest Plan would be maintained at very low levels, and below levels that would allow fulfillment of the Lower Elwha Tribe's treaty-reserved fishing rights.

- Hurd Creek Hatchery (river mile 0.2 on Hurd Creek, a tributary to the Dungeness River at river mile 2.8)
- Sol Duc Hatchery (river mile 29 on the Sol Duc River)
- Manchester Research Station (Manchester, Washington)

In addition, adult hatchery-origin fish would be released in mainstem and tributary areas above river mile 4.9 of the Elwha River. Monitoring and evaluation activities would occur from the mouth of the Elwha River upstream to river mile 45 (its headwaters) plus its tributaries, including in the Olympic National Park and Olympic Wilderness Area. Harvest activities may occur in the Elwha River mainstem as far upstream as the boundary of the Olympic National Park (river mile 9.6) starting with tribal ceremonial and subsistence fisheries in 2018.

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 action area, since some of the effects of the alternatives may occur outside the action area. The analysis area for each resource is described in Chapter 3, Affected Environment.

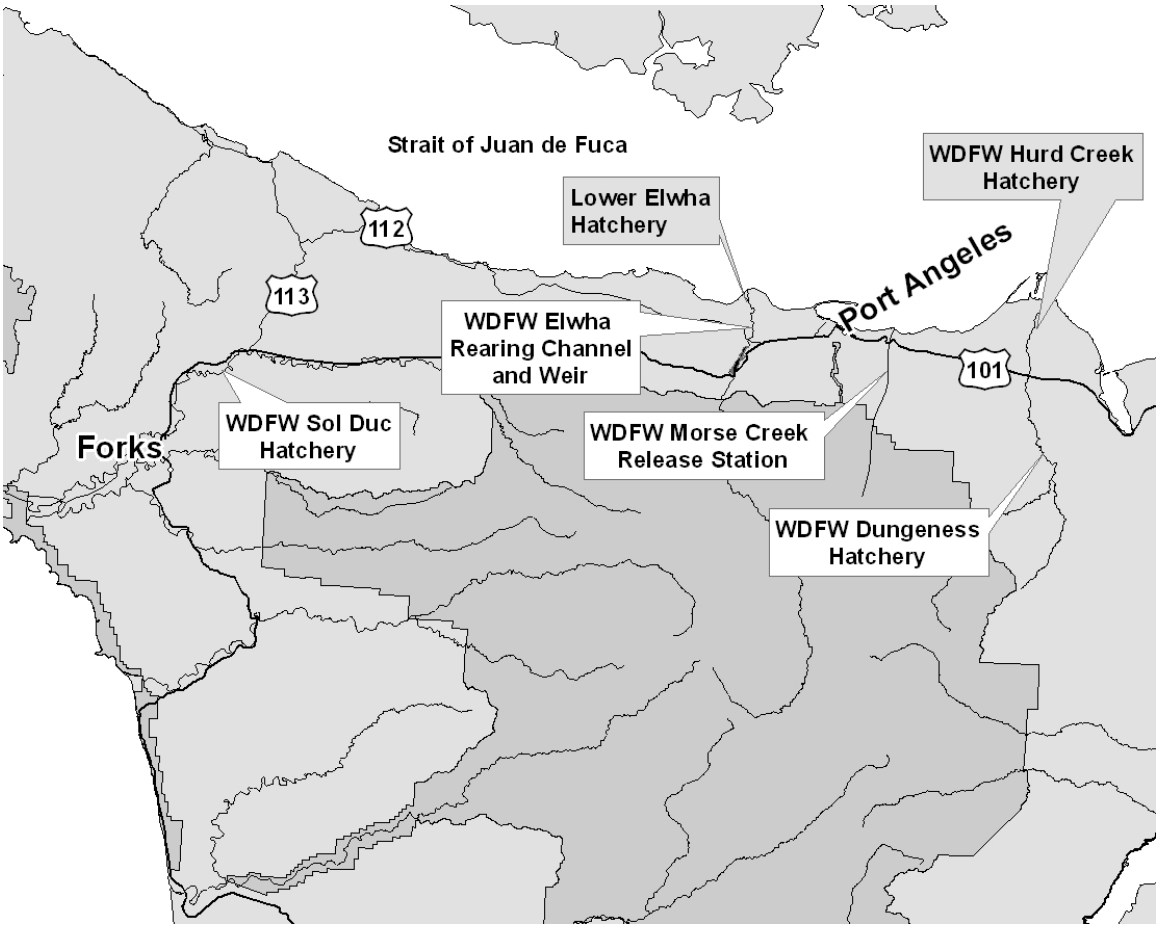

Figure 1. Action area (not shown: Manchester, Washington, hatchery facility). Source: Ward et al. 2008).

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 Elwha River. They are summarized below to provide additional context for Elwha River hatchery programs.

1.5.1. Elwha Act

The Elwha River Ecosystem and Fisheries Restoration Act, or "The Elwha Act" was signed on October 24, 1992 by the President of the United States of America. The Elwha Act authorized the Secretary of Interior to acquire the two hydroelectric dams on the Elwha River and implement the actions necessary to achieve full restoration of the Elwha River and native anadromous (salmon and steelhead) fisheries therein.

1.5.2. Elwha River Ecosystem Restoration EIS

To implement the Elwha Act's goal of "full restoration of the Elwha River ecosystem and native anadromous fisheries," the Secretary of the Interior directed the National Park Service to conduct NEPA analysis on the preferred method for doing so. A final EIS was completed in 1995 (NPS 1995). This document is herein incorporated by reference.

1.5.3. Elwha River Ecosystem Restoration Implementation EIS

After the National Park Service completed their EIS on Elwha River Ecosystem Restoration (Subsection 1.5.2, Elwha River Ecosystem Restoration EIS), they developed a second EIS, the "implementation EIS," to examine options for removing the Elwha and Glines Canyon Dams. The final EIS on Elwha River Ecosystem Restoration Implementation was complete in 1996 (NPS 1996). A supplemental EIS on Elwha River Ecosystem Restoration Implementation was completed in 2005 (NPS 2005). Both of these documents are herein incorporated by reference.

1.5.4. Elwha River Fish Restoration Plan

In 2008, the Elwha River Fish Restoration Plan was completed (Ward et al. 2008). It was developed collaboratively by biologists from Federal, state, and tribal agencies with expertise in Elwha salmon and steelhead populations and their habitat to identify a general multiagency approach and scientific framework for preserving and restoring fish populations before, during, and after dam removal. The plan is not self-implementing, but relies on various entities' subsequent actions, such as the proposed hatchery plans, to carry it out.

The primary objective of the agencies and tribe, as described in the Elwha River Fish Restoration Plan, is to reestablish self-sustaining fish populations and their habitats. The Elwha River Fish Restoration Plan recommends plans and schedules for salmon and steelhead hatchery programs. It also proposes a process for monitoring and evaluating the effects of hatchery programs during Elwha River restoration. Although the Elwha River Fish Restoration Plan identifies three phases of Elwha River recovery – before, during, and after dam removal – the submitted HGMPs and Tribal Harvest Plan would adopt four phases based on both biological and temporal conditions. The phases described in the HGMPs and referred to in the Tribal Harvest Plan divide the post preservation, "after dam removal" phase from the Elwha River Fish Restoration Plan into three additional phases (recolonization, local adaptation, and self-sustaining). The proposed HGMPs and Tribal Harvest Plan describe hatchery and harvest activities during the first two phases of recovery: (1) preservation and (2) recolonization.

1.5.5. Monitoring and Adaptive Management Plans for the Elwha Restoration Project

Biologists from federal, state, and tribal agencies with expertise in Elwha salmon and steelhead populations and their habitat have developed two draft monitoring and adaptive management plans for the Elwha Restoration Project. The purpose of the monitoring and adaptive management plans is to create recommended strategies that address uncertainty, incorporate the best available scientific methods and management responses, and best ensure the recovery of the native Elwha Chinook salmon, steelhead, and other non-listed stocks of anadromous salmonids, while minimizing the risks to these species from the dam removal and stock preservation efforts.

The adaptive management process includes recommendations for a decision making process and timeframe, defined decision rules, a decision focused monitoring and evaluation plan, and relies on performance indicators and triggers and thresholds tied to the monitoring in order to guide associated management actions. The plans develop objectives, performance indicators and triggers for the four different phases of restoration: preservation, recolonization, local adaptation, and self-sustaining population.

Like the Elwha River Fish Restoration Plan, the monitoring and adaptive management plans are the recommendations of the authors, and are not self-implementing or action-forcing. They rely on various entities' subsequent actions, such as the proposed hatchery plans, to carry them out. Many of the actions and goals recommended in the monitoring and adaptive management plans have been incorporated into the submitted HGMPs and Tribal Harvest Plan. Other actions have an identified funding source, and are, therefore, reasonably certain to occur. However, there are many actions identified in the monitoring and adaptive management plans that may be too costly for implementation in the near future. Therefore, these actions are not relied upon in NMFS' determinations based on this Environmental Assessment because they are not reasonably certain to occur.

1.5.6. 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, codified as Revised Code of Washington Chapter 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.

1.5.7. Bald Eagle and Golden Eagle Protection Act

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

1.5.8. Marine Mammal Protection Act

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

The Marine Mammal Protection Act 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 Marine Mammal Protection Act, means to “harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.” The Marine Mammal Protection Act 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 Marine Mammal Protection Act. Changes in fish production can indirectly affect marine mammals by altering the number of available prey (salmon and steelhead).

1.5.9. Executive Order 12898

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

1.5.10. 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).

1.5.11. 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. Hatcheries in Puget Sound provide salmon and steelhead for these fisheries. Without many of these hatcheries, there would be few, if any, fish for the tribes to harvest. These fishing rights and attendant access were established by treaties that the Federal government signed with the tribes in the 1850s. In those treaties, the tribes agreed to allow the peaceful settlement of Indian lands in western Washington in exchange for their continued right to fish, gather shellfish, hunt, and exercise other sovereign rights. Under Phase II of *U.S. v. Washington*, the Federal District Court ensured tribes the rights to the protection of fish habitat subject to treaty catch and a right to the fish that are produced by hatcheries. In 1974, Judge George Boldt decided in *U.S. v. Washington* that the tribes' fair and equitable share was 50 percent of all of the harvestable fish destined for the tribes' traditional fishing places.

1.5.12. Secretarial Order 3206

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

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

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

1.5.13. The Federal Trust Responsibility

The United States government has a trust or special relationship with Indian tribes. The unique and distinctive political relationship between the United States and Indian Tribes is defined by statutes, executive orders, judicial decisions, and agreements and differentiates tribes from other entities that deal with, or are affected by the Federal government. Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*, states that the United States has recognized Indian tribes as domestic dependent nations under its protection. The Federal government has enacted numerous statutes and promulgated numerous regulations that establish and define a trust relationship with Indian tribes. The relationship has been compared to one existing under common law trust, with the United States as trustee, the Indian tribes or individuals as beneficiaries, and the property and natural resources of the United States as the

trust corpus (Cohen 2005). The trust responsibility has been interpreted to require Federal agencies to carry out their activities in a manner that is protective of Indian treaty rights. This policy is also reflected in the March 30, 1995, document, *Department of Commerce - American Indian and Alaska Native Policy* (U. S. Department of Commerce 1995).

1.5.14. 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 (Washington Administrative Code Chapters 232-12-014 and 232-12-011) that include all state endangered, threatened, sensitive, and candidate species. These species are managed by WDFW, as needed, to prevent them from becoming endangered, threatened, or sensitive. The state-listed species are identified on WDFW's website (*http://wdfw.wa.gov/conservation/endangered/*); the most recent update occurred in June 2008. The criteria for listing and de-listing, and the requirements for recovery and management plans for these species are provided in Washington Administrative Code Chapter 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 identified in Washington Administrative Code Chapter 222-16-080. Species listed under the state endangered, threatened, and sensitive species list are reviewed in this EA if the Proposed Action or its alternatives may affect these species.

1.5.15. Hatchery and Fishery Reform Policy

WDFW's Hatchery and Fishery Reform Policy (Policy C-3619) was adopted by the Washington Fish and Wildlife Commission in 2009 (WFWC 2009). It supersedes WDFW's Wild Salmonid Policy, which was adopted in 1997. 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.

1.5.16. Recovery Plans for Puget Sound Salmon

Federal recovery plans are in place for the ESA-listed Puget Sound Chinook Salmon (NMFS 2007) and Hood Canal Summer Chum Salmon ESUs (Hood Canal Coordinating Council 2005). 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 each watershed within

the geographic boundaries of the two listed ESUs. Although listed in 2007, a recovery plan for the Puget Sound Steelhead DPS has not yet been completed.

1.5.17. Wilderness Act

The 1664 Wilderness Act directs Federal agencies to manage wilderness so as 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.

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

Five 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 and Tribal Harvest Plan meet the requirements of the 4(d) Rule, (3) NMFS would make a determination that revised HGMPs that include a sunset term and the Tribal Harvest Plan meet the requirements of limit 6 of the 4(d) Rule, (4) NMFS would make a determination that the submitted HGMPs and Tribal Harvest Plan do not meet the requirements of the 4(d) Rule, and (5) NMFS would make a determination that revised HGMPs with reduced production levels and the Tribal Harvest Plan meet the requirements of limit 6 of the 4(d) Rule. No other alternatives that would meet the purpose and need were identified that would be appreciably different from the five alternatives described below.

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

Under this alternative, NMFS would not make determinations under the 4(d) Rule. The Lower Elwha Klallam Tribe and WDFW would continue to operate the Elwha River hatchery programs as under baseline conditions without NMFS's ESA determination. Consequently, the hatchery programs would not have ESA coverage. No new environmental protection or enhancement measures would be implemented.

Other potential outcomes might occur under this No-action Alternative – the Tribe and WDFW could pursue other mechanisms for ESA coverage, for example. However, NMFS's No-action Alternative represents NMFS's best estimate of what would happen in the absence of the proposed Federal action – a determination that the submitted plans meet the requirements of the 4(d) Rule[3].

2.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under this alternative, NMFS would make a determination that the submitted HGMPs and Harvest Tribal Plan meet the requirements of the 4(d) Rule, and the Elwha River hatchery programs would be implemented as described in the five HGMPs until the Elwha River and its anadromous salmonid populations reach the local adaptation phase of recovery (Subsection 1.2., Description of the Proposed Action). Parameters marking the local adaptation phase and natural productivity milestones would likely be achieved at different times for the different species, with the result that hatchery programs might be terminated at different times.

[3] NMFS recognizes the possibility that the No-action alternative could result in discontinuation of the hatchery programs. However, this is not NMFS's best estimate of what would occur, and discontinuation is the subject of Alternative 4.

Under Alternative 2, the annual maximum release levels would be as follows:

- Steelhead: 175,000 yearlings
- Chum salmon: 450,000 age-0 fry
- Pink salmon: 3,000,000 age-0 fry
- Chinook salmon: 2,500,000 subyearlings; 200,000 yearlings released into the Elwha River; 200,000 yearlings released into Morse Creek
- Coho salmon: 425,000 yearlings

NMFS would determine that the submitted Tribal Harvest Plan meets the requirements of the Tribal 4(d) Rule, and fisheries would be implemented as follows:

- A moratorium on all Elwha River tribal fisheries would be in effect, and the Lower Elwha Klallam Tribe would not fish in the Elwha River Basin until 2018.
- At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on native stock, hatchery-origin fish if the natural-origin steelhead abundance in 2018 is projected to exceed 300 fish.
- Beginning January of 2020 or later, if the natural-origin component of the steelhead population exceeds 500 fish, the Lower Elwha Klallam Tribe would scale up their fishery to target 200 to 300 hatchery-origin steelhead.

2.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under this alternative, the HGMPs would be revised to specify a sunset term for the Elwha River hatchery programs, and NMFS would make a determination that the revised HGMPs and the Tribal Harvest Plan meet the requirements of the 4(d) Rule.

The revised HGMPs would terminate the Elwha River hatchery programs after the dams have been removed, sediment levels have returned to pre-dam removal levels, and salmon and steelhead have exhibited some natural productivity. The programs would be terminated near the end of the preservation phase (Subsection 1.5.2, Elwha River Fish Restoration Plan), and it would be expected that the last hatchery-origin fish would be released around 2019. This approximate termination date is in contrast to the Proposed Action, which is bounded by biological parameters marking the end of the preservation phase and natural productivity milestones, which would likely be achieved at different times for the different species, with the result that hatchery programs might be terminated at different times.

Under this alternative, the Tribal Harvest Plan would be revised because there would be no

hatchery-origin steelhead returning to the Elwha River after approximately 2021. A moratorium on all Elwha River tribal fisheries would be in effect until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Because hatchery-origin steelhead would stop returning to the Elwha River in approximately 2021, the steelhead fishery would only be ramped up to target 200 to 300 hatchery-origin steelhead for one year, and only if natural-origin steelhead abundance that year is projected to exceed 500 fish.

This alternative would not be expected to meet the applicants' purpose and need for action because substantial progress toward fish restoration in the Elwha River would not be expected to occur in a 20- to 30-year time frame 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 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan do Not Meet the Requirements of the 4(d) Rule

Under this alternative, NMFS would make a determination that the submitted HGMPs and Tribal Harvest Plan do not meet the requirements of the 4(d) Rule, and the Elwha River hatchery programs would be terminated immediately. All salmon and steelhead currently being raised in hatchery facilities would be released or killed, and no additional broodstock would be collected.

This alternative would not be expected to meet the applicants' purpose and need for action because substantial progress toward fish restoration in the Elwha River would not be expected to occur in a 20- to 30-year time frame 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.

2.5 Alternative 5 (Hatchery Programs with Decreased Production Levels) - Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under this alternative, NMFS would reduce the number of fish released from each of the five hatchery programs. This alternative has been added in response to the court order in Wild Fish Conservancy v. Department of the Interior, NO. C12-5109 BHS (W.D. Wash.), wherein the court

held that the Environmental Assessment must either provide detailed analysis of an alternative involving reduced releases of hatchery smolts, or more fully explain why such an alternative would not be a viable means of meeting the purpose and need. The plaintiffs in Wild Fish Conservancy, et al. v. National Park Service, et al., have suggested that the Elwha River native steelhead and coho hatchery programs should be reduced from their proposed annual release levels (175,000 and 425,000 smolts, respectively) to a maximum release level of 50,000 smolts. Although the plaintiffs did not suggest a reduced production level for the other hatchery programs, NMFS has applied a two-thirds reduction to the annual maximum release goals for the chum salmon, pink salmon, and Chinook salmon hatchery programs, which is similar to the roughly two-thirds reduction plaintiffs suggested for steelhead. Under Alternative 5, the annual maximum release levels would be as follows:

- Steelhead: 50,000 yearlings
- Chum salmon: 150,000 age-0 fry
- Pink salmon: 1,000,000 age-0 fry
- Chinook salmon: 833,333 subyearlings; 66,666 yearlings released into the Elwha River; 66,666 yearlings released into Morse Creek
- Coho salmon: 50,000 yearlings

NMFS would determine that the submitted Tribal Harvest Plan (LEKT 2012d) meets the requirements of the Tribal 4(d) Rule, and fisheries would be implemented as follows:

- A moratorium on all Elwha River tribal fisheries would be in effect, and the Lower Elwha Klallam Tribe would not fish in the Elwha River Basin until 2018.
- In 2018, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on native stock, hatchery-origin fish if the natural-origin steelhead abundance in 2018 is projected to exceed 300 fish.
- Beginning January of 2020 or later, if the natural-origin component of the steelhead population exceeds 500 fish, the Lower Elwha Klallam Tribe would scale up their fishery to target 200 to 300 hatchery-origin steelhead.

Although the submitted Tribal Harvest Plan (LEKT 2012d) would be implemented identically under Alternative 5 as under the Proposed Action, the timeframe for meeting the plan's triggers for initiating fisheries may be different (i.e., it may take longer to meet the natural-origin abundance targets identified in the plan under Alternative 5).

2.5. Alternatives Considered but not Analyzed in Detail

2.5.1. Operate Hatchery Programs for Listed Species Only

Under this alternative, NMFS would not make a determination that the proposed hatchery programs for non-listed species (Puget Sound chum, coho, and pink salmon) meet the requirements of limit 6 of the 4(d) rule. For the purpose of this analysis, NMFS would treat this alternative as resulting in hatchery production of only Chinook salmon and steelhead as proposed in the HGMPs for those species. The three HGMPs for the other species – 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 effects of the alternative would fall within the range of the effects of Alternative 1, Alternative 2, and Alternative 4. That is, the analysis of Alternative 1 and Alternative 2 will disclose the environmental effects of operating the Chinook salmon and steelhead hatchery programs, and the analysis of Alternative 4 will disclose the environmental effects of terminating the chum, coho, and pink salmon hatchery programs.

2.5.2. Approve Proposed Hatchery Programs under Section 10 of the Endangered Species Act

Under this alternative, NMFS would determine that the five proposed hatchery programs, as described in the HGMPs, meet the requirements for either section 10(a)(1)(A) permits (for Chinook salmon and steelhead programs) or section 10(a)(1)(B) permits (for 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 Additional Best Management Practices

Under this alternative, the applicants would revise their HGMPs to incorporate additional best management practices to further reduce the risk of adverse impacts of the hatchery programs on natural-origin salmon and steelhead populations, and NMFS would then determine that the revised HGMPs meet the criteria of limit 6 of the 4(d) Rule. However, because the proposed HGMPs have already incorporated best management practices identified by independent reviewers and because the HGMPs allow for the incorporation of additional best management practices in the future as a result of monitoring and evaluation activities, this alternative would not be meaningfully different from the Proposed Action and will not be analyzed in detail.

2.5.4. 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 limit 6 of the 4(d) Rule. This alternative will not be

analyzed in detail because substantially higher production levels would exceed fish rearing density limits for the hatchery facilities and result in increasingly adverse fish health and survival effects on the hatchery-origin fish. Constructing additional hatchery facilities to accommodate substantially increased production would not meet the purpose and need for action, which includes using existing hatchery facilities to meet the recovery objectives for the Elwha River (Subsection 1.3, Purpose and Need for the Action).

2.5.5. Hatchery Programs that Release Fish in Streams outside of the Elwha River Basin to Maintain a Genetic Reserve during the Preservation Phase

Under this alternative, the applicants would revise their HGMPs so that Elwha River fish would be propagated in hatcheries and released in rivers that would be more hospitable to salmon and steelhead than the Elwha River during the preservation phase of Elwha River restoration, and NMFS would make a determination that the revised HGMPs meet the criteria of limit 6 of the 4(d) Rule. This alternative is not meaningfully different than the Proposed Action because under the Proposed Action fish would be released into a stream outside the Elwha River Basin (Morse Creek) to maintain a genetic reserve for Chinook salmon during the preservation phase. No other streams would be needed to maintain a genetic reserve, and releasing fish into streams that contain native salmon and steelhead populations would adversely impact native salmon and steelhead populations in those streams.

3. AFFECTED ENVIRONMENT

3.1. Introduction

Chapter 3, Affected Environment, describes baseline conditions for nine resources that may be affected by implementation of the EA alternatives:

- Water quantity (Subsection 3.2)
- Water quality (Subsection 3.3)
- Salmon and steelhead (Subsection 3.4)
- Other fish (Subsection 3.5)
- Wildlife (Subsection 3.6)
- Socioeconomics (Subsection 3.7)
- Environmental justice (Subsection 3.8)
- Cultural resources (Subsection 3.9)
- Human health and safety (Subsection 3.10)

No other resources were identified during internal scoping that would potentially be impacted by the Proposed Action or alternatives.

Baseline conditions include the operation of the proposed Elwha River hatchery programs at juvenile and adult fish production levels described in the five HGMPs (Table 3). The Elwha River hatchery programs were initiated for fisheries harvest augmentation and stock preservation purposes and to partially mitigate for lost natural salmon and steelhead production from placement of the Elwha and Glines Canyon Dams. The Chinook salmon hatchery program was initiated in 1914 and has been consistently releasing fish since the 1950s. Hatchery-origin coho salmon have been released since the 1950s. A non-native (i.e., Chambers Creek) steelhead program was initiated in 1976, but it was terminated in 2011 to protect the native, ESA-listed steelhead population. In its place, a native steelhead program was initiated in 2005 (Table 3). The chum salmon hatchery program was founded in 1994 to maintain the genetic legacy of the native stock (LEKT 2012c). The pink salmon hatchery program was initiated in 2011 to mitigate for impacts of dam removal activities (Table 3).

Table 3. Annual juvenile and resultant adult hatchery production levels by salmon and steelhead species under baseline conditions.

Species	Hatchery Program Start Date	Target Annual Juvenile Release Levels (2014)	Hatchery-origin Adult Return Levels[3]
Chinook salmon	1914[1]	2.5 million subyearlings 200,000 yearlings (Elwha) 200,000 yearlings (Morse)	2,160 (Elwha)[4] 160 (Morse)
Steelhead (native stock)	2005[2]	175,000	1,300
Fall chum salmon (native stock	1994	450,000	2,250
Pink salmon (native stock)	2011	3,000,000	15,000
Coho salmon (native stock)	1970s	425,000	4,250

[1] Consistent releases of native Elwha River Chinook salmon since the 1950s.
[2] First release of juvenile fish that were progeny of 100% native Elwha River steelhead occurred in 2011.
[3] Total adult production estimates assuming survival rates to adult return (escapement and total contribution to any marine area fisheries) of 0.08% for Chinook (most recent year, combined subyearling and yearling survival rate); 0.75% for steelhead; 0.50% for fall chum; 0.50% for pink; and 1.00% for coho (Source: observed and target rates reported for each species in the five LEKT and WDFW HGMPs).
[4] Elwha Chinook salmon may be harvested incidentally in marine area fisheries in Canada and Alaska targeting other salmon populations. Approximately 25% of the total annual return of Chinook salmon originating in the Elwha River may be intercepted in those fisheries, reducing total annual escapement to the Elwha River to approximately 1,700 fish.

The action area (or project area) is the geographic area where the Proposed Action would take place. It includes the places where Elwha River fish would be spawned, incubated, reared, acclimated, released, or harvested under the proposed hatchery and tribal harvest plans (Subsection 1.4, Action Area). Each resource's analysis area includes the action area as a minimum area but may include locations beyond the action area if some of the effects of the Environmental Assessment's alternatives on that resource would be expected to occur outside the action area (Subsection 1.4, Action Area).

3.2. Water Quantity

Hatchery programs can affect water quantity when they take water from a well (groundwater) or a neighboring tributary streams (surface water) to use in the hatchery facility for broodstock holding, egg incubation, juvenile rearing, and juvenile acclimation. All water, minus evaporation, that is diverted from a river or taken from a well is discharged to the adjacent river or bay from which the water was appropriated after it circulates through the hatchery facility (non-consumptive use). When hatchery programs use groundwater, they may reduce the amount of water for other users in the same aquifer. When hatchery programs use surface water, they may lead to dewatering of the stream between the water intake and discharge structures, which may impact fish and wildlife if migration is impeded or dewatering leads to 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.

Six hatchery facilities are currently used by the Elwha River hatchery programs (Subsection 1.4, Action Area). One of the hatchery facilities uses groundwater exclusively except in the case of emergencies (Hurd Creek), two of the acclimation facilities use surface water exclusively (Morse Creek Facility and Sol Duc Hatchery), and three facilities use both groundwater and surface water (Elwha Channel Facility, Lower Elwha Fish Hatchery, and Manchester Research Station) (Table 4).

Table 4. Water source and use by hatchery facility.

Hatchery Facility	Surface Water Use (cfs)	Ground-water Use (cfs)	Amount Used for Elwha River Programs (cfs)	Proportion Used for Elwha River Programs (%)	Surface Water Source	Minimum Surface Water Flows (cfs)	Maximum Percentage of Surface Water Diverted for Elwha River Hatchery Programs	Discharge Location
Elwha Channel Facility	36	3[1]	39	100	Elwha River	212	16	Elwha River RM 3.5
Lower Elwha Fish Hatchery	29[4] (max.)	9[1]	38	100	Elwha River	219	13	Elwha River RM 1.3
Morse Creek Facility	5.4	0	5.4	100	Morse Creek	26	21	Morse Creek RM 1.0
Hurd Creek Hatchery	0[2]	4.5	1.5	30	N/A	N/A	N/A	Hurd Creek RM 0.2
Sol Duc Hatchery	76	0	15	20	Sol Duc River	214	7	Sol Duc River RM 29.0
Manchester Research Station	3.3	0.07	0.45	14	Puget Sound[3]	N/A	N/A	Clam Bay, Puget Sound

Source: Elwha-Dungeness Planning Unit 2005; WDOE 2012a; https://fortress.wa.gov/dfw/score/score/hatcheries/hatchery_details.jsp?hatchery=Solduc

[1] Must be treated as surface water because of hydrological connection between the aquifer and the Elwha River

[2] Emergency use only – de mini mis annual withdrawal level.

[3] Pumped seawater.

[4] In 2013, failure of the Elwha Surface Water Treatment Plant from heavy sediment loads that overwhelmed the system led to total reliance by the Lower Elwha Hatchery program on the hatchery's groundwater sources.

Up to 21 percent of the water in Morse Creek is temporarily diverted to the Morse Creek Facility to support Elwha River hatchery programs (Table 4). Up to 7 percent of the water in the Sol Duc River is diverted to the Sol Duc Hatchery to support Elwha River hatchery programs (Table 4). Between 13 and 16 percent of the water in the Elwha River is temporarily diverted to the Elwha Channel Facility and Lower Elwha Fish Hatchery to support Elwha River hatchery programs

(Table 4). The Manchester Research Station uses pumped seawater, and the amount diverted is not measurable relative to the total amount of water in the Puget Sound. All hatchery facilities have current water rights (Ecology 2012).

A water right permit is required for all groundwater withdrawal within Washington except those supporting single-family homes. All hatchery wells used by hatchery facilities supporting the Elwha River hatchery programs are permitted by the Washington Department of Ecology (Ecology 2012b). The Elwha Channel Facility and Lower Elwha Fish Hatchery withdraw groundwater from an aquifer that underlies the Elwha River valley and supplies municipal water for local residents and businesses (NPS 2005). Because of the extent of the hydrological connection between the Elwha River aquifer and the Elwha River, the aquifer has been designated as under the influence of surface water and must be treated as if it were a surface water source (NPS 2005). Critical Groundwater Areas are not designated in Washington State.

3.3. Water Quality

Hatchery programs could affect several water quality parameters in the aquatic system. Concentrating large numbers of fish within hatcheries could produce effluent with ammonia, organic nitrogen, total phosphorus, biological oxygen demand, pH, and suspended solids (Sparrow 1981; Ecology 1989; Kendra 1991; Cripps 1995; Bergheim and Åsgård 1996; Michael 2003). Chemical use within hatcheries could result in the release of antibiotics, fungicides, and disinfectants into receiving waters (Boxall et al. 2004; Pouliquen et al. 2008; Martinez-Bueno et al. 2009). Other chemicals and organisms that could potentially be released by hatchery operations are polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT) and its metabolites (Missildine 2005; HSRG 2009), fish disease pathogens (HSRG 2005; HSRG 2009), steroid hormones (Kolodziej et al. 2004), anesthetics, pesticides, and herbicides.

