U.S. Fish & Wildlife Service - Pacific Region

Olympic Peninsula Hatchery Review Team

Olympic Peninsula

Big Quilcene, Quinault, Hoh, Sooes, and Waatch River Watersheds

Quilcene, Quinault, and Makah National Fish Hatcheries Assessments and Recommendations

Final Report

May 2009

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Long-term conservation needs of natural salmonid populations and their inherent genetic resources require a reexamination of the role of hatcheries in basin-wide management and conservation strategies. Hatcheries must be viewed as part of the environmental and ecological landscape to help achieve both conservation and harvest goals. These goals need to be part of a holistic and integrated strategy that also combines habitat, hydropower, and harvest needs for conserving and managing fishery resources. These strategies must establish short- and long-term goals for both hatchery-propagated and naturally-spawning populations.

To ensure that its hatchery programs are best meeting conservation and harvest goals, the US Fish and Wildlife Service (Service) began, in October 2005, a multi-year review of 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. This review was expanded in 2007 to include the three National Fish Hatcheries on Washington's Olympic Peninsula. The goal of this review is to ensure that Service hatcheries are operated in accordance with best scientific principles, and contribute to sustainable fisheries and the conservation of naturally-spawning populations of salmon, steelhead and other aquatic species. The Service's review process is modeled after the recent Puget Sound and Coastal Washington Hatchery Reform Project[1]. The Service plans to complete its reviews by early 2010.

The report presented here provides benefit/risk assessments and recommendations for salmon and steelhead propagation programs conducted at Quilcene, Makah, and Quinault National Fish Hatcheries. Quilcene National Fish Hatchery (NFH) is located on the Big Quilcene River along the western side of Hood Canal. Quinault NFH is located on Cook Creek within the Quinault River watershed along the southern coast of Washington's Olympic Peninsula, and Makah NFH is located on the Sooes River along the northern coast of the Peninsula.

The Review Team considered, as a foundation for its assessments, four characteristics of each salmonid stock in the Northern Hood Canal, Quinault River and Sooes River watersheds: *biological significance*, *population viability*, *habitat* conditions, and *harvest* goals. The Review Team attempted to use both short- (15 years) and long-term (50–75 years) goals for each salmonid stock, as identified by the fishery comanagers[2], as a foundation for assessing the benefits and risks of the Service's hatchery programs. Source documents not readily available to the general public, including appendices and background documents for this report, are accessible via the Service's hatchery review website.[3]

[1] *www.lltk.org/HRP.html*

[2] *Comanagers in the Hood Canal/Quilcene River watershed (Quilcene NFH) are the Skokomish Tribe, Washington Department of Fish and Wildlife, Point No Point Treaty Council, Jamestown S'kallam Tribe, Port Gamble S'Kallam Tribe, Lower Elwha Klallam Tribe, National Marine Fisheries Service (NOAA Fisheries), and the U.S. Fish and Wildlife Service. Comanagers in the Quinault River watershed (Quinault NFH) are the Quinault Indian Nation, Washington Department of Fish and Wildlife, National Marine Fisheries Service (NOAA Fisheries), and the U.S. Fish and Wildlife Service. Comanagers in the Sooes River watershed (Makah NFH) are the Makah Nation, Washington Department of Fish and Wildlife, National Marine Fisheries Service (NOAA Fisheries), and the U.S. Fish and Wildlife Service.*

[3] *www.fws.gov/Pacific/fisheries/HatcheryReview/*

Quilcene National Fish Hatchery

Facility Overview: The Quilcene NFH began operations in 1911 to support salmon fisheries on adjacent federal lands to mitigate for the reduced abundance of natural-origin fish resulting from degraded habitat. The NFH releases also serve to partially mitigate reduced abundance due to substantial ocean catch of species such as coho. The Quilcene NFH occupies approximately 47.4 acres at RM 2.8 of the Big Quilcene River. Facilities consist of 39 8-feet x 80-feet raceways, three water intake structures (two on the Big Quilcene River and one on Penny Creek), a pre-settling pond; a pollution abatement pond; a hatchery building that contains the office, laboratory, and tank room; an isolation/quarantine building; and a shop/garage. Adult salmon returning to the hatchery are diverted to holding facilities by means of a graduated-field electrical weir and fish ladder at RM 2.8. Quilcene NFH is one of the oldest fish hatcheries in the region.

Funding: The hatchery is funded by Congressional appropriation of hatchery operations funds to the Service and the Service's hatchery cyclical maintenance fund. The operational budget for FY2008 was $617,343. Costs for monitoring and evaluation (M&E) and fish health in FY2008 were approximately $100,000 and $91,000, respectively. Capital Improvements to the Quilcene NFH have totaled $907,797 during the period 2004- 2008.

Economic Benefit: The estimated total annual economic value of commercial and sport caught coho reared at Quilcene NFH is approximately $1,500,000.

Coho

Program overview: The coho program operates as a segregated harvest program within Quilcene Bay and the Big Quilcene River. This stock has been artificially propagated since 1911 and currently exhibits a mean adult return date that is approximately three weeks to one month earlier than other hatchery and natural stocks of coho salmon in Hood Canal. Although some historic egg transfers from out-of-basin stocks to Quilcene NFH occurred sporadically prior to 1974, the Quilcene NFH coho stock is believed to largely represent the ancestral lineage of coho salmon native to the Quilcene River, However, the stock has been propagated artificially for nearly 100 years (more than 30 coho generations), largely as a "closed" hatchery population. The hatchery currently releases 400,000 yearling smolts annually on-station. An additional 200,000 smolts are released from a floating net pen in Quilcene Bay (Skokomish Tribal program). Adult collection, egg incubation, hatching, and juvenile rearing occur on-station at the hatchery. The program also transfers 450,000 eyed eggs to George Adams Fish Hatchery for rearing and subsequent release at Port Gamble net pens.

Benefits: Coho from Quilcene NFH support commercial, tribal, and sport fisheries coast wide (Alaska, British Columbia, North Coast, Strait of Juan de Fuca), in the Big Quilcene River, Hood Canal, and Admiralty Inlet of Puget Sound. Tribal fisheries within Hood Canal and hatchery-trapped adult fish distributed to tribal members confer highly significant subsistence and commercial benefits to local tribes. For broods 1993-2002, on average approximately 16,500 coho were recovered annually from releases at Quilcene NFH including 3,100 in treaty tribal fisheries. For the same brood years, on average approximately 4,000 coho were recovered annually from releases at the Quilcene Bay net pen including 900 in treaty tribal fisheries. For these same brood years, on average approximately 5,900 coho were recovered annually from releases at Port Gamble net pens including 2,950 in tribal treaty fisheries.

Risks: Juvenile coho destined for acclimation and rearing in the Quilcene Bay net pens prior to release are often retained on station after the desired transfer date because of toxic algae blooms in Quilcene Bay. The retention of these latter fish on-station results in rearing densities that exceed fish health guidelines, thus increasing disease risks. Quilcene NFH coho pose some genetic risks to adjacent coho populations in Hood Canal due to limited straying of returning adults to other rivers in the immediate vicinity of the Big Quilcene River. The hatchery weir and adult fishway inhibit upstream migration of winter steelhead and other wild fish native to the Big Quilcene River. Nearshore marine fisheries targeting the earlier returning coho from Quilcene NFH poses an incidental harvest risk to ESA-listed summer chum salmon in Hood Canal.

Recommendations for current program: The Review Team identified 24 specific recommendations to reduce risks and/or improve benefits of the current coho program at Quilcene NFH. These recommendations include; (a) development of natural production and escapement goals for Big Quilcene River coho, (b) assessment of straying risk of coho released from Quilcene NFH and Quilcene Bay to natural populations of coho in northern Hood Canal, (c) assessment of water management practices at the hatchery to determine the maximum number of fish and biomass capacities of the hatchery that would not exceed water-right limitations, and (d) modification of weir and ladder configurations to improve upstream passage conditions for winter steelhead. The Team also recommends improved visitor facilities and outreach programs. This latter recommendation is especially timely because of the location of the hatchery immediately adjacent to a highway heavily travelled by tourists and the pending 100th Anniversary of the Quilcene NFH in 2011.

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing coho program ranging from the current program with full implementation of all program specific recommendations (Alternative 1) to termination of all programs at Quilcene NFH and decommissioning of the facility (Alternative 4). The Review Team recommends the implementation of Alternative 2: reduce the size of the current program from 600,000 to 400,000 smolts, or other size equivalent that does not exceed the Service's rearing density guidelines and water right restrictions for the hatchery. The combined effects of water right restrictions, the presence of *harmful algal blooms* (HAB) in Quilcene Bay, and the large numbers of surplus coho returning to the hatchery in recent years warrant reducing the number of smolts released from the hatchery and the Quilcene Bay net pen from a combined total of 600,000 to 400,000 smolts. Adopting this alternative would allow the hatchery to continue to contribute significantly to local tribal, sport and commercial fisheries and still operate within the biological and water-right constraints of the hatchery and the Big Quilcene River, respectively. This recommended alternative also allows more flexible management of the Quilcene Bay net pen. For example, if a HAB occurs, then all 400,000 coho could remain on-station without exceeding the water right restrictions. Conversely when HAB is not an issue, up to 200,000 pre-smolt coho could be transferred to and released from the net pen. This latter approach would reduce feed and workloads at the hatchery and could, under some circumstances, present opportunities for the hatchery to participate in conservation and recovery programs of other aquatic species in the Hood Canal area.

Steelhead

Program overview: The Hood Canal Steelhead Project is a multi-agency, collaborative study and rebuilding effort – led by NOAA Fisheries - that involves supplementing three natural populations (Skokomish River, Dewatto River, and Duckabush River) with hatchery-origin steelhead, and monitoring those three "treatment" populations with three "control" populations that receive no

hatchery fish. This project will attempt to amplify the abundance of naturally spawning steelhead for approximately eight years, after supplementation will be terminated and returns of natural-origin adults monitored in treatment streams compared to control streams. For this project, eyed eggs are pumped from natural redds in the three treatment streams. Eggs from the Dewatto and Duckabush rivers are transferred to Quilcene NFH for incubation and hatching. The hatchery incubates up to 18,000 natural-origin steelhead embryos annually in a quarantine facility until viral pathogen testing is complete (30 d post-ponding) and the embryos are certified as low risk for viruses. Incoming embryos currently represent five to twenty redds from each of two populations, Duckabush and Dewatto rivers). The fry are transferred to the Long Live the Kings Lilliwaup Hatchery, about 20 miles south of Quilcene NFH along the west side of Hood Canal, for rearing prior to release. Incubation and rearing for the Skokomish River population occurs at McKernan Hatchery.

Benefits: The project is expected to confer significant research benefits by evaluating the potential use of artificial rearing to assist with conservation of imperiled steelhead populations. The effectiveness of hatchery supplementation for increasing the productivity of natural populations while maintaining genetic diversity will be determined by comanager monitoring of the abundance and productivity of the treatment and control populations in subsequent generations after the programs have been terminated. In addition, steelhead incubation and early rearing at the Quilcene NFH is expected to provide a significant conservation benefit to *threatened* steelhead populations in the Dosewallips, Dewatto, and Skokomish rivers by reducing demographic risks to the natural populations. Based on a similar program in the Hamma Hamma River, the expectation is that the program will result in an approximate 10-fold increase in the number of natural redds in the supplemented treatment streams relative to the control streams.

Risks: The project poses some demographic risks to the natural populations in the treatment streams by removing eyed steelhead eggs and disrupting redds. The disruption of redds can lead to increased predation (e.g., by sculpins) and subsequent dislodging of incubating eggs and pre-emerging alevins during freshets following spring rains. However, this project attempts to mitigate those risks by avoiding excess egg collections and precise triangulation of each redd to minimize human impacts. A proportion of the collected embryos do need to be sacrificed for pathology testing to minimize disease risks and comply with disease management policies. Nonetheless, some increased mortality is assumed for eggs remaining in the redds, although the actual mortality associated with redd pumping to non-collected eggs is unknown. Disease risks associated with the program have also been minimized due to utilization of the existing quarantine/isolation building and subsequent testing of representative fry prior to transfer. Although precautions are in place, there is a slight risk of transferring pathogens and disease from the source drainages to Lilliwaup Creek. Genetic risks to the supplemented populations are considered minimal because of (a) the very restricted period under which hatchery-reared fish are under the potential influence of *domestication selection* and (b) the expected number of natural-origin parents contributing to the captively-reared fish relative to the total number of adult steelhead spawning in each treatment stream.

Recommendations for Current Program: The Team recommends that Quilcene NFH continues to support the Hood Canal Steelhead Project through completion of the supplementation phase (2014). The Team concluded that the overall risks of the program are minimal and that the potential benefits of the program far outweigh those risks. This program is considered critically important to the success of the Hood Canal Steelhead Project.

Alternatives to Current Program: The Review Team considered the pros and cons of five alternatives to the existing steelhead incubation program. These alternatives ranged from maintaining the current level of support to termination of the steelhead incubation and early rearing program. Maintaining the current program requires no major modifications, only small adjustments to current practices and facilities. In the near term, the Team recommends expanding the existing program by developing the capability for Quilcene NFH to rear Hood Canal steelhead beyond the early rearing stage (Alternative 2). This capability would provide for complete implementation of the Hood Canal Steelhead Project by rearing 400 adult steelhead or rearing approximately 8,000 smolts, depending which of four rearing scenarios are chosen. To implement this recommended alternative, the team supports the following upgrades to the Quilcene NFH: 1) prioritizing water use from Penny Creek or adding some type of disinfection unit for Quilcene River water; 2) dedicating rearing containers in a secure area to provide isolation from the rest of the hatchery and adequate biosecurity, including disinfection of effluent; and 3) obtaining an exemption from *The Salmonid Disease Control Policy of the Fisheries Comanagers of Washington State* for a reduced virus testing level because of the ESA-listed status of the stocks and small size of the program. Maintaining the current program (Alternative 1) requires no major modifications, only small adjustments to current practices and facilities. Two longer-term alternatives would expand the capabilities of the Quilcene NFH to contribute to culture-based rebuilding efforts for Quilcene River steelhead (Alternative 3) or other Hood Canal salmon populations (Alternative 4).