The direct discharge of hatchery facility effluent is regulated by the Environmental Protection Agency under the Clean Water Act through National Pollutant Discharge Elimination System (NPDES) permits. For discharges from hatcheries not located on Federal or tribal lands within Washington, the Environmental Protection Agency 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). The Environmental Protection Agency administers NPDES permits for all projects on Federal and tribal lands. NPDES permits are not needed for hatchery facilities that release less than 20,000 pounds of fish per year or feed fish less than 5,000 pounds of fish feed per year. Additionally, Native American tribes may adopt their own water quality standards for permits on tribal lands (i.e., tribal wastewater plans). All hatchery facilities used by the Elwha River

hatchery programs are compliant with their NPDES permit or do not require a NPDES permit (Table 5). All hatchery effluent is passed through pollution abatement ponds to settle out uneaten food and fish waste before being discharged into receiving waters.

As part of administering elements of the Clean Water Act, the Washington Department of Ecology is required to assess water quality in streams, rivers, and lakes. 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, while the 303(d) list identifies specific water bodies considered impaired (based on a specific number of exceedances of state water quality criteria in a specific segment of a water body). The EPA reviewed and approved Washington Department of Ecology's 2008 303(d) list on January 29, 2009.

Within the analysis area, the Elwha River, Hurd Creek (a tributary to the Dungeness River), Sol Duc River, and the Puget Sound itself are on the 303(d) lists (Table 5). Activities within the analysis area that contribute to the degradation of water quality include dams, human development, agricultural practices, and forest practices.

Table 5. Water source and use by hatchery facility and applicable 303(d) listings.

Hatchery Facility	Compliant with NPDES Permit	Discharges Effluent into a 303(d) Listed Water Body[1]	Impaired Parameters	Cause of Impairment
Elwha Channel Facility	Yes	Yes	Temperature	Thermal heating behind dams
Lower Elwha Fish Hatchery	Yes	Yes	Temperature	Thermal heating behind dams
Morse Creek Facility	Yes	No	None[2]	None
Hurd Creek Hatchery	N/A	Yes	Fecal Coliform	Human development activities
Sol Duc Hatchery	Yes	Yes	Temperature and pH	Forest practices
Manchester Research Station	N/A	Yes	Bacteria	Human development activities

N/A = Not applicable because an NPDES permit is not required because the facility releases less than 20,000 pounds of fish per year or feeds fish less than 5,000 pounds of fish feed per year.
[1]Source: WDOE 2008; http://apps.ecy.wa.gov/wats08/Default.aspx
[2] Morse Creek does not have any Category 5 impaired parameters, which would require a pollution control plan under the Clean Water Act. However, Morse Creek is a "water of concern."

As of May 2014, removal of Glines Canyon Dam was nearly complete and removal of Elwha Dam has already been completed, resulting in adverse effects on water quality in the mainstem

Elwha River and estuary downstream of the dam sites. Fine and coarse sediments stored for 100 years behind the dams have been released downstream as the dams have been deconstructed, and will continue to be released after dam removal is complete. Fine sediment mobilized in the water column through dam removal has resulted in extremely high suspended-sediment concentrations in the Elwha River downstream of the Glines Canyon Dam site and fine and coarse sediment have deposited in salmon and steelhead habitat along the mainstem and in the tributaries. In planning for dam removal effects, experts anticipated that turbidity (suspended sediment) levels would exceed 1,000 parts per million (ppm) (lethal for fish at chronic exposures) for extended periods of time and would spike to levels exceeding 10,000 ppm (lethal for fish at acute exposures) for several weeks each year for approximately 3 to 5 years following dam removal (Ward et al. 2008; Duda et al. 2011). Fine sediment levels approaching these forecast levels were released after 2012, and have continued into 2014. Commencing in about mid-October 2012, with Elwha Dam completely gone and only one-third of Glines Canyon Dam remaining, suspended sediment levels dramatically increased. Sediment levels have exceeded 5,000 ppm for extended periods in 2013 and 2014 during critical adult salmon and steelhead migration and spawning periods. (USGS Sediment Monitoring Data, November, 2012; Currans et al. 2014). The highest turbidity levels in downstream areas are predicted to occur after the remainder of Glines Canyon Dam is removed during the summer of 2014 (B. Winter, NPS, pers. comm., March 28, 2014).

The high sediment loads will cause deleterious effects in the egg to outmigrant fry stage for all species of fish present in the lower watershed (Pess et al. 2008). Fish exposed to sediment loads between 50 and 100 ppm for an extended period of time may stop feeding, suffer gill abrasion, and experience loss of fitness due to the associated stress (Cook-Tabor 1995). At turbidity levels above 1,000 ppm, direct mortality of fish may result simply from the elevated sediment loads (Cook-Tabor 1995). With sediment loads expected to exceed 10,000 ppm, it was assumed for salmonid population recovery planning purposes that most or all fish rearing naturally in the Elwha River below the former site of Glines Canyon Dam (the dam farthest upstream) would be killed by stored sediment released during dam removal stages and for years following dam removal (Ward et al. 2008).

During spring, 2013, thousands of yearling Chinook salmon released into the lower Elwha River from WDFW's conservation hatchery program died very shortly after release from effects associated with high turbidity (Figure 2). Histopathological examinations of fish recovered from the river banks confirmed that high turbidity was the cause of these mortalities. Turbidity levels in the river when the event occurred were detected at 1,600 ppm. Turbidity levels during the juvenile fish seaward migration period this year have often exceeded 2,000 ppm. Last summer and fall, during the adult migration periods for Chinook, coho, and chum salmon, turbidity levels

in the lower river exceeded 5,000 ppm for the majority of a several week period (Curran et al. 2014).

In addition to fine sediment loading, coarser sediments stored behind the dams have deposited in and adversely affected the vast majority of salmon and steelhead habitat. This condition is expected to persist for up to 10 years (BOR 1996). Recent observations by NMFS Northwest Fisheries Science Center staff indicate that up to 10 feet of sediment material has overwhelmed portions of the lower Elwha River (Figure 3) (NPS 2014; George Pess, NMFS, pers. comm., November 28, 2012). Aggradation levels at these amounts affect river channel morphology by increasing the width-to-depth ratio of the channel cross section, filling pool habitat used by juvenile and adult fish, and reducing the quality of rearing habitat (Ward et al. 2008). As previously forecasted, stored sediment releases are adversely affecting water quality and negatively impacting the condition of river channel areas needed to support juvenile fish survival. Rather than persisting as refugia for natural origin fish, Elwha River floodplain channel areas downstream of the dam sites have instead become sediment repositories that are inhospitable to fish survival (Figures 4 and 5). Water quality has also been impaired by interstitial filling of the gravel beds with fine sediment from the release of stored sediments. This condition has degraded migration and spawning habitat in these and other lower river areas.

Mobilized sediment transported downstream and into marine waters of the Strait of Juan de Fuca should have both adverse and beneficial effects on fish habitat, as it is dispersed by waves and tidal currents and deposited on sediment-starved beaches and the seafloor of the Elwha River delta (Warrick et al. 2011 in Duda et al. 2011).

Figure 2. Elwha Channel Hatchery yearling Chinook salmon mortalities on the banks of the Elwha River resulting from lethal river turbidity levels, April 2013.

Figure 3. Elwha River mainstem condition on December 11, 2012. Photo courtesy of National Park Service, May 2014.

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Figure 4. Middle Elwha River floodplain habitat (Boston Charley Creek) prior to dam removal (on left from 1997) and same location after dam removal commenced (on right from 2013). Photos courtesy of Mike McHenry, Lower Elwha Klallam Tribe.

Figure 5. Middle Elwha River floodplain habitat (Elwha Campground) prior to dam removal (on left in 2003) and same location after dam removal commenced (on right from 2013). Photos courtesy of Mike McHenry, Lower Elwha Klallam Tribe.

3.4. Salmon and Steelhead

Salmon and steelhead populations in the Elwha River Basin are severely diminished in abundance, spatial structure, genetic diversity, and productivity as a result of the Elwha and Glines Canyon Dams. Until recently, the dams blocked upstream passage to 90 percent of the salmon and steelhead spawning and rearing habitat in the Elwha River Basin[4] (Figure 6) (Pess et al. 2008). The dams also interrupted the natural function of the river ecosystem. Over 24 million cubic yards (19 million cubic meters) of sediment has been captured in the two reservoirs behind the dams over the last 100 years (Duda et al. 2011), adversely affecting not only the lower river system, but also the estuarine and nearshore environments that are critical as salmon habitat to the east and west of the river mouth. As a result of the dam-caused truncation of alluvial transport of sediment, from 1939 to 2002, the lower 5 miles of the Elwha River, which remained accessible to salmon and steelhead, lost over 75 percent of available spawning habitat for salmonids (Pess et al. 2008). The recruitment of large woody debris from the upper watershed was virtually eliminated by the dams (Pess et al. 2008), and the two reservoirs behind the dams created "heat sinks" during the summer, significantly increasing downstream water temperature to the detriment of natural fish production. In summary, the two dams left the freshwater and marine habitat that is still available to Elwha River salmon and steelhead severely confined and degraded. The presence of the two dams was identified as the single largest factor limiting recovery of Elwha River salmon and steelhead (SSPS 2005; Ward et al. 2008). Because of the lack of accessible, high-quality habitat, salmon and steelhead populations have been primarily sustained through hatchery operations since the dams were constructed.

In 2011, dam removal efforts were initiated so some effects of dam removal efforts are captured in baseline conditions as described in Chapter 3, Affected Environment. By the end of 2014, both the Elwha and Glines Canyon Dams are expected to be removed, and environmental conditions in the Elwha River Basin will continue to change into the future as a result of dam removal activities (Table 10). Currently, there are no fisheries in the Elwha River due to a 5-year moratorium during and immediately after Elwha and Glines Canyon Dam removals.

[4] The Elwha River Dam was removed in 2011, so salmon and steelhead currently have access to river mile 13.5, which is the location of the Glines Canyon Dam.

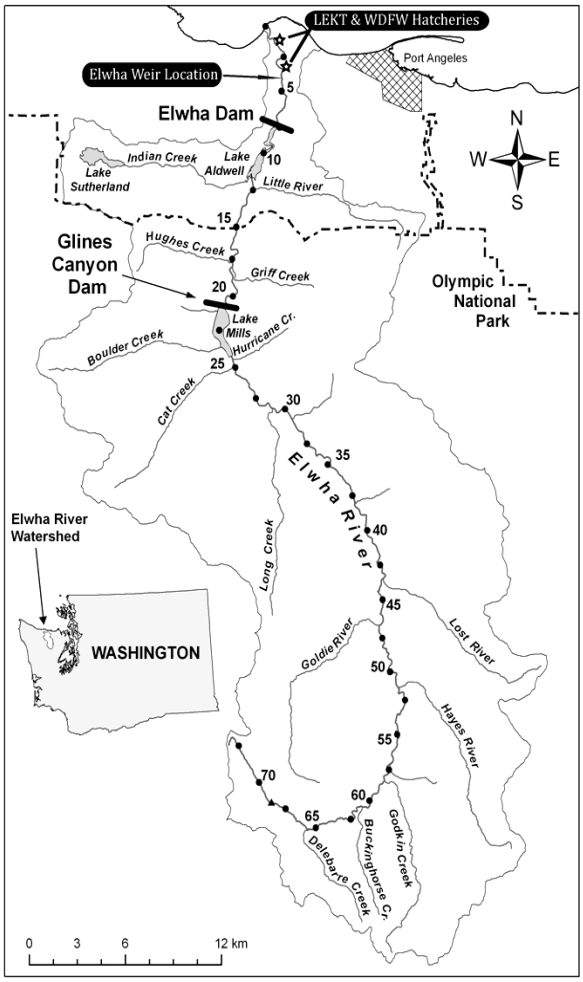

Figure 6. The Elwha River Basin, including the location of Elwha and Glines Canyon Dams, and hatchery structures relevant to the analysis. Numbers on the Elwha River mainstem are river kilometers from the mouth (e.g., river mile 13.5 is equal to river kilometer 20.1).

Generally, hatchery programs can adversely affect natural-origin salmon and steelhead and their habitat through genetic risks, competition and predation, facility effects, natural population status masking, incidental fishing effects, and disease transfer (Table 6). Hatchery programs can benefit natural-origin salmon and steelhead through marine-derived nutrient cycling effects, by preserving and increasing abundance and spatial structure, retaining genetic diversity, and potentially increasing productivity of a natural-origin population if natural-origin abundance is

Table 6. General mechanisms through which hatchery programs can affect natural-origin salmon and steelhead populations.

Effect Category	Description of Effect
Genetic risks	• Interbreeding with hatchery-origin fish can change the genetic character of the local salmon or steelhead populations. • Interbreeding with hatchery-origin fish may reduce the reproductive performance of the local salmon or steelhead populations.
Competition and predation	• Hatchery-origin fish can increase competition for food and space. • Hatchery-origin fish can increase predation on natural-origin salmon and steelhead.
Facility effects	• 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.
Incidental fishing effects	• Fisheries targeting hatchery-origin fish have incidental impacts on natural-origin fish.
Disease transfer	• Concentrating salmon and steelhead for rearing in a hatchery facility can lead to an increased risk of carrying fish disease pathogens. When hatchery-origin fish are released from the hatchery facilities, they may increase the disease risk to natural-origin salmon and steelhead.
Population viability benefits	• Abundance: Preservation of, and possible increases in, the abundance of a natural-origin fish population resulting from

Effect Category	Description of Effect
	implementation of a hatchery program. • Spatial Structure: Preservation or expansion of the spatial structure of a natural-origin fish population resulting from implementation of a hatchery program. • Genetic diversity: Retention of within-population genetic diversity of a natural-origin fish population resulting from implementation of a hatchery program. • Productivity: Hatchery programs could increase the productivity of a natural-origin population if naturally spawning hatchery-origin fish match natural-origin fish in reproductive fitness and when the natural-origin population's abundance is low enough to limit natural-origin productivity (i.e., they are having difficulty finding mates).
Nutrient cycling	• Returning hatchery-origin adults can increase the amount of marine-derived nutrients in freshwater systems.

low enough that they are having difficulty finding mates. Table 6 lists the various effects through which the hatchery programs could affect natural-origin salmon and steelhead populations in the Elwha River. The extent of adverse effects depends on the design of hatchery programs, the condition of the habitat, and the current status of the species, among other factors.

Although current understanding of the genetic effects of hatchery fish spawning with their natural-origin counterparts relies heavily on one study of steelhead in the Hood River, it appears that hatchery rearing can have a substantial genetic effect on fitness. However, the data and theory are insufficient to predict the magnitude and duration of loss in any particular situation. Recently studies of hatchery supplementation have also documented demographic benefits to natural production from hatchery fish spawning in the wild (Anderson et al. 2012; Berejikian et al. 2008; Hess et al. 2012). On balance, the benefits of artificial propagation for reducing extinction risk and for rebuilding severely depressed fish populations may outweigh the possibility of short-term fitness loss.

Hatchery supplementation also has the potential to increase competition with and predation on wild fish. However, hatchery programs may be designed to limit opportunities for co-occurrence and interaction between hatchery-origin fish and migrating natural-origin fish, reducing potential adverse effects from competition and predation. Although poorly managed hatchery programs can increase disease and pathogen transfer risks, compliance with applicable protocols for fish health can effectively minimize this risk.

Turning to the potential benefits of hatchery programs, in populations with few or no wild fish returning to spawn, hatchery programs can serve as the genetic reserve for the population and prevent the extirpation of the naturally-occurring species. This risk of extirpation is especially high in the Elwha Basin, where the extended release of sediment from dam removal has the potential to kill substantial numbers, if not all, of the remaining natural-origin salmon and steelhead.

A more detailed discussion of the general effects of hatchery programs on salmon, steelhead, and their habitat can be found in the draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of the Mitchell Act Hatchery Programs (NMFS 2010).

Since 1991, NMFS has identified one salmon ESU (Puget Sound Chinook Salmon) and one steelhead DPS (Puget Sound Steelhead) in the analysis area that require protection under the ESA (70 FR 37160, June 28, 2005; 72 FR 26722, May 11, 2007). There are three additional non-listed salmon species in the analysis area (fall chum salmon, pink salmon, and coho salmon).

Critical habitat was designated for Puget Sound Chinook salmon (70 FR 52630, September 2, 2005). Critical habitat has not been described for chum salmon, pink salmon, or coho salmon. However, NMFS has proposed designation of critical habitat for Puget Sound steelhead (78 FR 2725). The proposed extent of critical habitat for steelhead would encompass the same areas within the Elwha River watershed identified for Puget Sound Chinook salmon. In the Elwha River watershed, Puget Sound Chinook salmon critical habitat is limited to areas below the site of the Elwha Dam, and includes adjacent marine areas. Within these areas, NMFS identifies primary constituent elements, which are sites and habitat components that support one or more life stages and are considered essential for the conservation of the ESU. Critical habitat in the Elwha River includes all of the defined primary constituent elements, such as freshwater spawning and rearing sites, freshwater and estuarine migration corridors, all requiring adequate water quantity and quality, natural cover, freedom from excessive predation, and adequate substrate.

3.4.1. Puget Sound Chinook Salmon (ESA-listed)

The Elwha River Chinook salmon population, which includes Chinook salmon spawning in Morse Creek, is one of the 22 populations of Chinook salmon in the Puget Sound Chinook Salmon ESU. As one of only two populations in the Strait of Juan de Fuca biogeographical region, the Elwha Chinook salmon population has been recognized as a key population needing to be restored to a low extinction risk status for recovery and delisting of the ESU (NMFS 2007).

Abundance of Elwha Chinook salmon is substantially reduced from historical levels, and abundance of the remaining population is further threatened in the short term by excessive sediment and turbidity levels resulting from dam removal (Ward et al. 2008). Total Chinook salmon abundance over the last 35 years has ranged from 929 to 9,083 fish, and averaged 2,541 fish (Figure 6). WDFW estimates that approximately 95 percent of the total Chinook salmon adult returns to the river in 2008, 2009, and 2010 originated from Elwha River Basin hatchery programs, and just 4 percent were of natural-origin (1 percent were out of basin strays) (WDFW 2012a). The estimated recent year average number of natural-origin Chinook salmon is approximately 102 fish.

The hatchery program in the Elwha River that has supported the majority of adult returns currently releases 2.7 million juvenile fish into the Elwha River (2.5 million subyearlings and 200,000 yearlings) (WDFW 2012) (Table 3). The number of returning adult hatchery-origin fish in the river may also be expected to be reduced relative to the recent year abundances shown in Figure 3, because juvenile release levels for the program in previous decades were higher. The current program was reduced from its previous size following guidance provided in the Elwha Fish Restoration Plan and by the HSRG (2012) to ensure the program meets long term restoration goals, while minimizing hatchery-related risks to unsubstantial levels. This reduced program is expected to result in the total return of about 2,320 adult fish (Table 3), assuming average juvenile to adult return survival levels and before marine area fisheries impacts. Approximately 1,700 adult fish are needed as broodstock to sustain juvenile fish production from the hatchery program at current reduced levels (WDFW 2012).

Spatial structure of the Elwha Chinook population was adversely affected by dam construction and operation in the watershed, and spatial structure will be further affected as a result of dam removal activities. The construction of the Elwha Dam in 1911 blocked access of Elwha Chinook to 90 percent of their historical range of spawning and rearing habitat (Figure 3) (Pess et al. 2008). Furthermore, access to all areas previously used by the now likely extirpated spring-run Chinook salmon race native to the river was eliminated. Salmon habitat remaining in the lower Elwha River is generally of poor quality, with only a small area of relatively high-quality habitat remaining in about two dozen mainstem and side-channel areas (e.g., Hunt's Road side-channel). Because the Elwha River Dam was removed in 2011, Elwha River Chinook salmon currently have access to mainstem and tributary areas up to river mile 13.5 of the Elwha River, which is the site of the Glines Canyon Dam.

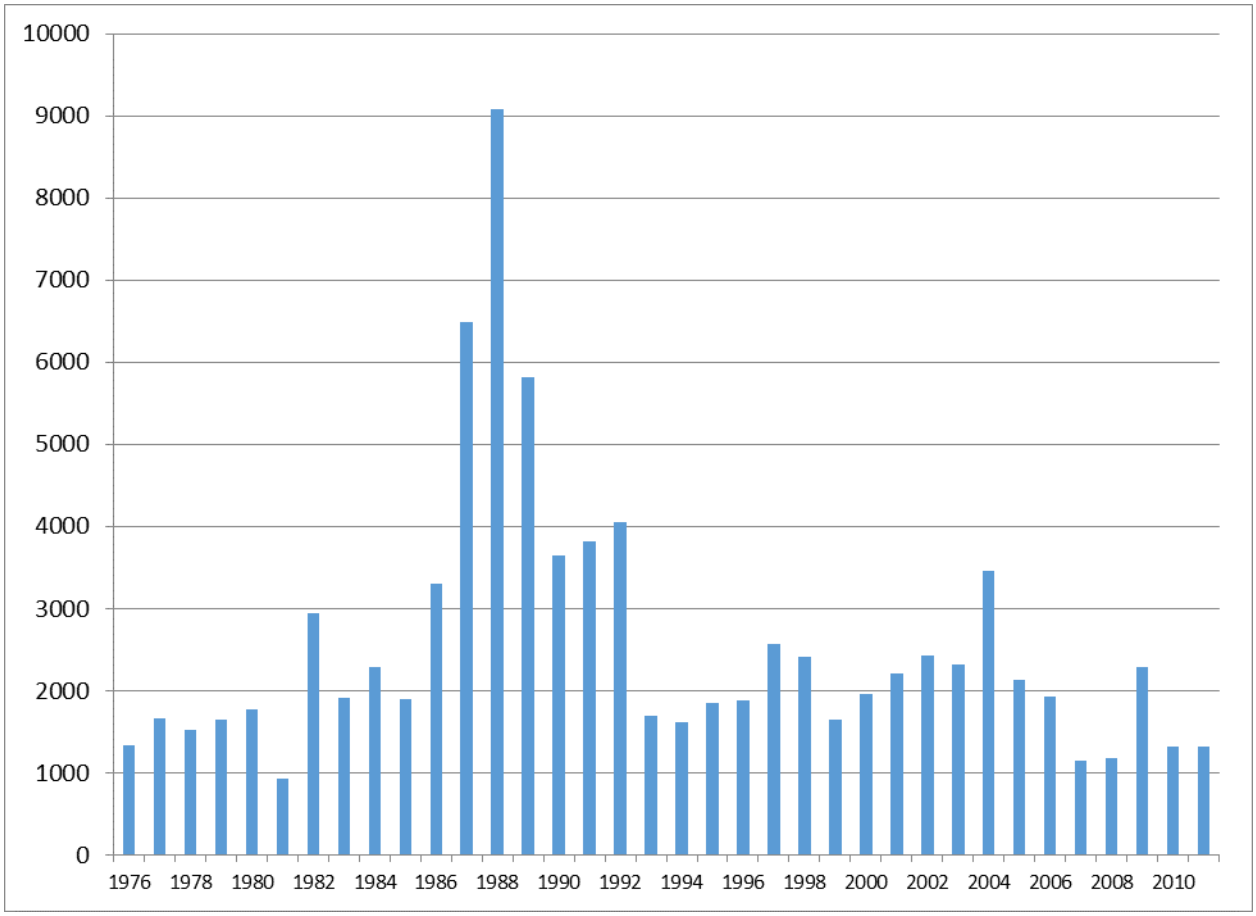

Figure 7. Total run size (natural-origin and hatchery-origin fish included) of Chinook salmon to the Elwha River – 1976 through 2011. Source: WDFW Run Reconstruction - January 23, 2013, and WDFW 2012.

Genetic diversity of the Elwha Chinook salmon was greatly reduced by anthropogenic activities, primarily dam placement and operation, over the last century, and is greatly reduced relative to historical levels. Currently, only a fraction of the original genetic diversity of the species remains (Pess et al. 2008). The spring-run Chinook salmon race, an important genetic component of the Elwha population (as expressed by early river entry, large adult body size, and spawning typically high in the watershed) have been largely extirpated from the Elwha River (Brannon and Hershberger 1984; Wunderlich et al. 1993). Loss of access to upriver habitat was the primary cause of their drastic decline. Genetic diversity of the remaining summer/fall run of Chinook salmon was reduced as a result of confinement to 10 percent of historically available habitat and to degradation and loss of habitat within the confined area where the population spawns. Considering that nearly all Chinook salmon returning to the river are hatchery-origin fish, remaining diversity of the population has likely been retained predominately through the

supportive breeding program for the native stock operated by WDFW for decades. The productivity of the Elwha natural-origin Chinook salmon population has been suppressed by the lack of available and suitable spawning and rearing habitat, with the species recruiting at below-replacement levels (Ford et al. 2011). Although the Elwha River Dam was removed in 2011 and removal of the Glines Canyon Dam is expected to be completed by the end of 2014, the benefits of dam removal on genetic diversity and productivity have not yet been realized. Depending on flow levels allowing passage at the Elwha Dam site, Chinook salmon have been observed spawning in mainstem and tributary reaches downstream of the Glines Canyon dam site. In 2014, 88 percent of the fish that spawned upstream of the Elwha Dam site spawned in mainstem Elwha River areas (S. Brenkman, NPS, unpublished data, November, 2013). Redds created by these spawning fish were exposed to excessive course and fine sediment levels inhospitable to fish survival (data from Currans et al 2014).

There are currently no fisheries impacting the abundance of the Elwha Chinook salmon population through direct harvest. Fisheries for Chinook salmon and other salmon species (e.g., coho salmon) have been largely curtailed since the 1980s in the Elwha River and adjacent marine areas as a specific measure to minimize impacts on the Elwha Chinook salmon population. There was a small Tribal commercial fishery in the lower 5 miles of the Elwha River that targeted non-native (i.e., Chambers Creek), hatchery-origin steelhead, but this fishery was terminated after the 2013-2014 fishing season. Elwha River Chinook salmon are harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks.

3.4.2. Puget Sound Steelhead (ESA-listed)

The Elwha River late-returning, winter-run steelhead population is included in the Puget Sound Steelhead DPS. Under draft DPS viability criteria under development and consideration by NMFS (Hard et al., pending), it is likely that Elwha River steelhead will be a key population needing to be restored to a low extinction risk status for recovery and delisting of the DPS.

In the most recent status review for the Puget Sound Steelhead DPS, NMFS found that, since 1995, Puget Sound winter-run steelhead abundance has shown a widespread declining trend over much of the DPS (NMFS 2011b). The native Elwha steelhead population was among the most severely affected, with sharply declining population trends over both the long (1985 through 2009) and short (1995 through 2009) terms. The recent-year (2005-2006 run year through 2009-2011 run year) average escapement of 141 fish (all natural-origin) is 7.3 percent of the viability trigger level of 1,938 naturally spawning fish developed by scientists for progression into the local adaptation phase of restoration (NMFS 2012). Naturally spawning fish abundance is

further threatened over the short term by dam removal activities. The Puget Sound Steelhead DPS was recently amended to clarify that the Lower Elwha Klallam Tribe's native Elwha River steelhead hatchery population is included in the listing along with the wild population (FR 79 20802, April 14, 2014).

Spatial structure of the Elwha River steelhead population has been adversely affected by dam construction and operation in the watershed. The construction of the Elwha Dam in 1911 blocked access of steelhead to 90 percent of their historical range of spawning and rearing habitat. Because the Elwha River Dam was removed in 2011, Elwha River steelhead currently have access up to river mile 13.5 of the Elwha River, which is the site of the Glines Canyon Dam. However, steelhead habitat in the mainstem river and floodplain below the Glines Canyon Dam is of generally poor quality, with only a small area of relatively high-quality habitat remaining in two tributaries above the Elwha Dam site, and about two dozen mainstem and side-channel areas downstream of the site (e.g., Hunt's Road side-channel).

Because of dam construction and resultant degradation of downstream habitat, genetic diversity of Elwha River steelhead has been substantially reduced from historical levels. Occurrence, distribution, and connectivity of *O. mykiss* life history forms have been severely affected, to the detriment of within- and among-population genetic diversity in the watershed. For example, loss of access to upper watershed areas caused by dam construction has led to decreased life-history diversity (Beechie et al. 2006). Historically, the majority of summer steelhead migrated upstream above Elwha Dam in the late spring and early summer to access river habitats that have more suitable temperatures for holding and spawning (Pess et al. 2008). For 100 years, up-river habitat has not been accessible to anadromous fish because of upstream migration blockage by Elwha Dam. Summer steelhead were confined to the lower Elwha River, where peak summer temperatures when the race entered and held in the river typically reach 18 to 21°C, and this race is now believed by the Puget Sound TRT to be extirpated (PSSTRT 2012). Genetic diversity of remaining winter-run forms of the species in the lower river is further threatened in the short term by excessive sediment and turbidity levels resulting from the stored sediment released by dam removal (Beechie et al. 2006; Ward et al. 2008). The productivity of the Elwha River late-returning steelhead population is suppressed, with the species recruiting at levels well below replacement (Ford et al. 2011). Although the Elwha River Dam was removed in 2011 and removal of the Glines Canyon Dam is expected to be completed by the end of 2014, the benefits of dam removal on genetic diversity and productivity have not yet been realized. A few steelhead have escaped upstream of the Elwha Dam site to spawn naturally in tributaries downstream of Glines Canyon Dam (McMillan et al. 2013). However, the vast majority of steelhead spawning naturally in the tributaries in 2012-2014 originated from releases from adult steelhead returning to and trapped at the hatcheries, and adjacent lower river areas, and trucked upstream (McMillan et al. 2013). These trapping and upstream release actions for adult

hatchery-origin and natural-origin steelhead surplus to hatchery broodstock needs are consistent with requirements included in the NMFS biological opinions to mitigate for dam deconstruction effects (NMFS 2012).

There have been no directed fisheries since the late 1970s on the late-returning, winter-run steelhead population. In recognition of the depleted state of the native late-returning steelhead population, tribal and recreational fisheries harvests have targeted only early-returning hatchery-origin steelhead (an out-of-basin stock originating from Chambers Creek stock) that entered the river prior to the majority of late-returning fish in need of protection. However, a small portion of the late-returning run (i.e., the native stock) were taken incidentally each year during fisheries that target early-returning hatchery-origin steelhead produced at Lower Elwha Fish Hatchery. The Lower Elwha Klallam Tribe's steelhead catch monitoring data for 1982 through 1996 indicate an estimated 10 to 18 natural-origin, late-returning steelhead were harvested annually by the Tribal commercial fishery in the Elwha River. Estimated total annual harvests in Tribal fisheries directed at early-returning Chambers Creek lineage steelhead have ranged from 173 to 296 fish for the 2003-2004 through 2007-2008 fishing seasons. The early-returning Chambers Creek lineage steelhead program has been terminated, and the last four year old Chambers Creek adult steelhead returned in 2014. There are no fisheries in the Elwha River on any species at this time due to a 5-year moratorium during and immediately after Elwha and Glines Canyon dam removals.

3.4.3. Puget Sound Fall Chum Salmon

The fall chum salmon population in the Elwha River is part of the Puget Sound/Strait of Georgia Chum Salmon ESU (Johnson et al. 1997). The ESU includes all naturally spawned populations of chum salmon from Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca up to and including the Elwha River, with the exception of summer-run chum salmon from Hood Canal and the Strait of Juan de Fuca. After reviewing the status of chum salmon populations in the region, NMFS determined that ESA listing of the ESU was not warranted on August 10, 1998 (63 FR 11774).

Chum salmon in the Elwha River are considered a native, natural-origin stock (WDFW and WTIT 1994) with a fall-run timing. Historical spawner estimates placed population abundance at many thousands, likely the second most-abundant species in the river behind pink salmon. Abundance, spatial structure, productivity, and genetic diversity have been greatly reduced by Elwha and Glines Canyon dams. Spawner surveys in 1993 to 1995 indicated the population had declined to 150 to 300 adults (Hiss 1995). The Elwha chum salmon stock is considered critically depressed in status, with annual abundance of adult fish escaping to spawn in the Elwha River in the 100 to 200 fish range. Estimated escapements in 2010, 2011, and 2012 were 4 fish, 80 fish,

and 205 fish, respectively (Aaron Default, WDFW, pers. comm., May 14, 2014). Naturally spawning fish abundance, genetic diversity, and productivity are further threatened over the short term by dam removal activities. Spatial structure has improved as a result of the removal of the Elwha River Dam. However, the benefits of dam removal on abundance, genetic diversity, and productivity have not yet been realized.

No harvest is directed at Elwha chum salmon, though very low levels of incidental harvest of the species has occurred historically incidental to commercial and recreational fisheries targeting Elwha River coho salmon. Currently, there are no salmon or steelhead fisheries in the Elwha River due to a 5-year moratorium during and immediately after Elwha and Glines Canyon dam removals. Chum salmon are not encountered during tribal steelhead fisheries.

3.4.4. Puget Sound Pink Salmon

The odd- and even-year pink salmon aggregations in the Elwha River are included as part of the Washington Odd- and Puget Sound Even-Year Pink Salmon ESUs, respectively (Hard et al. 1996). NMFS has determined that ESA listing for the two ESUs and their component populations, including the Elwha populations, was not warranted (60 FR 192, October 4, 1995). However, both Elwha River populations are at a critically low abundance status, and are in danger of extirpation (WDFW 2002; LEKT and WDFW 2012). Although the Elwha River pink salmon populations are in danger of extirpation, the ESUs as a whole, are not in danger of extirpation because they contain several healthy pink salmon populations.

Pink salmon historically were the most numerous salmonids in the Elwha River and their recovery is critical to the overall success of the restoration effort. The historical Elwha River pink salmon populations were considered the “cornerstone” anadromous salmonid species in the Elwha River watershed, and were estimated to have numbered in the hundreds of thousands of adult fish (Pess et al 2008). Abundance, spatial structure, productivity, and genetic diversity have been greatly reduced by Elwha and Glines Canyon Dams. Odd-year pink salmon escapement indices have ranged from approximately 200 fish in 2001 to less than 40 fish in 2009, with even-year pink salmon escapements estimated to be under 20 fish during that period (LEKT and WDFW 2012). The native Elwha River pink salmon population is considered to be at high risk of extirpation due to its extremely low annual adult abundance levels.

The quantity and quality of available habitat for pink salmon production will be gradually restored when the Glines Canyon Dam is removed, but pink salmon will be threatened with extirpation over the short term by inhospitable water quality and sedimentation conditions during the adult return and egg incubation periods associated with dam removal in currently accessible river areas.

No directed harvest of Elwha River pink salmon has occurred for decades. Adult fish may be harvested incidentally in marine area fisheries directed at other pink salmon populations and other species (sockeye and Chinook salmon) in United States and Canadian waters. Exploitation rates on Elwha River pink salmon are expected to be very low (under 5 percent), given weak stock management requirements for fisheries occurring in adjacent marine waters (NMFS 2011). Pink salmon are not encountered during tribal steelhead fisheries.

3.4.5. Puget Sound Coho Salmon

The coho salmon population in the Elwha River is part of the Puget Sound/Strait of Georgia coho salmon ESU (Weitkamp et al 1995). ESA listing of the ESU was determined by NMFS to be not warranted (75 FR 38776, July 6, 2010).

Total run size abundance of Elwha River coho salmon (including both hatchery and natural-origin fish) has ranged from 2,000 to 10,000 fish in the last decade. Until 2011, natural coho salmon production was confined to the degraded mainstem area and tributaries downstream of Elwha Dam (river mile 4.9) for 100 years, and hatchery-origin coho salmon have comprised the majority of annual returns to the river for at least four decades. Approximately 90 percent of adult coho encountered in the lower Elwha River in 2013 and trucked upstream to allow the fish to spawn naturally, were identified through mark and tag analyses as hatchery-origin fish (unpublished data from Mike McHenry, LEKT, December, 2013). Coho salmon currently have access to mainstem and tributary areas up to river mile 13.5 as a result of the removal of the Elwha River Dam, but the Glines Canyon Dam continues to block their access to most of their historical habitat. Furthermore, remaining coho spawning and rearing habitats downstream of the Elwha Dam site are affected in the short-term by high sediment transport, channel instability, and reduced water quality resulting from dam removal and the release of stored sediments. Consequently, naturally-spawning fish abundance, spatial structure, genetic diversity, and productivity are threatened over the short term by dam removal activities. The benefits of dam removal on abundance, spatial structure, genetic diversity, and productivity have not yet been realized.

Elwha River coho salmon are a mixed-origin stock of composite production associated with hatchery facilities in the lower Elwha River. The river was planted with out-of-basin hatchery coho salmon, beginning in the early 1950s and continuing to the 1970s (WDFW and WWTIT 1993). Artificial production of the current hatchery stock began with Dungeness and Elwha River fish in the mid-1970s.

Currently, no fisheries target hatchery-origin or natural-origin coho salmon in the Elwha River Basin due to a 5-year moratorium during and immediately after the Elwha and Glines Canyon dam removals. However, Elwha coho salmon would continue to be harvested incidentally in United States and Canadian mixed stock marine area fisheries targeting more abundant salmon stocks. Coho have been encountered during the now terminated steelhead fishery on the early-timed, Chambers Creek population. Coho would not be encountered during the steelhead fishery on the late-timed, hatchery-origin steelhead population.

3.5. Other Fish Species

Many fish species in the Elwha River Basin and nearshore marine areas have a relationship with salmon and steelhead as prey, predators, or competitors (Table 7). The following species may eat salmon and steelhead eggs and fry: Pacific lamprey, Western brook lamprey, coast range sculpin, prickly sculpin, eastern brook trout, rainbow trout, kokanee, bull trout, cutthroat trout, and rockfish. All fish species in the Elwha River Basin may be prey for salmon and steelhead at some life stage. Additionally, all fish species in the Elwha River Basin compete with salmon and steelhead for food and space.

In addition to Chinook salmon and steelhead, there are two other fish species listed under the ESA in the Elwha River Basin: eulachon and bull trout are both listed as threatened (Table 7). Critical habitat has been designated for the southern DPS of Pacific eulachon (76 FR 65324, October 20, 2011). In general, watershed areas designated as critical habitat extend from the mouth of the river upstream to a fixed location where eulachon were known to be present, including the stream channel and side channels; critical habitat also includes tidally influenced areas. In the Elwha River, Reservation, adjacent, and nearby lands owned by the Lower Elwha Klallam Tribe were excluded from the critical habitat designation. The physical or biological features essential for conservation of the southern DPS of Pacific eulachon include freshwater spawning and incubation sites, freshwater and estuarine migration corridors, and nearshore and offshore marine foraging habitat.

The Elwha River Basin includes habitat designated as critical for bull trout (75 FR 63898, October 18, 2010). Bull trout critical habitat includes primary constituent elements considered essential for the conservation of bull trout, and may require special management considerations or protection. Such elements include adequate migration, spawning, and rearing habitat, including maintained connectivity, sufficient water quality and quantity, low levels of piscivorous (i.e., fish eating) or competing species, and an abundant food base.

Pacific lamprey and Western brook lamprey are Federal “species of concern” and are Washington State “monitored species” (Table 7). In marine areas, several species of rockfish are

Table 7. Range and status of other fish species that may interact with Elwha River salmon and steelhead.

Species	Range in Elwha River Basin	Federal/State Listing Status	Type of Interaction with Salmon and Steelhead
Freshwater -			
Pacific lamprey and Western brook lamprey	Pacific: accessible reaches below Glines Canyon Dam Western brook: watershed areas upstream and downstream of the Glines Canyon Dam.	Federal species of concern; Washington State monitored species.	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Coast range and Prickly sculpin	All accessible reaches in the Elwha River Basin	None	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Eulachon	Accessible reaches below Glines Canyon Dam	Federal threatened species	• May compete with salmon and steelhead for food and space • Potential prey item for salmon and steelhead • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Three-spine stickleback	Accessible reaches upstream and downstream of the Glines Canyon Dam	None	• May compete with salmon and steelhead for food and space • Potential prey item for salmon and steelhead • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Red-side shiner	Accessible reaches downstream of RM 7.0. (Highway 101 Bridge)	None	• May compete with salmon and steelhead for food and space. • Potential prey item for salmon and steelhead • May benefit from additional marine-

Species	Range in Elwha River Basin	Federal/State Listing Status	Type of Interaction with Salmon and Steelhead
			derived nutrients provided by hatchery-origin fish
Eastern brook trout	High lakes and localized below Rica Canyon to the river mouth. Non-native but localized to the watershed.	None	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Rainbow trout (resident)	Elwha River watershed upstream of the Glines Canyon Dam and in mainstem areas downstream of the dam site.	None	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May interbreed with steelhead • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Kokanee	Lake Sutherland, Elwha River watershed	None	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Bull Trout	Accessible reaches upstream and downstream of the Glines Canyon Dam	Federal threatened species	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May benefit from additional marine-derived nutrients provided by hatchery-origin fish

Species	Range in Elwha River Basin	Federal/State Listing Status	Type of Interaction with Salmon and Steelhead
Cutthroat trout	Accessible reaches upstream and downstream of the Glines Canyon Dam	None	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Marine Areas			
Rockfish	Rocky reef habitats in certain areas of Puget Sound including South Sound, Hood Canal, waters east of Admiralty Inlet, the eastern Strait of Juan de Fuca and the San Juan Island region	Several species are federally listed as threatened and/or have State Candidate listing status [1]	• Predators of juvenile salmon and steelhead • Juveniles are prey for juvenile and adult salmon • May compete with salmon and steelhead for food
Forage fish	Most marine waters within Puget Sound and the Strait of Juan de Fuca	Pacific herring is a Federal species of concern and a State candidate species	• Prey for juvenile and adult salmon and steelhead • May compete with salmon and steelhead for food

Sources: NPS 1996; DOI et al 1994; Brenkman et al. 2008; Gustafson et al. 2010; Ward et al. 2008; http://www.elwhainfo.org/research-and-science/fisheries/fish-elwha-river/fish-species; Sam Brenkman, National Park Service, pers. comm., August 8, 2012.

[1] Georgia Basin bocaccio DPS (*Sebastes paucispinis*)- Federally listed as endangered and state candidate species; Georgia Basin yelloweye rockfish DPS (*S. ruberrimus*)- Federally listed as threatened and state candidate species; 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 are state candidate species.

listed as threatened under the ESA. Pacific herring (a forage fish for salmon and steelhead) is a Federal species of concern and a State candidate species. All of these species have a range that includes the Elwha River Basin or nearby marine areas. However, none of these species is located exclusively in the Elwha River Basin or nearby marine waters, and in most cases these areas are a very small percentage of their total range.

The last non-native, Chambers Creek steelhead returned to the Elwha River in 2014. Until 2014, a Tribal steelhead fishery in the lower 5 miles of the Elwha River used commercial gillnets (5-inch mesh) to target Chambers Creek hatchery-origin steelhead. Tribal fishermen did not encounter any freshwater species, including Pacific lamprey, Western brook lamprey, coast range and prickly sculpin, eulachon, three-spined stickleback, red-side shiner, eastern brook trout, kokanee, bull trout, and cutthroat trout (D. Morrill, pers. comm. with Amilee Wilson,

NMFS, September 5, 2012). These species are too small to be captured by 5-inch mesh gillnets. Until this year, Tribal members also had a subsistence fishery in the lower Elwha River using commercial gillnets and hook and line gear. Larger fish species such as bull trout were periodically encountered in the subsistence fishery, but no documented information on total incidental mortality is available at this time (D. Morrill, pers. comm. with Amilee Wilson, NMFS, September 5, 2012). There are no other fisheries in the Elwha River at this time due to a 5-year moratorium during and immediately after Elwha and Glines Canyon Dam removals.

3.6. Wildlife

Hatchery operations have the potential to affect wildlife by changing the total abundance of salmon and steelhead in aquatic and marine environments. Changes in the abundance of salmon and steelhead can affect wildlife through predator/prey interactions. Many wildlife species feed on salmon carcasses in the Elwha River and subsequently bring nutrients from the salmon into the terrestrial ecosystem (i.e., nutrient cycling). In addition, hatcheries could affect wildlife through transfer of toxic contaminants from hatchery-origin fish to wildlife, the operation of weirs (which could block or entrap wildlife), or predator control programs (which may harass or kill wildlife preying on juvenile salmon at hatchery facilities).

The Elwha River Basin area supports a variety of birds, large and small mammals, amphibians, and invertebrates that may eat or be eaten by salmon and steelhead (Table 8). Salmon and steelhead eat invertebrates and amphibians, which may include insects and frogs. Salmon predators include several species of birds, cougars, black bear, river otter, mink, weasels, and some amphibians. Some bird species, including bald eagle and cormorants, scavenge on salmon and steelhead carcasses, as do minks, weasels, and several invertebrate species. Other wildlife species compete with salmon and steelhead for food or habitat (e.g., gulls). Fish are not the only component of the diets of these species, though salmonids may represent a somewhat larger proportion of the diet during the relatively short period of the year that adult salmon return to the analysis area.

Within the analysis area, the following wildlife species are listed under the ESA: Northern spotted owl, marbled murrelet, Southern resident killer whale, and Steller sea lion (Table 8). The Pacific fisher and Mazama pocket gopher are Federal candidate species. The brown pelican, Northern goshawk, and peregrine falcon are Federal species of concern.

Although killer whales, seals, sea lions, dolphins, and porpoises are not found in the Elwha River Basin, they may intercept Elwha River salmon and steelhead when feeding in marine waters. No other marine mammals eat Elwha River salmon and steelhead. The Southern resident killer whale diet consists of a high percentage of Chinook salmon, with an overall average of 82

Table 8. Status and habitat associations of wildlife in the analysis area with direct or indirect relationships with hatchery-origin salmon and steelhead.

	Status	Habitat[1]			Relationship with Salmon and Steelhead			
Species		Fresh-water	Estuary	Marine	Predator	Competitor	Prey	Scavenger
Bald eagle	State threatened species	√	√	√	√			√
Northern spotted owl	Federal threatened species	√			√			
Marbled Murrelet	Federal threatened species		√	√	√			
Brown Pelican	State endangered species; Federal Species of Concern			√	√			
Northern goshawk	Federal species of concern	√	√		√			
Pacific Fisher	Federal candidate species	√			√			
Peregrine falcon	Federal species of concern	√	√					
Gulls and cormorants	None	√	√	√	√	√		√
Great blue heron	State Monitored Species	√	√		√	√		
Duck (species)	None	√	√	√	√			
Beaver	None	√				√		
Cougar	None	√			√			
Black bear	None	√	√		√			
River otter	None	√	√		√			
Mink and weasels	None	√	√		√			√
(Olympic) Mazama	State threatened,	√						

pocket gopher	Federal candidate species							
Bats	Varies by species[2]	√				√		
Amphibians (e.g., salamanders and frogs)	Varies by species[3]	√			√	√	√	
Aquatic/terrestrial/ riparian zone invertebrates (e.g., insects and snails)	Varies by species[4]	√	√				√	√
Southern Resident Killer Whale	Federal Endangered Species			√	√			
Harbor seal	Protected under MMPA[5]		√	√	√	√		
California and Steller sea lions	Protected under MMPA; Western DPS of Steller sea lion ESA-listed endangered		√	√	√	√		
Sea otter (Washington Coastal stock)	State-listed endangered; protected under MMPA			√	√	√		
Harbor porpoise (Inland Washington and Oregon-Washington Coastal stocks)	Protected under MMPA; State species of concern			√	√	√		
Dall's porpoise (California /Oregon/Washington stock)	Protected under MMPA.			√	√	√		
Pacific white-sided dolphin (California /Oregon/Washington stock)	Protected under MMPA.			√	√	√		
Marine invertebrates (e.g., zooplankton)	None		√	√			√	

Sources: Listed And Proposed Endangered And Threatened Species And Critical Habitat; Candidate Species; And Species Of Concern In Clallam County. As Prepared By The U.S. Fish And Wildlife Service Washington Fish And Wildlife Office. (Revised August 1, 2011); Washington State Species of Concern Lists: http://wdfw.wa.gov/conservation/endangered/lists/search.php?searchby=simple&search=black+bear&orderby=AnimalType%2CCommonName

[1] Includes those habitats most relevant for evaluating interactions with salmon and steelhead; does not include all habitats used by each species.

[2] Applicable listed species include Longeared myotis (Myotis evotis) (Federal sensitive species); Longlegged myotis (Myotis volans) (Federal sensitive species); and Pacific Townsend's big-eared bat (Corynorhinus townsendii townsendii) (state and Federal candidate species).

[3] Applicable listed species include federally listed sensitive species (Cascades frog (Rana cascadae) (State Monitored); Olympic torrent salamander (Rhyacotriton olympicus); Tailed frog (Ascaphus truei) (State Monitored); Van Dyke's salamander (Plethodon vandykei); and Western toad (Bufo boreas).

[4] Applicable listed species include federally listed snails (Bliss Rapids snail, Taylorconcha serpenticola, (federally threatened), Banbury Springs lanx, Lanx sp., (federally endangered), Snake River physa snail, Physa natricina, (federally endangered), Utah valvata, Valvata utahensis, (federally endangered).

[5] Marine Mammal Protection Act. Enacted by Congress in 1972, 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.

percent Chinook salmon (Hanson et al. 2010). However, because Elwha River salmon and steelhead co-occur with many other hatchery-origin and natural-origin salmon and steelhead populations from the Puget Sound, Fraser River, Columbia River, and Washington Coast while in marine waters, Elwha River salmon and steelhead are not expected to be a substantial component of their diet.[5]

None of the hatchery facilities supporting the Elwha River hatchery programs hazes wildlife to prevent them from eating fish being raised in the hatchery facilities. Instead, the hatchery facilities use nets over their raceways to exclude predators, and this practice is not expected to adversely affect any wildlife species (LEFT 2012a; LEKT 2012b; LEKT 2012c; LEKT and WDFW 2012).

Fisheries have the potential to affect wildlife through habitat disruption that may occur from physical damage or disruption of riparian vegetation from angler access as well as physical disruption of streambed material by wading or motorized boat use. Currently, there are no salmon and steelhead fisheries in the Elwha River due to a 5-year moratorium during and immediately after the Elwha and Glines Canyon dam removals. However, because there has been subsistence and recreational fishing in the Elwha River Basin prior to the fishing

[5] The number of adult fish produced by Elwha River hatchery programs represents an unsubstantial proportion of the total abundance of each salmon species present in Puget Sound and Pacific Coastal marine areas. For example, an estimated 2,104 Chinook salmon on average have returned to the Elwha River in recent years (2000-2009) (estimated total annual adult return to the Elwha River from WDFW Run Reconstruction, January 8, 2010). The 2000-2009 average total run size for Chinook salmon in Puget Sound is 247,917 fish, and the estimated total annual abundance of Chinook salmon from all regions in Washington State and British Columbia Pacific Ocean coastal waters averages approximately 1,000,000 fish (L. LaVoy, NMFS, pers. comm., January 6, 2012).

moratorium, fishery access points, roads, and boat launches are present throughout the analysis area.

3.7. Socioeconomics

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

Annual operation of the Elwha River hatchery programs contributes over $1.65 million (through the procurement of local goods and services) and 14 full-time jobs to the regional economy (LEFT 2012a; LEKT 2012b; LEKT 2012c; LEKT and WDFW 2012). WDFW operates the Elwha Channel Facility, the Sol Duc Hatchery, and Hurd Creek Hatchery. The WDFW facilities employ 10 full-time employees to support the Elwha River hatchery programs. The Lower Elwha Klallam Tribe operates the Lower Elwha Hatchery, which employs 4 full-time employees to support the Elwha River hatchery programs (LEFT 2012a; LEKT 2012b; LEKT 2012c; LEKT and WDFW 2012).

Fisheries 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.

No Elwha River salmon or steelhead populations are currently targeted in fisheries. The State and Tribe have terminated all other fisheries during the 5-year period following initiation of dam removal activities to assist in the restoration efforts. Although salmon and steelhead originating from the Elwha River may be incidentally intercepted in fisheries in Puget Sound/Strait of Juan de Fuca, Washington Coast, Southeast Alaska, and British Columbia, Elwha River fish are a very small percentage of the total number of fish in the fisheries in these areas, and the Elwha River hatchery programs do not meaningfully contribute to these fisheries. Although data on the amount of money and the number of jobs currently supported through fishing-related expenditures in the Elwha River Basin are not available, fishing-related expenditures in the state of Washington accounted for less than 0.2 percent ($534 million) of the total state revenue in 2006, and salmon and steelhead angling only accounted for a portion of that total (USCB 2012).

3.8. Cultural Resources

Impacts on cultural resources typically occur when an action disrupts or destroys cultural artifacts, disrupts cultural use of natural resources, or would disrupt cultural practices. Hatchery programs have the potential to affect cultural resources if there is construction or expansion at the hatchery facilities that disrupts or destroys cultural artifacts or if the hatchery programs affect the ability of Native American tribes to use salmon and steelhead in their cultural practices.

Salmon represent an important cultural resource to the Lower Elwha Klallam Tribe. Salmon is regularly eaten by individuals and families, and served at gatherings of elders and to guests at feasts and traditional dinners (NMFS 2005). It is a core symbol of tribal identity, individual identity, and the ability of Native American cultures to endure (NMFS 2005). The survival and well-being of salmon is seen as inextricably linked to the survival and well-being of Native American people and the cultures of the tribes (NMFS 2005).

The Lower Elwha Klallam Tribe's "usual and accustomed" fishing area includes the entire Elwha River Basin. Historically, the Tribe relied on all species of fish in the watershed for sustenance and as a valuable cultural resource. However, construction of the Elwha River dams prevented salmon from traveling upriver and led to the degradation of habitat for the fish in the remaining 5 miles downstream of the dams. The resultant precipitous decline in natural-origin salmon and steelhead productivity and abundance severely diminished the availability of all species for harvest by the Tribe relative to historical levels. After the dams were constructed, the Lower Elwha people watched, year after year, as the salmon runs declined (Busch 2008). The river's legendary Chinook salmon were reduced to remnants of hatchery offspring and of the naturally spawning population (Busch 2008). Since dam construction, the Tribe has targeted salmon and steelhead produced by the tribal and state hatchery programs in the lower 5 miles of the Elwha River. These fisheries have played a central role in the Lower Elwha Klallam Tribe's culture, in particular fisheries conducted for ceremony and subsistence purposes (NPS 1995). Currently, no salmon or steelhead returning to the Elwha River are targeted in Tribal fisheries. The Tribe has terminated all other fisheries during the 5-year period following initiation of dam removal activities.

3.9. Human Health and Safety

Hatchery facilities may use a variety of chemicals to maintain a clean environment for the production of disease-free fish. Common chemical classes include disinfectants, therapeutics (e.g., antibiotics), anesthetics, pesticides/herbicides, and feed additives. The production of these chemicals for the protection of public health and the environment is governed by the Environmental Protection Agency (through the Federal Insecticide, Fungicide, and Rodenticide Act) and Food and Drug Administration (through the Federal Food, Drug, and Cosmetic Act).

Use of chemical products in the workplace is not considered a threat to human health when label warnings and directions are followed as established by EPA or FDA. Chemicals used in hatcheries are typically disposed of according to label requirements or discharged as effluents to receiving waters according to established water-quality guidelines developed through Federal or state regulations. However, some chemicals (e.g., antibiotics) do not have established water-quality criteria. A more in-depth description of specific chemicals used at hatchery facilities and their potential effects can be found in Subsection 3.3, Water Quality; Subsection 4.3, Water Quality; and in the Draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of the Mitchell Act Hatchery Programs (NMFS 2010).

Hatchery facility workers may also be exposed to diseases while handling fish. A number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species (NMFS 2010). Many of these are transmitted primarily through seafood consumption (i.e., improperly or under-cooked fish). However, exposure to these pathogens may also occur through skin contact with fish or accidental needle-stick injuries during vaccination of fish (Section 3.7.6, Relevant Disease Vectors and Transmission).

Seafood consumption by humans is generally promoted due to the nutritional value of fish products. For example, fish contain elevated levels of omega-3 fatty acids, which are considered beneficial to the cardiovascular system (Mayo Clinic 2010). However, concerns have been raised that farm-raised and hatchery-origin fish may contain toxic contaminants that may pose a health risk to consumers (WHO 1999; Hites et al. 2004; Jacobs et al. 2002a; Jacobs et al. 2002b; Easton et al. 2002). Sources of contaminants in the fish may include chemicals or therapeutics, contamination of the nutritional supplements or feeds, and/or contamination of the environment where the fish are reared or released (Jacobs et al. 2002a; Jacobs et al. 2002b; Easton et al. 2002; Hites et al. 2004; Carlson and Hites 2005; Johnson et al. 2007; Johnson et al. 2009; Maule et al. 2007; Kelly et al. 2008). While hatchery-origin fish may contain chemicals of concern, the risk from consuming contaminants in hatchery-origin fish remains uncertain.

3.10. Environmental Justice

This section was prepared in compliance with Presidential Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (EO 12898), dated February 11, 1994, and Title VI of the Civil Rights Act of 1964.

Executive Order 12898 (59 FR 7629) states that Federal agencies shall identify and address, as appropriate "…disproportionately high and adverse human health or environmental effects of [their] programs, policies and activities on minority populations and low-income populations…." While there are many economic, social, and cultural elements that influence the viability and

location of such populations and their communities, 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.

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

- Minority – all people of the following origins: Black, Asian, American Indian and Alaskan Native, Native Hawaiian or Other Pacific Islander, and Hispanic[6]
- Low income – persons whose household income is at or below the U.S. Department of Health and Human Services poverty guidelines.

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

The CEQ guidelines do not specifically state the percentage considered meaningful in the case of low-income populations. For this EA, the assumptions set forth in the CEQ guidelines for identifying and evaluating impacts on minority populations are used to identify and evaluate impacts on low-income populations. More specifically, potential environmental justice impacts are assumed to occur in an area if the percentage of minority, per capita income, and percentage below poverty level are meaningfully greater than the percentage of minority, per capita income, and percentage below poverty level in Washington State.

The entire Elwha River Basin and all hatcheries supporting the Elwha River hatchery programs are located in Clallam County. Elwha River salmon and steelhead do not meaningfully contribute to fisheries outside of the Elwha River Basin (Subsection 3.7, Socioeconomics). Therefore, Clallam County is the only county that would be meaningfully affected by Elwha River hatchery programs. Clallam County is an environmental justice community of concern

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

because 14.2 percent of the population is below the poverty level, compared to 12.1 percent for the state as a whole (Table 9).

Table 9. Percentage minority, per capita income, and percentage below poverty level in Clallam County and Washington State.

Indicator	Clallam County	Washington State
Black (percent in 2011)	1.0	3.8
American Indian (percent in 2011)	5.3	1.8
Asian (percent in 2011)	1.5	7.5
Pacific Islanders (percent in 2011)	0.2	0.7
Hispanic or Latino origin (percent in 2011)	5.3	11.6
Per capita income (2006-2010)	$24,449	$29,733
Below poverty level (percent in 2006-2010)	14.3	12.1

Source: http://quickfacts.census.gov/qfd/states/53/53009.html

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

The Lower Elwha Klallam Tribe resides in the Lower Elwha River Valley and adjacent bluffs on the north coast of the Olympic Peninsula just west of Port Angeles, Washington, in Clallam County. As recognized by the United States in the 1855 Treaty of Point No Point, the Lower Elwha Klallam Tribe has lived in this area since time immemorial. As described in Subsection 3.8, Cultural Resources, the Elwha River hatchery programs provide cultural, nutritional,

economic, and social benefits to the Tribe. In addition, the Lower Elwha Klallam Tribe and other tribes participate in marine salmon fisheries in the Strait of Juan de Fuca and shellfish fisheries.

4. ENVIRONMENTAL CONSEQUENCES

4.1. Introduction

The five alternatives being evaluated in this EA are described in Chapter 2, Alternatives Including the Proposed Action. The baseline conditions for the nine resources (water quantity; water quality; salmon, steelhead, and their habitat; other fish and their habitat; wildlife; socioeconomics; environmental justice; cultural resources; and human health and safety) that may be affected by the Proposed Action and alternatives are described in Chapter 3, Affected Environment. This chapter provides an analysis of the direct and indirect environmental effects associated with the alternatives on these nine resources. In 2011, dam removal efforts were initiated so some effects of dam removal efforts are captured in baseline conditions as described in Chapter 3, Affected Environment. By the end of 2014, both the Elwha and Glines Canyon Dams are expected to be removed, and environmental conditions in the Elwha River Basin will continue to change into the future as a result of dam removal activities (Table 10). This chapter analyzes the effects of the Proposed Action and its alternatives in the context of these changing environmental conditions. Cumulative effects are presented in Chapter 5, Cumulative Effects.

The effects of Alternative 1 are described relative to baseline conditions (Chapter 3, Affected Environment). The effects of the other alternatives are described relative to Alternative 1 (No Action). Where applicable, the relative magnitude of impacts is described using the following terms:

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

Table 10. Summary of expected changes in environmental conditions in the Elwha River Basin relative to baseline conditions.

	Environmental Conditions
Baseline Conditions (2014)	• Elwha Dam has been removed since 2011. Since 2011, natural-origin salmon and steelhead have been able to bypass the Elwha Dam and can access habitat up to the Glines Canyon Dam at river mile 13.5. • Removal of Glines Canyon Dam has begun, but at this point, salmon and steelhead do not have volitional access above Glines Canyon Dam (river mile 13.5). • Non-native Chambers-creek early returning steelhead have stopped returning to the Elwha River. • There are no fisheries in the Elwha River basin that target salmon and steelhead • Because dam removal activities have started, course and fine sediment levels have increased in the lower Elwha River to levels inhospitable to fish and other aquatic life • Chinook salmon, native steelhead, coho salmon, pink salmon, and fall chum salmon produced by WDFW and tribal hatchery programs continue to return. • High sediment levels have been relatively continuous, and suspended sediment concentrations are often higher than 1000 mg/l.
Expected Future Conditions	• During dam removal, it is anticipated that turbidity (suspended sediment) levels will exceed 1,000 parts per million (ppm) for extended periods of time and will spike to levels exceeding 10,000 ppm for several weeks each year, with periodically high concentrations for as much as 3 to 5 years following dam removal (Randle et al., 1996; Ward et al. 2008; Duda et al. 2011) • Dam removal is expected to almost immediately correct elevated water temperature conditions throughout the lower river caused in the past by thermal warming in the reservoirs that adversely affected fish migrating in the summer months (Ward et al. 2008) • In late 2014, hatchery- and natural-origin salmon and steelhead are expected to have access to habitat above Glines Canyon Dam • The greatest turbidity levels are expected immediately after the Glines Canyon Dam has been fully removed.