Quinault National Fish Hatchery

Facility Overview: The Quinault NFH began operations in 1968 to support salmon and steelhead fisheries on the Quinault Indian Reservation and adjacent federal lands to mitigate for the reduced abundance of natural-origin fish resulting from degraded habitat. The NFH releases also serve to partially mitigate reduced abundance due to substantial ocean catch of species such as coho and fall Chinook. The main facilities of Quinault NFH consist of 36, 16x80-foot raceways, two water re-use pumps, a pollution abatement pond, and three surface water intake structures. The main intake structure is located on Cook Creek, and a smaller one is located on Hatchery Creek. A third intake structure siphons water from a large natural pond and springs (Duck Pond) adjacent to the Moclips Highway, approximately two miles northeast of the facility. The hatchery diverts returning adult salmon to on-station holding facilities by means of an electric fish barrier and ladder. Hatchery operations are coordinated with the Quinault Indian Nation via a Cooperative Agreement.

Funding: The hatchery is funded by Congressional appropriation of hatchery operations funds to the Service and the Service's hatchery cyclical maintenance fund. The operational budget for FY2008 was $798,251. Costs for monitoring and evaluation (M&E) and fish health in FY2008 were approximately $235,000 and $115,000, respectively. Capital Improvements to the Quinault NFH have totaled $1,586,167 during the period 2004-2008.

Economic benefit: The total economic net benefit of Quinault NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $3.3 million annually. The hatchery fish from the Quinault River that are commercially caught in the tribal fishery are being processed and marketed commercially by Quinault Tribal Enterprises under the "Quinault Pride" label.

Steelhead (Cook Creek, Quinault River program)

Program overview: The current steelhead hatchery stock was founded from natural-origin adults captured in the lower portion of the Quinault River watershed downstream from Lake Quinault. The stock is comprised of early returning adults, a result of hatchery practices that continuously selected for the early portion of the steelhead run while the hatchery stock was being established. The hatchery currently rears 190,000 winter steelhead smolts for release into Cook Creek. The purpose of the program is to mitigate for reduced tribal and sport fishery opportunities in the Quinault River and Cook Creek where abundance of natural-origin adult recruits has declined due to degraded habitat. The program also releases 20,500 steelhead fry into Cook Creek upstream of the hatchery to mitigate for the loss of natural reproduction associated with precluding adult salmon and steelhead from the vicinity of the water intake structure.

Benefits: The location of the hatchery on tribal lands provides significant economic, educational and cultural benefit to the Quinault Indian Nation. In addition, surplus hatchery-origin fish trapped at the hatchery are provided to tribal members for subsistence use. For broods 1993-2002, approximately 3,700 steelhead were recovered annually including 1,300 in treaty tribal fisheries.

Risks: Incidental passage of adult steelhead upstream of the weir on Cook Creek into the hatchery's water source (e.g., due to weir malfunction or high stream flows) poses a disease transmission risk to fish reared on station. Of special concern is the *Infectious Hematopoietic Necrosis* (IHN) virus. The operation of an electric weir in an area where tribal and sport fishing occurs poses a human safety risk because of the tendency of fishers to overlook signage and safety warnings. The segregated steelhead hatchery program poses an unknown genetic risk to natural populations of steelhead in the Quinault River basin due to potential straying and the domestication effects of artificial propagation. Available information indicates high homing fidelity of fish reared and released on-station. Information regarding the incidence of hatchery-origin steelhead in natural spawning areas of the watershed is lacking.

Recommendations for current program: The Review Team identified 31 specific recommendations to reduce risks and/or improve benefits of the current steelhead program at Quinault NFH. These recommendations include: (a) assess distribution and abundance of naturally spawning steelhead in the lower Quinault River Basin and assess the extent of straying of Quinault NFH steelhead that occurs in the lower Quinault River basin; (b) re-implement mass marking of steelhead released on-station at Quinault NFH; (c) reduce disease risks to steelhead reared on station by either disinfecting the water supply (e.g. UV or ozone treatment) and/or reconfiguring the existing water supplies so that Duck Pond and Hatchery Creek can be used for rearing steelhead; and (d) discontinue all steelhead fry outplants.

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing steelhead program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Quinault NFH and decommissioning of the facility (Alternative 4). The Review Team recommends the implementation of Alternative 1: continuation of the current program with full implementation of all program-specific recommendations.

Steelhead (Hoh River program)

Program overview The Quinault NFH was originally established to restore fisheries to the Quinault Reservation and to adjacent federal lands. As part of this commitment, the Service initiated a program in the mid-1980's to transfer pre-smolt steelhead from Quinault NFH to the

Hoh Indian Reservation for a smolt release into the Hoh River in support of tribal and recreational fisheries. At the present time, 50,000 steelhead smolts are reared at Quinault NFH for direct release into the Hoh River at *Allen's Bar* (river mile 15). In addition, 50,000 pre-smolts are transferred to the Hoh Tribe for subsequent rearing, imprinting, and release as smolts from Chalaat Creek hatchery (near the mouth of the Hoh River). Hatchery-origin steelhead returning to Quinault NFH provide broodstock for this program. No fish are collected for broodstock in the Hoh River. All steelhead released into the Hoh River receive an adipose fin clip.

Benefits: The program confers significant sport and tribal harvest benefits in the Hoh River. From return years 1990-2007, approximately 2,110 Quinault NFH steelhead were recovered in the Hoh River annually. Of this an average of 1,492 were harvested in tribal fisheries and 618 in sport fisheries. The program provides important economic, social, and cultural benefits to the Hoh Tribe.

Risks: The annual transfer and release of 100,000 Quinault NFH steelhead smolts into the Hoh River poses fish health risks to natural fish populations in the Hoh River. The annual transfer and release of Quinault NFH steelhead into the Hoh River also poses competition and genetic risks to native populations of steelhead in the Hoh River. These genetic and ecological risks are especially acute from hatchery-origin fish that may residualize in the Hoh River. No terminal recovery facilities currently exist for trapping Quinault NFH steelhead returning to the Hoh River. The continued release of out-of-basin steelhead into the Hoh River also poses ecological risks to other native aquatic species.

Recommendations for current program: The Review Team identified 10 specific recommendations to reduce risks and/or improve benefits of the current Hoh River steelhead program. These recommendations include: (a) discontinue the direct outplanting of 50,000 smolts at Allen's Bar; (b) assess the feasibility of capturing returning adult hatchery steelhead at Chalaat Creek or at an alternate lower Hoh River site, (c) assist the Hoh Tribe with the purchase and installation of bird netting over the Chalaat Creek pond (d) work with the Hoh Tribe, WDFW, and the National Park Service to conduct spawning ground surveys and smolt trapping studies to estimate the productivity of naturally spawning populations in the Hoh River, and (e) provide or assist with a training internship for a Hoh Tribal staff member at Quinault NFH or other appropriate facility.

Alternatives to Current Program: The Review Team considered the pros and cons of six alternatives to the existing Hoh steelhead program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of the steelhead hatchery program and managing the Hoh River for natural production only (Alternative 6). The Review Team recommends implementation of Alternative 1 for the next five years while the Service works with tribal and state comanagers to develop a long-term steelhead management strategy for the Hoh River. Development of a segregated, locally-adapted steelhead hatchery stock derived annually from adult returns to the Hoh River may be feasible in the lower river area (Alternative 4). An integrated program derived from natural-origin steelhead returning to the Hoh River may also be feasible (Alternative 5). In the long-term, the Team concluded that the Hoh River may present the capability and somewhat rare opportunity to meet tribal fishery needs strictly under a natural populations management strategy as habitats continue to improve and recover from past land-use practices.

Coho

Program overview: The Quinault NFH coho program is a segregated hatchery program intended to provide fish for harvest. The program is intended to support marine and freshwater fisheries to mitigate for degraded habitat and reduced abundance of natural-origin coho in the Quinault River. The hatchery currently releases 660,000 yearling coho salmon into Cook Creek. An additional 143,000 fry are released upstream of the hatchery into Cook Creek. The original broodstock was founded from natural-origin coho trapped in Cook Creek. Since 1983, all broodstock have been derived from hatchery-origin fish returning to the hatchery.

Benefits: The coho program supports commercial, tribal and sport fisheries in both marine and freshwater areas. In addition, surplus hatchery-origin fish trapped at the hatchery are provided to members of the Quinault Indian Nation for subsistence use. For broods 1993-2002, on average approximately 14,000 coho were recovered annually including 6,800 in treaty tribal fisheries.

Risks: Coho released from Quinault NFH pose some genetic and ecological risks to natural populations of coho in the Quinault River basin. Coho released as fry are known to compete with, and displace, natural-origin young-of-the-year coho in the preferred rearing habitat of juveniles (deep pools in nursery streams). The release of fry thus poses additional ecological risks to natural populations of coho. The use of surface water at the hatchery increases disease risks to fish reared on station. Lack of shade covers over the raceways concentrates fish in shaded areas along pond walls, increasing effective rearing densities, potential stress, and disease risks.

Recommendations for Current Program: The Review Team identified six specific recommendations to reduce risks and/or improve benefits of the current coho program at Quinault NFH. These recommendations include: (a) assess distribution and abundance of naturally spawning coho in the lower Quinault River basin and assess the extent that returning hatchery-origin adults stray in the lower Quinault River basin; (b) discontinue all fry outplants; and (c) continue to investigate and implement methods to maximize green-to-eyed-egg survivals on a consistent basis.

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing coho program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Quinault NFH and decommissioning of the facility (Alternative 4). The Review Team recommends the implementation of Alternative 1: continuation of the current program with implementation of all recommendations.

Fall Chinook

Program overview: The Quinault NFH fall Chinook program is a segregated hatchery program intended to provide fish for harvest. The program began in 1968 to mitigate for declines in the abundance of natural-origin fish resulting from degraded habitat. Initial broodstock sources included natural-origin Chinook from the Quinault River and eggs or fish from other hatchery stocks of Chinook from the Washington coast and Puget Sound. No imports of eggs or fish from outside the Quinault River basin have occurred since 1985. Stated goals of the program were to enhance and restore coastal fisheries, especially those conducted by the Quinault Indian Nation. The program is currently designed to rear 600,000 fall Chinook smolts for release into Cook Creek. Most of the eggs for this program are currently taken from adults returning to the Lake Quinault Pen Rearing facility (Quinault Indian Nation) because of poor adult returns back to Cook Creek and Quinault NFH.

Benefits: The program supports marine and freshwater sport and tribal fisheries. In addition, surplus hatchery-origin fish trapped at the hatchery are provided to members of the Quinault Indian Nation for subsistence use. For brood years 1993-2002, an average of 1,150 hatchery origin fall Chinook were recovered annually including 575 in treaty tribal fisheries.

Risks: The apparent lack of cross-breeding between adults trapped at Quinault NFH and adults trapped at the Lake Quinault Pen Rearing facility may be posing a genetic risk to the hatchery stock by reducing the genetic effective size of the population and inhibiting maximization of local adaptations. High stray rates of returning hatchery-origin fall Chinook from Quinault NFH into natural spawning areas of the Quinault River pose a genetic risk to natural populations in the Quinault River. Predator exclusion and control devices at the hatchery are inadequate, increasing the risk of horizontal disease transmission into the hatchery from outside the hatchery and between ponds within the hatchery.

Recommendations for Current Program: The Review Team identified six specific recommendations to reduce risks and/or improve benefits of the current fall Chinook program at Quinault NFH. These recommendations include: (a) develop future fall Chinook broodstock management strategies consistent with genetic guidelines for managing hatchery-origin fall Chinook in the Quinault River as a properly integrated population that is derived from the natural population in the lower Quinault River,; and (b) adjust species composition and program sizes at Quinault NFH to achieve desired survival and return rates for the Quinault NFH fall Chinook program

Alternatives to Current Program: The Review Team considered the pros and cons of five alternatives to the existing fall Chinook program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Quinault NFH and decommissioning of the facility (Alternative 5). The Review Team recommends the implementation of Alternative 2, transfer the rearing of all fall Chinook to the Lake Quinault Pen Rearing facility (subject to agreement with tribal comanager).

Chum

Program overview: The Quinault NFH fall Chum program is a segregated hatchery program intended to provide fish for harvest. The program is intended to mitigate for declines in the abundance of natural-origin chum resulting from degraded habitat. Initial broodstock sources for the program included other hatchery stocks in Washington State and returning adults back to Quinault NFH. Imports of eggs from stocks outside the basin ended in approximately 1985. Most of the eggs for this program are currently taken from adults returning to the hatchery. Stated goals were to enhance and restore coastal fisheries, especially those conducted by the Quinault Indian Nation. The hatchery program is currently designed to rear 1.5 million subyearling chum smolts for release into Cook Creek.

Benefits: The average annual harvest of hatchery and naturally produced Quinault River chum from 1996 to 2005 was 1,995 fish. The proportion of the total harvest contributed by hatchery-origin fish is unknown.