4.1.1 Critical Habitat

Critical habitat for ESA-listed species in the Elwha River Basin includes many of the identified primary constituent elements, but most are affected primarily by the existence of the dams, or by the anticipated near-term effects of dam removal (e.g., sediment impacts on freshwater rearing sites, floodplain connectivity, or migration corridors), which is not part of the Proposed Action. The aspects of critical habitat that may be affected by the Proposed Action include (1) adequate

water quantity and quality, and (2) freedom from excessive predation. Potential impacts on critical habitat are analyzed in this Environmental Assessment in the broader discussion of impacts on habitat (Subsection 4.2, Water Quantity; Subsection 4.3, Water Quality; Subsection 4.4, Salmon and Steelhead; and Subsection 4.5, Other Fish Species).

4.2. Water Quantity

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

Under Alternative 1 (No Action), the Elwha River hatchery programs would have the same production levels as under baseline conditions, so the same amount of groundwater and surface water would be used as under baseline conditions for broodstock holding, egg incubation, juvenile rearing, and juvenile acclimation (Table 11). Because the same amount of water would be used, there would be no change in the amount of surface water flowing between the hatchery facilities' water intake and discharge structures. Likewise, there would be no change in the amount of water in any aquifer and no change in compliance with water permits or water rights at any of the hatchery facilities relative to baseline conditions (Subsection 3.2, Water Quantity).

4.2.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, the Elwha River hatchery programs would have the same production levels as under Alternative 1, so the same amount of groundwater and surface water would be used as under Alternative 1 for broodstock holding, egg incubation, juvenile rearing, and juvenile acclimation (Table 11). Because the same amount of water would be used, there would be no change in the amount of surface water flowing between the hatchery facilities' water intake and discharge structures. Likewise, there would be no change in the amount of water in any aquifer and no change in compliance with water permits or water rights at any of the hatchery facilities relative to Alternative 1.

Table 11. Water use by hatchery facility and alternative.

Hatchery Facility	Water Use By Alternative											
	Baseline Conditions		Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
	Sur-face	Ground	Sur-face	Ground	Sur-face	Ground	Sur-face	Ground	Sur-face	Ground	Sur-face	Ground

Elwha Channel Facility	36	3	36	3	36	3	0	0	0	0	12	1
Lower Elwha Fish Hatchery	29 max	9	29 max	9	29 max	9	0	0	0	0	9.67	3
Morse Creek Facility	5.4	0	5.4	0	5.4	0	0	0	0	0	1.8	0
Hurd Creek Hatchery	0	4.5	0	4.5	0	4.5	0	3.15	0	3.15	0	3.6
Sol Duc Hatchery	76	0	76	0	76	0	60.8	0	60.8	0	65.8	0
Manchester Research Station	3.3	0.07	3.3	0.07	3.3	0.07	2.84	0.06	2.84	0.06	2.99	0.06

[1] Under Alternative 3, the Programs would operate as under the Proposed Action through most of the Preservation Phase of Elwha River restoration. The hatchery programs would be terminated near the end of the Preservation phase. Numbers in the table represent the long-term effects on water quantity. Short-term effects under Alternative 3 would be identical as under Alternative 2.

4.2.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 3, hatchery programs would be operated at levels similar to those under Alternative 1 until the Glines Canyon Dams have been removed, sediment levels have returned to pre-dam removal levels, and salmon and steelhead have exhibited some natural productivity. The programs would be terminated near the end of the preservation phase, and the last hatchery-origin fish would be released in approximately 2019. Therefore, in the short term, production levels would be the same as under Alternative 1 and effects on water quantity (e.g., ground and surface water) would be the same as under Alternative 1. However, after approximately 2019, the Elwha River hatchery programs would be terminated, so long-term water use would be less under Alternative 3 than under Alternative 1. There would be no change in compliance with water permits or water rights at any of the hatchery facilities under Alternative 3 because the same amount of water or less would be used relative to Alternative 1. An analysis of the site-specific effects of the Elwha River hatchery programs is provided below.

Hurd Creek Hatchery

Hurd Creek uses groundwater exclusively except in the case of emergencies (Subsection 3.2, Water Quality). Under Alternative 3, the Hurd Creek Hatchery would not be used for Elwha River hatchery programs after around 2019, and 1.5 cfs less groundwater would be used than under Alternative 1 (Table 11). A 1.5 cfs reduction in water use would be slight but detectable and may increase the amount of water available for other users of the aquifer. Therefore, Alternative 3 would have a low and beneficial effect on groundwater relative to Alternative 1.

Morse Creek Facility and Sol Duc Hatchery

Morse Creek Facility and Sol Duc Hatchery use surface water exclusively. All water diverted from these rivers (minus evaporation) is returned after it circulates through the facility, so the only segment of the river that may be impacted by the hatchery facility would be the area between the water intake and discharge structures (Subsection 3.2, Water Quantity).

Under Alternative 3, the Morse Creek Facility would be closed after approximately 2019, and 5.4 cfs less water would be diverted from Morse Creek in the area between the water intake and discharge structures (Table 11). Because 5.4 cfs is up to 21 percent of the water in Morse Creek during low-flow conditions (Subsection 3.2, Water Quantity), the effect on water quantity in Morse Creek would be readily apparent, and Alternative 3 may reduce the long-term potential for impacts on fish or wildlife as a result of stream dewatering. Consequently, the long-term effects of Alternative 3 would be medium and beneficial relative to Alternative 1.

Under Alternative 3, Sol Duc Hatchery would not be used for Elwha River hatchery programs after approximately 2019, and 15 cfs less water would be diverted from the Sol Duc River in the area between the water intake and discharge structures (Table 11). Because 15 cfs is up to 7 percent of the water in Sol Duc River during low-flow conditions (Subsection 3.2, Water Quantity), the effect would be slight but detectable and may reduce the long-term potential for impacts on fish and wildlife as a result of stream dewatering. Consequently, the long-term effects of Alternative 3 on water quantity in the Sol Duc River would be low and beneficial relative to Alternative 1.

Elwha Channel Facility and Lower Elwha Fish Hatchery

The Elwha Channel Facility and Lower Elwha Fish Hatchery use both groundwater and surface water (Subsection 3.2, Water Quality). All surface water diverted from the Elwha River (minus evaporation) is returned after it circulates through the facility. The only segment of the Elwha River that may be impacted by the hatchery facilities would be the area between the water intake and discharge structures (Subsection 3.2, Water Quantity).

Under Alternative 3, the Elwha Channel Facility and Lower Elwha Fish Hatchery would be closed after approximately 2019, and between 29 and 36 cfs less water would be diverted from the Elwha River in the areas between the water intakes and discharge structures (Table 10). Because 29 to 36 cfs is between 13 and 16 percent of the water in the Elwha River during low-flow conditions (Subsection 3.2, Water Quantity), the effect would be readily apparent and may reduce the long-term potential for impacts on fish and wildlife as a result of stream dewatering.

Because of the hydrological connection between the Elwha River aquifer and the Elwha River, the aquifer has been designated as under the influence of surface water and must be treated as if it were a surface water source (Subsection 3.2, Water Quantity). Under Alternative 3, the Elwha Channel Facility and the Lower Elwha Fish Hatchery would use between 3 and 9 cfs less well water than under Alternative 1 (Table 11). A reduction of between 3 and 9 cfs of well water would have a negligible impact on surface water relative to Alternative 1.

Manchester Research Station

Manchester Research Station uses both groundwater and surface water (i.e., marine water from the Puget Sound) (Subsection 3.2, Water Quantity). Under Alternative 3, the Manchester Research Station would not be used for Elwha River hatchery programs after approximately 2019, and 0.46 cfs less water would be diverted from the Puget Sound (Table 11). Because 0.46 cfs is a very small amount of water relative to the total amount of water in Puget Sound, the long-term effects of Alternative 3 of water quantity in Puget Sound would be undetectable relative to Alternative 1. Under Alternative 3, 0.01 cfs less groundwater would be used at the Manchester Research Station relative to Alternative 1. The effect on groundwater would be at the lower levels of detection. Therefore, Alternative 3 would have a negligible, long-term effect on groundwater relative to Alternative 1.

4.2.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, the Elwha River hatchery programs would be terminated immediately (Subsection 2.4, Alternative 4). Consequently, short- and long-term water use would be less under Alternative 4 relative to Alternative 1. There would be no change in compliance with water permits or water rights at any of the hatchery facilities under Alternative 4 because less water would be used relative to Alternative 1.

The site-specific evaluation of effects described under Alternative 3 (Subsection 4.2.3, Alternative 3) would apply in both the short and long term under Alternative 4. In summary, 36 cfs less water would be diverted between the intake and discharge structures of the Elwha Channel Facility relative to Alternative 1, up to 29 cfs less water would be diverted between the intake and discharge structures of the Lower Elwha Fish Hatchery relative to Alternative 1, and over 5 cfs less water would be diverted from Morse Creek relative to Alternative 1 (Table 11). These changes would reduce the short- and long-term potential for impacts on fish and wildlife as a result of stream dewatering. In addition, less groundwater would be used relative to Alternative 1, which may increase the amount of water available for other users of aquifers used by the Elwha River hatchery programs.

4.2.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) - Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 5, hatchery programs would be operated at decreased production levels so short and long-term water use would be less under Alternative 5 than under Alternative 1. There would be no change in compliance with water permits or water rights at any of the hatchery facilities under Alternative 5 because less water would be used relative to Alternative 1. An analysis of the site-specific effects of the Elwha River hatchery programs is provided below.

Hurd Creek Hatchery

Hurd Creek uses groundwater exclusively except in emergencies (Subsection 3.2, Water Quality). Under Alternative 5, 0.9 cfs less groundwater would be used than under Alternative 1 (Table 11). A 0.9 cfs reduction in water use would be slight, but detectable and may increase the amount of water available for other users of the aquifer. Therefore, Alternative 3 would have a low and beneficial effect on groundwater relative to Alternative 1.

Morse Creek Facility and Sol Duc Hatchery

Morse Creek Facility and Sol Duc Hatchery use surface water exclusively. All water diverted from these rivers (minus evaporation) is returned after it circulates through the facility, so the only segment of the river that may be impacted by the hatchery facility would be the area between the water intake and discharge structures (Subsection 3.2, Water Quantity).

Under Alternative 5, the Morse Creek Facility would use 3.6 cfs less water from Morse Creek in the area between the water intake and discharge structures (Table 11). Because 3.6 cfs is up to 14 percent of the water in Morse Creek during low-flow conditions (Subsection 3.2, Water Quantity), the effect on water quantity in Morse Creek would be slight, but detectable, and Alternative 5 may reduce the long-term potential for impacts on fish or wildlife as a result of stream dewatering. Consequently, the long-term effects of Alternative 5 would be low and beneficial relative to Alternative 1.

Under Alternative 5, 10.2 cfs less water would be diverted from the Sol Duc River in the area between the water intake and discharge structures (Table 11). Because 10.2 cfs is up to 4.8 percent of the water in Sol Duc River during low-flow conditions (Subsection 3.2, Water Quantity), the effect would be slight, but detectable and may reduce the long-term potential for impacts on fish and wildlife as a result of stream dewatering. Consequently, the long-term effects of Alternative 5 on water quantity in the Sol Duc River would be low and beneficial relative to Alternative 1.

Elwha Channel Facility and Lower Elwha Fish Hatchery

The Elwha Channel Facility and Lower Elwha Fish Hatchery use both groundwater and surface water (Subsection 3.2, Water Quality). All surface water diverted from the Elwha River for these two facilities (minus evaporation) is returned to the river after it circulates through the facility. The only segment of the Elwha River that may be impacted by the hatchery facilities would be the area between the water intake and discharge structures (Subsection 3.2, Water Quantity).

Under Alternative 5, between 19 and 24 cfs less water would be diverted from the Elwha River in the areas between the water intakes and discharge structures (Table 10). Because 19 to 24 cfs is between 8 and 11 percent of the water in the Elwha River during low-flow conditions (Subsection 3.2, Water Quantity), the effect would be slight, but detectable, and may reduce at a low level the long-term potential for impacts on fish and wildlife as a result of stream dewatering.

Because of the hydrological connection between the Elwha River aquifer and the Elwha River, the aquifer has been designated as under the influence of surface water and must be treated as if it were a surface water source (Subsection 3.2, Water Quantity). Under Alternative 5, the Elwha Channel Facility and the Lower Elwha Fish Hatchery would use between 2 and 6 cfs less well water than under Alternative 1 (Table 11). A reduction of between 2 and 6 cfs of well water would have a negligible impact on surface water relative to Alternative 1.

Manchester Research Station

Manchester Research Station uses both groundwater and surface water (i.e., marine water from the Puget Sound) (Subsection 3.2, Water Quantity). Under Alternative 5, approximately 0.31 cfs less water would be diverted from the Puget Sound (Table 11). Because 0.31 cfs is a very small amount of water relative to the total amount of water in Puget Sound, the long-term effects of Alternative 5 of water quantity in Puget Sound would be undetectable relative to Alternative 1. Under Alternative 5, 0.01 cfs less groundwater would be used at the Manchester Research Station relative to Alternative 1. The effect on groundwater would be at the lower level of detection. Therefore, Alternative 5 would have a negligible, long-term effect on groundwater relative to Alternative 1.

4.3. Water Quality

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

Under Alternative 1 (No Action), the Elwha River hatchery programs would have the same production levels as under baseline conditions, so there would be no expected change in the

discharge of ammonia, nutrients (e.g., nitrogen), biological oxygen demand, pH, suspended solids levels, antibiotics, fungicides, disinfectants, steroid hormones, pathogens, anesthetics, pesticides, and herbicides into the Elwha River, Hurd Creek, Sol Duc River, or the Puget Sound from Elwha River hatchery programs(Subsection 3.3, Water Quality). Consequently, there would be no change in compliance with NPDES permits or tribal wastewater plans.

No changes would be expected to 303(d) listings for Hurd Creek, Sol Duc River, or the Puget Sound because hatchery production levels and ongoing contributions of substances from other sources (e.g., from activities such as human development, agricultural practices, and forest practices) would be the same as under baseline conditions, and there are no known mitigation actions being implemented within the analysis area that would remove these impaired water bodies from the 303(d) list in the foreseeable future.

However, water quality conditions in the Elwha River would be expected to change in the short and long term from dam removal (Table 10). In the short term, sediment levels would increase immediately after removal of the Glines Canyon Dam, but water temperature conditions throughout the lower river would be expected to improve immediately (Ward et al. 2008). In the long-term, sediment levels will dissipate and temperatures in the lower Elwha River would be reduced (NPS 2005). Consequently, the Elwha River may be removed from the 303(d) list because temperatures would be reduced in lower part of the river after dam removal, and temperature is its only 303(d) listing parameter (Subsection 3.3, Water Quality).

4.3.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, the Elwha River hatchery programs would have the same production levels, so there would be no expected change in water quality relative to Alternative 1 as a result of changes in the discharge of ammonia, nutrients (e.g., nitrogen), biological oxygen demand, pH, suspended solids levels, antibiotics, fungicides, disinfectants, steroid hormones, pathogens, anesthetics, pesticides, and herbicides into the Elwha River, Hurd Creek, Sol Duc River, or the Puget Sound from Elwha River hatchery programs (Subsection 3.3, Water Quality). Consequently, there would be no change in compliance with NPDES permits or tribal wastewater plans, and there would be no change in the contribution of hatcheries to water quality in any 303(d) listed segments of the analysis area relative to Alternative 1.

4.3.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 3, hatchery programs would be operated at levels similar to those under Alternative 1 until the dams have been removed, sediment levels have returned to pre-dam removal levels, and salmon and steelhead have exhibited some natural productivity. The programs would be terminated near the end of the preservation phase, and it would be expected that the last hatchery-origin fish would be released in approximately 2019. Therefore, in the short term, production levels would be the same as under Alternative 1, so there would be no expected change in water quality as a result of changes in the discharge of ammonia, nutrients (e.g., nitrogen), biological oxygen demand, pH, suspended solids levels, antibiotics, fungicides, disinfectants, steroid hormones, pathogens, anesthetics, pesticides, and herbicides into the Elwha River, Hurd Creek, Sol Duc River, or the Puget Sound from Elwha River hatchery programs (Subsection 3.3, Water Quality). However, after around 2019, the Elwha River hatchery programs would be terminated, and, therefore, long-term effects on water quality may differ relative to Alternative 1.

Over the long-term, there would be a reduction in the discharge of ammonia, nutrients (e.g., nitrogen), biological oxygen demand, pH, suspended solids levels, antibiotics, fungicides, disinfectants, steroid hormones, pathogens, anesthetics, pesticides, and herbicides into the Elwha River, Hurd Creek, Sol Duc River, or the Puget Sound from Elwha River hatchery programs (Subsection 3.3, Water Quality). The effects of a reduction in the discharge of these substances would be slight because hatchery effluent is passed through a pollution abatement pond to settle out uneaten food and waste before being discharged into receiving waters (Subsection 3.3, Water Quality), but because changes may be detectable in the immediate vicinity of the hatchery discharge structures, Alternative 3 may provide a low and beneficial, long term and localized benefit to water quality relative to Alternative 1.

Alternative 3 would not be expected to change any of the 303(d) lists relative to Alternative 1 because the contribution of substances from these programs is very small relative to the contribution of substances described under baseline conditions (e.g., from activities such as human development, agricultural practices, and forest practices) (Subsection 3.3, Water Quality). Because long-term water quality would be expected to improve under Alternative 3 relative to Alternative 1, there would be no change in compliance with applicable NPDES permits or tribal wastewater plans relative to Alternative 1.

4.3.4. Alternative 4 (No Hatchery Programs in the Elwha River) -- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Do not Meet the Requirements of the 4(d) Rule.

Under Alternative 4, the Elwha River hatchery programs would be terminated immediately. Consequently, there would be a reduction in the discharge of ammonia, nutrients (e.g., nitrogen), biological oxygen demand, pH, suspended solids levels, antibiotics, fungicides, disinfectants, steroid hormones, pathogens, anesthetics, pesticides, and herbicides into the Elwha River, Hurd Creek, Sol Duc River, or the Puget Sound over the short and long term relative to Alternative 1. The effects of a reduction in the discharge of these substances would be slight because hatchery effluent is passed through a pollution abatement pond to settle out uneaten food and waste before being discharged into receiving waters (Subsection 3.3, Water Quality), but because changes would be detectable in the immediate vicinity of the hatchery discharge structures, Alternative 4 would provide low and beneficial, long-term, and localized benefits to water quality relative to Alternative 1.

Alternative 4 would not be expected to change any of the 303(d) lists because the contribution of substances from these programs is very small relative to the contribution of these substances from activities such as human development, agricultural practices, and forest practices (Subsection 3.3, Water Quality). Because water quality would be expected to improve in both the short and long term, there would be no change in compliance with applicable NPDES permits or tribal wastewater plans at the Hurd Creek Hatchery, Sol Duc Hatchery, or Manchester Research Station relative to Alternative 1. These facilities use between 14 and 30 percent of their capacity to raise Elwha River fish and would continue to operate under Alternative 4 (Subsection 3.3, Water Quality). Because the Elwha Channel Facility and the Lower Elwha Fish Hatchery raise Elwha River fish exclusively (Subsection 3.3, Water Quality), they would close under Alternative 4, and NPDES or tribal wastewater plans would no longer be necessary or applicable.

4.3.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 5, there would be a long-term reduction in the discharge of ammonia, nutrients (e.g., nitrogen), biological oxygen demand, pH, suspended solids levels, antibiotics, fungicides, disinfectants, steroid hormones, pathogens, anesthetics, pesticides, and herbicides into the Elwha River, Hurd Creek, Sol Duc River, or the Puget Sound from Elwha River hatchery programs (Subsection 3.3, Water Quality). The effects of a reduction in the discharge of these substances would be slight because hatchery effluent is passed through a pollution abatement pond to settle out uneaten food and waste before being discharged into receiving waters (Subsection 3.3, Water

Quality), but because changes may be detectable in the immediate vicinity of the hatchery discharge structures, Alternative 5 may provide a low and beneficial, long term and localized benefit to water quality relative to Alternative 1.

Alternative 5 would not be expected to change any of the 303(d) lists relative to Alternative 1 because the contribution of substances from these programs is very small relative to the contribution of substances described under baseline conditions (e.g., from activities such as human development, agricultural practices, and forest practices) (Subsection 3.3, Water Quality). Because long-term water quality would be expected to improve under Alternative 5 relative to Alternative 1, there would be no change in compliance with applicable NPDES permits or tribal wastewater plans relative to Alternative 1.

4.4. Salmon and Steelhead

As removal of the two dams on the Elwha River continues, habitat conditions for salmon and steelhead downstream of the dams will continue to degrade in the short-term, as sediment that was trapped behind the dams is released, increasing turbidity levels, and making water quality conditions inhospitable for fish in mainstem and side-channel reaches of the lower Elwha River. Turbidity levels are expected to exceed 1,000 parts per million (ppm) for extended periods of time and will spike to levels exceeding 10,000 ppm for several weeks each year, with periodically high concentrations for as much as 3 to 5 years following dam removal (Randle et al. 1996; Ward et al. 2008; Duda et al. 2011).

The high sediment loads will cause deleterious effects in the egg to fry life stages for all species of fish present in the lower watershed (Pess et al. 2008). Fish exposed to sediment loads between 50 and 100 ppm for an extended period of time may stop feeding, suffer gill abrasion, and experience loss of fitness due to the associated stress (Cook-Tabor 1995). At turbidity levels above 1,000 ppm, direct mortality of fish may result simply from the elevated sediment loads (Cook-Tabor 1995). With sediment loads expected to exceed 10,000 ppm, all salmon and steelhead rearing naturally and/or migrating in the Elwha River below Glines Canyon Dam may be killed by stored sediment released during dam removal (Ward et al. 2008).

As described in Subsection 3.3 Water Quality, water quality in the river has become degraded by high fine and course sediment loads stored behind the Elwha River dams for 100 years, and released downstream as the dams are removed. Sediment levels at concentrations lethal to fish have been realized commensurate with removal of the dams. Based on course sediment accumulations documented in side channel and mainstem areas (G. Pess, NOAA Northwest Fisheries Science Center, unpublished data, March 26, 2014), and turbidity levels recorded in the lower Elwha River mainstem (Currans et al. 2014), water quality conditions in mainstem, side

channel, and estuarine areas downstream of the dam sites have become inhospitable to Elwha River salmon and steelhead.

In the long term, dam removal is expected to fully restore riverine sediment delivery to a natural condition, and partially restore sediment-starved areas in the nearshore marine environment. Several years will likely be required to reach equilibrium between sediment supply and transport capacity (Ward et al. 2008). It is expected that dam removal will almost immediately correct elevated water temperature conditions throughout the lower river caused in the past by thermal warming in the reservoirs. These temperatures adversely affected fish migrating in the summer months (Ward et al. 2008). By the end of 2014, natural-origin salmon and steelhead are expected to have access to habitat above Glines Canyon Dam (river mile 13.5) because of the scheduled dam removal.

Table 6 lists the various effects through which the hatchery programs could affect natural-origin salmon and steelhead populations in the Elwha River. However, NMFS also recognizes the substantial program elements designed to minimize these impacts, as well as the dynamics of hatchery operations during the native salmon and steelhead preservation and recolonization phases of Elwha River restoration. Potential impacts such as disease, competition and predation are minimized by the location of the hatchery release sites near the mouth of the river, which limits the potential for interactions between hatchery and natural-origin fish. The risk of disease transfer is further minimized by the hatchery operators' strict adherence to Washington State disease control protocols. Genetic risks are minimized by propagating only the native fish stocks, using large effective breeding population sizes, collecting broodstock across the entire run-timing of the species, and applying proper broodstock selection and mating protocols.

4.4.1. Puget Sound Chinook Salmon (ESA-listed)

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

Under Alternative 1, the hatchery programs would be operated the same as under baseline conditions (Subsection 2.1, Alternative 1), but habitat conditions would continue to change as Glines Canyon Dam is removed. Therefore, there would be no change in risks associated with competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to baseline conditions (Table 6) (Subsection 3.4, Salmon and Steelhead). Nutrient cycling and population viability benefits would continue to change relative to baseline conditions as the processes associated with dam removal proceed.

In the short term, while the effects of dam removal activities continue, the hatchery programs would continue to preserve genetic diversity under Alternative 1 at a level consistent with baseline conditions, but the hatchery programs would provide the following additional benefits going forward:

- The hatchery program would add marine-derived nutrients to the aquatic and terrestrial systems above Glines Canyon Dam, which are inaccessible to salmon and steelhead under baseline conditions.
- The Chinook salmon hatchery program would increase total and natural-origin abundance and spatial structure of the Chinook salmon population as additional habitat becomes available and as first-generation hatchery-origin fish, and the offspring of naturally spawning hatchery-origin fish, return to spawn naturally.
- The Chinook salmon hatchery program would preserve the Elwha River Chinook salmon population when turbidity levels are high and detrimental to natural-origin fish survival due to dam removal activities.

In the long term, spatial structure and abundance of the Elwha River Chinook salmon population would be expected to continue to improve relative to baseline conditions because Chinook salmon would continue to re-seed habitat that has been inaccessible since dam construction.

Table 12. Naturally spawning fish contributions by alternative relative to the recolonization phase abundance target for Elwha River Chinook salmon.

Alt	Elwha River Juvenile Chinook Release Numbers	Estimated Hatchery-Origin Adult Return[1]	Estimated Natural-origin Adult Return[2]	Estimated Total Adult Return	Annual Broodstock Collection to Maintain 500 Fish per Generation Effective Size[3]	Required Number of Broodstock to Meet Annual Smolt Release Target	Estimated Number of Naturally Spawning Fish in 2018[4]	Target for Natural Chinook Abundance [6]	Estimated Naturally Spawning Fish Percent of Abundance Target
1	2,700,000	2,160	102	2,262	500	1,700	562	4,340	**13**
2	2,700,000	2,160	102	2,262	500	1,700	562	4,340	**13**
3	2,700,000[5]	2,160	102	2,262	500	1,700	562	4,340	**13**
4	0	0	102	102	N/A	N/A	102	4,340	**2**
5	900,000 [7]	720	102	722	500	510	212 - 222	4,340	**5**

[1] Estimated hatchery-origin adult return is based on recent average smolt-to-adult survival rates. Actual survival rates will be lower while sediment levels are high.

[2] Estimated natural-origin adult return is based on recent average abundance in the Elwha River based on otolith mark recovery data (NMFS 2012), prior to commencement of dam removal and resultant inhospitable to lethal sediment loads in critical habitat for fish. Actual return levels will be lower while sediment levels are high.

[3] To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For Chinook, the generation time is 4 years, so you would need 125 effective spawners per year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the Chinook spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 125 times four to calculate the number of annual broodstock needed to achieve a 500 fish per generation effective size. For the Chinook salmon hatchery program, you would need to collect 500 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

[4] The estimate of natural spawners under each alternative is the average natural-origin adult return (102 fish) plus the number of hatchery-origin Chinook surplus to broodstock needs. When the number of broodstock needed to meet target annual smolt release levels was greater than the number needed to maintain a 500 fish per generation effective size, NMFS assumed hatchery operators would collect the number of broodstock needed to meet target annual smolt release levels. When the opposite was true, NMFS analyzed the range in broodstock numbers. NMFS assumed a hatchery-origin juvenile-to-adult return survival rate of 0.08%. Actual survival rates in the short-term will likely be worse while sediment levels are high.

[5] Alternative 3 includes a sunset, so although the Chinook program would release up to 2,700,000 juveniles into the Elwha River in year 1, the program would sunset after the Chinook population reached the preservation phase of restoration (NMFS 2012; EMG 2014).

[6] Natural Chinook spawner population viability target identified by the Elwha Monitoring Group (EMG 2014) for the end of the recolonization phase, and the beginning of the local adaptation phase of restoration, when the population would begin to become self-sustaining and the supportive breeding program for the species would no longer be needed.

[7] Juvenile fish releases directly into the Elwha River reduced to 1/3 of proposed levels – 833,333 subyearlings and 66,666 yearlings = ~900,000 fish.

Under Alternative 1, an estimated 2,262 adult Chinook salmon would return to the Elwha River in the short term (Table 12). After broodstock collection, 562 Chinook salmon would be available to spawn naturally, or 13 percent of the spawner abundance level needed to end the recolonization phase and begin the local adaptation phase of restoration, under which the hatchery program for steelhead would no longer be needed (Table 12).

As a result of the removal of Gline Canyons Dam, newly accessible habitat will be of higher quality than existing habitat in the long-term, so in the long term productivity would be expected to improve relative to baseline conditions. However, in the short term, the productivity of spawners above the dams will likely be lower than spawners below the dam until the spawning gravel above the dams is conditioned by salmon and steelhead spawners (i.e., the first generation of spawners would loosen and clean the spawning gravel, which would make it better for subsequent generations of salmon and steelhead). As fish colonize new areas, they would be subject to a broader array of selective pressures, which would be expected to increase genetic diversity relative to baseline conditions.

Under Alternative 1, no fisheries would directly harvest hatchery-origin or natural-origin Elwha River Chinook salmon. However, Elwha River Chinook salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Under Alternative 1, there would be no change in the long-term potential for tribal and recreational fisheries on Chinook salmon in the Elwha River relative to baseline conditions.

4.4.1.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). Additionally, the operation of the Elwha River hatchery programs would be the same as under Alternative 1 (Subsection 2.2, Alternative 2), so the hatchery programs would have identical impacts on natural-origin Chinook salmon and their habitat as under Alternative 1. There would not be any change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Table 6) (Subsection 3.4, Salmon and Steelhead). Similarly, there would be no change in population viability benefits or benefits from nutrient cycling relative to Alternative 1. There would be no change in total population abundance relative to Alternative 1 (Table 12).

Under Alternative 2, there would be no change in fisheries affecting Elwha River Chinook salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River Chinook salmon, but Elwha River Chinook salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Fisheries on native, hatchery-origin steelhead (ceremonial/subsistence and later commercial) would be initiated under Alternative 2 once the Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect Chinook salmon because adult Chinook salmon would not be in the fishing area during the steelhead fisheries. Under Alternative 2, there would be no change in the long-term potential for tribal and recreational fisheries on Chinook salmon in the Elwha River relative to Alternative 1.

4.4.1.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the short term, the operation of the Elwha River hatchery programs and habitat conditions as a result of dam removal would be the same under Alternative 3 as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed) (Subsection 2.3, Alternative 3). Therefore, in the short term, there would be no change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Table 6) (Subsection 3.4, Salmon and Steelhead). Similarly, there would be no change in the short term in total species abundance and population viability benefits or benefits from nutrient cycling relative to Alternative 1.

In the long term, Alternative 3 would eliminate risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer from hatchery programs, because the hatchery programs would be terminated in approximately 2019. Similarly, population viability and nutrient cycling benefits would be eliminated after hatchery-origin fish stop returning to the Basin to spawn (Subsection 3.4, Salmon and Steelhead). Salmon and steelhead would have similar access to high quality habitat throughout the Elwha River Basin under Alternative 3 as under Alternative 1, so there would be no change in the spatial structure or productivity of the Elwha River Chinook salmon population relative to Alternative 1, but the pace in achieving benefits to these parameters will likely be delayed by decades relative to Alternative 1 because of decreases in total population abundance. Because some hatchery programs may reduce the genetic diversity and fitness of a salmon population, eliminating the hatchery programs in approximately 2019 would reduce any genetic diversity and fitness loss risks associated with hatchery production relative to Alternative 1.

Under Alternative 3, there would be no short-term change in fisheries affecting Elwha River Chinook salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River Chinook salmon. However, Elwha River Chinook salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Tribal steelhead fisheries would be initiated under Alternative 3 if Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect Chinook salmon because adult Chinook salmon would not be in the fishing area during the steelhead fisheries. Because Alternative 3 would delay attainment of a viable abundance level relative to Alternative 1, Alternative 3 would reduce the long-term potential for tribal and recreational fisheries on Chinook salmon in the Elwha River relative to Alternative 1.

4.4.1.4. Alternative 4 (No Hatchery Programs in the Elwha River) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). However, under Alternative 4, the Elwha River hatchery programs would be terminated immediately (Subsection 2.4, Alternative 4). Consequently, Alternative 4 would eliminate short- and long-term risks associated with genetic effect caused by hatchery programs, competition and predation, facility effects, natural population status masking, incidental fishing effects, and disease transfer from the hatchery programs. These risks would, therefore, be lower than under Alternative 1. Similarly, benefits from the hatchery programs on population viability and nutrient cycling would be eliminated after hatchery-origin fish stop returning to the Basin to spawn (Table 6) (Subsection 3.4, Salmon and Steelhead).

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam. Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish held for spawning, rearing and release in the hatcheries) are going to have a higher survival rate when compared to fish migrating, spawning, and rearing in the Elwha River. The Elwha River Chinook salmon population is an ESA-listed threatened population that is considered at high risk of extinction and has low abundance relative to population viability parameter target levels (Subsection 3.4.1, Puget Sound Chinook Salmon). Nearly all (about 95 percent) of adult fish escaping to spawn in recent years are hatchery-origin fish, and the natural-origin Chinook salmon population averages only about 102 fish (Subsection 3.4.1, Puget Sound Chinook salmon). The already very low number of natural-origin fish is expected to decline further as a result of dam removal activities, and Alternative 4 would further reduce short-term abundance relative to Alternative 1, directly increasing extinction risk. Any Chinook salmon

that survive dam removal activities would have access to high-quality habitat throughout the Elwha River Basin, but because abundance levels would be expected to be critically low, the spatial structure, productivity, and genetic diversity status of the species would be markedly reduced relative to Alternative 1, which would also increase extinction risk. Therefore, Alternative 4 would increase the extinction risk of the Elwha River Chinook population relative to Alternative 1 both directly and indirectly.

Under Alternative 4, no fisheries would directly harvest Elwha River Chinook salmon. However, Elwha River Chinook salmon may continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks (if they are not extirpated), and the adverse effects of any fisheries would be increased over Alternative 1, as the consequences to the population of intercepting the few remaining natural-origin Chinook salmon would increase as the proportion of hatchery-origin fish, and hence the total population, decreases. Because Alternative 4 would increase the risk of extirpation and delay attainment of a viable abundance level relative to Alternative 1, Alternative 4 would reduce the long-term potential for tribal and recreational fisheries on Chinook salmon in the Elwha River.

4.4.1.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Decreased juvenile Chinook salmon production levels under Alternative 5 relative to Alternative 1 (Table 3) would reduce short-term risks associated with domestication, competition and predation, facility effects, natural population status masking, and disease transfer from the hatchery programs (Table 6) (Subsection 3.4, Salmon and Steelhead). Competition and predation risks are low under Alternative 1, but they would be even lower under Alternative 5 because fewer fish would be released.

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam. Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish in the hatcheries) are going to have a higher survival rate when compared to fish that are rearing and spawning in the Elwha River. The Elwha River Chinook salmon population is an ESA-listed threatened population that is considered at high risk of extinction (Subsection 3.4.1, Puget Sound Chinook Salmon). The natural-origin steelhead population averages only 102 fish (Subsection 3.4.1, Puget Sound Chinook Salmon), and these numbers are expected to decline as a result of the adverse sediment impact period during and immediately following dam removal . Under Alternative 5, the hatchery program would be reduced by two-thirds, so hatchery-origin fish returning the Elwha River would be reduced from 2,160 Chinook

salmon to 720 Chinook salmon under average survival rates (actual survival rates in the short term will be lower because of the adverse sediment impact period) (Table 13). After broodstock collection, the short-term total abundance of Chinook salmon would be between 212 and 222 fish, or 5 percent of the Chinook spawner abundance level needed to end the recolonization phase and begin the local adaptation phase of restoration, under which the hatchery program for Chinook salmon would no longer be needed. (Table 12).

Because of the critically low abundance levels under Alternative 5 and the deleterious river turbidity levels caused by dam removal, the hatchery would be primarily responsible for the conservation of genetic diversity of the native species in the Elwha River. A genetic effective population size (a measure of the rate at which a population of a certain size will lose diversity) of 500 per generation is needed for conservation of genetic diversity (Lande and Barrowclough 1987), and the production levels under Alternative 5 may be adequate to achieve a 500 fish per generation effective size within the hatchery if survival rates remain similar to those observed in recent years (Table 12). However, if the majority of returning adults cannot be collected, and if survival of juveniles to adulthood is substantially less than in recent years (recent year survivals have been 0.08 percent of the juveniles released), adequate numbers of broodstock would not be available, and the 500 fish per generation size would not be achieved[7]. Therefore, Alternative 5 would be less effective at conserving genetic diversity of the Elwha River Chinook salmon population relative to Alternative 1 if survival rate are substantially less than in recent years.

Any Chinook salmon that survive the adverse sediment impact period during and immediately following dam removal would have access to high-quality habitat throughout the Elwha River Basin. However, in the short term, the productivity of spawners above the dams will likely be lower than spawners below the dam until the spawning gravel above the dams is conditioned by salmon and steelhead spawners (i.e., the first generation of spawners would loosen and clean the spawning gravel, which would make it better for subsequent generations of salmon and steelhead). The process of conditioning gravel would take longer under Alternative 5 relative to Alternative 1. There would also be fewer salmon and steelhead spawning under Alternative 5 relative to Alternative 1, so fewer marine-derived nutrients would be added to an aquatic system that has been cut off from this important source of nutrients for decades.

[7] The "effective population size" is usually less than the census population size. To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For Chinook, the generation time is 4 years, so you would need 125 effective spawners per year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the Chinook spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 125 times four to calculate the number of annual broodstock needed to achieve a 500 fish per generation effective size. For the Chinook salmon hatchery program, you would need to collect 500 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

Because of the reduced number of spawners, extinction risk would be higher under Alternative 5 relative to Alternative 1. Loss of the unique Elwha Chinook salmon population would be highly detrimental to recovery of the listed Puget Sound Chinook salmon ESU, as it is one of only two extant populations within the Strait of Juan de Fuca biogeographical region. As such, the population is considered an important component of overall diversity of the species and essential for the ESU's recovery to a viable status (Subsection 3.4, Salmon and Steelhead).

Under Alternative 5, there would be no short-term change in fisheries affecting Elwha River Chinook salmon relative to Alternative 1. No fisheries would directly harvest listed hatchery-origin or natural-origin Elwha River Chinook salmon. However, Elwha River Chinook salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting annually determined, static annual harvest quotas for more abundant salmon stocks. The adverse effects of any fisheries would be increased over Alternative 1, as the incidence of intercepting a natural-origin Chinook salmon would increase as the proportion of listed hatchery-origin fish decreases. Because Alternative 5 would delay attainment of a viable abundance level relative to Alternative 1, Alternative 5 would delay the long-term potential for fisheries on Chinook salmon in the Elwha River relative to Alternative 1.

Tribal steelhead fisheries would be initiated under Alternative 5 if Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect Chinook salmon because adult Chinook salmon would not be in the fishing area during the steelhead fisheries.

4.4.2. Puget Sound Steelhead (ESA-listed)

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

Under Alternative 1, the hatchery programs would be operated the same as under baseline conditions (Subsection 2.1, Alternative 1), but habitat conditions would continue to change as Glines Canyon Dam is removed. Therefore, there would be no change in risks associated with competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to baseline conditions (Subsection 3.4, Salmon and Steelhead). Nutrient cycling and population viability benefits would continue to change relative to baseline conditions.

In the short term, while the effects of dam removal activities continue, the hatchery programs would continue to preserve genetic diversity under Alternative 1 at a level consistent with baseline conditions, but the hatchery programs would provide the following additional benefits going forward:

- The hatchery programs would add marine-derived nutrients to the aquatic and terrestrial systems above Glines Canyon Dam, which are inaccessible to salmon and steelhead under baseline conditions.
- By 2018, the hatchery program would be expected increase total abundance of the naturally spawning Chinook salmon aggregation to a level that is 94 to 97 percent of the total natural spawner population abundance level needed to end the recolonization phase and begin the local adaptation phase of restoration, under which the hatchery program for steelhead would no longer be needed (Table 13).
- The hatchery program would increase natural-origin abundance and spatial structure of the steelhead population as additional habitat becomes available and as first-generation hatchery-origin fish, and the offspring of naturally spawning hatchery-origin fish, return to spawn naturally.
- The steelhead hatchery program would preserve the late-returning, native Elwha River steelhead population when turbidity levels are high and detrimental to natural-origin fish survival due to dam removal activities.

Table 13. Naturally spawning fish contributions by alternative relative to the recolonization phase abundance target for Elwha River steelhead.

Alternative	Elwha River Native Steelhead Smolt Release Numbers	Estimated Hatchery-Origin Adult Return[1]	Estimated Natural-origin Adult Return[2]	Estimated Total Adult Return	Annual Broodstock Collection to Maintain 500 Fish per Generation Effective Size[3]	Required Number of Broodstock to Meet Annual Smolt Release Target	Estimated Number of Naturally Spawning Fish in 2018[4]	Target for Natural Steelhead Abundance [6]	Estimated Naturally Spawning Fish Percent of Abundance Target
1	175,000	1,300	141	1,441	526	500	915 - 941	969	**94 - 97**
2	175,000	1,300	141	1,441	526	500	915 - 941	969	**94 - 97**
3	175,000[5]	1,300	141	1,441	526	500	915 - 941	969	**94 - 97**
4	0	0	141	141	N/A	N/A	141	969	**15**
5	50,000	375	141	516	526	143 [7]	0 - 373	969	**0 - 39**

[1] Estimated hatchery-origin adult return is based on a smolt-to-adult survival rate of 0.75%. Actual annual survival rates will be lower while sediment levels are high.

[2] Estimated natural-origin adult return is based on recent average abundance in the Elwha River (LEKT 2012a; NMFS 2012) prior to commencement of dam removal and resultant inhospitable to lethal sediment loads in critical habitat for fish. Actual return levels will be lower while sediment levels are high.

[3] To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For steelhead, the generation time is 3.8 years, so you would need 132 effective spawners per year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the steelhead spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 132 times four to calculate the number of annual broodstock needed to achieve a 500 fish per generation effective size. For steelhead hatchery program, you would need to collect 526 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

[4] The estimate of the contribution of natural spawners under each alternative is the pre-dam removal average natural-origin adult return (141 fish) plus contributions of hatchery-origin steelhead surplus to effective size and smolt release target broodstock needs and available for natural spawning. When the number of broodstock needed to meet target annual smolt release levels was greater than the number needed to maintain a 500 fish per generation effective size, NMFS assumed hatchery operators would collect the number of broodstock needed to meet target annual smolt release levels. When the opposite was true, NMFS analyzed the range in broodstock numbers. Assumed in estimated hatchery-origin steelhead contributions is a smolt to adult return survival rate of 0.75%. Actual survival rates in the short-term will be worse while sediment levels are high.

[5] Alternative 3 includes a sunset, so although the steelhead program would release 175,000 juveniles in year 1, the program would sunset after the steelhead population reached the preservation phase of restoration (NMFS 2012; EMG 2014).

[6] Natural steelhead spawner population viability target identified by the Elwha Monitoring Group (EMG 2014) for the end of the recolonization phase, and the beginning of the local adaptation phase of restoration, when the population would begin to become self-sustaining and the supportive breeding program for the species would no longer be needed.

[7] Required number of broodstock needed to meet a 50,000 smolt release levels assumed to be 28.6% (50,000/175,000) of the number of adult fish identified as needed by LEKT (500 fish) to produce 175,000 two-year-old smolts through the program at the Lower Elwha Fish Hatchery facility.

4.4.2.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). Additionally, the operation of the Elwha River hatchery programs would be the same as under Alternative 1 (Subsection 2.2, Alternative 2), so the hatchery programs would have identical impacts on natural-origin steelhead and their habitat as under Alternative 1. There would not be any change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Subsection 3.4, Salmon and Steelhead). Similarly, there would be no change in population viability benefits or benefits from nutrient cycling relative to Alternative 1. There would be no change in total population abundance relative to Alternative 1 (Table 13).

Under Alternative 2, there would be moratorium on salmon and steelhead fishing in the Elwha River until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Beginning January of 2020 or later, if the natural-origin component of the steelhead population exceeds 500 fish, the Lower Elwha Klallam Tribe would scale up their fishery to target 200 to 300 hatchery-origin steelhead. The Tribal fisheries would only incidentally harvest natural-origin steelhead. The rate of incidental mortality in the ceremonial and subsistence fishery would be less than 2 percent of the natural-origin steelhead that reach the mouth of the Elwha River, and the rate of incidental mortality in the commercial fishery would be less than 7 percent of the natural-origin steelhead that reach the mouth of the Elwha River (LEKT 2012d). Based on population growth and harvest modeling done by the Lower Elwha Klallam Tribe, a 2 to 7 percent harvest rate on natural-origin steelhead would have a very small effect on the growth trajectory of the natural-origin population in the 10- to 15-year period after initiation of the fishery.

4.4.2.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Plan Meet the Requirements of the 4(d) Rule

In the short term, the operation of the Elwha River hatchery programs and habitat conditions as a result of dam removal would be the same under Alternative 3 as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed (Subsection 2.3, Alternative 3). Therefore, in the short term, there would be no change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Subsection 3.4, Salmon,

Steelhead, and Their Habitat). Similarly, there would be no change in the short term in total population abundance and population viability benefits or benefits from nutrient cycling relative to Alternative 1.

In the long term, Alternative 3 would eliminate risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer from hatchery programs, because the hatchery programs would be terminated in approximately 2019. Similarly, population viability and nutrient cycling benefits would be eliminated after hatchery-origin fish stop returning to the Basin to spawn (Subsection 3.4, Salmon and Steelhead). However, it would take longer for the species to recolonize the Elwha River Basin to a viable population level without hatchery programs (Ward et al. 2008). Salmon and steelhead would have similar access to high-quality habitat throughout the Elwha River Basin under Alternative 3 as under Alternative 1, so there would be no change in the spatial structure or productivity of the Elwha River steelhead population relative to Alternative 1, but the pace in achieving benefits to these parameters might be reduced by decades relative to Alternative 1 because of decreases in total population abundance. Because certain hatchery programs can reduce the genetic diversity and fitness of a salmon population, eliminating the hatchery programs in approximately 2019 would reduce genetic diversity and fitness loss risks associated with hatchery production relative to Alternative 1.

Under Alternative 3, there would be a moratorium on salmon and steelhead fishing in the Elwha River until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Because hatchery-origin steelhead would stop returning to the Elwha River in approximately 2021, the steelhead fishery would only be ramped up to target 200 to 300 hatchery-origin steelhead for one year, and only if natural-origin steelhead abundance that year is projected to exceed 500 fish.

The rate of incidental mortality in the ceremonial and subsistence fishery is expected to be less than 2 percent of the natural-origin steelhead that reach the mouth of the Elwha River, and the rate of incidental mortality in the commercial fishery would be less than 7 percent of the natural-origin steelhead that reach the mouth of the Elwha River (LEKT 2012d). Based on population growth and harvest modeling done by the Lower Elwha Klallam Tribe, a 2 to 7 percent harvest rate on natural-origin steelhead would have a very small effect on the growth trajectory of the natural-origin population in the 10- to 15-year period after initiation of the fishery.

4.4.2.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Do Not Meet the 4(d) Rule

Under Alternative 4, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). However, under Alternative 4, the Elwha River hatchery programs would be terminated immediately (Subsection 2.4, Alternative 4). Consequently, Alternative 4 would eliminate short- and long-term risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, and disease transfer from the hatchery programs. These risks would be lower than under Alternative 1. Similarly, benefits from the hatchery programs on population viability and nutrient cycling would be eliminated after hatchery-origin fish stop returning to the Basin to spawn (Subsection 3.4, Salmon and Steelhead).

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam. Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish in the hatcheries) are going to have a higher survival rate when compared to fish that are rearing and spawning in the Elwha River. The Elwha River steelhead population is an ESA-listed threatened population that is considered at high risk of extinction and has low abundance relative to population viability parameter target levels (Subsection 3.4.2, Puget Sound Steelhead). The natural-origin steelhead population averages only 141 fish (Subsection 3.4.2, Puget Sound Steelhead), and these numbers are expected to decline as a result of the adverse sediment impact period during and immediately following dam removal. Therefore, Alternative 4 would reduce short-term steelhead abundance relative to Alternative 1 (Table 13), directly increasing extinction risk. Any steelhead that survive dam removal activities would have access to high-quality habitat throughout the Elwha River Basin but, because abundance levels would be expected to be critically low (with possible extirpation of the population), the spatial structure, productivity, and genetic diversity status of the species would be markedly reduced relative to Alternative 1, which would also increase extinction risk.

Under Alternative 4, like under Alternative 1, there would be no fisheries targeting Elwha River steelhead.

4.4.2.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Decreased juvenile steelhead production levels under Alternative 5 relative to Alternative 1 (Table 3) would reduce risks associated with domestication, competition and predation, facility

effects, natural population status masking, and disease transfer from the hatchery programs (Table 6) (Subsection 3.4, Salmon and Steelhead). Competition and predation risks are low under Alternative 1, but they would be even lower under Alternative 5 because fewer fish would be released.

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam. Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish in the hatcheries) are going to have a higher survival rate when compared to fish that are rearing and spawning in the Elwha River. The Elwha River steelhead population is an ESA-listed threatened population that is considered at high risk of extinction and has low abundance relative to population viability parameter target levels (Subsection 3.4.2, Steelhead). The natural-origin steelhead population averages only 141 fish (Subsection 3.4.2, Puget Sound Steelhead), and these numbers are expected to decline as a result of the adverse sediment impact period during and immediately following dam removal. Under Alternative 5, the hatchery program would be reduced to 50,000 smolts, so adult hatchery-origin fish returning the Elwha River would be reduced from 1,300 steelhead to 375 steelhead under average survival rates (actual survival rates in the short term will be lower because of the adverse sediment impact period) (Table 13). After broodstock collection, the short-term total abundance of native stock hatchery-origin steelhead provided to natural spawning areas under Alternative 5 would be between 0 and 373 steelhead, or 0 to 39 percent of the natural steelhead spawner abundance level needed to end the recolonization phase and begin the local adaptation phase of restoration, under which the hatchery program for steelhead would no longer be needed (Table 13).

Because of the critically low abundance levels under Alternative 5 and the deleterious river turbidity levels caused by dam removal, the hatchery would be primarily responsible for the conservation of genetic diversity of the native species in the Elwha River. A genetic effective population size (a measure of the rate at which a population of a certain size will lose diversity) of 500 per generation is needed for conservation of genetic diversity (Lande and Barrowclough 1987). Given that 375 adult fish would return under Alternative 5, and considering that it would be unlikely that all returning hatchery-origin steelhead could be captured from the river, a reduction in the size of the program to 50,000 smolts under Alternative 5 would prevent hatchery managers from being able to collect enough broodstock to conserve genetic diversity in the hatchery (Table 13)[8]. Therefore, Alternative 5 would be less effective at conserving genetic diversity of the Elwha River steelhead population relative to Alternative 1.

[8] The "effective population size" is usually less than the census population size. To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For steelhead, the generation time is 3.8 years, so you would need 132 effective spawners per year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the steelhead

Any steelhead that survive the adverse sediment impact period during and immediately following dam removal would have access to high-quality habitat throughout the Elwha River Basin. However, in the short term, the productivity of spawners above the dams will likely be lower than spawners below the dam until the spawning gravel above the dams is conditioned by salmon and steelhead spawners (i.e., the first generation of spawners would loosen and clean the spawning gravel, which would make it better for subsequent generations of salmon and steelhead). The process of conditioning gravel would take longer under Alternative 5 relative to Alternative 1. There would also be fewer salmon and steelhead spawning under Alternative 5 relative to Alternative 1, so fewer marine-derived nutrients would be added to an aquatic system that has been cut off from this important source of nutrients for decades.

Because of the reduced number of spawners, extinction risk would be higher under Alternative 5 relative to Alternative 1. Loss of the unique Elwha steelhead population would be highly detrimental to recovery of the listed Puget Sound steelhead DPS, as it is one of only a few extant populations within the Strait of Juan de Fuca biogeographical region. As such, the population is considered an important component of overall diversity of the species and essential for the DPS's recovery to a viable status (Subsection 3.4, Salmon and Steelhead).

Under Alternative 5, there would be a moratorium on salmon and steelhead fishing until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. However, under Alternative 5, the hatchery program would not be used to rebuild populations after the Glines Canyon Dam has been removed. Therefore, it will take more years for natural-origin abundance to reach the 300-fish abundance target, and for the Lower Elwha Klallam Tribe to initiate a ceremonial and subsistence fishery.

The rate of incidental mortality in the ceremonial and subsistence fishery is expected to be less than 2 percent of the natural-origin steelhead that reach the mouth of the Elwha River, and the rate of incidental mortality in the commercial fishery would be less than 7 percent of the natural-origin steelhead that reach the mouth of the Elwha River (LEKT 2012d). Based on population growth and harvest modeling done by the Lower Elwha Klallam Tribe, a 2 to 7 percent harvest rate on natural-origin steelhead would have a very small effect on the growth trajectory of the natural-origin population.

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spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 132 times four to calculate the number of annual broodstock needed to achieve a 500 fish per generation effective size. For steelhead hatchery program, you would need to collect 526 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

4.4.3. Puget Sound Fall Chum Salmon

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

Under Alternative 1, the hatchery programs would be operated the same as under baseline conditions (Subsection 2.1, Alternative 1), but habitat conditions would continue to change as Glines Canyon Dam is removed. Therefore, there would be no change in risks associated competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to baseline conditions (Subsection 3.4, Salmon and Steelhead). Nutrient cycling and population viability benefits would continue to change relative to baseline conditions.

In the short term, while the effects of dam removal activities continue, the hatchery programs would continue to preserve genetic diversity under Alternative 1 at a level consistent with baseline conditions, but the hatchery programs would provide the following additional benefits going forward:

- The hatchery programs would add marine-derived nutrients to the aquatic and terrestrial systems above Glines Canyon Dam, which are inaccessible to salmon and steelhead under baseline conditions.
- The fall chum salmon hatchery program would increase total and natural-origin abundance and spatial structure of the chum salmon population as additional habitat becomes available and as first-generation hatchery-origin fish, and the offspring of naturally spawning hatchery-origin fish, return to spawn naturally.
- The fall chum salmon hatchery program would preserve the Elwha River chum salmon population when turbidity levels are high and detrimental to natural-origin fish survival due to dam removal activities.

In the long term, spatial structure and abundance of the Elwha River chum salmon population would be expected to continue to improve relative to baseline conditions because chum salmon would continue to re-seed habitat that has been inaccessible since dam construction. Additionally, in the long term, the newly accessible habitat would be of higher quality than existing habitat, so productivity would be expected to improve relative to baseline conditions. However, in the short term, the productivity of spawners above the dams will likely be lower than spawners below the dam until the spawning gravel above the dams is conditioned by salmon and steelhead spawners (i.e., the first generation of spawners would loosen and clean the spawning gravel, which would make it better for subsequent generations of salmon and steelhead). As fish colonize new areas, they would be subject to a broader array of selective pressures, which would be expected to increase genetic diversity relative to baseline conditions.

Under Alternative 1, there would be no fishing for salmon and steelhead in the Elwha River. However, Elwha River chum salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks.

Under Alternative 1, there would be a no change in long-term potential for tribal and recreational fisheries on chum salmon in the Elwha River relative to baseline conditions.

Table 14. Naturally spawning fish contributions by alternative relative to the recolonization phase abundance target for Elwha River fall chum salmon.

Alternative	Elwha River Chum Fry Release Numbers	Estimated Hatchery-Origin Adult Return[1]	Estimated Natural-origin Adult Return[2]	Estimated Total Adult Return	Annual Broodstock Collection to Maintain 500 Fish per Generation Effective Size[3]	Required Number of Broodstock to Meet Annual Smolt Release Target	Estimated Number of Naturally Spawning Fish in 2018[4]	Target for Natural Chinook Abundance [6]	Estimated Naturally Spawning Fish Percent of Abundance Target
1	450,000	2,250	<100	2,350	572	460	1,778 – 1,890	18,000	**10 - 11**
2	450,000	2,250	<100	2,350	572	460	1,778 – 1,890	18,000	**10 - 11**
3	450,000 [5]	2,250	<100	2,350	572	460	1,778 – 1,890	18,000	**10 - 11**
4	0	0	<100	<100	N/A	N/A	<100	18,000	**< 1**
5	150,000 [7]	750	<100	850	572	138	278 - 712	18,000	**2 - 4**

[1] Estimated hatchery-origin adult return is based on fry-to-adult survival rate goal for fall chum salmon of 0.5%. Actual survival rates will be lower while sediment levels are high.

[2] Estimated natural-origin adult return is based on recent year estimated escapements to the Elwha River prior to commencement of dam removal and resultant inhospitable to lethal sediment loads in critical habitat for fall chum salmon. Actual return levels will be lower while sediment levels are high.

[3] To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For chum salmon, the generation time is 3.5 years, so you would need 143 effective spawners per year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the chum salmon spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 143 times four to calculate the number of annual broodstock needed to achieve a 500 fish per generation effective size. For the fall chum salmon hatchery program, you would need to collect 572 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

[4] The estimate of the contribution of natural spawners under each alternative is the pre-dam removal average natural-origin adult return (100 fish) plus contributions of hatchery-origin fall chum surplus to effective size and fry release target broodstock needs and available for natural spawning. When the number of broodstock needed to meet target annual smolt release levels was greater than the number needed to maintain a 500 fish per generation effective size, NMFS assumed hatchery operators would collect the number of broodstock needed to meet target annual smolt release levels. When the opposite was true, NMFS analyzed the range in broodstock numbers. Assumed in estimated hatchery-origin chum salmon contributions is a fry to adult return survival rate of 0.5%. Actual survival rates in the short-term will be worse while sediment levels are high.

[5] Alternative 3 includes a sunset, so although the fall chum program would release up to 450,000 juveniles into the Elwha River in year 1, the program would sunset after the fall chum population reached the preservation phase of restoration (NMFS 2012; EMG 2014).

[6] Interim restoration target for abundance after 25 years from the Elwha Fish Restoration Plan (Ward et al. 2008).

[7] Fall chum salmon fry releases reduced to 1/3 of proposed levels.

4.4.3.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). Additionally, the operation of the Elwha River hatchery programs would be the same as under Alternative 1 (Subsection 2.2, Alternative 2), so the hatchery programs would have identical impacts on natural-origin chum salmon and their habitat as under Alternative 1. There would not be any change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Subsection 3.4, Salmon and Steelhead). Similarly, there would be no change in population viability benefits or benefits from nutrient cycling relative to Alternative 1 (Table 14).

Under Alternative 2, there would be no change in fisheries affecting Elwha River chum salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River chum salmon, but Elwha River chum salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Fisheries on native, hatchery-origin steelhead (ceremonial/subsistence and later commercial) would be initiated under Alternative 2 once the Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect chum salmon because adult chum salmon would not be in the fishing area during the steelhead fisheries. Under Alternative 2, there would be a no change in long-term potential for tribal and recreational fisheries on chum salmon in the Elwha River relative to Alternative 1.

4.4.3.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Plan Meet the Requirements of the 4(d) Rule

In the short term, the operation of the Elwha River hatchery programs and habitat conditions as a result of dam removal would be the same under Alternative 3 as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed) (Subsection 2.3, Alternative 3). Therefore, in the short term, there would be no change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Subsection 3.4, Salmon and Steelhead). Similarly, there would be no change in the short term in total species abundance and population viability benefits or benefits from nutrient cycling relative to Alternative 1.

In the long term, Alternative 3 would eliminate risks associated with genetic effects, competition

and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer from hatchery programs, because the hatchery programs would be terminated in approximately 2019. Similarly, population viability and nutrient cycling benefits would be eliminated after hatchery-origin fish stop returning to the Basin to spawn (Subsection 3.4, Salmon and Steelhead). However, it would take longer for the species to recolonize the Elwha River Basin to a viable population level without hatchery programs (Ward et al. 2008). Salmon and steelhead would have similar access to high quality habitat throughout the Elwha River Basin under Alternative 3 as under Alternative 1, so there would be no change in the spatial structure or productivity of the Elwha River chum salmon population relative to Alternative 1, but the pace in achieving benefits to these parameters would be reduced relative to Alternative 1. Because certain hatchery programs can reduce the genetic diversity and fitness of a salmon population, eliminating the hatchery programs in approximately 2019 would reduce genetic diversity and fitness loss risks associated with hatchery production relative to Alternative 1.

Under Alternative 3, there would be no change in fisheries affecting Elwha River chum salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River chum salmon. However, Elwha River chum salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Tribal steelhead fisheries would be initiated under Alternative 3 once Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect chum salmon because adult chum salmon migrate much earlier in the season and would not be in the fishing area during the steelhead fisheries. Because Alternative 3 would delay attainment of a viable abundance level relative to Alternative 1, Alternative 3 would reduce the long-term potential for tribal and recreational fisheries on chum salmon in the Elwha River relative to Alternative 1.

4.4.3.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). However, under Alternative 4, the Elwha River hatchery programs would be terminated immediately (Subsection 2.4, Alternative 4). Consequently, Alternative 4 would eliminate short- and long-term risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer from the hatchery programs. Similarly, benefits from the hatchery programs on population viability and nutrient cycling would be eliminated after hatchery-origin fish stop returning to the Basin to spawn (Subsection 3.4, Salmon and Steelhead).