Risks: Potential mass spawning of hatchery-origin chum in the Quinault River poses a genetic risk to the natural population. The smoltification and outmigration of chum salmon fry within a few weeks after hatching essentially precludes the marking or tagging of fish prior to release. The

inability to distinguish hatchery and natural origin adult chum increases demographic risks to the naturally spawning population resulting from potential over-harvest in the Quinault River.

Recommendations for Current Program: The Review Team identified six specific recommendations to reduce risks and/or improve benefits of the current chum salmon program at Quinault NFH. These recommendations include: (a) the application of otolith marks to hatchery-origin chum prior to release to allow assessments of natural spawning stray rates and identification of hatchery and natural-origin chum during or after broodstock selection and spawning, (b) determine an appropriate future broodstock management strategy (e.g., *segregated* vs. *integrated*), and (c) evaluate new methods of trapping and collecting chum adults for broodstock.

Alternatives to Current Program: The Review Team considered the pros and cons of three alternatives to the existing chum program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Quinault NFH and decommissioning of the facility (Alternative 4). The Review Team recommends the implementation of Alternative 1 but also concludes that Alternative 2 - increase the size of the program from 1.5 to 3.0 million subyearling smolts - would most likely increase benefits without increasing risks if an alternative broodstock collection site can be developed.

Makah National Fish Hatchery

Facility Overview: The Makah NFH began operations in 1981 to support salmon and steelhead fisheries on the Makah Indian Reservation and adjacent federal lands to mitigate for the reduced abundance of natural-origin fish resulting from degraded habitat. The NFH releases also serve to partially mitigate reduced abundance due to substantial ocean catch of species such as coho and fall Chinook. The Makah NFH is located within the Makah Indian Reservation, approximately 8 miles southwest of the town of Neah Bay, Washington, on the northwest tip of the Olympic Peninsula. The hatchery is located at river mile 3 of the Sooes River. Its main facilities consist of 29,11 x 80-foot raceways, four 4 x 40-foot raceways, a pump house building, and a two-story hatchery building. A satellite acclimation and release facility is present on Educket Creek and is operated by the Makah Nation for release of hatchery-origin fish into the Waatch River. Service operation of the Makah NFH is coordinated with the Makah Nation.

Funding: The hatchery is funded by Congressional appropriation of hatchery operations funds to the Service and the Service's hatchery cyclical maintenance fund. The operational budget for FY2008 was $743,859. Costs for monitoring and evaluation (M&E) and fish health in FY2008 were approximately $340,000 and $115,000, respectively. Capital Improvements to the Makah NFH have totaled $2,512,120 during the period 2004-2008.

Economic Benefit: The overall total economic net benefit of Makah NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $1.2 million annually.

Fall Chinook

Program overview: The Makah NFH fall Chinook program is an integrated hatchery program intended to provide fish for harvest and to maintain the fall Chinook run in the Sooes River. A variety of fall Chinook stocks were introduced into the Sooes River prior to the construction of the hatchery in 1981. Since the construction of the hatchery, only fall Chinook returning to the Sooes River have been used as broodstock for the Makah NFH fall Chinook program. The hatchery

currently produces 2.2 million Chinook smolts for release into the Sooes River at the hatchery and produces 100,000 smolts for transfer and subsequent release at the Educket Creek acclimation facility (Waatch River). Fish not otherwise coded-wire tagged are all given adipose-fin clips for release in both the Sooes River and Educket Creek.

Benefits: The hatchery fall Chinook program confers significant sport, tribal, and commercial harvest benefits as well as fish for tribal subsistence and ceremonial use by the Makah Nation. Based on coded-wire tag data, for brood years 1993-2002, on average approximately 4,400 fall Chinook were recovered annually including 250 in treaty tribal fisheries.

Risks: The hatchery program poses a genetic domestication risk to Sooes River fall Chinook – which conflicts with the conservation goal of the program - because neither the proportion of natural spawners composed of hatchery-origin fish (*pHOS*) nor the proportion of the broodstock composed of natural-origin fish (*pNOB*) are controlled or properly managed. Makah NFH is more susceptible to catastrophic loss than most other hatcheries due to the incidence of floods, frequent power outages, and potential tsunamis. Disease risks, low water flows, high water temperatures (during the summer) and dependence on mechanical devices (pumps, generators, sand filters, etc.) are more prevalent at Makah NH than most other hatcheries, further increasing the risk of catastrophic fish losses.

Recommendations for Current Program: The Review Team identified 19 specific recommendations to reduce risks and/or improve benefits of the current fall Chinook program at Makah NFH. These recommendations include: (a) in consultation with the Makah Nation, develop a natural escapement and hatchery broodstock management plan for the Sooes watershed based on the relative numbers of hatchery-origin and natural-origin fall Chinook intercepted at the hatchery, (b) install a tsunami warning system that can be heard throughout the facility and develop a tsunami evacuation plan, (c) develop a consistent and clearly defined M&E program and review on an annual basis, (d) conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Sooes and Waatch Rivers, and (e) work with the Makah Nation to develop a single cooperative agreement regarding program management which addresses fish production levels, marking, responsibilities of the parties, and communications.

Alternatives to Current Program: The Review Team considered the pros and cons of three alternatives to the existing fall Chinook program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Makah NFH and decommissioning of the facility (Alternative 5). The Review Team recommends the implementation of Alternative 1.

Coho

Program overview: The Makah NFH coho program is a intended to be a segregated hatchery program that provides fish for harvest. The coho program was initiated in 1982 with eggs obtained from the Quinault NFH. In the late 1980's two brood years of fish were replaced with fish from Quinault NFH after an outbreak of *Viral Hemorrhagic Septicemia* (VHS) virus required the euthanization of all fish at Makah NFH. The hatchery currently rears 200,000 coho smolts for release into the Sooes River at the hatchery and 40,000 smolts for transfer and subsequent release at the Educket Creek acclimation facility (Waatch River). Fish not otherwise coded-wire tagged are mass marked with adipose-fin clips for both the Sooes River release and Educket Creek transfer. Broodstock are collected from both hatchery-origin and natural-origin adults. Hatchery and natural origin adults not needed for broodstock are passed upstream to spawn naturally.

Benefits: The hatchery program confers significant sport, tribal, and commercial harvest benefits. In addition, surplus hatchery-origin fish trapped at the hatchery are provided to the Makah Nation for subsistence and ceremonial use. An estimated mean of 4,700 coho are caught annually in various fisheries based on coded-wire tag data for brood years 1993-2002. Nearshore and in-river fisheries are of particular economic, social, and cultural significance to the Makah Nation.

Risks: Passing an unknown number of hatchery versus natural-origin coho upstream poses genetic and ecological risks for maintaining a self-sustaining natural population in the watershed, although the current status and viability of the natural population is unknown Amplification of disease within the hatchery poses a disease risk, especially with the occurrence of *Furunculosis*, to fish populations in the Sooes River. Antibiotics used during coho rearing are discharged with hatchery effluent into the Sooes River and may contribute to development of drug-resistant pathogens that could impact fish, wildlife or humans.

Recommendations for Current Program: The Review Team identified seven specific recommendations to reduce risks and/or improve benefits of the current coho program at Makah NFH. These recommendations include: (a) evaluate the ability of the watershed to maintain a self-sustaining natural population of under current habitat and harvest conditions, (b) in consultation with the Makah Nation, develop a natural escapement and hatchery broodstock management plan for coho in the Sooes watershed, (c) discontinue coho fry outplants and (d) evaluate opportunities for chilling and/or disinfecting incoming water for use during summer months

Alternatives to Current Program: The Review Team considered the pros and cons of five alternatives to the existing coho program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Makah NFH and decommissioning of the facility (Alternative 5). The Review Team recommends implementation of Alternative 1.

Steelhead

Program overview: The Makah NFH winter steelhead program is a segregated hatchery program intended to provide fish for harvest. The steelhead program was started in 1983 with eggs from the Quinault NFH. Broodstock are collected from hatchery-origin adults returning to the hatchery. Operation of the weir for steelhead currently directs early-returning hatchery-origin fish into the facility but allows later-returning natural-origin fish to bypass the facility and swim upstream. In the late 1980's, two brood years of fish were replaced with fish from Quinault NFH after an outbreak of VHS virus required euthanization of all fish at Makah NFH. The hatchery currently rears 158,000 winter steelhead smolts for release into the Sooes River and 22,000 smolts for release at the Educket Creek acclimation facility (Waatch River). Currently no tags or fin clips are applied to either group of smolts.

Benefits: The program confers significant tribal and sport harvest benefits in the Sooes and Waatch Rivers. The mean annual harvest was 2,563 fish (range, 1,163-4,362 fish) based on catch records for the Sooes and Waatch Rivers, 1997– 2007. The average harvest in the Waatch River was 99 fish (range, 23-301 fish), 1997– 2007. The harvest is predominantly tribal. Spawned out fish used for broodstock and surplus adults trapped at the hatchery are provided to the Makah Nation for subsistence and ceremonial purposes.

Risks: Steelhead are particularly susceptible to domestication selection. Hatchery-origin steelhead reared at Makah NFH vary greatly in size at the time of release, and fish released below the target

size are expected to have a significantly lower return rate than larger fish. This differential survival exacerbates domestication effects, and reduces overall smolt-to-adult return rates, thereby affecting the total number fish available for broodstock and harvest. Rearing densities in the start tanks appear to exceed the maximum recommended density index guideline of 0.20 prior to transfer to outdoor raceways. Increased rearing densities increases disease risks, particularly for bacterial cold-water disease. Hatchery-origin steelhead migrating upstream after March 1 can pass upstream unimpeded when the electric weir is turned off, or during extreme flood conditions, thus posing an unquantified genetic risk to the natural population.

Recommendations for current program: The Review Team identified 16 specific recommendations to reduce risks and/or improve benefits of the current steelhead program at Makah NFH. These recommendations include: (a) mass mark all released steelhead annually to allow hatchery and natural-origin fish to be distinguished, in accordance with the Service's best management practices, (b) initiate a study to determine the current upstream migration timing of hatchery and natural-origin steelhead in the Sooes River, (c) reduce initial egg loading densities to the eggs from a maximum of two females per tray, or approximately 8,000 eggs per tray, (d) increase predator control measures in the outdoor raceways to reduce fish losses resulting from bird and mammal predation, (e) conduct genetic analyses of hatchery and natural-origin steelhead in the Sooes River, and (f) work with comanagers to develop a Washington State coast-wide monitoring and evaluation plan for a new emerging strain of the IHN virus.

Alternatives to Current Program: The Review Team considered the pros and cons of five alternatives to the existing steelhead program at Makah NFH ranging from the current program with full implementation of all program specific recommendations (Alternative 1) to termination of all programs at Makah NFH and decommissioning of the facility (Alternative 5). The Review Team recommends the implementation of Alternative 1.

Ozette Sockeye

Program overview: The Lake Ozette sockeye program is an integrated hatchery program intended to assist with the recovery of sockeye salmon in the Lake Ozette system. Lake Ozette sockeye were listed as a threatened species under the U.S. Endangered Species Act in 1999. The current hatchery supplementation program was initiated in 2000. An evaluation of the program is scheduled to occur 12 years (three sockeye generations) after initiation of the program. The evaluation will determine whether the program should be continued or terminated. Beginning in 2000, eggs were collected from adult sockeye trapped in tributaries to Lake Ozette, primarily Umbrella Creek. At the request of the Makah Nation, Makah NFH became involved in the Lake Ozette sockeye program in 2003. The Makah NFH Isolation/Quarantine facility was modified at that time for initial incubation of fertilized eggs to reduce the risk of egg losses that could occur at the Umbrella and Stony Creek remote sites. Unfertilized gametes are taken to Makah NFH, fertilized there, treated with disinfectant, and then incubated to the eyed stage in quarantine. The egg take goal is 305,000 unfertilized "green" eggs. Embryos are otolith-marked during egg incubation at Makah NFH. Eyed eggs are taken subsequently to Umbrella Creek (122,000 eyed eggs) and to Stony Creek Hatchery (183,000 eyed eggs). Release goals are 122,000 subyearling sockeye at 450 fish per pound into Umbrella Creek, and 91,500 subyearling sockeye at 900 fish per pound and 91,500 at 450 fish per pound into Stony Creek.

Benefits: The program provides a conservation benefit by reducing the demographic risk of extinction of Lake Ozette sockeye salmon. This program also provides a research benefit regarding the efficacy of hatchery supplementation to rebuild and/or reintroduce a natural,

tributary-spawning population of sockeye to an eventual level of self sustainability. The Proposed Recovery Plan (PRP) outlines numerous educational and outreach benefits regarding the recovery of Lake Ozette sockeye salmon.

Risks: The hatchery program poses a genetic risk to the population's spatial structure by potentially preventing distinct shoreline and tributary spawning populations from developing and evolving naturally. An inherent risk of domestication exists also. The program also poses demographic risks to the population by removing adults for broodstock and placing all their eggs in one quarantine facility. The risk of catastrophic loss of an entire brood year exists in the isolation incubation building, the staging facility, remote rearing sites, and during transport. Hatchery-reared sockeye may have greater vulnerability to predation than naturally-produced smolts.

Recommendations for Current Program: The Review Team identified one specific recommendation to reduce risks and/or improve benefits of the current Lake Ozette sockeye program at Makah NFH. This recommendation is to acquire a chilling unit to reduce the incubation water temperature to a safe range for thermal otolith marking

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing sockeye program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Makah NFH and decommissioning of the facility (Alternative 4). The Review Team recommends the implementation of Alternative 1 and to use the isolation quarantine facility to support conservation programs for other naturally spawning populations of salmonid fishes in the region (Alternative 2) as needed, consistent with the Ozette sockeye program.