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam. Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish held for spawning, rearing and release in the hatcheries) are going to have a higher survival rate when compared to fish migrating, spawning, and rearing in the Elwha River. Although not an ESA-listed species, the Elwha River fall chum salmon population is considered at high risk of extinction due to very low average abundance levels observed prior to the commencement of dam removal, and the natural-origin fall chum salmon population averages under 100 fish (Subsection 3.4.3, Fall Chum Salmon). The already very low number of natural-origin fish is expected to decline further as a result of dam removal activities. Alternative 4 would reduce short-term abundance relative to Alternative 1 (Table 14), directly increasing extinction risk. Any chum salmon that survive dam removal activities would have access to high quality habitat throughout the Elwha River Basin, but because abundance levels would be expected to be critically low (with possible extirpation of the population), the spatial structure, productivity, and diversity status of the species would be markedly reduced relative to Alternative 1, which would also increase extinction risk.

Under Alternative 4, no fisheries would directly harvest hatchery-origin or natural-origin Elwha River chum salmon. However, Elwha River chum salmon may continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks (if they are not extirpated). But under this alternative, the adverse effects of any fisheries would be increased over Alternative 1, as the incidence of intercepting a natural-origin chum salmon would increase as the proportion of hatchery-origin fish decreases. Because Alternative 4 would increase the risk of extirpation and delay attainment of a viable abundance level relative to Alternative 1, Alternative 4 would reduce the long-term potential for tribal and recreational fisheries on chum salmon in the Elwha River.

4.4.3.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) – Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Decreased juvenile fall chum salmon production levels under Alternative 5 relative to Alternative 1 (Table 3) would reduce short-term risks associated with domestication, competition and predation, facility effects, natural population status masking, and disease transfer from the hatchery programs (Table 6) (Subsection 3.4, Salmon and Steelhead). Competition and predation risks are low under Alternative 1, but they would be even lower under Alternative 5 because fewer fish would be released.

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam.

Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish in the hatcheries) are going to have a higher survival rate when compared to fish that are rearing and spawning in the Elwha River. The total hatchery and natural-origin population is already at low abundance (Subsection 3.4.3, Puget Sound Fall Chum Salmon), and these numbers are expected to decline as a result of the adverse sediment impact period during and immediately following dam removal. Under Alternative 5, the hatchery program would be reduced by two-thirds, so hatchery-origin fish returning the Elwha River would be reduced from 2,250 fall chum salmon to 750 fall chum salmon under average survival rates (actual survival rates in the short term will be much lower) (Table 14). After broodstock collection, the short-term total abundance of fall chum salmon would be between 278 and 712 adult fish, or 2 to 4 percent of the fall chum salmon abundance level needed to end the recolonization phase of restoration, under which the hatchery program for fall chum salmon would no longer be needed. Because of the reduced number of spawners, extinction risk would be higher under Alternative 5 relative to Alternative 1.

Because of low abundance levels under Alternative 5 and the deleterious river turbidity levels caused by dam removal, the hatchery would be primarily responsible for the conservation of genetic diversity of the native species in the Elwha River. A genetic effective population size (a measure of the rate at which a population of a certain size will lose diversity) of 500 per generation is needed for conservation of genetic diversity in the hatchery (Lande and Barrowclough 1987), and the production levels under Alternative 5 may be adequate to achieve a 500 fish per generation effective size within the hatchery if a majority of returning adult fish are collected and survival rates remain similar as in recent years (Table 14)[9]. However, if survival of juveniles to adulthood is substantially less than in recent years, adequate numbers of broodstock would likely not be available, and the effective size of 500 would likely not be achieved.

Any fall chum salmon that survive the adverse sediment impact period during and immediately following dam removal would have access to high-quality habitat throughout the Elwha River Basin. However, in the short term, the productivity of spawners above the dams will likely be lower than spawners below the dam until the spawning gravel above the dams is conditioned by salmon and steelhead spawners (i.e., the first generation of spawners would loosen and clean the spawning gravel, which would make it better for subsequent generations of salmon and

[9] The "effective population size" is usually less than the census population size. To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For chum salmon, the generation time is 3.5 years, so you would need 143 effective spawners per year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the chum salmon spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 143 times four to calculate the number of annual broodstock needed to achieve a 500 fish per generation effective size. For the fall chum salmon hatchery program, you would need to collect 572 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

steelhead). The process of conditioning gravel would take longer under Alternative 5 relative to Alternative 1. There would also be fewer salmon and steelhead spawning under Alternative 5 relative to Alternative 1, so fewer marine-derived nutrients would be added to an aquatic system that has been cut off from this important source of nutrients for decades.

Under Alternative 5, there would be no change in fisheries affecting Elwha River fall chum salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River fall chum salmon. However, Elwha River fall chum salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Tribal steelhead fisheries would be initiated under Alternative 5 once Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect chum salmon because adult chum salmon migrate much earlier in the season and would not be in the fishing area during the steelhead fisheries. Because Alternative 5 would delay attainment of a viable abundance level relative to Alternative 1, Alternative 5 would delay the long-term potential for fisheries on chum salmon in the Elwha River relative to Alternative 1.

4.4.4. Puget Sound Pink Salmon

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

Under Alternative 1, the hatchery programs would be operated identically as under baseline conditions (Subsection 2.1, Alternative 1), but habitat conditions would continue to change as Glines Canyon Dam is removed. Therefore, there would be no change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to baseline conditions (Subsection 3.4, Salmon and Steelhead). Nutrient cycling and population viability benefits would continue to change relative to baseline conditions.

In the short term, while the effects of dam removal activities continue, the hatchery programs would continue to preserve genetic diversity under Alternative 1 at a level consistent with baseline conditions, but the hatchery programs would provide the following additional benefits going forward:

- The hatchery programs would add marine-derived nutrients to the aquatic and terrestrial systems above Glines Canyon Dam, which are inaccessible to salmon and steelhead under baseline conditions.

- The hatchery program would increase total abundance of the naturally spawning pink salmon aggregation to a level that is 12 to 15 percent of the interim restoration target abundance level for pink salmon identified in the Elwha Fish Restoration Plan (Ward et al. 2008)(Table 15).
- The pink salmon hatchery program would increase total and natural-origin abundance and spatial structure of the pink salmon population as additional habitat becomes available and as first-generation hatchery-origin fish, and the offspring of naturally spawning hatchery-origin fish, return to spawn naturally.
- The pink salmon hatchery program would preserve the Elwha River pink salmon population when turbidity levels are high and detrimental to natural-origin fish survival due to dam removal activities.

Table 15. Naturally spawning fish contributions by alternative relative to the recolonization phase abundance target for Elwha River pink salmon.

Alt	Elwha River Native Pink Fry Release Numbers	Estimated Hatchery-Origin Adult Return[1]	Estimated Natural-origin Adult Return[2]	Estimated Total Adult Return	Annual Broodstock Collection to Maintain 500 Fish per Generation Effective Size[3]	Required Number of Broodstock to Meet Annual Smolt Release Target	Estimated Number of Naturally Spawning Fish in 2018[4]	Target for Natural Chinook Abundance [7]	Estimated Naturally Spawning Fish Percent of Abundance Target
1	3,000,000	15,000	<100	15,100	1,000	3,700	11,400	96,000	**12**
2	3,000,000	15,000	<100	15,100	1,000	3,700	11,400	96,000	**12**
3	3,000,000[6]	15,000	<100	15,100	1,000	3,700	11,400	96,000	**12**
4	0	0	<100	<100	N/A	N/A	<100	96,000	**0.1**
5	1,000,000 [8]	5,000	<100	5,100	1,000	1,110	3,990 – 4,100	96,000	**4 – 4.3**

[1] Estimated hatchery-origin adult return is based on fry-to-adult survival rate goal for fall chum salmon of 0.5%. Actual survival rates will be lower while sediment levels are high.

[2] Estimated natural-origin adult return is based on recent odd year pink salmon escapement estimates (LEKT 2012c) prior to commencement of dam removal and resultant inhospitable to lethal sediment loads in critical habitat for pink salmon. Actual return levels will be lower while sediment levels are high.

[3] To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For pink salmon, the generation time is 2 years, so you would need 250 effective spawners per year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the pink salmon spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 250 times four to calculate the number of annual broodstock needed to achieve a 500 fish per generation effective size. For the pink salmon hatchery program, you would need to collect 1,000 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

[4] Estimated minimum number of adult pink salmon needed as broodstock to produce production levels derived, assuming 90% green egg to fry survival rate applied to the total fry release, divided by 1,800 eggs per female, then multiplied by 2, assuming a 1.0 : 1.0 sex ratio for broodstock collected.

[5] The estimate of the contribution of natural spawners under each alternative is the pre-dam removal average natural-origin adult return (<100 fish) plus contributions of hatchery-origin pink salmon surplus to effective size and fry release target broodstock needs and available for natural spawning. When the number of broodstock needed to meet target annual smolt release levels was greater than the number needed to maintain a 500 fish per generation effective size, NMFS assumed hatchery operators would collect the number of broodstock needed to meet target annual smolt release levels. When the opposite was true, NMFS analyzed the range in broodstock numbers. Assumed in estimated hatchery-origin pink salmon contributions is a fry to adult return survival rate of 0.5%. Actual survival rates in the short-term will be worse while sediment levels are high.

[6] Alternative 3 includes a sunset, so although the pink salmon program would release up to 3,000,000 fry into the Elwha River in year 1, the program would sunset after the pink salmon population reached the preservation phase of restoration (NMFS 2012; EMG 2014).

[7] Interim restoration target for abundance after 25 years from the Elwha Fish Restoration Plan (Ward et al. 2008).

[8] Pink salmon fry releases reduced to 1/3 of proposed levels.

In the long term, spatial structure and abundance of the Elwha River pink salmon population would be expected to continue to improve relative to baseline conditions because pink salmon would continue to re-seed habitat that has been inaccessible since dam construction. Additionally, in the long term, the newly accessible habitat would be of higher quality than existing habitat, so productivity would be expected to improve relative to baseline conditions. However, in the short term, the productivity of spawners above the dams will likely be lower than spawners below the dam until the spawning gravel above the dams is conditioned by salmon and steelhead spawners (i.e., the first generation of spawners would loosen and clean the spawning gravel, which would make it better for subsequent generations of salmon and steelhead). As fish colonize new areas, they would be subject to a broader array of selective pressures, which would be expected to increase genetic diversity relative to baseline conditions.

Under Alternative 1, there would be no fishing for salmon and steelhead in the Elwha River. However, Elwha River pink salmon would continue to be harvested incidentally in United States and Canadian mixed stock marine area fisheries targeting more abundant salmon stocks. Under Alternative 1, there would be no change in long-term potential for tribal and recreational fisheries on pink salmon in the Elwha River relative to baseline conditions.

4.4.4.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). Additionally, the operation of the Elwha River hatchery programs would be the same as under Alternative 1 (Subsection 2.2, Alternative 2), so the hatchery programs would have identical impacts on natural-origin pink salmon and their habitat as under Alternative 1. There would not be any change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Subsection 3.4, Salmon and Steelhead). Similarly, there would be no change in population viability benefits or benefits from nutrient cycling relative to Alternative 1 (Table 15).

Under Alternative 2, there would be no change in fisheries affecting Elwha River pink salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River pink salmon, but Elwha River pink salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Fisheries on native, hatchery-origin steelhead (ceremonial/subsistence and later commercial) would be initiated under Alternative 2 once the Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect pink

salmon because adult pink salmon would not be in the fishing area during the steelhead fisheries. Under Alternative 2, there would be no change in long-term potential for tribal and recreational fisheries on pink salmon in the Elwha River relative to Alternative 1.

4.4.4.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the short term, the operation of the Elwha River hatchery programs and habitat conditions as a result of dam removal would be the same under Alternative 3 as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed) (Subsection 2.3, Alternative 3). Therefore, in the short term, there would be no change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Subsection 3.4, Salmon, and Steelhead). Similarly, there would be no change in the short term in total species abundance and population viability benefits or benefits from nutrient cycling relative to Alternative 1.

In the long term, Alternative 3 would eliminate risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer from hatchery programs because the hatchery programs would be terminated in approximately 2019. Similarly, population viability and nutrient cycling benefits would be eliminated after hatchery-origin fish stop returning to the Basin to spawn (Subsection 3.4, Salmon and Steelhead). However, it would take longer for the species to recolonize the Elwha River Basin to a viable population level without hatchery programs (Ward et al. 2008). Salmon and steelhead would have similar access to high quality habitat throughout the Elwha River Basin under Alternative 3 as under Alternative 1, so there would be no change in the spatial structure or productivity of the Elwha River pink salmon population relative to Alternative 1, but the pace in achieving benefits to these parameters may be reduced relative to Alternative 1. Because certain hatchery programs can reduce the genetic diversity and fitness of a salmon population, eliminating the hatchery programs in approximately 2019 may reduce genetic diversity risks relative to Alternative 1.

Under Alternative 3, there would be no change in fisheries affecting Elwha River pink salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River pink salmon. However, Elwha River pink salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Tribal steelhead fisheries would be initiated under Alternative 3 once Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect pink salmon because adult pink salmon migrate much earlier in the season and would not be in the fishing area during the steelhead fisheries. Because Alternative 3 would

delay attainment of a viable abundance level relative to Alternative 1, Alternative 3 would reduce the long-term potential for tribal and recreational fisheries on pink salmon in the Elwha River relative to Alternative 1.

4.4.4.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). However, under Alternative 4, the Elwha River hatchery programs would be terminated immediately (Subsection 2.4, Alternative 4). Consequently, Alternative 4 would eliminate short- and long-term risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer from the hatchery programs. Similarly, benefits from the hatchery programs on population viability and nutrient cycling would be eliminated after hatchery-origin fish stop returning to the Basin to spawn (Subsection 3.4, Salmon and Steelhead).

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam. Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish held for spawning, rearing and release in the hatcheries) are going to have a higher survival rate when compared to fish migrating, spawning, and rearing in the Elwha River. Although not an ESA-listed species, the Elwha River pink salmon population is considered at high risk of extinction due to very low average abundance levels observed prior to the commencement of dam removal (Subsection 3.4.4, Pink Salmon). The natural-origin pink salmon population averages under 100 fish. The already very low number of natural-origin fish is expected to decline further as a result of dam removal activities. Alternative 4 would reduce short-term abundance relative to Alternative 1 (Table 15), directly increasing extinction risk. Any pink salmon that survive dam removal activities would have access to high-quality habitat throughout the Elwha River Basin but, because abundance levels would be expected to be critically low (with possible extirpation of the population), the spatial structure, productivity, and diversity status of the species would be markedly reduced relative to Alternative 1, which would also increase extinction risk.

Under Alternative 4, no fisheries would directly harvest hatchery-origin or natural-origin Elwha River pink salmon. However, Elwha River pink salmon may continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks (if they are not extirpated). Under this alternative, the adverse effects of any fisheries would be increased over Alternative 1, as the incidence of intercepting a natural-

origin pink salmon would increase as the proportion of hatchery-origin fish decreases. Because Alternative 4 would increase the risk of extirpation and delay attainment of a viable abundance level relative to Alternative 1, Alternative 4 would reduce the long-term potential for tribal and recreational fisheries on pink salmon in the Elwha River.

4.4.4.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Decreased juvenile fall pink salmon production levels under Alternative 5 relative to Alternative 1 (Table 3) would reduce short-term risks associated with domestication, competition and predation, facility effects, natural population status masking, and disease transfer from the hatchery programs (Table 6) (Subsection 3.4, Salmon and Steelhead). Competition and predation risks are low under Alternative 1, but they would be even lower under Alternative 5 because fewer fish would be released.

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam. Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish in the hatcheries) are going to have a higher survival rate when compared to fish that are rearing and spawning in the Elwha River. Both Elwha River populations are at a critically low abundance status (Subsection 3.4.3, Puget Sound Pink Salmon), and abundance is expected to decline as a result of dam removal activities. Under Alternative 5, the hatchery program would be reduced by two-thirds, so hatchery-origin fish returning the Elwha River would be reduced from 15,000 pink salmon to 5,000 pink salmon under average survival rates (actual survival rates in the short term will be much lower) (Table 15). After broodstock collection, the short-term total abundance of Chinook salmon would be between 3,990 and 41,000 adult fish, or 4 to 4.3 percent of the pink spawner abundance level needed to end the recolonization phase. Because of the reduced number of spawners, extinction risk would be higher under Alternative 5 relative to Alternative 1.

Because of critically low abundance levels under Alternative 5 and the deleterious river turbidity levels caused by dam removal, the hatchery would be primarily responsible for the conservation of genetic diversity of the native species in the Elwha River. A genetic effective population size (a measure of the rate at which a population of a certain size will lose diversity) of 500 per generation is needed for conservation of genetic diversity in the hatchery (Lande and

Barrowclough 1987), and the production levels under Alternative 5 should be adequate to achieve a 500 fish per generation effective size within the hatchery (Table 15)[10].

Any pink salmon that survive the adverse sediment impact period during and immediately following dam removal would have access to high-quality habitat throughout the Elwha River Basin. However, in the short term, the productivity of spawners above the dams will likely be lower than spawners below the dam until the spawning gravel above the dams is conditioned by salmon and steelhead spawners (i.e., the first generation of spawners would loosen and clean the spawning gravel, which would make it better for subsequent generations of salmon and steelhead). The process of conditioning gravel would take longer under Alternative 5 relative to Alternative 1. There would also be fewer salmon and steelhead spawning under Alternative 5 relative to Alternative 1, so fewer marine-derived nutrients would be added to an aquatic system that has been cut off from this important source of nutrients for decades.

Under Alternative 5, there would be no change in fisheries affecting Elwha River pink salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River pink salmon. However, Elwha River pink salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Tribal steelhead fisheries would be initiated under Alternative 5 once Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect pink salmon because adult pink salmon migrate much earlier in the season and would not be in the fishing area during the steelhead fisheries. Because Alternative 5 would delay attainment of a viable abundance level relative to Alternative 1, Alternative 5 would delay the long-term potential for fisheries on pink salmon in the Elwha River relative to Alternative 1.

4.4.5. Puget Sound Coho Salmon

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

Under Alternative 1, the hatchery programs would be operated identically as under baseline conditions (Subsection 2.1, Alternative 1), but habitat conditions would continue to change as Glines Canyon Dam is removed. Therefore, there would be no change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking,

[10] The "effective population size" is usually less than the census population size. To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For pink salmon, the generation time is 2 years, so you would need 250 effective spawners per year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the pink salmon spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 250 times four to calculate the number of annual broodstock needed to achieve a 500 fish per generation effective size. For the pink salmon hatchery program, you would need to collect 1,000 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

incidental fishing effects, or disease transfer relative to baseline conditions (Subsection 3.4, Salmon and Steelhead). Nutrient cycling and population viability benefits would continue to change relative to baseline conditions.

In the short term, while the effects of dam removal activities continue, the hatchery programs would continue to preserve genetic diversity under Alternative 1 at a level consistent with baseline conditions, but the hatchery programs would provide the following additional benefits going forward:

- The hatchery programs would add marine-derived nutrients to the aquatic and terrestrial systems above Glines Canyon Dam, which are inaccessible to salmon and steelhead under baseline conditions.
- The coho salmon hatchery program would increase total and natural-origin abundance and spatial structure of the coho salmon population as additional habitat becomes available and as first-generation hatchery-origin fish, and the offspring of naturally spawning hatchery-origin fish, return to spawn naturally.
- The coho salmon hatchery program would preserve the Elwha River coho salmon population when turbidity levels are high and detrimental to natural-origin fish survival due to dam removal activities.

In the long term, spatial structure and abundance of the Elwha River coho salmon population would be expected to continue to improve relative to baseline conditions because coho salmon would continue to re-seed habitat that has been inaccessible since dam construction. Additionally, in the long term, the newly accessible habitat would be of higher quality than existing habitat, so productivity would be expected to improve relative to baseline conditions. However, in the short term, the productivity of spawners above the dams may be lower than

Table 16. Naturally spawning fish contributions by alternative relative to the recolonization phase abundance target for Elwha River coho salmon.

Alternative	Elwha River Coho Smolt Release Numbers	Estimated Hatchery-Origin Adult Return[1]	Estimated Natural-origin Adult Return[2]	Estimated Total Adult Return	Annual Broodstock Collection to Maintain 500 Fish per Generation Effective Size[3]	Required Number of Broodstock to Meet Annual Smolt Release Target	Estimated Number of Naturally Spawning Fish in 2018[4]	Target for Natural Chinook Abundance[6]	Estimated Naturally Spawning Fish Percent of Abundance Target
1	425,000	4,250	168	4,418	667	600	3,751 – 3,818	12,100	**31 - 32**
2	425,000	4,250	168	4,418	667	600	3,751 – 3,818	12,100	**31 - 32**
3	425,000[5]	4,250	168	4,418	667	600	3,751 – 3,818	12,100	**31 - 32**
4	0	0	168	168	N/A	N/A	168	12,100	**1**
5	50,000	500	168	668	667	72[7]	1 – 596	12,100	**0.01 - 5**

[1] Estimated hatchery-origin adult return is based on recent average smolt-to-adult survival rates. Actual survival rates will be lower while sediment levels are high.

[2] Estimated natural-origin adult return is based on recent observed proportion (based on tagged fish recoveries) of the 2006-2011 estimated average total return (1,683 from WDFW runs reconstruction, Haymes, 2011) that are hatchery-origin fish (>90% or 168 wild coho), prior to commencement of dam removal and resultant inhospitable to lethal sediment loads in critical habitat for coho salmon. Actual return levels will be lower while sediment levels are high.

[3] To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For Coho, the generation time is 3 years, so you would need 167 effective spawners per year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the coho spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 167 times four to calculate the number of annual broodstock needed to achieve a 500 fish per generation effective size. For the coho salmon hatchery program, you would need to collect 667 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

[4] The estimate of the contribution of natural spawners under each alternative is the pre-dam removal average natural-origin adult return (168 fish) plus contributions of hatchery-origin coho surplus to effective size and smolt release target broodstock needs and available for natural spawning. When the number of broodstock needed to meet target annual smolt release levels was greater than the number needed to maintain a 500 fish per generation effective size, NMFS assumed hatchery operators would collect the number of broodstock needed to meet target annual smolt release levels. When the opposite was true, NMFS analyzed the range in broodstock numbers. Assumed in estimated hatchery-origin coho contributions is a juvenile to adult return survival rate of 1.0%. Actual survival rates in the short-term will be worse while sediment levels are high.

[5] Alternative 3 includes a sunset, so although the coho program would release up to 425,000 juveniles into the Elwha River in year 1, the program would sunset after the coho population reached the preservation phase of restoration (NMFS 2012; EMG 2014).

[6] Interim restoration target for abundance after 25 years from the Elwha Fish Restoration Plan (Ward et al. 2008). Required number of broodstock needed to meet a 50,000 smolt release levels assumed to be 11.8% (50,000/425,000) of the number of adult fish identified as needed by LEKT (600 fish) to produce 425,000 coho salmon smolts through the program at the Lower Elwha Fish Hatchery facility.

spawners below the dam until the spawning gravel above the dams is conditioned by salmon and steelhead spawners (i.e., the first generation of spawners would loosen and clean the spawning gravel, which would make it better for subsequent generations of salmon and steelhead). As fish colonize new areas, they would be subject to a broader array of selective pressures, which would be expected to increase genetic diversity relative to baseline conditions.

Under Alternative 1, there would be no salmon and steelhead fisheries in the Elwha River. However, Elwha River coho salmon would continue to be harvested incidentally in United States and Canadian mixed stock marine area fisheries targeting more abundant salmon stocks. Under Alternative 1, there would be no change in long-term potential for tribal and recreational fisheries on coho salmon in the Elwha River relative to baseline conditions.

4.4.5.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). Additionally, the operation of the Elwha River hatchery programs would be the same as under Alternative 1 (Subsection 2.2, Alternative 2), so the hatchery programs would have identical impacts on natural-origin pink salmon and their habitat as under Alternative 1. There would not be any change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Subsection 3.4, Salmon and Steelhead). Similarly, there would be no change in population viability benefits or benefits from nutrient cycling relative to Alternative 1 (Table 16).

Under Alternative 2, there would be no change in fisheries affecting Elwha River coho salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River coho salmon, but Elwha River coho salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Fisheries on native, hatchery-origin steelhead (ceremonial/subsistence and later commercial) would be initiated under Alternative 2 once the Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect coho salmon because adult coho salmon would not be in the fishing area during fisheries targeting late-returning steelhead (i.e., native stock). Under Alternative 2, there would be no change in long-term potential for tribal and recreational fisheries on coho salmon in the Elwha River relative to Alternative 1.

4.4.5.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the short term, the operation of the Elwha River hatchery programs and habitat conditions as a result of dam removal would be the same under Alternative 3 as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed) (Subsection 2.3, Alternative 3). Therefore, in the short term, there would be no change in risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer relative to Alternative 1 (Subsection 3.4, Salmon, and Steelhead). Similarly, there would be no change in the short term in total species abundance and population viability benefits or benefits from nutrient cycling relative to Alternative 1.

In the long term, Alternative 3 would eliminate risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer from hatchery programs because the hatchery programs would be terminated in approximately 2019. Similarly, population viability and nutrient cycling benefits would be eliminated after hatchery-origin fish stop returning to the Basin to spawn (Subsection 3.4, Salmon, Steelhead, and Their Habitat). However, it would take longer for the species to recolonize the Elwha River Basin to a viable population level without hatchery programs (Ward et al. 2008). Salmon and steelhead would have similar access to high quality habitat throughout the Elwha River Basin under Alternative 3 as under Alternative 1, so there would be no change in the spatial structure or productivity of the Elwha River coho salmon population relative to Alternative 1, but the pace in achieving benefits to these parameters may be reduced relative to Alternative 1. Because certain hatchery programs can reduce the genetic diversity and fitness of a salmon population, eliminating the hatchery programs in approximately 2019 may reduce genetic diversity risks relative to Alternative 1.

Under Alternative 3, there would be no change in fisheries affecting Elwha River coho salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River coho salmon. However, Elwha River coho salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Tribal steelhead fisheries would be initiated under Alternative 3 once Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect coho salmon because adult coho salmon migrate much earlier in the season and would not be in the fishing area during the late-returning steelhead fisheries. Because Alternative 3 would delay attainment of a viable abundance level relative to Alternative 1, Alternative 3 may reduce the long-term potential for tribal and recreational fisheries on coho salmon in the Elwha River relative to Alternative 1.

4.4.5.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). However, under Alternative 4, the Elwha River hatchery programs would be terminated immediately (Subsection 2.4, Alternative 4). Consequently, Alternative 4 would eliminate short- and long-term risks associated with genetic effects, competition and predation, facility effects, natural population status masking, incidental fishing effects, or disease transfer from the hatchery programs. Similarly, benefits from the hatchery programs on population viability and nutrient cycling would be eliminated after hatchery-origin fish stop returning to the basin to spawn (Subsection 3.4, Salmon and Steelhead).

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam. Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish held for spawning, rearing and release in the hatcheries) are going to have a higher survival rate when compared to fish migrating, spawning, and rearing in the Elwha River. Although not an ESA-listed species, the Elwha River coho salmon population is considered at high risk of extinction due to low average abundance levels observed prior to the commencement of dam removal (Subsection 3.4.5, Coho Salmon). The natural-origin coho salmon population averages under 200 fish. The already very low number of natural-origin fish is expected to decline further as a result of dam removal activities. Alternative 4 would reduce short-term abundance relative to Alternative 1 (Table 15), directly increasing extinction risk. Any coho salmon that survive dam removal activities would have access to high-quality habitat throughout the Elwha River Basin but, because abundance levels would be expected to be critically low (with possible extirpation of the population), the spatial structure, productivity, and genetic diversity status of the species would be markedly reduced relative to Alternative 1, which would also increase extinction risk.

Under Alternative 4, no fisheries would directly harvest hatchery-origin or natural-origin Elwha River coho salmon. However, Elwha River coho salmon may continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks (if they are not extirpated). But under this alternative, the adverse effects of any fisheries would be increased over Alternative 1, as the incidence of intercepting a natural-origin coho salmon would increase as the proportion of hatchery-origin fish decreases. Because Alternative 4 would increase the risk of extirpation and delay attainment of a viable abundance level relative to Alternative 1, Alternative 4 would reduce the long-term potential for tribal and recreational fisheries on coho salmon in the Elwha River.

4.4.5.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Decreased juvenile coho salmon production levels under Alternative 5 relative to Alternative 1 (Table 3) would reduce short-term risks associated with domestication, competition and predation, facility effects, natural population status masking, and disease transfer from the hatchery programs (Table 6) (Subsection 3.4, Salmon and Steelhead). Competition and predation risks are low under Alternative 1, but they would be even lower under Alternative 5 because fewer fish would be released.

Dam removal activities are leading to water quality conditions that are reducing the survival rate of all fish migrating, spawning, and rearing in the Elwha River below Glines Canyon Dam. Consequently, fish that spend less time in the Elwha River during adverse water quality conditions (i.e., fish in the hatcheries) are going to have a higher survival rate when compared to fish that are rearing and spawning in the Elwha River. The total hatchery and natural-origin population is already at low abundance (Subsection 3.4.3, Puget Sound Coho Salmon), and these numbers are expected to decline as a result of the adverse sediment impact period during and immediately following dam removal. Under Alternative 5, the hatchery program would be reduced to 50,000 smolts, so the number of hatchery-origin fish returning to the Elwha River would be reduced from 4,250 coho salmon to 500 coho salmon under average survival rates (actual survival rates in the short term will be much lower) (Table 16). After broodstock collection, the short-term abundance of coho salmon would be between 1 and 596 fish, or 0.01 and 5 percent of the coho salmon abundance needed to end the recolonization phase and begin the local adaptation phase of restoration, under which the hatchery programs for coho salmon would no longer be needed (Table 16). Because of the reduced number of spawners, extinction risk would be higher under Alternative 5 relative to Alternative 1.

Because of low abundance levels under Alternative 5 and the deleterious river turbidity levels caused by dam removal, the hatchery would be primarily responsible for the conservation of genetic diversity of the native species in the Elwha River. A genetic effective population size (a measure of the rate at which a population of a certain size will lose diversity) of 500 per generation is needed for conservation of genetic diversity in the hatchery (Lande and Barrowclough 1987), and the production levels under Alternative 5 would not be adequate to achieve a 500 fish per generation effective size within the hatchery (Table 16)[11].

[11] The "effective population size" is usually less than the census population size. To determine the total number of fish needed to achieve a 500 fish per generation effective size, divide 500 by the generation time of the fish species. For coho salmon, the generation time is 3 years, so you would need 167 effective spawners each year. Because of the high mortality from the time a fish is a fry to the time it is an adult, an average of one in four of the coho

Any coho salmon that survive the adverse sediment impact period during and immediately following dam removal would have access to high-quality habitat throughout the Elwha River Basin. However, in the short term, the productivity of spawners above the dams will likely be lower than spawners below the dam until the spawning gravel above the dams is conditioned by salmon and steelhead spawners (i.e., the first generation of spawners would loosen and clean the spawning gravel, which would make it better for subsequent generations of salmon and steelhead). The process of conditioning gravel would take longer under Alternative 5 relative to Alternative 1. There would also be fewer salmon and steelhead spawning under Alternative 5 relative to Alternative 1, so fewer marine-derived nutrients would be added to an aquatic system that has been cut off from this important source of nutrients for decades.

Under Alternative 5, there would be no change in fisheries affecting Elwha River coho salmon relative to Alternative 1. No fisheries would directly harvest hatchery-origin or natural-origin Elwha River coho salmon. However, Elwha River coho salmon would continue to be harvested incidentally in United States and Canadian mixed-stock marine area fisheries targeting more abundant salmon stocks. Tribal steelhead fisheries would be initiated under Alternative 5 once Elwha River natural-origin steelhead reach abundance thresholds, but these fisheries would not be expected to affect coho salmon because adult coho salmon migrate much earlier in the season and would not be in the fishing area during the steelhead fisheries. Because Alternative 5 would delay attainment of a viable abundance level relative to Alternative 1, Alternative 5 would delay the long-term potential for fisheries on coho salmon in the Elwha River relative to Alternative 1.

4.5. Other Fish Species

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

Under Alternative 1, the hatchery programs and would be operated identically as under baseline conditions, so there would be no change in weir or incidental fishery effects relative to baseline conditions (Subsection 3.5.1, Other Fish and Their Habitat). However, habitat conditions will continue to change as Glines Canyon Dam is removed, and these changes will affect the frequency of predator/prey/competitor interactions.

The U.S. Department of Interior estimates that more than 380,000 adult salmon and steelhead will be produced in the Elwha River once the Glines Canyon Dam is removed and restoration is

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spawned in the hatchery contribute to the subsequent generation of fish (Pers. Comm. between M. Ford and C. Busack; June 3, 2014). Therefore, multiply 167 times four to calculate the annual number of broodstock needed to achieve a 500 fish per generation effective size. For a coho salmon hatchery program, you would need to collect 667 broodstock annually to maintain a 500 fish per generation effective size. These calculations assume equal numbers of males and females.

complete (NPS 1995). These fish and their progeny will provide a source of food for a variety of fish species, including Pacific lamprey, Western brook lamprey, coast range sculpin, prickly sculpin, eastern brook trout, rainbow trout, kokanee, cutthroat trout, bull trout, and rockfish (Subsection 3.5, Other Fish and Their Habitat), perhaps increasing populations of some bird and mammal populations in the Elwha River Basin relative to baseline conditions (NPS 1995). These salmon and steelhead will add an estimated 817,800 pounds of carcasses to the system relative to the baseline conditions, which will bring nutrients from the marine ecosystem to the freshwater ecosystem (i.e., nutrient cycling), benefiting all freshwater fish species (NPS 1995).

Increasing the number of salmon and steelhead in the Elwha River Basin would increase competition for food with all fish species in the analysis area and increase competition for space among freshwater species (Subsection 3.5, Other Fish Species and Their Habitat). Similarly, increasing the number of salmon and steelhead in the Elwha River Basin would increase the number of predators on all fish species in the analysis area (Subsection 3.5, Other Fish Species and Their Habitat) relative to baseline conditions, indirectly increasing predation risks to co-occurring fish species.

In summary, bull trout may be affected by predation, competition, supply of marine-derived nutrients, and fishing, but these effects are not expected to be substantial under Alternative 1 for the following reasons: (1) bull trout would largely benefit from having hatchery-origin salmon and steelhead released into the Elwha River Basin because they eat juvenile salmon and steelhead, and (2) bull trout are not found exclusively in the Elwha River Basin or nearby marine waters (the Elwha River Basin is a very small percentage of their total range, so any mortalities as a resulting from implementation of Alternative 1 would not be expected to impact the overall size, health, survival, or status of the species).

Despite the occasional presence of eulachon in the Elwha River, the relatively small numbers of straying fish are not likely to be successfully contributing to the annual recruitment of juveniles that would substantially support recovery of the DPS (Gustafson et al. 2010). Therefore, any adverse or beneficial effects on eulachon as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

Because Pacific lamprey, Western brook lamprey, all rockfish species, and Pacific herring are not located exclusively in the Elwha River Basin or nearby marine waters, and in most cases these areas are a very small percentage of their total range, any adverse or beneficial effects on these species as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

4.5.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). Additionally, the operation of the Elwha River hatchery programs would be the same as under Alternative 1 (Subsection 2.2, Alternative 2), so the hatchery programs would have identical impacts on other fish species as under Alternative 1.

Under Alternative 2, there would be moratorium on salmon and steelhead fishing in the Elwha River until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Beginning January of 2020 or later, if the natural-origin component of the steelhead population exceeds 500 fish, the Lower Elwha Klallam Tribe would scale up their fishery (i.e., commercial fishery) to target 200 to 300 hatchery-origin steelhead. Subsistence fishermen would use hook and line, and commercial fishermen would use both gillnets and hook and line. In the past, larger fish species such as bull trout were periodically encountered in the subsistence fishery, but no documented information on total incidental mortality is available at this time (Subsection 3.5, Other Fish and Their Habitat). Tribal fishermen using commercial gillnets would not be expected to encounter any other freshwater species, including Pacific lamprey, Western brook lamprey, coast range and prickly sculpin, eulachon, three-spined stickleback, red-side shiner, eastern brook trout, kokanee, bull trout, and cutthroat trout (Subsection 3.5, Other Fish and Their Habitats). These freshwater species would not be captured by 5-inch mesh gillnets. Some of these species may be susceptible to hook and line capture, however.

In summary, bull trout may be affected by predation, competition, supply of marine-derived nutrients, and fishing, but, as under Alternative 1, these effects are not expected to be substantial under Alternative 2 for the following reasons: (1) bull trout would largely benefit from having hatchery-origin salmon and steelhead released into the Elwha River Basin because they eat juvenile salmon and steelhead; (2) although bull trout would be expected to be periodically encountered in the Tribal subsistence fishery, incidental mortalities would be expected to be low; and (3) bull trout are not found exclusively in the Elwha River Basin or nearby marine waters. The Elwha River Basin is a very small percentage of their total range, so any mortalities as a result of the Proposed Action would not be expected to impact the overall size, health, survival, or status of the species.

Impacts to eulachon under Alternative 2 would be the same as under Alternative 1. Despite the occasional presence of eulachon in the Elwha River, the relatively small numbers of straying fish

are not likely to be successfully contributing to the annual recruitment of juveniles that would substantially support recovery of the DPS (Gustafson et al. 2010). Therefore, any adverse or beneficial effects on eulachon as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

Because Pacific lamprey, Western brook lamprey, all rockfish species, and Pacific herring are not located exclusively in the Elwha River Basin or nearby marine waters, and in most cases these areas are a very small percentage of their total range, as under Alternative 1, any adverse or beneficial effects on these species as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

4.5.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the short term, the operation of the Elwha River hatchery programs and habitat conditions as a result of dam removal would be the same under Alternative 3 as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed) (Subsection 2.3, Alternative 3). Therefore, in the short term, the hatchery programs would have identical impacts on other fish species as under Alternative 1. However, after the hatchery programs are terminated (in approximately 2019) and hatchery-origin fish stop returning to the Basin, the total number of salmon and steelhead (hatchery-origin and natural-origin) would decrease, which would reduce the frequency of predator/prey/competitor interactions relative to Alternative 1.

Under Alternative 3, there would be moratorium on salmon and steelhead fishing in the Elwha River until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Because hatchery-origin steelhead would stop returning to the Elwha River in approximately 2021, the steelhead fishery would only be ramped up to target 200 to 300 hatchery-origin steelhead for one year, and only if natural-origin steelhead abundance that year is projected to exceed 500 fish. Larger fish species such as bull trout have been periodically encountered in the subsistence fishery in the past, but no documented information on total incidental mortality is available at this time (Subsection 3.5, Other Fish and Their Habitat). Tribal fisherman have not encountered any freshwater species when using commercial gillnets, because these species are too small to be captured in gillnets used to target steelhead (Subsection 3.5, Other Fish and Their Habitat), but may encounter certain species when hook and line gear is used.

In summary, bull trout may be affected by predation, competition, supply of marine-derived nutrients, and fishing, but, as under Alternative 1, these effects are not expected to be substantial under Alternative 3 for the following reasons: (1) bull trout would largely benefit from having hatchery-origin salmon and steelhead released into the Elwha River Basin because they eat juvenile salmon and steelhead; (2) although bull trout would be expected to be periodically encountered in the Tribal subsistence fishery, incidental mortalities would be expected to be low; and (3) bull trout are not found exclusively in the Elwha River Basin or nearby marine waters. The Elwha River Basin is a very small percentage of their total range, so any mortalities resulting from implementation of Alternative 3 would not be expected to impact the overall size, health, survival, or status of the species).

As under Alternative 1, despite the occasional presence of eulachon in the Elwha River, the relatively small numbers of straying fish are not likely to be successfully contributing to the annual recruitment of juveniles that would substantially support recovery of the DPS (Gustafson et al. 2010). Therefore, any adverse or beneficial effects on eulachon as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

Because Pacific lamprey, Western brook lamprey, all rockfish species, and Pacific herring are not located exclusively in the Elwha River Basin or nearby marine waters, and in most cases these areas are a very small percentage of their total range, As under Alternative 1, any adverse or beneficial effects on these species as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

4.5.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). However, under Alternative 4, the Elwha River hatchery programs would be terminated immediately (Subsection 2.4, Alternative 4). Consequently, in the short and long term, the total number of salmon and steelhead (hatchery-origin and natural-origin) would decrease relative to Alternative 1, which would reduce the frequency of predator/prey/competitor interactions.

Under Alternative 4, there would be no salmon or steelhead fisheries in the Elwha River Basin, so there would be no potential to intercept species such as bull trout, which have been periodically encountered in the subsistence fishery in the past.

In summary, bull trout may be affected by predation, competition, supply of marine-derived nutrients, and fishing, but, as under Alternative 1, these effects are not expected to be substantial under Alternative 4 for the following reasons: (1) bull trout would largely benefit from having hatchery-origin salmon and steelhead released into the Elwha River Basin because they eat juvenile salmon and steelhead; and (2) bull trout are not found exclusively in the Elwha River Basin or nearby marine waters. The Elwha River Basin is a very small percentage of their total range, so any mortalities resulting from implementation of Alternative 5 would not be expected to impact the overall size, health, survival, or status of the species.

As under Alternative 1, despite the occasional presence of eulachon in the Elwha River, the relatively small numbers of straying fish are not likely to be successfully contributing to the annual recruitment of juveniles that would substantially support recovery of the DPS (Gustafson et al. 2010). Therefore, any adverse or beneficial effects on Eulachon as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

Because Pacific lamprey, Western brook lamprey, all rockfish species, and Pacific herring are not located exclusively in the Elwha River Basin or nearby marine waters, and in most cases these areas are a very small percentage of their total range, as under Alternative 1, any adverse or beneficial effects on these species as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

4.5.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Decreased juvenile hatchery salmon and steelhead production levels under Alternative 5 relative to Alternative 1 (Table 3) would reduce risks to other fish species associated with competition and predation, facility effects, incidental fishing effects, and disease transfer from the hatchery programs (Table 6) (Subsection 3.4, Salmon and Steelhead). Although decreased relative to Alternative 1, competition and predation risks would remain low under Alternative 5 due to the continued lower river release of smolts only and at times that minimize risks to any co-occurring natural-origin fish populations.

Benefits to the population viability of other fish species (through increased prey availability), and benefits afforded to the fish species through nutrient cycling (Table 6) (Subsection 3.4, Salmon and Steelhead) would be reduced relative to Alternative 1 as a result of a roughly two-thirds

reduction in the number of juvenile fish produced, and the expected commensurate reduction in adult returns that would increase marine-derived nutrients in the watershed.

Under Alternative 5, habitat conditions as a result of dam removal would be the same under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed) (Subsection 2.5, Alternative 5). However, under Alternative 5, the Elwha River juvenile fish release levels for hatchery programs would be reduced by roughly two-thirds relative to Alternative 1 (Subsection 2.5, Alternative 5). Consequently, the total number of salmon and steelhead (hatchery-origin and natural-origin) would decrease relative to Alternative 1 (Table 3), which would reduce the frequency of predator/prey/competitor interactions with other fish species in the watershed.

Under Alternative 5, there would continue to be a moratorium on salmon and steelhead fishing in the Elwha River until 2018. In 2018, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Because adult hatchery-origin steelhead returns to the Elwha River would be reduced in number by roughly two-thirds relative to Alternative 1, the steelhead fishery proposed in 2012 to target 200 to 300 hatchery-origin steelhead would have a decreased likelihood of being implemented (subject to a natural-origin steelhead abundance projected to exceed 500 fish) relative to Alternative 1.

Large fish species such as bull trout have been periodically encountered in tribal subsistence fisheries in the past, but no documented information on total incidental mortality is available at this time (Subsection 3.5, Other Fish and Their Habitat). Tribal fisherman have not encountered any other freshwater fish species when using commercial gillnets, because these species are too small to be captured in the net mesh sizes used by gillnetters to target steelhead (Subsection 3.5, Other Fish and Their Habitat). Certain species may be encountered when hook and line gear is used.

In summary, bull trout may be affected by predation, competition, supply of marine-derived nutrients, and fishing, but, as under Alternative 1, these effects are not expected to be substantial under Alternative 5 for the following reasons: (1) bull trout would largely benefit from having hatchery-origin salmon and steelhead released into the Elwha River Basin because they eat juvenile salmon and steelhead; (2) although bull trout would be expected to be periodically encountered in the Tribal subsistence fishery, incidental mortalities would be expected to be low; and (3) bull trout are not found exclusively in the Elwha River Basin or nearby marine waters. The Elwha River Basin is a very small percentage of their total range, so any mortalities as a result of implementation of Alternative 5 would not be expected to impact the overall size, health, survival, or status of the species.

As under Alternative 1, despite the occasional presence of eulachon in the Elwha River, the relatively small numbers of straying fish are not likely to be successfully contributing to the annual recruitment of juveniles that would substantially support recovery of the DPS (Gustafson et al. 2010). Therefore, any adverse or beneficial effects on eulachon under Alternative 5 as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

Because Pacific lamprey, Western brook lamprey, all rockfish species, and Pacific herring are not located exclusively in the Elwha River Basin or nearby marine waters, and in most cases these areas are a very small percentage of their total range. As under Alternative 1, any adverse or beneficial effects on these species as a result of competition, predation, or supply of marine derived-nutrients is not expected to impact the overall size, health, survival, or status of the species.

4.6. Wildlife

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

Under Alternative 1, the hatchery programs and tribal fishery would be operated the same as under baseline conditions (Subsection 2.1, Alternative 1), so there would be no change in the risk of transfer of toxic contaminants from hatchery-origin fish to wildlife, nor in risks associated with operation of weirs at the hatcheries, predator control programs, or habitat disruption from angler access (Subsection 3.6, Wildlife). However, habitat conditions will continue to change as Glines Canyon Dam is removed.

The Department of Interior estimates that more than 380,000 natural-origin salmon and steelhead adults will be produced in the Elwha River once the Glines Canyon Dam is removed and restoration is complete (NPS 1995). These fish and their progeny will provide a source of food for a variety of birds and mammals, perhaps increasing populations of some bird and mammal populations in the Elwha River Basin relative to baseline conditions (NPS 1995). An estimated 817,800 pounds of carcasses are expected to be added to the system relative the baseline conditions (NPS 1995). These carcasses will bring nutrients from the marine ecosystem to the terrestrial ecosystem (i.e., nutrient cycling), which will benefit wildlife.

Similarly, increasing the number of Elwha River salmon and steelhead would increase the amount of food available for marine mammals such as killer whales, seals, and sea lions. However, because Elwha River salmon and steelhead commingle with many other hatchery-origin and natural-origin salmon and steelhead from the Puget Sound, Fraser River, Columbia River, and Washington Coast while in marine waters, the impact on the abundance of marine

mammals would likely be negligible (i.e., at the lower levels of detection) relative to baseline conditions.

Increasing the number of salmon and steelhead in the Elwha River Basin would increase the food availability for salmon and steelhead predators and scavengers (e.g., bald eagles), which would have a low beneficial impact on these wildlife populations. Increasing the number of salmon and steelhead in the Elwha River Basin would also increase the number of predators on some invertebrates and amphibian species, which might have a low adverse impact on the abundance of invertebrates and amphibian species in the Elwha River Basin relative to baseline conditions.

Alternative 1 would not be expected to change the size, health, survival, or Federal listing status of Northern spotted owl, marbled murrelet, Southern resident killer whale, and Steller sea lion, because none of these species is located exclusively in the Elwha River Basin or nearby marine waters, and the analysis area represents a very small percentage of their total range.

4.6.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). Additionally, the operation of the Elwha River hatchery programs would be the same as under Alternative 1 (Subsection 2.2, Alternative 2), so the hatchery programs would have identical impacts on wildlife as under Alternative 1. There would be no change in the risk of transfer of toxic contaminants from hatchery-origin fish to wildlife, operation of weirs at the hatcheries, predator control programs, predation/competition effects, or nutrient cycling (Subsection 3.6, Wildlife).

Under Alternative 2, the Lower Elwha Klallam Tribe would initiate a small mark-selective, ceremonial and subsistence fishery (50 fish) on hatchery-origin, late-returning steelhead after the number of natural-origin steelhead returns is projected to exceed 300 adults. Additionally, the Lower Elwha Klallam Tribe would initiate a commercial and recreational fishery (200 to 300 fish) on hatchery-origin, late-returning (i.e., native stock) steelhead after the number of natural-origin steelhead is projected to exceed 500 adults. However, because there has been recreational fishing throughout the Elwha River Basin, fishery access points, roads, and boat launches are already present in the analysis area, and Alternative 2 is not expected to lead to additional impacts on wildlife relative to Alternative 1 from physical damage or disruption of riparian vegetation from angler access or physical disruption of streambed material from wading or motorized boat use.

Alternative 2 would not be expected to change the size, health, survival, or Federal listing status of Northern spotted owl, marbled murrelet, Southern resident killer whale, and Steller sea lion, because none of these species is located exclusively in the Elwha River Basin or nearby marine waters, and in most cases these areas are a very small percentage of their total range.

4.6.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the short term, the operation of the Elwha River hatchery programs and habitat conditions as a result of dam removal would be the same under Alternative 3 as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed) (Subsection 2.3, Alternative 3). Therefore, in the short term, there would be no change in the risk of transfer of toxic contaminants from hatchery-origin fish to wildlife, operation of weirs at the hatcheries, predator control programs, habitat disruption from angler access, predation/competition effects, or nutrient cycling (Subsection 3.6, Wildlife).

In the long term, Alternative 3 would eliminate risks associated with the transfer of toxic contaminants from hatchery-origin fish to wildlife, predator control programs, and predation/competition effects relative to Alternative 1 (Subsection 3.6, Wildlife).

Under Alternative 3, the Lower Elwha Klallam Tribe would initiate a small mark-selective, ceremonial and subsistence fishery (50 fish) on hatchery-origin, late-returning steelhead after the number of natural-origin steelhead returns is projected to exceed 300 adults, assuming the natural-origin abundance reaches 300 adults while hatchery-origin fish are returning to the Basin. However, because there has been recreational fishing throughout the Elwha River Basin, fishery access points, roads, and boat launches are already present in the analysis area, and Alternative 3 is not expected to lead to additional impacts on wildlife relative to Alternative 1 from physical damage or disruption of riparian vegetation from angler access or physical disruption of streambed material from wading or motorized boat use. Since there would be no hatchery-origin fish to support a ceremonial and subsistence or commercial fishery, the Tribe would not initiate any fisheries on hatchery-origin fish.

Alternative 3 would not be expected to change the size, health, survival, or Federal listing status of Northern spotted owl, marbled murrelet, Southern resident killer whale, and stellar sea lion, because none of these species is located exclusively in the Elwha River Basin or nearby marine waters, and the analysis area represents a very small percentage of the total ranges for the species.

4.6.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). However, under Alternative 4, the Elwha River hatchery programs would be terminated immediately (Subsection 2.4, Alternative 4). Consequently, Alternative 4 would eliminate short- and long-term risks of hatchery programs on wildlife from the transfer of toxic contaminants from hatchery-origin fish to wildlife, predator control programs, or predation/competition effects (Subsection 3.6, Wildlife).

Under Alternative 4, extinction risk for salmon and steelhead populations would be greater than under Alternative 1. If extirpated, there would be less food available for wildlife species that eat salmon and steelhead and up to 817,800 fewer pounds of salmon and steelhead carcasses that would add nutrients from the marine ecosystem to the terrestrial ecosystem (NPS 1995). Thus, the population abundance of some fish-eating bird and mammal species would likely be reduced under Alternative 4 relative to Alternative 1.

Under Alternative 4, there would be no salmon or steelhead fisheries in the Elwha River, so there would be no further risk of impacts on wildlife from physical damage or disruption of riparian vegetation from angler access or physical disruption of streambed material from wading or motorized boat.

Reducing the number of salmon and steelhead in the Elwha River Basin may increase competition for food for wildlife species with shared food preferences, such as gulls and cormorants. It would reduce the number of predators on some invertebrates and amphibian species, which might have a low beneficial effect on the abundance of invertebrates and amphibian species in the Elwha River Basin.

Alternative 4 would not be expected to change the size, health, survival, or Federal listing status of Northern spotted owl, marbled murrelet, Southern resident killer whale, and Steller sea lion,

because none of these species is located exclusively in the Elwha River Basin or nearby marine waters, and these areas are a very small percentage of their total range.

4.6.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 5, habitat conditions as a result of dam removal would be the same as under Alternative 1 (i.e., habitat conditions would continue to change as Glines Canyon Dam is removed). However, under Alternative 5, juvenile salmon and steelhead releases from the Elwha River hatchery programs, and hence, adult hatchery-origin return levels to the watershed, would be reduced by roughly two-thirds relative to levels under Alternative 1 (Subsection 2.5, Alternative 5). Consequently, Alternative 4 would reduce short- and long-term risks of hatchery programs on wildlife from the transfer of toxic contaminants from hatchery-origin fish to wildlife, predator control programs, or predation/competition effects (Subsection 3.6, Wildlife).

Under Alternative 5, extinction risk of the native Elwha River salmon and steelhead populations would be greater than under Alternative 1. If extirpated, there would be less food available for wildlife species that eat salmon and steelhead, and substantially fewer pounds of salmon and steelhead carcasses that would add nutrients from the marine ecosystem to the terrestrial ecosystem in the long term. Thus, the population abundance of some fish-eating bird and mammal species would likely be reduced under Alternative 5 in the near term while achieving viable abundance levels, and possibly in the long term if extirpated, relative to Alternative 1.

Under Alternative 5, the Lower Elwha Klallam Tribe would initiate a small mark-selective, ceremonial and subsistence fishery (50 fish) on hatchery-origin, late-returning steelhead after the number of natural-origin steelhead returns is projected to exceed 300 adults. Additionally, the Lower Elwha Klallam Tribe would initiate a commercial and recreational fishery (200 to 300 fish) on hatchery-origin, late-returning (i.e., native stock) steelhead after the number of natural-origin steelhead is projected to exceed 500 adults. However, because there has been recreational fishing throughout the Elwha River Basin, fishery access points, roads, and boat launches are already present in the analysis area, and Alternative 5 is not expected to lead to additional impacts on wildlife relative to Alternative 1 from physical damage or disruption of riparian vegetation from angler access or physical disruption of streambed material from wading or motorized boat use.

Reducing the number of salmon and steelhead in the Elwha River Basin relative to Alternative 1 would increase competition for food for wildlife species with shared food preferences, such as gulls and cormorants. With reductions in juvenile salmon and steelhead that serve as prey to sustain certain wildlife species, Alternative 5 may reduce the number of predators on some

invertebrates and amphibian species, which might have a low beneficial effect on the abundance of invertebrates and amphibian species in the Elwha River Basin.

Alternative 5 would not be expected to change the size, health, survival, or Federal listing status of Northern spotted owl, marbled murrelet, Southern resident killer whale, and Steller sea lion, because none of these species is located exclusively in the Elwha River Basin or nearby marine waters, and these areas are a very small percentage of their total range.

4.7. Socioeconomics

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

Under Alternative 1, the hatchery programs would be operated the same as under baseline conditions, so there would be no change in employment opportunities or the local procurement of goods and services for hatchery operations (Subsection 3.7, Socioeconomics).

Under Alternative 1, there would be no salmon or steelhead fishing in the Elwha River, which is identical as under baseline conditions. Therefore, there would be no change in the purchase of fishing-related supplies at local businesses (Subsection 3.7, Socioeconomics) after the 2013-2014 fishing season.

Because the Elwha River salmon and steelhead populations are expected to rebound to harvestable numbers after the Elwha River dams are removed and the Elwha River has recovered, there is long-term potential for the fisheries to add substantially to the regional economy. One National Park Service study found that commercial fishermen could obtain $3.5 million per year of net economic benefits after fish stocks are restored in the Elwha River Basin (NPS 1995). However, under Alternative 1, no fishing plans would be in place for salmon and steelhead in the Elwha River, so although fishing potential would eventually be greater under Alternative 1 than under baseline conditions, the socioeconomic benefits cannot be quantified.

4.7.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

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

Under Alternative 2, there would be no salmon or steelhead fishing in the Elwha River, which is identical as under Alternative 1. Therefore, there would be no change in the purchase of fishing-related supplies in the short-term (before 2014). There would be a small reduction in the

purchase of fishing-related supplies during the fishing moratorium, and, after reinitiating fisheries, there would be long-term increase in the purchase of fishing-related supplies relative to Alternative 1.

There would be no change in long-term potential for fisheries to contribute substantially to the regional economy under Alternative 2 relative to Alternative 1, because salmon and steelhead stocks would be expected to rebound to harvestable numbers at similar rates under both alternatives.

4.7.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 3, the operation of the Elwha River hatchery programs would be the same as under Alternative 1 in the short term but, in the long term (i.e.**,** it would be expected that the last hatchery-origin fish would be released around 2019), the hatchery programs would be closed and no longer contribute $1.65 million and 14 full-time jobs to the regional economy.

Under Alternative 3, there would be a moratorium on salmon and steelhead fishing until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Because hatchery-origin steelhead would stop returning to the Elwha River in approximately 2021, the steelhead fishery would only be ramped up to target 200 to 300 hatchery-origin steelhead for one year, and only if natural-origin steelhead abundance that year is projected to exceed 500 fish. Therefore, Alternative 3 would not lead to any short-term changes (before 2018) in the purchase of fishing-related supplies, but there would be a short-term increase in the purchase of fishing related supplies under Alternative 3 relative to Alternative 1 from approximately 2018 until hatchery-origin fish stopped returning to the Elwha River Basin (in approximately 2021).

There would be no change in long-term potential for fisheries to contribute substantially to the regional economy under Alternative 3 relative to Alternative 1 because salmon and steelhead stocks would be expected to rebound to harvestable numbers under both alternatives, but it would be expected to take salmon and steelhead a much longer time, possibly decades, to reach harvestable numbers under Alternative 3 relative to Alternative 1.

4.7.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, the Elwha River hatchery programs would be terminated immediately (Subsection 2.4, Alternative 4), and hatchery programs would no longer contribute $1.65 million and 14 full-time jobs to the regional economy (Subsection 3.7, Socioeconomics).

Under Alternative 4, like under Alternative 1, there would be no salmon or steelhead fishing in the Elwha River. Therefore, there would be no change in the purchase of fishing-related supplies relative to Alternative 1. However, the long-term potential for Elwha River fisheries to contribute meaningfully to the regional economy would be greatly reduced under Alternative 4 relative to Alternative 1 because, without the Elwha River hatchery programs, it is uncertain whether the Elwha River salmon and steelhead populations will be able to survive the degradation in environmental conditions resulting from dam removal activities. Consequently, Alternative 4 would lead to a $3.5 million annual loss in potential net economic benefits to commercial fishers relative to Alternative 1.

4.7.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 5, juvenile fish production by the Elwha River hatchery programs would be reduced by roughly two-thirds (Subsection 2.5, Alternative 5). It is expected that substantially reduced fish production from the hatchery programs under Alternative 5 would have detectable effects on income to the region through reduced harvest and fishing opportunity resulting from fewer returning adult fish. With reduced hatchery salmon production and labor needs, employment at the hatcheries would also be reduced relative to Alternative 1 to at least a medium extent.

Under Alternative 5, there would be a moratorium on salmon and steelhead fishing until 2018. In 2018, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Because hatchery-origin steelhead would return to the Elwha River at roughly two-thirds of the abundance level expected under Alternative 1, Alternative 5 would likely reduce the chances that the Tribal Harvest Plan target of 200 to 300 hatchery-origin steelhead would be available for harvest as the natural steelhead population is restored. Reduced abundances of naturally spawning native Elwha River hatchery-origin steelhead under Alternative 5 would also reduce the likelihood that natural-origin steelhead abundance would exceed 500 fish, decreasing the likelihood for a tribal steelhead fishery relative to Alternative 1.

For these reasons, Alternative 5 would not be expected to lead to any short-term changes (before 2018) in the purchase of fishing-related supplies, but there would be a short-term decrease in the purchase of fishing related supplies under Alternative 5 relative to Alternative 1 after approximately 2018, because prospects for steelhead fisheries would be reduced or delayed.

The long-term potential for Elwha River fisheries to contribute meaningfully to the regional economy would be reduced under Alternative 5 relative to Alternative 1 because with a roughly two-thirds reduction in the Elwha River hatchery programs it is uncertain whether the resultant reduced abundance of Elwha River salmon and steelhead populations would enable the species to persist in degraded environmental conditions resulting from dam removal. Reductions in adult fish returns under Alternative 5 would at least decrease benefits to the local economy relative to Alternative 1 because the availability of returning adult fish for harvest in fisheries and sale would be reduced. Consequently, Alternative 5 would lead to a medium reduction in the estimated annual $3.5 million net economic benefits to commercial fishers expected under Alternative 1.

4.8. Cultural Resources

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

Under Alternative 1, there would be no construction or expansion of the hatchery facilities, so no cultural artifacts would be disrupted or destroyed. The hatchery programs would continue to operate as under baseline conditions in both the near and long-term, but environmental conditions would continue to change as freshwater and estuarine habitat improve from dam removal. In the short-term, the hatchery-programs would preserve the remaining extant salmon and steelhead populations while water-quality conditions inhospitable for fish in mainstem reaches of the Elwha River persist (Subsection 4.4., Salmon and Steelhead). In the long-term, the hatchery programs would increase total and natural-origin abundance and spatial structure of salmon and steelhead populations as additional habitat becomes available and first-generation hatchery-origin fish, and the offspring of naturally spawning hatchery-origin fish, return to spawn naturally (Subsection 4.4, Salmon, Steelhead, and Their Habitat). Consequently, under Alternative 1, the survival and well-being of salmon would improve relative to baseline conditions, which would be expected to improve the well-being of the Lower Elwha Klallam Tribe, because salmon and the Tribe are inextricably linked (Subsection 3.8, Cultural Resources).