Conclusions

The Team concluded that each of the three NFHs on the Olympic Peninsula is effectively performing its original intended function of providing fishing opportunities to partially replace the availability of natural-origin fish that were reduced or lost due to habitat degradation in the Olympic Peninsula region. Each of the three National Fish Hatcheries works closely with Native American Tribes in each region. Hatchery programs at Quilcene, Quinault, and Makah NFHs provide important economic, social, and cultural benefits to local tribal members. These latter benefits represent a very significant role for these facilities and should remain a Service priority. While the Team identified some ways in which the individual facilities can improve their success in providing fish for harvest, many of the Team's recommendations address conservation needs for naturally spawning populations in the respective watersheds and regions where each hatchery is located. The Team concluded that the current hatchery programs have overlooked some conservation needs for natural populations by focusing primarily on increasing harvest opportunities. In the long run, such an approach may reduce the viability of natural populations and affect future harvest opportunities on all fish.

Each of the three NFHs has isolation and early rearing capability for small conservation programs. The Service should actively seek opportunities to take advantage of those facilities by partnering with comanagers in developing and implementing new conservation/recovery programs where needed.

I. Introduction

In the past 150 years, habitat alterations, hydroelectric development and consumptive fisheries have affected the productivity, abundance, spatial distribution, and diversity of natural populations of salmon (*Oncorhynchus spp.)* and steelhead (*Oncorhynchus mykiss*) in the Pacific Northwest. To mitigate for those impacts, hatcheries have been used to increase the number of fish available for harvest. However, long-term conservation needs of natural salmonid populations and their inherent genetic resources now require a reexamination of the role of hatcheries in basin-wide management and conservation strategies.

Hatcheries need to be part of a holistic and integrated strategy that combines habitat, hydropower and harvest needs for conserving and managing fishery resources. These strategies must establish short- and long-term goals for both hatchery-propagated and naturally-spawning populations. However, modifying hatchery programs and operations to achieve both conservation and harvest goals in a coordinated manner is difficult and complex. Scientific uncertainties exist regarding the ability of hatcheries and hatchery-origin fish to directly assist with recovery of naturally-spawning populations while, at the same time, sustaining major fisheries. Uncertainties also exist regarding genetic and ecological interactions between natural- and hatchery-origin fish. Only an objective, collaborative, science-based approach can address these problems in a manner that is both scientifically defensible and accepted by the public.

In an effort to improve its hatchery programs and to ensure that existing facilities are best meeting conservation and harvest goals, the U.S. Fish and Wildlife Service (Service) initiated, in October 2005, a three-year review of 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. The goal of these reviews is to ensure that Service hatcheries are operated in accordance with best scientific principles, and contribute to sustainable fisheries and the recovery of naturally-spawning populations of salmon, steelhead and other aquatic species.

This internal review is modeled after the recent Puget Sound and Coastal Washington Hatchery Reform Project.[4] That project provided a solid template and operational tools (e.g. software spreadsheets, population dynamic models) for reviewing Service hatcheries in the Columbia River Basin. Much of the background information necessary for reviewing hatcheries in the Columbia River Basin has already been compiled in Hatchery and Genetic Management Plans (HGMPs),[5] Comprehensive Hatchery Management Plans (CHMPs),[6] and the Artificial Propagation Review and Evaluation (APRE)[7] database developed by the Northwest Power and Conservation Council (NWPCC).

Based on the recommendations of a Hatchery Review Working Group (Working Group),[8] the Assistant Regional Director for Fisheries (ARD) has assembled an Olympic Peninsula Hatchery

[4] *For more information on this project, and for all project publications, see www.hatcheryreform.org.*

[5] *For more information on HGMPs, visit www.nwr.noaa.gov/Salmon-Harvest-Hatcheries/Hatcheries/Hatchery-and-Genetic-Management-Plans.cfm.*

[6] *For more information on CHMPs, visit www.fws.gov/pacific/Fisheries/CHMP.htm.*

[7] *For more information on APRE, visit www.nwcouncil.org/fw/apre/.*

[8] *The Working Group was appointed in November 2004 by the Service's Assistant Regional Director for Fisheries, Pacific Region. The Working Group's report and all other Pacific Region Hatchery Review documents are available from the project's website, www.fws.gov/pacific/fisheries/hatcheryreview/.*

Review Team (Review Team). This Review Team, comprised of Service and other federal agency scientists, has adapted the Puget Sound and Coastal Washington Hatchery Scientific Review Group's (HSRG) scientific framework, principles and hatchery review tools and is applying them to create recommendations for each hatchery program and facility. The team provides continuity with the HSRG because the vice chair served on the HSRG, the chair served on the policy-makers' Hatchery Reform Coordinating Committee, and three other team members represented the Service at HSRG regional review meetings. The Service has contracted for project facilitation with Long Live the Kings (LLTK), a non-profit organization devoted to restoring wild salmon to the waters of the Pacific Northwest. LLTK provided facilitation, communications, and coordination for the Puget Sound and coastal Washington hatchery review process.

Review Team members include:

- **Douglas DeHart** (Chair), Senior Fishery Biologist, USFWS, Pacific Regional Office, Portland, Oregon.
- **Don Campton** (Vice Chair), Senior Scientist, USFWS, Abernathy Fish Technology Center, Longview, Washington.
- **Barry Berejikian**, Supervisory Fish Biologist, NOAA Fisheries, Manchester Research Station, Manchester, Washington.
- **Ray Brunson**, Fish Health Biologist, USFWS, Olympia Fish Health Center, Olympia, Washington.
- **Chris Pasley**, Project Leader and Manager, USFWS, Winthrop NFH, Winthrop, Washington.
- **Doug Olson**, Hatchery Assessment Team Leader, USFWS, Columbia River Fisheries Program Office, Vancouver, Washington.
- **Bruce Stewart**, Fish Health Program Manager, Northwest Indian Fisheries Commission, Olympia, Washington.
- **Larry Telles**, Project Leader and Manager, USFWS, Eagle Creek NFH, Estacada, Oregon.
- **Dave Zajac**, Fish and Wildlife Biologist, USFWS, Western Washington Fish and Wildlife Office, Lacey, Washington.

Team support members include:

- **Michael Schmidt** (Facilitator), Fish Program Coordinator, Long Live the Kings, Seattle, Washington.
- **Jed Moore**, Project Assistant, Long Live the Kings, Seattle, Washington.
- **Cheri Anderson** (Outreach), Information and Education Manager, USFWS, Spring Creek NFH, Underwood, Oregon.

The Fisheries ARD has also appointed a Hatchery Oversight Team (Oversight Team), consisting of line supervisors with policy and managerial responsibilities, as the Service's primary internal mechanism to oversee the review process, monitor its progress, and transmit communications and reports from the Review Team to the ARD and project leaders within the Service's Pacific Region Fisheries Program. The Oversight Team, along with the ARD, will be the primary contact group between the Service and its partners for developing mechanisms and policies for implementing, or modifying, the Review Team's recommendations.

The review process began in October 2005 with the Warm Springs National Fish Hatchery (NFH). This hatchery is located on the Warm Springs River, in the Deschutes River watershed/Columbia Plateau province, in Oregon. This review was conducted as a pilot to help the Service test and refine the review process. Fishery comanagers and stakeholders were involved in the review process and asked to comment on draft reports and recommendations. The final report for Warm Springs NFH was released in May 2006 (available at www.fws.gov/Pacific/fisheries/hatcheryreview/reports.html).

Following this pilot review, the Service adjusted the process for reviewing federal hatcheries in three regions: Mid-Columbia, Lower Columbia, and Lower Snake River (Fig. 1). Facilities in these regions include five NFHs in the Lower Columbia region (Eagle Creek, Carson, Little White Salmon, Willard, and Spring Creek NFHs); three NFHs in the Mid-Columbia region (Leavenworth, Entiat, and Winthrop NFHs); three NFHs in the Snake River region: (Dworshak, Kooskia, and Hagerman NFHs), and nine federally-owned hatcheries operated by the states of Washington, Oregon, or Idaho as part of the Lower Snake River Compensation Plan (LSRCP). The Service plans to complete reviews of all Columbia River National Fish Hatcheries by June 2009 and all federally owned facilities in the Snake River region by April 2010.

In 2007, Service managers asked the Hatchery Review Team to extend its review to include a re-assessment of the hatchery programs located at the three National Fish Hatcheries on the Olympic Peninsula: Quinault, Quilcene, and Makah NFHs. The Olympic Peninsula programs were previously reviewed by the Hatchery Scientific Review Group during the Puget Sound and Coastal Washington Hatchery Review. A second team was formed to complete this review, which began in April 2008. The Service plans to complete this review by May 2009.

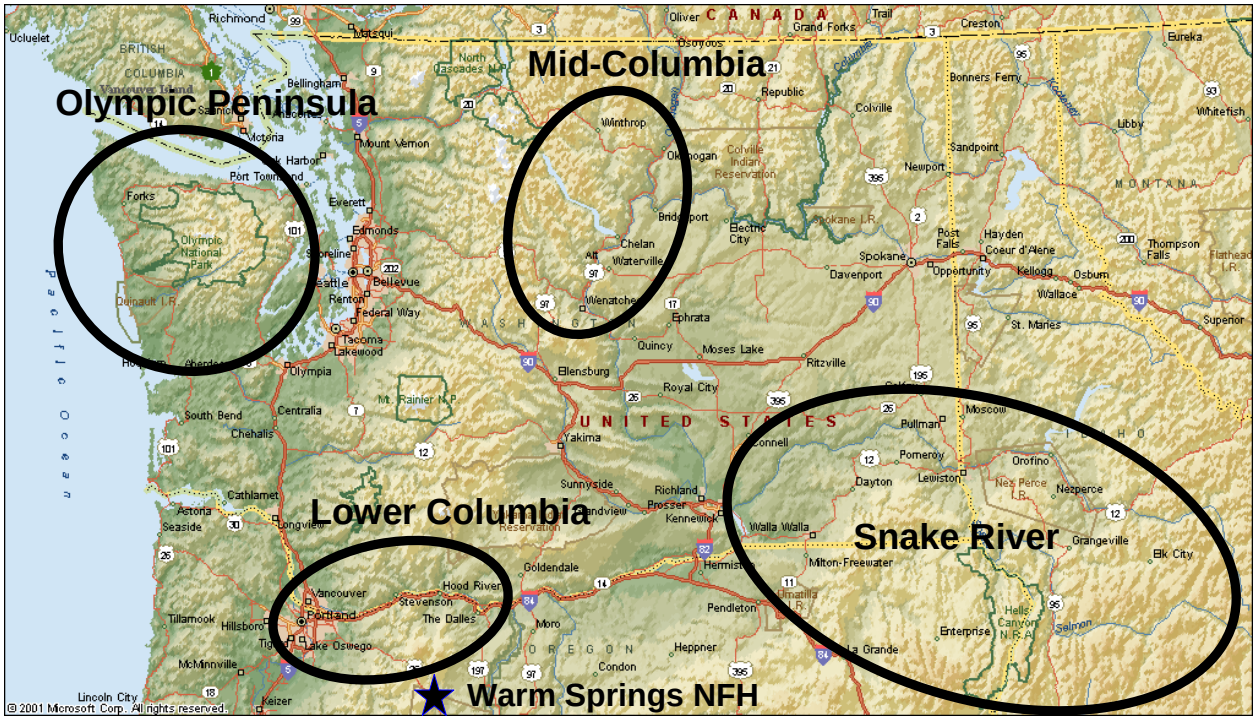

Figure 1. Regions of the Pacific Region Hatchery Review Project

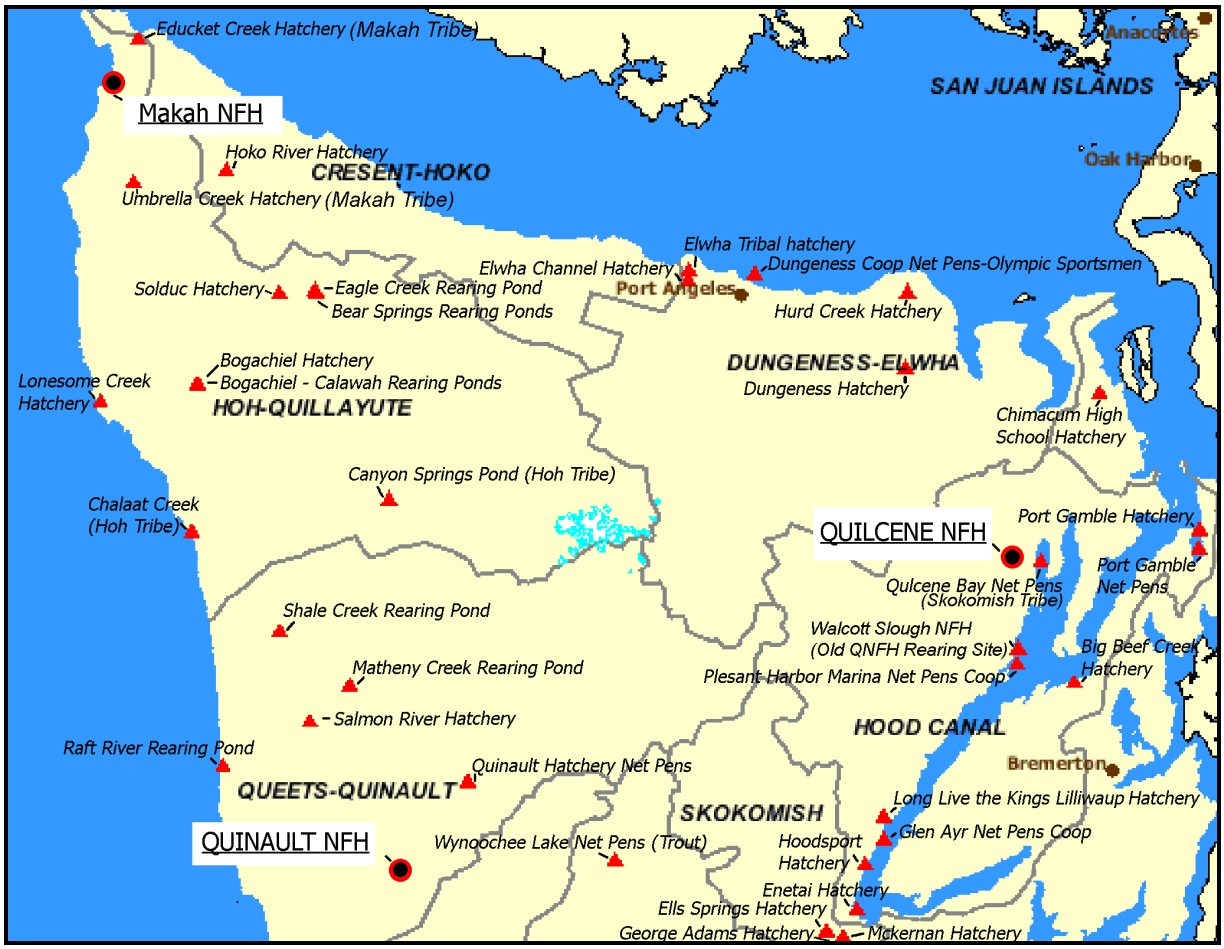

Figure 2. Map of Olympic Peninsula Fisheries Facilities (National Fish Hatcheries are underlined).[9]

[9] *Modified figure from Streamnet- http://map.streamnet.org/website/snetmapper/viewer.htm*

II. Components of this Report

This report provides assessments and recommendations developed from a comprehensive review of current propagation programs at Quilcene, Quinault and Makah NFHs. Recommendations presented herein are based on the best scientific information available at the time of the review. This information includes peer-reviewed scientific information in published works (scientific journals, etc.), agency reports, and pertinent information directly accessible via electronic download. In its review, the Team followed three fundamental principles it adopted from the HSRG (Mobrand et al. 2005[10]): (1) hatchery programs need to have well-defined goals in terms of desired benefits; (2) they must be scientifically defensible; and (3) they need to have programmatic flexibility to respond adaptively to new information.

The Review Team reviewed a large number of background documents, toured the three NFH and habitat features, and received presentations on a variety of Big Quilcene, Quinault, and Sooes watershed salmonid management issues. The Team then met with biologists representing the comanagers and stakeholders to discuss the purpose of the review, hatchery operations, stock goals, and specific issues the comanagers and stakeholders wanted the Review Team to consider. All source documents not readily available to the general public are accessible via the Service's hatchery review website[11]. Appendix A of this report summarizes the hatchery information on which the review and recommendations are based.

Based on the information gathered, the Review Team assessed benefits and risks of each hatchery program relative to current or short-term (10-15 years) goals and then drafted a set of preliminary recommendations that would increase or maintain benefits while minimizing or reducing risks, respectively. The Team also examined possible program alternatives to address long-term (15-50 years or greater) conservation and/or harvest goals. The initial results of the review were presented orally to the comanagers. The Review Team then developed a draft report, circulated it to comanagers for initial comment and revision, and then posted it on the Team's website for one month for public comment. The Team also conducted a meeting with interested stakeholders (e.g., fishing guides, conservation groups, etc.) to receive verbal input. The final report presented here was prepared after written comments on the draft report were received from comanagers, interested stakeholders, and the general public. Review Team responses to those written comments are presented in Appendix B. The complete texts of all written comments received are compiled in Appendix C.

Watershed Overview

The following report contains a background overview of the Big Quilcene, Quinault, and Sooes River watersheds. The overview includes information on geography, fisheries, conservation, habitat, and the current status of each salmonid stock within the watershed. Information on the status and hatchery propagation of each stock is summarized in a table for quick reference.

[10] *Mobrand, L., J. Barr, L. Blankenship, D.E. Campton, T.T.P. Evelyn, T.A. Flagg, C.V.W. Mahnken, L.W. Seeb, P.R. Seidel, and W.W. Smoker. 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries 30(6): 11-23.*

[11] *www.fws.gov/Pacific/fisheries/hatcheryreview/*

Stock Status

An understanding of the current status of each salmonid stock in each watershed was necessary for assessing the benefits and risks associated with each hatchery program. The Review Team summarized the current status of each stock in terms of four population parameters: *biological significance*, *viability*, *habitat*, and *harvest*. Each of those parameters was given a generalized rating of "high", "medium", or "low" as a foundation for assessing the benefits and risks of each hatchery program. The Review Team also needed to understand the short-term (10–15 years) and long-term (50 years or greater) goals for each salmonid stock within each watershed relative to the four population parameters. However, it was neither the mandate nor the responsibility of the Review Team to perform detailed, scientific assessments of population status. Instead, the Review Team relied on the consensus assessments of the comanagers: Quinault Indian Nation, Makah Nation, Washington Department of Fish and Wildlife (WDFW), Hoh Tribe, National Oceanic and Atmospheric Administration/National Marine Fisheries Service (NOAA Fisheries), Jamestown S'Klallam Tribe, Port Gamble S'Klallam Tribe, Lower Elwha Klallam Tribe, Skokomish Tribe, Point-No-Point Treaty Council, and our own Service biologists.

Biological significance is a measure of the biological uniqueness of a particular stock relative to other stocks of the same species. This measure considers the genetic origins of the stock (e.g. native or non-native), biological attributes that are unique or shared with other stocks (e.g. life history, physiological, or genetic attributes), and the extent to which the stock may be considered one component of a larger population structure, including population subdivisions within the stock. In general, a stock is defined as low, *medium* or *high* biological significance depending on its level of uniqueness and the ability of other stocks to potentially replace it in the occupying habitat if local extirpation were to occur. Stocks with *high* biological significance usually have one or more unique biological characteristics that may reflect local adaptations and would be difficult to replace by other stocks of the same species. Consequently, biological significance is not based on the degree to which the stock may be considered essential for recovery or harvest, but rather on its own innate biological attributes within the watershed in which the stock occurs. For example, a particular stock or population may be abundant and productive and, therefore, considered to have high *management* significance for harvest or recovery. However, that stock would not necessarily be considered to have high *biological* significance unless it possessed biological attributes not shared by other stocks of the same species or if all other stocks within the region or DPS/ESU[12] were substantially less viable. This approach thus distinguishes the *evolutionary legacy* of a stock within a particular watershed from comanager decisions regarding the potential *management value* of that stock. In this context, *biological significance* ratings are based on the factors described by Mobrand et al. (2005)[13].

Population viability measures the ability of a stock to sustain itself under current environmental conditions. NOAA Fisheries has assembled several *Technical Recovery Teams* (TRT) to assess viabilities and develop recovery criteria for ESA-listed salmon and steelhead populations throughout the Pacific Northwest. Those assessments involve significant mathematical modeling and attempt to predict extinction probabilities over the next 100 years based on four viability parameters: abundance, productivity, spatial structure, and diversity.[14] Preliminary viability estimates for listed salmonid

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[12] *Distinct Population Segment (DPS) and Evolutionarily Significant Unit (ESU). ESU is NOAA Fisheries' definition for a Distinct Population Segment (DPS) of Pacific Salmon under the U.S. Endangered Species Act. NOAA Fisheries has retained DPS designations for steelhead.*

[13] *Mobrand, L., et al. 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries 30(6): 11-23.*

[14] *McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmon populations and the recovery of evolutionary significant units. U.S. Department of Commerce, NOAA Technical*

stocks in the Olympic Peninsula region have been compiled by the Puget Sound TRT[15]. Where available, the Review Team relied on those viability estimates, as developed by the Puget Sound TRT; otherwise, the Review Team relied on the viability criteria of Mobrand et al. (2005)[16]. The goal here was to establish a qualitative understanding of the current viability for each salmonid stock potentially affected by each Service hatchery program as a foundation for assessing potential benefits and risks of those programs. However, estimating the viability of a natural population, including *integrated* hatchery stocks, is difficult because those estimations require detailed evaluations of natural reproductive output and enumeration of natural-origin adult returns over multiple generations. In contrast, the viability estimation of *segregated* hatchery stocks is more tractable and is determined primarily by the number of hatchery-origin adult recruits (R) recaptured in fisheries, the hatchery, or other areas per adults spawned in the hatchery (S) one generation earlier (R/S).

Habitat conditions for a particular stock are primarily assessed qualitatively in this report based upon discussions with comanagers. In some cases, conditions are assessed quantitatively through estimates of the *capacity* and *productivity* of the habitat to support adult spawners and juveniles, and to subsequently produce smolts in sufficient numbers to yield returning adults. In this context, premises regarding habitat refer primarily to natural populations and the specific watersheds in which hatcheries are located. These premises are important for assessing the ability of the local habitat and watershed to support self-sustaining natural populations and genetically *integrated* hatchery broodstocks, including assessment of risks posed by hatchery-origin fish spawning naturally.

Harvest on salmonid fishes occurs at different locations and times and can be assessed by the mean number of adult fish harvested annually in mixed stock ocean fisheries and/or terminal fisheries within the particular sub-basin or watershed under consideration.

Hatchery Programs

Hatchery programs are associated with many salmonid stocks. In general, hatchery programs can be classified according to their type and purpose.

Hatchery programs are classified as either *integrated* or *segregated* according to the genetic goals for the broodstock. Hatchery programs (or broodstocks) are classified as *integrated* if natural-origin fish are systematically included in the broodstock each year with the goal that the natural environment will primarily determine the genetic constitution of hatchery-origin fish. The integrated strategy manages hatchery and wild fish as one population (or one gene pool) that spawns in two different environments but recognizes that the phenotypic performances of hatchery and wild fish can be quite different even when the two components are genetically the same. *Segregated* programs or broodstocks are intended to maintain the hatchery population as a distinct, genetically segregated population via the exclusive use of hatchery-origin adults for broodstock. The segregated strategy creates a hatchery-adapted population that can facilitate management goals (e.g. harvest) but which can also increase genetic and ecological risks to natural populations.

Hatchery programs need to be defined also in terms of their intended benefits. The primary purpose of most hatchery programs is to achieve *conservation* or *harvest* benefits (or both). A secondary purpose

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Memorandum NOAA Fisheries-NWFSC-42, Seattle, WA 156pp. Also see www.nwfsc.noaa.gov/trt/trt_Columbia.htm.

[15] *<http://www.nwfsc.noaa.gov/trt/puget.cfm>.*

[16] *Mobrand, L., et al. 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries 30(6): 11-23.*

can also be conservation or harvest, but often includes education, research, socioeconomic or cultural/ceremonial benefits. These purposes should be closely linked to the goals of hatchery programs. Although *mitigation* is often stated as a "purpose" of a hatchery program, mitigation typically refers to the replacement of wild fish with hatchery fish without defining specific goals in terms of desired benefits (e.g., *mitigate* for fish losses associated with hydropower dams).

Operational Considerations

The Review Team considered all components of each hatchery program. Major features and issues of each program were summarized into the following subcategories: (a) program goals and objectives; (b) broodstock choice and collection; (c) hatchery and natural spawning, including adult returns; (d) incubation and rearing; (e) release and outmigration; (f) facilities and operations; (g) research, monitoring, and accountability, and (h) education and outreach.

Benefit and Risk Assessment

In conducting this review, the Review Team considered a wide range of possible benefits and risks potentially conferred and imposed, respectively, by hatchery programs.

Benefits considered include:

- Contributions to tribal and non-tribal harvests (commercial and recreational).
- Short- and long-term conservation benefits (both demographic and genetic).
- Research opportunities afforded by the program.
- Educational, cultural, ceremonial and socioeconomic benefits conferred by the program and the hatchery facility itself.

Risks considered include:

Genetic Risks

- Risks from artificial propagation on the genetic constitution and fitness of hatchery-origin fish representing the cultured stock.
- Risks from natural spawning by hatchery-origin adults on the mean fitness of natural-origin fish of the same species in target and non-target watersheds.

Demographic Risks

- Pre-release risks from the hatchery facility and operations on the abundance of the propagated stock including the following: pre-spawning mortality associated with trapping, holding and/or bypassing adults; disease risks associated with overcrowding or high rearing densities of cultured fish; inadequate fish health protocols and water flow alarms to prevent catastrophic fish losses in the hatchery; poaching by humans; and predation by birds, mammals and fish at the point of release or on the hatchery grounds (e.g. by otters and birds).
- Post-release risks to the abundance of the propagated stock, including congregation of released fish at the release point and/or unnatural surface feeding (conditioned by hatchery rearing) that may increase vulnerability of released fish to predators, thus decreasing smolt-to-adult survival.

- Demographic risks from hatchery operations on the abundance of other stocks and species within the watershed in which the hatchery is located (e.g. effects of a barrier weir for trapping adults for hatchery broodstock).