The Lower Elwha Klallam Tribe's "usual and accustomed" fishing area includes the entire Elwha River Basin (Subsection 3.8, Cultural Resources). These fisheries have played a central role in the Lower Elwha Klallam Tribe's culture, in particular the fisheries conducted for ceremony and subsistence purposes (Subsection 3.8, Cultural Resources). Under Alternative 1, the Tribe would not have a fishing plans in place for salmon and steelhead in the Elwha River.

However, under Alternative 1, the Elwha River salmon and steelhead populations would be expected to rebound to harvestable numbers and recolonize the entire watershed encompassed by the Tribe's "usual and accustomed" fishing area after the Elwha River dams are removed and the Elwha River and estuarine areas have recovered. Therefore, relative to baseline conditions, Alternative 1 would improve the long-term *potential* for Elwha River salmon and steelhead to meaningfully contribute to the Tribe's fisheries.

4.8.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, environmental conditions would be the same as under Alternative 1. Additionally, the operation of the Elwha River hatchery programs would be the same as under Alternative 1 (Subsection 2.2, Alternative 2), so as under Alternative 1, no cultural artifacts would be disrupted or destroyed. Additionally, in the short-term, the hatchery-programs would preserve the remaining extant salmon and steelhead populations while water-quality conditions inhospitable for fish in mainstem reaches of the Elwha River persist (Subsection 4.4., Salmon and Steelhead). In the long-term, the hatchery programs would increase total and natural-origin abundance and spatial structure of salmon and steelhead populations as additional habitat becomes available and first-generation hatchery-origin fish, and the offspring of naturally spawning hatchery-origin fish, return to spawn naturally (Subsection 4.4, Salmon, Steelhead, and Their Habitat). Consequently, like under Alternative 1, the survival and well-being of salmon would improve under Alternative 2 relative to baseline conditions, which would be expected to improve the well-being of the Lower Elwha Klallam Tribe, because salmon and the Tribe are inextricably linked (Subsection 3.8, Cultural Resources).

The Lower Elwha Klallam Tribe's "usual and accustomed" fishing area includes the entire Elwha River Basin (Subsection 3.8, Cultural Resources). These fisheries have played a central role in the Lower Elwha Klallam Tribe's culture, in particular the fisheries conducted for ceremony and subsistence purposes (Subsection 3.8, Cultural Resources). Under Alternative 2, there would be a moratorium on salmon and steelhead fishing until 2018. After the 2013-2014 steelhead fishing season, the Lower Elwha Klallam Tribe would stop fishing in the Elwha River Basin until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Beginning January of 2020 or later, if the natural-origin component of the steelhead population exceeds 500 fish, the Lower Elwha Klallam Tribe would scale up their fishery to target 200 to 300 hatchery-origin steelhead. Consequently, Alternative 2 would increase the Tribe's harvest of steelhead after the 2013-2014 fishing season, because the Tribe would have a fishing plan in place under Alternative 2 after the 2013-2014 fishing season. However, relative to Alternative 1, Alternative 2 would not change

the long-term *potential* for Elwha River salmon and steelhead to meaningfully contribute to the Tribe's fisheries, because salmon and steelhead would be expected to rebound to harvestable numbers and recolonize the entire watershed encompassed by the Tribe's "usual and accustomed" fishing area under both alternatives.

4.8.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the short term, the operation of the Elwha River hatchery programs, and environmental conditions, would be the same under Alternative 3 as under Alternative 1 (Subsection 2.3, Alternative 3), so as under Alternative 1, no cultural artifacts would be disrupted or destroyed. Under Alternative 3, there would be a moratorium on salmon and steelhead fishing until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Because hatchery-origin steelhead would stop returning to the Elwha River in approximately 2021, the steelhead fishery would only be ramped up to target 200 to 300 hatchery-origin steelhead for one year, and only if natural-origin steelhead abundance that year is projected to exceed 500 fish. Therefore, in the short term, there would be no change in effects on cultural resources relative to Alternative 1.

However, under Alternative 3, the Elwha River hatchery programs would be terminated after the dams have been removed, sediment levels have returned to pre-dam removal levels, and salmon and steelhead have exhibited some natural productivity. The programs would be terminated near the end of the preservation phase (Subsection 1.5.2, Elwha River Fish Restoration Plan), and it would be expected that the last hatchery-origin fish would be released around 2019. Alternative 3 would delay attainment of harvestable salmon and steelhead populations relative to Alternative 1. Therefore, although Alternative 3 would be expected to have similar long-term benefits to cultural resources as under Alternative 1, the attainment of these benefits would be delayed, possibly by decades.

4.8.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, like under Alternative 1, there would be no salmon or steelhead fisheries in the Elwha River.

Because dam removal activities are expected to lead to water-quality conditions that are detrimental, and perhaps lethal, to all fish migrating and rearing in the lower Elwha River (Ward

et al. 2008), Alternative 4 would reduce short-term salmon and steelhead abundance relative to Alternative 1. Extinction risk for salmon and steelhead populations would be greater under Alternative 4 relative to Alternative 1. Relative to Alternative 1, Alternative 4 would markedly reduce the likelihood of salmon and steelhead recolonizing the entire watershed encompassed by the Tribe's "usual and accustomed" fishing area, would reduce the Tribe's access to salmon and steelhead for ceremonial and other cultural practices, and would be expected to reduce the well-being of the Tribe. Because there would be no construction under Alternative 4, there would be no change in the likelihood of disrupting or destroying cultural artifacts relative to Alternative 1.

4.8.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 5, environmental conditions would be the same as under Alternative 1. Additionally, operational components of the Elwha River hatchery programs that could affect surrounding habitat would essentially be the same as under Alternative 1 (Subsection 2.2, Alternative 2). Consequently, as under Alternative 1, no cultural artifacts would be disrupted or destroyed.

A roughly two-thirds reduction in salmon and steelhead production under Alternative 5 would reduce the likelihood, relative to Alternative 1, that the remaining native Elwha River salmon and steelhead populations would be preserved. Further, water-quality conditions inhospitable for fish in mainstem reaches of the Elwha River would persist (Subsection 4.4., Salmon and Steelhead), which would also adversely impact the abundance of native populations. In the long-term, because of decreased contributions of the hatchery-origin fish to total returns and natural spawning, total and natural-origin Elwha River salmon and steelhead population abundance and spatial structure benefits would decrease relative to Alternative 1. As additional habitat becomes available, under Alternative 1 there would be roughly two-thirds fewer first-generation hatchery-origin fish, and fewer offspring of naturally spawning hatchery-origin fish, that would be produced relative to Alternative 1 (Subsection 4.4, Salmon and Steelhead). Consequently, the survival and well-being of salmon would decrease under Alternative 5 relative to Alternative 1, which would be expected to adversely affect the well-being of the Lower Elwha Klallam Tribe, because salmon and the Tribe are inextricably linked (Subsection 3.8, Cultural Resources).

The Lower Elwha Klallam Tribe's "usual and accustomed" fishing area includes the entire Elwha River Basin (Subsection 3.8, Cultural Resources). These fisheries have played a central role in the Lower Elwha Klallam Tribe's culture, in particular the fisheries conducted for ceremony and subsistence purposes (Subsection 3.8, Cultural Resources). Under Alternative 5, there would be a moratorium on salmon and steelhead fishing until 2018. After the 2013-2014 steelhead fishing season, the Lower Elwha Klallam Tribe would stop fishing in the Elwha River

Basin until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Because hatchery-origin steelhead would return to the Elwha River at roughly two-thirds of the abundance level expected under Alternative 1, Alternative 5 would likely reduce the chances that the Tribal Harvest Plan target of 200 to 300 hatchery-origin steelhead would be available for harvest as the natural steelhead population is restored. Reduced abundances of naturally spawning native Elwha River hatchery-origin steelhead under Alternative 5 would also reduce the likelihood that natural-origin steelhead abundance would exceed 500 fish, decreasing the likelihood for a tribal steelhead fishery relative to Alternative 1. For these reasons, Alternative 5 would not be expected to lead to any short-term differences in cultural resource effects relative to Alternative 1 before 2018. However, Alternative 5 would decrease cultural resource benefits relative to Alternative 1 after 2018, because prospects for steelhead fisheries valuable to the Lower Elwha Klallam Tribe would be reduced or delayed.

The long-term potential for Elwha River fisheries to contribute meaningfully to the cultural resources would be reduced under Alternative 5 relative to Alternative 1 because, with a roughly two-thirds reduction in the Elwha River hatchery programs, it is uncertain whether the resultant reduced abundance of Elwha River salmon and steelhead populations would enable the species to persist in degraded environmental conditions resulting from dam removal. Reductions in adult fish returns under Alternative 5 will at least decrease at a medium level cultural benefits to the Lower Elwha Klallam Tribe relative to Alternative 1.

4.9. Human Health and Safety

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

Under Alternative 1, the Elwha River hatchery programs would continue as under baseline conditions, and there would be no change in the risk of exposure of hatchery workers to chemicals or pathogens. Likewise, there would be no change in the potential nutritional benefits of the hatchery programs to human health and no change in the risk of consumer exposure to toxic contaminants relative to baseline conditions (Subsection 3.9, Human Health and Safety).

4.9.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 2, the Elwha River hatchery programs would continue as under Alternative 1, and there would be no change in the risk of exposure of hatchery workers to chemicals or pathogens. Likewise, there would be no change in the potential nutritional benefits of the

hatchery programs to human health and no change in the risk of consumer exposure to toxic contaminants relative to Alternative 1 (Subsection 3.9, Human Health and Safety).

4.9.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the short term, the operation of the Elwha River hatchery programs and environmental conditions would be the same under Alternative 3 as under Alternative 1 (Subsection 2.3, Alternative 3). Therefore, in the short term, there would be no change in the risk of exposure of hatchery workers to chemicals or pathogens. Likewise, there would be no change in the potential nutritional benefits of the hatchery programs to human health and no change in the risk of consumer exposure to toxic contaminants relative to Alternative 1 (Subsection 3.9, Human Health and Safety).

However, under Alternative 3, the last hatchery-origin fish would be released around 2019. Therefore, in the long term, Alternative 3 may reduce the risk of exposure of hatchery workers to chemicals or pathogens. Likewise, Alternative 3 would reduce the potential nutritional benefits of the hatchery programs to human health (e.g., improved cardiovascular health), and it would reduce the risk of consumer exposure to toxic contaminants relative to Alternative 1 (Subsection 3.9, Human Health and Safety), as the number of hatchery-origin fish and, potentially, the total number of fish returning to the Elwha River would be reduced relative to Alternative 1.

4.9.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan do Not Meet the Requirements of the 4(d) Rule

Under Alternative 4, the Elwha River hatchery programs would be terminated immediately. Therefore, in the short and long term, Alternative 4 may reduce the risk of exposure of hatchery workers to chemicals or pathogens. Likewise, Alternative 4 would reduce the potential nutritional benefits of the hatchery programs to human health and reduce the risk of consumer exposure to toxic contaminants relative to Alternative 1 (Subsection 3.9, Human Health and Safety).

4.9.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

Under Alternative 5, because annual juvenile fish production from the hatchery programs would be reduced by roughly two-thirds, there would be a reduced risk of exposure of hatchery workers to chemicals or pathogens relative to Alternative 1. Likewise, Alternative 5 would reduce the

potential nutritional benefits of the hatchery programs to human health (e.g., improved cardiovascular health), and it would reduce the risk of consumer exposure to toxic contaminants relative to Alternative 1 (Subsection 3.9, Human Health and Safety), as the number of hatchery-origin fish and the total number of fish returning to the Elwha River would be reduced relative to Alternative 1.

4.10. Environmental Justice

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

In the analysis area, one county (Clallam County) and one Native American Tribe (Lower Elwha Klallam Tribe) have been identified as environmental justice communities of concern (Subsection 3.8, Environmental Justice). There are no other communities in the analysis area, so all effects under Alternative 1 as described in Subsections 4.2 (Water Quantity) through Subsection 4.9 (Cultural Resources) would disproportionately impact environmental justice communities.

Under Alternative 1, the hatchery programs would be operated the same as under baseline conditions. There would not be any fisheries in the Elwha during the 5-year moratorium that ends in 2018.

Because the Elwha River salmon and steelhead populations are expected to rebound to harvestable numbers after the Elwha River dams are removed and the Elwha River has recovered, there is long-term *potential* for the fisheries to add substantially to personal income within environmental justice communities. One National Park Service study found that commercial fishermen could obtain $3.5 million per year of net economic benefits after fish stocks are restored in the Elwha River Basin (NPS 1995). However, under Alternative 1, no fishing plans would be in place for salmon and steelhead in the Elwha River, so the socioeconomic benefits cannot be quantified.

Water quality conditions in the Elwha River would be expected to change in the short and long term from dam removal (Table 10). In the short term, sediment levels would increase immediately after removal of the Glines Canyon Dam, but water temperature conditions throughout the lower river would be expected to improve immediately (Ward et al. 2008). In the long term, sediment levels will dissipate and temperatures in the lower Elwha River would be reduced (NPS 2005).

There would be no change in water quantity, employment opportunities, or the local procurement of goods and services in environmental justice communities relative to baseline conditions

(Subsection 4.2, Water Quantity; Subsection 4.3, Water Quality; Subsection 4.7, Socioeconomics). Under Alternative 1, there would be no change in the nutritional benefits of the hatchery programs to human health within environmental justice communities and no change in the risk of consumer exposure to toxic contaminants relative to baseline conditions (Subsection 4.9, Human Health and Safety).

Because the Elwha River salmon and steelhead populations are expected to rebound to harvestable numbers after the Elwha River dams are removed and the Elwha River has recovered, there is long-term *potential* for the various tribal fisheries in the Strait of Juan de Fuca to benefit from the increased adult fish returning to the Elwha River. However, because the proportion of the harvestable salmonids in the Strait of Juan de Fuca that would be represented by Elwha River fish is small, it is unlikely that the benefit would be discernible outside of near-shore marine areas.

4.10.2. Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs and Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the analysis area, one county (Clallam County) and one Native American Tribe (Lower Elwha Klallam Tribe) have been identified as environmental justice communities of concern (Subsection 3.8, Environmental Justice). There are no other communities in the analysis area, so all effects under Alternative 2 as described in Subsections 4.2 (Water Quantity) through Subsection 4.9 (Cultural Resources) would disproportionately impact environmental justice communities.

Under Alternative 2, the operation of the Elwha River hatchery programs would be the same as under Alternative 1. Under Alternative 2, there would be a 5-year moratorium on salmon and steelhead fishing until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Beginning January of 2020 or later, if the natural-origin component of the steelhead population exceeds 500 fish, the Lower Elwha Klallam Tribe would scale up their fishery to target 200 to 300 hatchery-origin steelhead.

The following ecological, cultural, human health, economic, or social impacts on environmental justice communities would be expected in both the short and long term:

- Additional fishing and cultural benefits to the Lower Elwha Klallam Tribe from implementation of steelhead fisheries relative to Alternative 1 (Subsection 4.8, Cultural Resources)

There would be no change in water quantity or quality, employment opportunities, or the local procurement of goods and services in environmental justice communities (Subsection 4.2, Water Quantity; Subsection 4.3, Water Quality; Subsection 4.7, Socioeconomics). There would be no change in long-term *potential* for fisheries to contribute substantially to personal income within environmental justice communities under Alternative 2 relative to Alternative 1, because salmon and steelhead stocks would be expected to rebound to harvestable numbers at similar rates under both alternatives. For the same reason, there would be no discernible change in benefits to tribal fisheries in usual and accustomed areas in the Strait of Juan de Fuca outside of near-shore marine areas. Under Alternative 2, there would be no change in the potential nutritional benefits of the hatchery programs to human health within environmental justice communities and no change in the risk of consumer exposure to toxic contaminants relative to Alternative 1 (Subsection 4.9, Human Health and Safety).

4.10.3. Alternative 3 (Proposed Hatchery Programs with a Sunset Term) – Make a Determination that Revised HGMPs that Include a Sunset Term and a Revised Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the analysis area, one county (Clallam County) and one Native American Tribe (Lower Elwha Klallam Tribe) have been identified as environmental justice communities of concern (Subsection 3.8, Environmental Justice). There are no other communities in the analysis area, so all effects under Alternative 3 described in Subsections 4.2 (Water Quantity) through Subsection 4.9 (Cultural Resources) would disproportionately impact environmental justice communities.

Under Alternative 3, hatchery programs would be operated at levels similar to those under Alternative 1 until the dams have been removed, sediment levels have returned to pre-dam removal levels, and salmon and steelhead have exhibited some natural productivity. The hatchery programs would be terminated near the end of the preservation phase, and it would be expected that the last hatchery-origin fish would be released in approximately 2019. There would be a 5-year moratorium on salmon and steelhead fishing until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. Because hatchery-origin steelhead would stop returning to the Elwha River in approximately 2021, the steelhead fishery would only be ramped up to target 200 to 300 hatchery-origin steelhead for one year, and only if natural-origin steelhead abundance that year is projected to exceed 500 fish.

Therefore, in the short term, there would be no expected impacts on environmental justice communities relative to Alternative 1. However, in the long term (i.e., after the hatchery programs are terminated), the following ecological, cultural, human health, economic, or social impacts on environmental justice communities would be expected:

- A small increase in the amount of surface and ground water that would be available to environmental justice communities relative to Alternative 1 (Subsection 4.2, Water Quantity)
- A loss of $1.65 million through the local procurement of goods and services and the loss of 14 full-time jobs in environmental justice communities relative to Alternative 1 (Subsection 4.7, Socioeconomics)
- Additional fishing and cultural benefits to the Lower Elwha Klallam Tribe from implementation of steelhead fisheries relative to Alternative 1 (Subsection 4.8, Cultural Resources)
- A reduction in the potential nutritional benefits of the hatchery programs to human health within environmental justice communities relative to Alternative 1 (Subsection 4.9, Human Health and Safety)
- A reduction in the risk of consumer exposure to toxic contaminants relative to Alternative 1 (Subsection 4.9, Human Health and Safety)

There would be no change in long-term *potential* for fisheries to contribute substantially to personal income within environmental justice communities under Alternative 3 relative to Alternative 1. This is because salmon and steelhead stocks would be expected to rebound to harvestable numbers under both alternatives, but it would be expected to take salmon and steelhead a much longer time, possibly decades, to reach harvestable numbers under Alternative 3 relative to Alternative 1. For tribal fisheries in usual and accustomed areas in the Strait of Juan de Fuca, the slower increase in abundance of Elwha River salmon and steelhead under Alternative 3 relative to Alternative 1 would not be discernible outside of near-shore marine areas, because the hatcheries would not be expected to contribute substantially to the total number of harvestable fish in those areas. This delay would also delay attainment of $3.5 million annually in *potential* net economic benefits to environmental justice communities relative to Alternative 1 (Subsection 4.7, Socioeconomics).

4.10.4. Alternative 4 (No Hatchery Programs in the Elwha River) --- Make a Determination that the Submitted HGMPs and Tribal Harvest Plan do Not Meet the Requirements of the 4(d) Rule

In the analysis area, one county (Clallam County) and one Native American Tribe (Lower Elwha Klallam Tribe) have been identified as environmental justice communities of concern (Subsection 3.8, Environmental Justice). There are no other communities in the analysis area, so all effects under Alternative 4 described in Subsections 4.2 (Water Quantity) through Subsection 4.9 (Cultural Resources) would disproportionately impact environmental justice communities.

Under Alternative 4, the Elwha River hatchery programs would be terminated. The following

ecological, cultural, human health, economic, or social impacts on environmental justice communities would be expected in both the short and long term:

- A small increase in the amount of surface and ground water that would be available to environmental justice communities relative to Alternative 1 (Subsection 4.2, Water Quantity)
- A loss of $1.65 million through the local procurement of goods and services and the loss of 14 full-time jobs in environmental justice communities relative to Alternative 1 , including the loss of four full-time jobs for Lower Elwha Klallam Tribal members from the Lower Elwha Hatchery (Subsection 4.7, Socioeconomics)
- A loss of $3.5 million annually in *potential* net economic benefits to environmental justice communities relative to Alternative 1 (Subsection 4.7, Socioeconomics)
- A reduction in the Tribe's access to salmon and steelhead for ceremonial and other cultural practices relative to Alternative 1 (Subsection 4.8, Cultural Resources)
- A reduction in the potential nutritional benefits of the hatchery programs to human health within environmental justice communities relative to Alternative 1 (Subsection 4.9, Human Health and Safety)
- A reduction in the risk of consumer exposure to toxic contaminants relative to Alternative 1 (Subsection 4.9, Human Health and Safety)
- A small reduction in the number of harvestable salmon and steelhead in the tribal fisheries in usual and accustomed areas in the Strait of Juan de Fuca relative to Alternative 1 (Subsection 4.10, Environmental Justice)

Alternative 4 would reduce population abundance of salmon and steelhead relative to Alternative 1, placing the Elwha River populations at increased risk of extirpation. There would be a reduced long-term potential for fisheries to contribute substantially to personal income within environmental justice communities under Alternative 4 relative to Alternative 1. For tribal fisheries in usual and accustomed areas in the Strait of Juan de Fuca, the potential extirpation of Elwha River salmon and steelhead would not have a discernable effect on fisheries outside of near-shore marine areas, because the Elwha River populations do not contribute substantially to the total number of harvestable fish in those areas.

4.10.5. Alternative 5 (Hatchery Programs with Decreased Production Levels) –Make a Determination that Revised HGMPs with Decreased Production Levels and the Tribal Harvest Plan Meet the Requirements of the 4(d) Rule

In the analysis area, one county (Clallam County) and one Native American Tribe (Lower Elwha Klallam Tribe) have been identified as environmental justice communities of concern

(Subsection 3.8, Environmental Justice). There are no other communities in the analysis area, so all effects under Alternative 3 described in Subsections 4.2 (Water Quantity) through Subsection 4.9 (Cultural Resources) would disproportionately impact environmental justice communities.

Under Alternative 5, hatchery programs would be operated at reduced levels relative to Alternative 1. There would be a 5-year moratorium on salmon and steelhead fishing until 2018. At that point, the Tribe would initiate a small (less than 50 hatchery-origin steelhead) ceremonial and subsistence fishery on hatchery-origin fish if the natural-origin steelhead abundance is projected to exceed 300 fish. However, under Alternative 5, there would be less certainty that natural-origin steelhead abundance would increase above current, extremely low levels for many years. Given current average natural-origin adult steelhead return levels averaging under 150 fish (Subsection 3.4 Salmon and Steelhead), and the uncertain term for the restoration of lower river and estuarine areas critical to steelhead survival and productivity to a healthy status, abundances would not likely exceed 300 natural-origin steelhead in the short term. Under Alternative 5, there would, therefore, be a decreased likelihood, relative to Alternative 1, of implementation of a tribal ceremonial and subsistence fishery for steelhead in the short term.

Under Alternative 5, the following ecological, cultural, human health, economic, or social impacts on environmental justice communities would be expected:

- A small increase in the amount of surface and ground water that would be available to environmental justice communities relative to Alternative 1 (Subsection 4.2, Water Quantity)
- A decrease in economic benefits of $1.65 million estimated to accrue under Alternative 1 through reduced local procurement of goods and services, and the loss of a proportion of the 14 full-time jobs in environmental justice communities relative to Alternative 1 (Subsection 4.7, Socioeconomics)
- Reductions in fishing and cultural benefits to the Lower Elwha Klallam Tribe from the reduced likelihood for implementation of steelhead fisheries relative to Alternative 1 (Subsection 4.8, Cultural Resources)
- A reduction in the potential nutritional benefits of the hatchery programs to human health within environmental justice communities relative to Alternative 1 (Subsection 4.9, Human Health and Safety)
- A reduction in the risk of consumer exposure to toxic contaminants relative to Alternative 1 (Subsection 4.9, Human Health and Safety)

CUMULATIVE IMPACTS

4.11. Introduction

This section discusses the impact on the environment that 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. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7). The purpose of this assessment is to describe the additional impact of the hatchery programs in light of all the other impacts on ESA-listed fish and their habitats.

Chapter 3, Affected Environment describes baseline conditions, which reflect the effects of past and existing actions (including hydropower, habitat loss, harvest, and hatchery production). Chapter 4, Environmental Consequences, evaluates the direct and indirect effects of the Proposed Action on baseline conditions. Chapter 4 evaluates the effects of the Proposed Action in the context of changes that are expected in the Elwha River Basin as a result of the removal of the Elwha and Glines Canyon Dams. Chapter 5, Cumulative Effects, now considers any additional, incremental, cumulative impacts that may result from past, present, and reasonably foreseeable future actions and conditions within the vicinity of the action area.

4.12. Other Programs, Plans, and Policies

Other actions are expected to occur within the action area, the Puget Sound, or in the Pacific Ocean that would affect the fish populations considered under the Proposed Action. These include fishing activities that may incidentally intercept Elwha River salmon and steelhead in the Pacific Ocean and habitat restoration actions identified under the Monitoring and Adaptive Management Plan for the Elwha Restoration Project (Subsection 1.5, Relationship to Other Plans, Regulations, Agreements, Laws, Secretarial Orders, and Executive Orders).

All future actions would be managed based on the impacts on ESA-listed salmon and steelhead. If the cumulative effects of other hatchery programs, fisheries, ocean conditions, or conservation efforts do not allow sufficient escapement of returning adult salmon and steelhead to the action area to meet recovery goals while providing for the operation of the proposed hatchery programs, adjustments to fisheries and to the hatchery production levels and management actions would likely be proposed.

If the cumulative effects of salmon management efforts fail to provide for recovery of listed species, then any adverse impacts due to the hatchery programs and any fishing in the action area may be substantially diminished. Management of the hatchery programs and of fishing opportunity is only one element of a large suite of regulations and environmental factors that may influence the overall health of listed salmon and steelhead populations and their habitat. The proposed hatchery programs are coordinated with monitoring so that hatchery managers can respond to changes in the status of affected listed species. Monitoring and adaptive management would help ensure that the affected ESA-listed species are adequately protected and would help mitigate potential for adverse cumulative impacts. Finally, the presence of hatchery-origin fish, like natural-origin fish, within the Olympic Wilderness Area is compatible with Wilderness Act policy.

4.13. Climate Change

The climate is changing in the Pacific Northwest due to human activities that increase greenhouse gasses in the atmosphere, and this is affecting hydrologic patterns and water temperatures. Regionally averaged air temperature rose about 1.5°F over the past century (with some areas experiencing increases up to 4°F) and is projected to increase another 3°F to 10°F during this century. Increases in winter precipitation and decreases in summer precipitation are projected by many climate models, although these projections are less certain than those for temperature (USGCRP 2009).

Higher temperatures in the cool season (October through March) are likely to increase the percentage of precipitation falling as rain rather than snow, and to contribute to earlier snowmelt. The amount of snowpack measured on April 1, a key indicator of natural water storage available for the warm season, has already declined substantially throughout the region. The average decline in the Cascade Mountains, for example, was about 25 percent over the past 40 to 70 years, with most of this due to the 2.5°F increase in cool season temperatures over that period. Further declines in Northwest snowpack are likely due to additional warming this century, varying with latitude, elevation, and proximity to the coast. April 1 snowpack is likely to decline as much as 40 percent in the Cascades by the 2040s (USGCRP 2009).

High and base stream flows are likely to change with warming. Increasing winter rainfall is likely to increase winter flooding in some areas. Earlier snowmelt, and increased evaporation and water loss from vegetation, will increase stream flows during the warm season (April through September). In some sensitive watersheds, both increased flood risk in winter and increased drought risk in summer are likely due to warming of the climate (USGCRP 2009).

In areas where it snows, a warmer climate means major changes in the timing of runoff: increased stream flows during winter and early spring, and decreases in late spring, summer, and fall. Flow timing has shifted over the past 50 years, with the peak of spring runoff shifting from a few days earlier in some places to as much as 25 to 30 days earlier in others. This trend is likely to continue, with runoff shifting 20 to 40 days earlier within this century. Major shifts in the timing of runoff are not likely in areas dominated by rain rather than snow (ISAB 2007; USGCRP 2009).

Fish habitat changes due to climate change are likely to create a variety of challenges for ESA-listed species of fish. Higher winter stream flows can scour streambeds, damaging spawning redds and washing away incubating eggs (USGCRP 2009). Earlier peak stream flows could flush young salmon and steelhead from rivers to estuaries before they are physically mature enough for the transition, increasing a variety of stresses and the risk of predation (USGCRP 2009). Lower summer stream flows and warmer water temperatures will degrade summer rearing conditions in many parts of the Pacific Northwest for a variety of salmon and steelhead species (USGCRP 2009), and are likely to reduce the survival of steelhead fry in streams with incubation in early summer. Other likely effects include alterations to migration patterns, accelerated embryo development, premature emergence of fry, and increased competition and predation risk from warm-water, non-native species (ISAB 2007). The increased prevalence and virulence of diseases and parasites that tend to tend to flourish in warmer water will further stress salmon and steelhead (USGCRP 2009). Overall, about one-third of the current habitat for the Pacific Northwest's coldwater fish may well no longer be suitable for them by the end of this century as key temperature thresholds are exceeded (USGCRP 2009).

Climate change is also likely to affect conditions in the Pacific Ocean. Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances (USGCRP 2009). It is likely that, as ocean conditions change, abundances of salmon and steelhead will continue to change accordingly, resulting in changes in abundance of adults returning to freshwater to spawn.

In the Elwha River Basin, impacts from climate change may be similar to those described above. The Elwha River is fed largely by glaciers and snow melt; if climate change reduces the average snow pack, then reductions in summer-time flows would result, which may reduce the suitable habitat for salmon and steelhead yearling rearing, decreasing their abundance. Climate change may also increase the frequency of major flood events that can scour redds. Lower summer flows due to a reduced winter snow pack may increase water temperatures, which may lead to an

increase in the abundance of non-native warm water species that can compete with and prey on listed salmon and steelhead. Warmer water temperatures may also increase the incidence of disease outbreaks and virulence in both the natural-origin and hatchery-origin juveniles.

If climate change contributes to a substantial decline in the abundance of listed salmon and steelhead populations in the Elwha River Basin through impacts on habitat and from changes in ocean conditions, the proposed hatchery programs may continue to be used as a "safety net" program to maintain genetic resources. The adult and earliest life stages of fish held in the proposed hatchery programs are somewhat protected from the possible increase in disease prevalence from warmer water temperatures because well water water is used during these periods and the fish are tested at spawning, during rearing, and prior to release to limit disease transmission to the natural-origin populations.

While climate change may well have impacts on the abundance and/or distribution of ESA-listed salmonids that are considered under the Proposed Action, the proposed hatchery management described in the HGMPs and the associated monitoring provide the ability to evaluate hatchery program risks and benefits as abundances change, making adjustments possible.

5. AGENCIES CONSULTED

Lower Elwha Klallam Tribe
Washington Department of Fish and Wildlife
Northwest Indian Fisheries Commission

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