Ecological Risks

- Competition, predation, and disease transfer from hatchery-origin adults and juveniles of the propagated stock to naturally spawning populations of the same species or stock in target and non-target watersheds.
- Competition, predation, and disease transfer from hatchery-origin adults and juveniles of the propagated stock to naturally spawning populations of different species in target and non-target watersheds, including non-salmonid fish species of particular concern (e.g. lamprey).
- Risks from the hatchery facility and operations on the aquatic biota and ecosystem within the target watershed, including the effects of hatchery effluent, water intake, use of chemicals, and upstream/downstream passage of fish and other aquatic species in the watershed.
- Risk of antibiotic use resulting in developing resistant strains of pathogenic organisms that infect salmonid fishes, other aquatic species, and humans.
- Producing fish that are not qualitatively similar to natural fish of the same species in size, growth rate, morphology, behavior, physiological status or health, which may adversely affect the performance of natural fish via competition or predation.
- The Team recognizes that hatchery-origin juveniles and adults may ecologically impact other fish species and populations in the estuary and ocean environment; however, little information on these *cumulative effects* is currently available.

Physical Risks

- Risks from the hatchery facility and operations to human health and safety, including potential contaminants.

The Team evaluated the benefits and risks of all operational and physical components of each hatchery program. These components are the same as those outlined above under *Operational Considerations.* Those evaluations then formed the bases of the Team's recommendations.

Recommendations

After careful assessment of the benefits and risks conferred by a hatchery program, the Review Team developed a series of recommendations to increase the likelihood of achieving the desired goals and benefits of the program and/or reducing biological and other risks. Recommendations for the current hatchery programs are grouped into the same categories as listed above under *Operational Considerations*. Recommendations for current programs are intended to address short-term goals and needs.

Alternatives

The review team then identified several alternatives to the current program, as suggested by comanagers or inferred from long term goals for salmonid stocks within the region, with an overall

assessment of the value and merits (pros and cons) of those potential alternatives relative to the current program. By default, the following alternatives were included in each assessment: (a) the current program with full implementation of all recommendations and (b) termination of the current program and decommission of the hatchery in favor of alternative mitigation strategies (e.g., habitat restoration, construction of a new hatchery elsewhere, etc). The Team then selected a recommended alternative, or combination of alternatives, that the Team concluded would provide the greatest benefit-risk ratio in support of long-term harvest and conservation goals.

III. Big Quilcene River Watershed (Hood Canal)

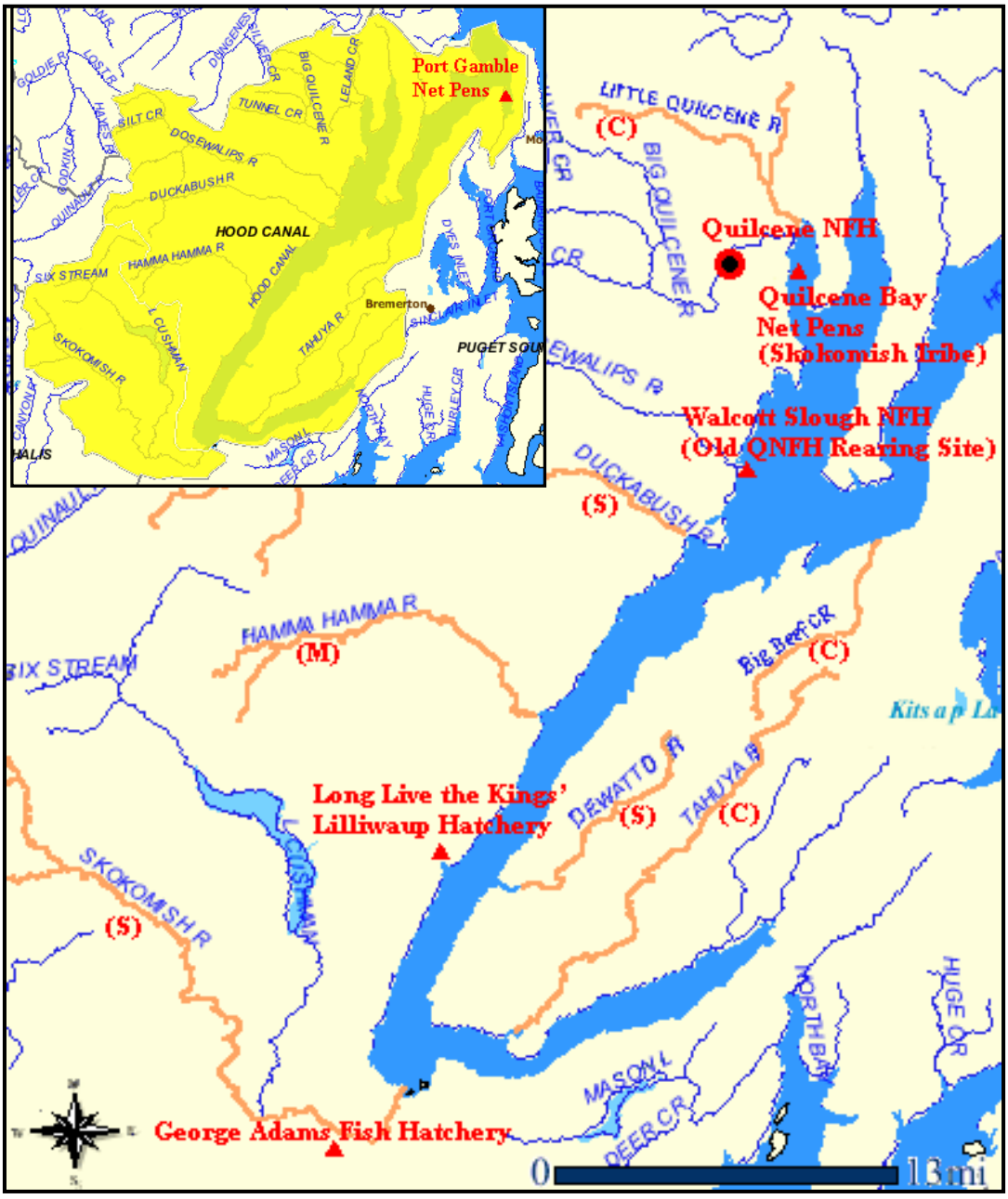

Figure 3. Hood Canal region map including Quilcene NFH and associated facilities[17]

Also highlighted are the rivers included in the Hood Canal Steelhead Project. (S) supplemented rivers; (C) control rivers; and (M) indicates that the Hamma Hamma River was previously supplemented and is currently being monitored for long-term effects.

[17] *Modified figure from Streamnet- http://map.streamnet.org/website/snetmapper/viewer.htm*

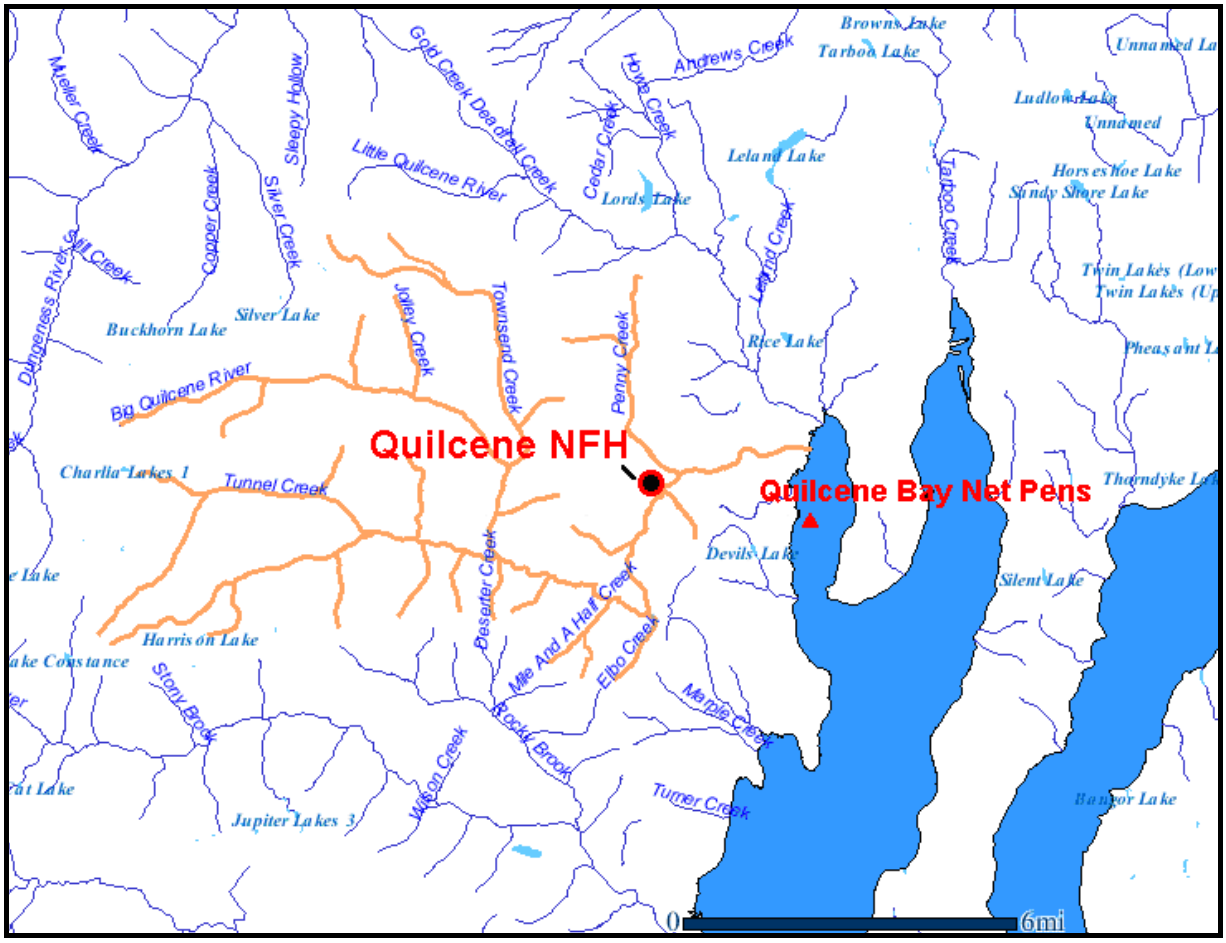

Figure 4. Big Quilcene River Watershed[18]

[18] *Modified figure from Streamnet- http://map.streamnet.org/website/snetmapper/viewer.htm*

Big Quilcene River Overview

Watershed Description

The Big Quilcene watershed is a diverse ecosystem encompassing 53,016 acres from Mt. Constance at an elevation of 7,747 feet in Olympic National Park to sea level at Quilcene Bay. Within the watershed, 41,734 acres of land (79% of the watershed) are administered by the U.S. Forest Service (USFS), 6,449 acres are owned by private or municipal interests, 3,676 acres are managed by the Washington State Department of Natural Resources, and 1,158 acres lie within the Olympic National Park.

The watershed displays a wide range of physical, biological, and social functions. Three main tributaries comprise the majority of the watershed: the mainstem Big Quilcene River, originating from Buckhorn Mountain; Tunnel Creek, originating from Mt. Constance; and Townsend Creek, originating from Mt. Townsend. Other tributaries to the Big Quilcene River include Penny Creek, Mile and a Half Creek, Three Mile Creek, and numerous unnamed streams. The watershed drains approximately 83 square miles of the eastern Olympic Peninsula via 117 miles of streams.

The mainstem length is 18.9 miles. There are also 81.9 miles of tributaries entering the Big Quilcene River. However, no tributaries are accessible to anadromous fish (WDFW 1975)[19]. There is a natural impasse (falls) at RM 7.6 that is 15 to 20 feet tall. It is doubtful that coho can ascend this far due to the cumulative effect of numerous cascades and rapids between RM 5 and RM 6 (WDFW 1975; Zajac 1989)[20]; however, it is likely that steelhead can pass above the cascades under certain water conditions. These falls are the upper limit to anadromous fish migration.

Fisheries

The primary fishery in the Big Quilcene River is a hatchery supported recreational coho fishery. This fishery has become very popular among citizens of northwest Puget Sound and to locally-based military personnel. However, Big Quilcene River hatchery coho also provide frequent subsistence fishery opportunities to local tribal members. The river also supports some limited "catch and release" trout fishing opportunities primarily in the upper reaches.

Conservation

The Quilcene River is currently managed for natural production of winter steelhead, and summer and fall chum salmon. Coho are managed as a hatchery supported harvest program. Steelhead and summer chum were listed as threatened under ESA in 2007 and 1999 respectfully.

[19] *Washington Department of Fisheries. 1975. A Catalog of Washington Streams and Salmonid Utilization. Hood Canal Region. Olympia, Washington.*

[20] *Ibid. AND Zajac, David. 1989. Adult coho passage issue at Quilcene NFH. Memorandum dated October 11, 1989 to Project Leader, Fisheries Assistance Office, FWS, Olympia, Washington.*

Summer chum recovery is being addressed through the "Summer Chum Conservation Initiative" and a recovery plan.[21,22] A draft "Statewide Steelhead Management Plan" has been developed to define a new management strategy for steelhead.

Habitat[23]

In 1911, Quilcene NFH was constructed at the confluence of the Big Quilcene River and Penny Creek. Since then, the Service has acquired lands adjacent to the original hatchery site to construct and maintain other hatchery structures and to maintain water quality for fish production. Stream bank protection, including barbs and revetments, has been installed on the Big Quilcene River mainstem to protect hatchery property from erosion.

In 1928, the City of Port Townsend constructed a timber crib diversion dam to meet its municipal and industrial water requirements. The dam is located above anadromous fish access on the Big Quilcene River just below its confluence with Tunnel Creek. The water is piped underground approximately 28 miles to Port Townsend. The intake is fitted with a trash rack but it is not screened to prevent fish entry.

Local and federal government agencies are currently addressing habitat deficiencies in the Big Quilcene River watershed. Active habitat improvements include land acquisition and dike setbacks in the lower river (Al Latham, Jefferson County, pers. comm., 2000). Gravel traps were installed in the lower river, when funding was available (Ken Cook, Jefferson County, per. comm., 2000), to reduce flooding impacts to land owners and to reduce gravel aggradations in spawning areas. The operation of these traps ceased in 2004 when the accumulated benefits of several projects resulted in improved stabilization of the bed of the lower Big Quilcene River (Al Latham, Jefferson County Conservation District, pers. comm., 2008). The Skokomish Tribe has installed engineered log jams at about RM 2. The USFS has obliterated logging roads and added woody debris structures in some sections of the upper watershed to improve habitat for resident trout (Marc McHenry, USFS, pers. comm., 2000). Passive habitat improvement is being implemented by the USFS, since it classified most of the watershed as "Late Successional Reserve" in 1994. This action is primarily aimed at promoting old-growth development by eliminating timber harvest after the stands reach the age of 80 years. Younger stands may be thinned, but no other harvest is scheduled by the USFS in the near-term (Marc McHenry, USFS, pers. comm., 2000). The northern side of the diking at the mouth of the Big Quilcene River was removed in 2000. The Schenke sea dike and duck pond dike were also removed in 2008. This leaves only a small portion of the south dike remaining to be removed and restore more natural geomorphological function to the lower Big Quilcene.

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[21] *Washington Department of Fish and Wildlife and Point No Point Treaty Tribes. April 2000. Summer Chum Salmon Conservation Initiative: An Implementation Plan to Recover Summer Chum in the Hood Canal and Strait of Juan de Fuca Region. http://wdfw.wa.gov/fish/chum/chum.htm.*

[22] *NOAA Fisheries. May 2007. Final Supplement to the Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/Hood-Canal-Plan.cfm.*

[23] *U.S. Forest Service. 1994. Big Quilcene Watershed Analysis; An Ecological Report at the Watershed Level. Quilcene Ranger District, Quilcene, Washington.*

Current Status of Salmonid Stocks

The Review Team, in conjunction with Hood Canal comanagers, identified twelve salmonid stocks that are either: in the Quilcene River watershed; reared at Quilcene NFH; affected by Quilcene NFH programs; or are stocks in the greater Hood Canal region that are of concern to the comanagers. The native population of natural-origin coho that once inhabited a small estuary formed by the confluence of Penny Creek and the Big Quilcene River and the area above the Quilcene NFH weir has been heavily influenced by the coho hatchery program and construction and operation of the hatchery facility and weir; therefore, the Team believes that there may no longer be a self-sustaining natural coho population in this area. Summer chum and steelhead stocks within Hood Canal, as well as mid-Hood Canal summer/fall Chinook, are part of the Hood Canal summer chum, Puget Sound steelhead, and Puget Sound Chinook evolutionarily significant units (ESUs), respectively, listed as threatened under the Endangered Species Act. :

- Quilcene NFH coho salmon(segregated hatchery)
- Quilcene/Dabob Bay coho salmon – below Quilcene NFH weir (depressed)[24]
- Northeast Hood Canal coho salmon (healthy)
- Big Quilcene/Little Quilcene summer chum salmon (threatened)
- Dosewallips and Duckabush summer chum salmon (threatened)
- Big Beef Creek summer chum salmon (threatened)
- Mid-Hood Canal summer/fall Chinook salmon (threatened)
- Big Quilcene Winter steelhead (threatened)
- Dewatto, Duckabush and Skokomish winter steelhead (Hood Canal Steelhead Project Supplementation Streams) (threatened)
- Big Beef Creek, Tahuya, Dosewallips, Little Quilcene, and Hamma Hamma rivers Winter steelhead (Hood Canal Steelhead Project Control Streams) (threatened)
- Hood Canal bull trout (threatened)
- Hood Canal sea-run cutthroat trout

The following tables summarize the current status and management premises of those stocks as identified by Hood Canal comanagers. The principal sources of information provided in these tables were: Washington Department of Fish and Wildlife's (WDFW) Salmon Stock Inventory (SaSI) and subsequent annual escapement estimates [25]; the Puget Sound and Coastal Washington Hatchery Scientific Review Group's (HSRG) recommendations for Hood Canal[26]; Puget Sound Technical Recovery Team (PSSTRT) documentation[27]; the Puget Sound Salmon Recovery Plan and associated watershed plans[28]; Hood Canal Summer Chum Conservation Initiative documentation, including the

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[24] *Based on WDFW SaSI report, available through WDFW's Salmonscape web utility http://wdfw.wa.gov/mapping/salmonscape/.*

[25] *SaSI and escapement data available through WDFW's Salmonscape web utility http://wdfw.wa.gov/mapping/salmonscape/.*

[26] *Hatchery Scientific Review Group. March 2004. Hatchery Reform Recommendations for the Puget Sound and Coastal Washington Hatchery Reform Project. Seattle, WA. www.hatcheryreform.org.*

[27] *http://www.nwfsc.noaa.gov/trt/puget.cfm*

[28] *http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Recovery-Plan.cfm*

recovery plans[29,30]; and through personal communications with Thom Johnson of WDFW, Barry Berejikian of NOAA regarding the Hood Canal Steelhead Project stocks, and other Hood Canal region comanagers. The HSRG (2004) ratings are shown if the Review Team concurred with those ratings. If the Review Team had a different rating based on current conditions and more recent comanager input, then the rationale for that difference is noted.

[29] *Washington Department of Fish and Wildlife and Point No Point Treaty Tribes. April 2000. Summer Chum Salmon Conservation Initiative: An Implementation Plan to Recover Summer Chum in the Hood Canal and Strait of Juan de Fuca Region. http://wdfw.wa.gov/fish/chum/chum.htm.*

[30] *NOAA Fisheries. May 2007. Final Supplement to the Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/Hood-Canal-Plan.cfm.*

Table 1. Quilcene NFH coho salmon (Quilcene NFH, Quilcene Bay net pen, George Adams Hatchery, and Port Gamble net pens)

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological Significance	*Low.* The HSRG (2004) classified the biological significance of this stock as "medium". The stock has been propagated in hatcheries since 1911. The temporal distribution of run timing is skewed 2-4 weeks earlier than natural Hood Canal stocks. The stock is composed of three genetically distinct broodlines, two of which are distinct from other Hood Canal stocks. The Quilcene NFH coho population is considered a "domesticated" stock.
Population Viability	*High (HSRG 2004).* For broodyears 1993-2002, an estimated average of approximately 16,500 adults resulting from on-station smolt releases were recovered in fisheries or at the hatchery. In addition, approximately 5,900 and 4,000 returning adults were recovered from smolt releases at Port Gamble and Quilcene Bay net pens, respectively. The mean recruit per spawner (R/S) is approximately R/S=22 based on an average hatchery broodstock of 1,200 spawned adults.
Habitat	*Medium (HSRG 2004).* The Big Quilcene River and Quilcene Bay provide adequate to good habitat for smolt outmigration and returning adults back to the hatchery. Approximately 600 hatchery-origin adults are passed upstream of the hatchery annually, but the natural productivity of those hatchery fish is unknown[31].
Harvest	*High (HSRG 2004).* For brood years 1993-2002, harvests of coho salmon resulting from on-station releases averaged 2,800, 3,100 and 300 adults in U.S. sport and commercial, tribal, and Canadian fisheries, respectively. Smolt releases from Quilcene Bay net pen releases yielded an average harvest of 890, 900 and 10 adults in U.S., tribal, and Canadian fisheries, respectively. Smolt releases from Port Gamble net pen yielded an average harvest of 2,125, 2,950, and 135 adults in U.S., tribal, and Canadian fisheries, respectively.
Hatchery Program	
Facilities	Quilcene NFH, including an adult weir and trap. Trapping, spawning, incubation, rearing, and release occur on-site (400,000) and at a net pen operated by the Skokomish Tribe in Quilcene Bay (200,000). 450,000 eyed eggs are transferred to George Adams Hatchery (operated by Washington Department of Fish and Wildlife) for rearing and transfer to a net pen operated by the Port Gamble S'Klallam Tribe in Port Gamble Bay.
Type	Segregated
Authorization and Funding	U.S. Fish and Wildlife Service, Skokomish Tribe and Washington Department of Fish and Wildlife.
Primary Purpose	Harvest from on-station release.
Secondary	Harvest from net pen fish and egg transfer to tribal programs.

[31] *Zajac, Dave. 2002. An Assessment of Anadromous Fish Habitat Use above Quilcene National Fish Hatchery in the Big Quilcene River. U.S. Fish and Wildlife Service, Western Washington Office, Lacey, Washington.*

Purposes	
Broodstock Origin(s)	Primarily Big Quilcene River. Occasional introductions of other stocks were seldom more than one or two years at a time. Differential selection over generations has resulted in substantially advanced run timing and a total return duration that has been reduced to 4 to 5 weeks.

Table 2. Quilcene/Dabob Bay coho salmon (Lower Big Quilcene (below weir), Little Quilcene, Tarboo, etc.)

Management Premises and Goals	
ESA Status	*Not Listed*.
Biological Significance	*Medium (HSRG 2004)*. The HSRG assessed all natural populations of coho salmon in Hood Canal as one stock of "medium" biological significance. Natural populations of coho salmon in Dabob Bay, Quilcene Bay, and other regions of Hood Canal most likely represent an ancestral mixture of native and introduced stocks.
Population Viability	*Low.* WDFW rated the viability of the Quilcene/Dabob Bay coho salmon stock as "depressed*"* (WDFW SaSI reports). A mean of approximately 500 natural-origin adult coho spawn annually in tributaries to Dabob/Quilcene Bay. The HSRG (2004) rated the overall viability of natural population of coho in Hood Canal as "medium".
Habitat	*Low.* Spawning and rearing habitat in the Lower Big Quilcene River is poor. The river lacks overwintering habitat and is degraded due to water withdrawal, low channel complexity, sub-estuarine modifications (diking), sediment accumulation, and a young deciduous-dominated riparian forest. However, the HSRG (2004) characterized the cumulative habitat (Quilcene River, little Quilcene River, and Tarboo Creek) as *Medium.*
Harvest	*Low.* Unmarked, natural-origin coho returning to tributaries in Dabob and Quilcene bays are harvested incidentally in fisheries targeting hatchery-origin coho. The HSRG (2004) rated the harvest on all naturally produced Hood Canal coho as "medium". There are no mark-selective fisheries from Marine Area 9 southward (Admiralty Inlet and any area south of a line from Point Wilson in the south to Partridge Point in the north) for sport harvest. In other words, all coho may be retained.

Table 3. Northeast Hood Canal coho salmon (Big Beef, etc.)

Management Premises and Goals	
ESA Status	*Not Listed*.
Biological Significance	*Medium (HSRG 2004)*. This stock is likely a mixture of native and introduced stocks. Hatchery fish comprise greater than 10% of the total number of naturally spawning fish in some years.
Population Viability	*High.* WDFW (SaSI) classified this stock as "healthy". Based on expanded counts of adult returns to Big Beef Creek weir, the estimated mean number of natural-origin spawners in 1991-2007 was 2,172 adults. Maximum sustained harvest escapement level is 1,260 adults. The HSRG (2004) rated the overall viability of natural population of coho in Hood Canal as "medium". *Medium (HSRG 2004 for all naturally produced Hood Canal coho).*
Habitat	*Medium (HSRG 2004).* Most spawning and rearing occurs in Big Anderson, Stavis, Seabeck, Big Beef, Little Beef, Gamble, Miller, Lake, Kinman, Thorndyke, Shine creeks.
Harvest	*Low*. Unmarked, natural-origin coho returning to tributaries in Dabob and Quilcene bays are harvested incidentally in fisheries targeting hatchery-origin coho. The HSRG (2004) rated the harvest on all naturally produced Hood Canal coho as "medium".

Table 4. Big Quilcene/Little Quilcene summer chum salmon

Management Premises and Goals	
ESA Status	*Threatened*
Biological Significance	*High.* Big/Little Quilcene summer chum are genetically distinct from other Hood Canal populations of summer chum, except for Hamma Hamma summer chum. The HSRG (2004) rated the biological significance of all summer chum stocks in Hood Canal as "medium." The comparatively low viability of summer chum stocks in Hood Canal, compared to fall chum, increases the biological significance of individual summer chum populations.
Population Viability	*Medium (HSRG 2004).* Recent 10 year (1998-2007) escapement of naturally spawning fish has averaged 9,356 adults which includes hatchery-origin fish used for supplementing the natural population.
Habitat	*Medium*. Spawning occurs in the lower three miles of the Big Quilcene River and lower two miles of the Little Quilcene River. Current habitat capacity is estimated at 4,684 adults compared to a historic habitat capacity estimated at 8,760 adults. The HSRG (2004) rated habitat for this stock as "low". The Review Team believes a higher rating is warranted based on current conditions and comanager input.
Harvest	*Low.* No direct harvest occurs; summer chum are only caught incidentally in fisheries targeting other species (e.g., coho salmon). The estimated exploitation rate on returning adults is less than 20%, although exploitation rates have ranged from1% to 40% for return years 2000 to 2004. The HSRG recorded the *harvest opportunity* for this stock as "none".
Hatchery Program	
Facilities	Quilcene NFH, 1993-2004. The hatchery program was terminated after the release of broodyear 2003 summer chum.
Type	N/A. The terminated program was *integrated*.
Authorization and Funding	U.S. Fish and Wildlife Service, Skokomish Tribe and Washington Department of Fish and Wildlife.
Primary Purpose	*Conservation*. Recover the naturally spawning summer chum population in Big and Little Quilcene rivers to a self-sustaining level of viability.
Secondary Purposes	*None*. The long-term goal of the hatchery program was to recover the naturally-spawning population of summer chum in the Big Quilcene River and adjacent areas to a level of viability that could support harvest in the future.
Broodstock Origin(s)	Big Quilcene/Little Quilcene rivers.

Table 5. Dosewallips and Duckabush summer chum salmon

Management Premises and Goals	
ESA Status	*Threatened*.
Biological Significance	*High.* The HSRG (2004) rated the biological significance of all summer chum stocks in Hood Canal as "medium." The comparatively low viability of summer chum stocks in Hood Canal, compared to fall chum, increases the biological significance of individual summer chum populations.
Population Viability	*Medium (HSRG 2004).* Recent 10 year (1998-2007) escapement of naturally spawning fish has averaged 2,721 adults in the Dosewallips River and 1,680 adults in the Duckabush River.
Habitat	*Medium (HSRG 2004).* Current habitat capacity estimated at 3,991 adults for Duckabush and 5,565 for Dosewallips. Historic habitat capacity estimated at 7,097 adults for Duckabush and 10,340 for Dosewallips.
Harvest	*Low.* No direct harvest occurs; summer chum are only caught incidentally in fisheries targeting other species (e.g., coho salmon). The HSRG recorded the *harvest opportunity* for this stock as "none".

Table 6. Big Beef Creek summer chum salmon

Management Premises and Goals	
ESA Status	*Extirpated.* A locally extinct population within the *Hood Canal Summer Chum ESU*, which is currently listed as *Threatened*.
Biological Significance	*Medium (HSRG 2004).* A hatchery program to reintroduce summer chum to Big Beef Creek was initiated in 1996 with adult broodstock from Quilcene NFH. Beginning in 2000, adult returns back to Big Beef Creek were used for broodstock to establish a self-sustaining population within the watershed.
Population Viability	*Low (HSGRG 2004).* From 1968 to 1981, approximately 100 to 1,200 summer chum returned annually to Big Beef Creek. However, from 1982 to 2000, zero to only a few adult summer chum returned. With advent of the hatchery reintroduction program, recent returns (2001-2007) of adult summer chum have averaged approximately 1,000 fish.
Habitat	*Medium*. Spawning by summer chum occurs in the lower two miles of Big Beef Creek. This habitat is now considered adequate to support a self-sustaining natural population. The HSRG (2004) rated habitat for summer chum in Big Beef Creek as "low".
Harvest	*Low.* No direct harvest occurs; summer chum are only caught incidentally in fisheries targeting other species (e.g., coho salmon). The HSRG recorded the *harvest opportunity* for this stock as "none".
Hatchery Program	
Facilities	Quilcene NFH and Big Beef Creek hatchery. The hatchery program was terminated in 2005 after the release of broodyear 2004 fish.
Type	N/A. The terminated program was *integrated.*
Authorization and Funding	US Fish and Wildlife Service, Washington Department of Fish and Wildlife and University of Washington
Primary Purpose	Conservation. Reintroduce summer chum to Big Beef Creek and establish a self-sustaining natural population.
Secondary Purposes	*None.* The long-term goal of the hatchery program was to recover the naturally-spawning population of summer chum in Big Beef Creek and adjacent areas to a level of viability that could support harvest in the future.
Broodstock Origin(s)	Big Quilcene/Little Quilcene rivers.

Table 7. Mid-Hood Canal summer/fall Chinook salmon (Dosewallips, Duckabush, Hamma Hamma)

Management Premises and Goals	
ESA Status	Threatened.
Biological Significance	*Low.* Fall Chinook spawning in the Dosewallips, Duckabush, and Hamma Hamma rivers are believed to represent a mixture of wild and hatchery fish with less than 50% "native genes" (HSRG 2004). The HSRG (2004) classified the biological significance of these populations as "medium", but only marginally so relative to a possible "low" rating.
Population Viability	*Low (HSRG 2004).* Current escapements of naturally spawning fall Chinook are less than 50 adults in the Duckabush River, and less than 100 adults each in the Dosewallips and Hamma Hamma rivers.
Habitat	*Medium (HSRG 2004).* Current habitat capacity is estimated to be 1,670 adults in the Dosewallips River, 752 adults in the Duckabush River, and 619 adults in the Hamma Hamma River. Historic habitat capacities are estimated to be 5,049, 2,224, and 1,615 adults in the Dosewallips, Duckabush, and Hamma Hamma rivers, respectively.
Harvest	*Medium.* No direct harvest occurs on fall Chinook from these populations. However, fall Chinook from these populations are caught incidentally in marine commercial fisheries targeting other stocks. Based on a modeling run (FRAM) of Washington fisheries at the conclusion of the 2005 North of Falcon fisheries planning effort, the estimated average harvest rate on adults is 31% in the ocean but less than 1% in Hood Canal. The HSRG recorded the *harvest opportunity* for these populations as "none", based primarily on directed harvest opportunities in Hood Canal and adjoining waters.
Hatchery Program	
Facilities	George Adams Fish Hatchery (WDFW) and Johns Creek (Hamma Hamma River) Conservation Ponds (Long Live the Kings). Up to 80,000 subyearling smolts - 40,000 from George Adams Hatchery and 40,000 representing the F1 progeny of adults returning to the Hamma Hamma River - are released annually into the Hamma Hamma River from the Johns Creek Conservation Ponds.
Type	*Integrated.*
Authorization and Funding	US Fish and Wildlife Service, Long Live the Kings, and Washington Department of Fish and Wildlife
Primary Purpose	*Conservation*. Recover the naturally spawning fall Chinook population in the Hamma Hamma River to a self-sustaining level of viability
Secondary Purposes	*None.* The long-term goal of the hatchery program is to recover the naturally-spawning population of fall Chinook in the Hamma Hamma River to a level of viability that could support harvest in the future.
Broodstock Origin(s)	Hamma Hamma River and George Adams Hatchery.

Table 8. Big Quilcene winter steelhead

Management Premises and Goals	
ESA Status	*Threatened.*
Biological Significance	*Low.* The limited spawning and rearing habitat available for steelhead in the Big Quilcene River compared to the rest of Hood Canal, coupled with historic sustained releases of out-of-basin hatchery-origin steelhead into many Hood Canal tributaries (that were discontinued in 2004), limits or reduces the biological significance of any one population. The HSRG (2004) rated the biological significance of all natural populations of steelhead in Hood Canal as "medium".
Population Viability	*Low (HSRG 2004).* The HSRG (2004) rated the viability of all natural populations of steelhead in Hood Canal as "low".
Habitat	*Low.* Fish passage upstream of Quilcene NFH to natural spawning areas needs to be improved. The HSRG (2004) rated habitat for all natural populations of steelhead in Hood Canal as "medium".
Harvest	*Low.* The HSRG (2004) rated "harvest opportunity" for all natural populations of steelhead in Hood Canal as "none" because of incidental harvest only in fisheries targeting hatchery-origin fish.

Table 9. Dewatto, Duckabush, and Skokomish winter steelhead: Hood Canal Steelhead Project Supplementation Streams)

Management Premises and Goals	
ESA Status	*Threatened*.
Biological Significance	*Medium (HSRG 2004).* Historic sustained releases of out-of-basin hatchery-origin steelhead into many Hood Canal tributaries (that were discontinued in 2004), limits or reduces the biological significance of any one population.
Population Viability	*Low (HSRG 2004).* Based on return years 1998 through 2007, an estimated mean of 28, 18, and 247 natural-origin winter-run steelhead adults have escaped annually into the Dewatto, Duckabush, and Skokomish rivers, respectively.[32]
Habitat	*Medium (HSRG 2004).* Current habitat capacities for producing returning steelhead adults are estimated to be 475, 429, and 3,467 adults in the Dewatto, Duckabush, and Skokomish rivers, respectively.[33,34]
Harvest	*Low.* The HSRG (2004) rated "harvest opportunity" for all natural populations of steelhead in Hood Canal as "none" because of incidental harvest only in fisheries targeting hatchery-origin fish.
Hatchery Program	
Facilities	Quilcene NFH for incubation and early rearing in quarantine prior to viral sampling. Eyed eggs are pumped from redds on the Dewatto and Duckabush and transferred to Lilliwaup Hatchery (Long Live the Kings) for hatch and grow-out to yearling smolts. Eyed eggs pumped from redds in the Skokomish River are incubated, hatched and reared at McKernan Hatchery (WDFW).
Type	*Integrated.* Only natural-origin fish are used in the hatchery program.
Authorization and Funding	NOAA Fisheries, US Fish and Wildlife Service, Washington Department of Fish and Wildlife, Skokomish Tribe, Long Live the Kings, Hood Canal Salmon Enhancement Group, and US Forest Service.
Primary Purpose	*Research.*
Secondary Purposes	*Conservation.*
Broodstock Origin(s)	Dewatto, Duckabush and Skokomish rivers.

[32] *Data extracted from Streamnet. http://www.streamnet.org/.*

[33] *Escapement goals developed using WDFW's spawner escapement goal methodology (Gibbons et al. 1985).*

[34] *Johnson, T (WDFW). DRAFT May 4, 2006.Hood Canal Steelhead Study Production Assessment.*

Table 10. Big Beef Creek, Tahuya, Dosewallips, Little Quilcene, and Hamma Hamma rivers winter steelhead (Hood Canal Steelhead Project Control Streams)

Management Premises and Goals	
ESA Status	*Threatened*.
Biological Significance	*Medium (HSRG 2004).* Historic sustained releases of out-of-basin hatchery-origin steelhead into many Hood Canal tributaries (that were discontinued in 2004), limits or reduces the biological significance of any one population.
Population Viability	*Low (HSRG 2004).* Based on return years 1998 through 2007, the estimated mean number of adult steelhead returning annually has been: Tahuya (156), Big Beef Creek (40 in 2007 and ~50 in 2008), Dosewallips (68), Little Quilcene River (28), and Hamma Hamma River (17 pre-supplementation, from 1995-2001 and 181 post supplementation, 2002-2007).[35].
Habitat	*Medium (HSRG 2004).* Current habitat capacity for producing returning steelhead adults is estimated to be 1,405 adults in the Dosewallips.[36] Habitat capacity data was not available for the other stocks discussed in this table.
Harvest	*Low.* The HSRG (2004) rated "harvest opportunity" for all natural populations of steelhead in Hood Canal as "none" because of incidental harvest only in fisheries targeting hatchery-origin fish.

Table 11. Hood Canal bull trout

Management Premises and Goals	
ESA Status	Threatened. Bull trout were listed as a threatened species under the ESA in 1999 (64 FR 58910).
Biological Significance	*Medium (HSRG 2004)*. Bull trout in Hood Canal watersheds occur primarily in the Skokomish River. The overall Coastal-Puget Sound Distinct Population Segment, to which bull trout in Hood Canal belong, is believed to have high biological significance because it contains the only anadromous forms of bull trout in the coterminous United States (UFFWS 2004 Draft Recovery Plan).
Population Viability	*Medium (HSRG 2004)*. The Skokomish River basin is considered a core population area for recovery (May 2004 draft recovery plan). WDFW considers the Lake Cushman population to be "healthy" (WDFW SaSI 1998). The USFWS considers the potential for recovery of the Coastal-Puget Sound DPS to be high.
Habitat	*Medium (HSRG 2004).* Habitat in the upper South Fork of the Skokomish River is classified as "Late Successional Reserve", and clear-cut harvest is severely restricted. However, past logging operations have had major impacts on habitat quality. . Although effects from past timber harvest are significant, future timber harvests are expected to be

[35] *Data extracted from: Streamnet - http://www.streamnet.org/; NOAA Fisheries. February 2008. Hood Canal Steelhead Project Hatchery and Genetic Management Plan; pers. comm. Joy Lee, Long Live the Kings. 2009.*

[36] *EDT analysis for Dosewallips steelhead. 2008. http://edt.jonesandstokes.com/.*

	reduced significantly (May 2004 draft recovery plan).
Harvest	*None (HSRG 2004).* Bull trout are only caught incidentally in resident trout fisheries and are required to be released if caught.

Table 12. Hood Canal sea-run cutthroat trout

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological Significance	*Medium (HSRG 2004).*
Population Viability	*High (HSRG 2004).*
Habitat	*Medium (HSRG 2004).*
Harvest	*High (HSRG 2004).*

Other Species of Concern

Table 13. Additional salmonid and non-salmonid native fish species present in the Big Quilcene River watershed[37]

Common name	Scientific Name
Pink salmon	*Oncorhynchus gorbuscha*
Brook trout	*Salvelinus fontinalis*
Rainbow trout	*Oncorhynchus mykiss*
Cutthroat trout	*Oncorhynchus clarki*
Unknown/Unidentified Char*	*Salvelinus* sp
Sculpins	*Cottus* sp
Lamprey	*Lampetra* sp

**In the early 1980's a WDFW staffer checked an angler fishing below highway 101 who had caught an "unknown" char. Also, in 1998 USFWS personnel captured a char from Penny Creek and had a tissue sample analyzed. The sample did not match either bull trout or brook trout collections.*

Avian predators commonly observed include gulls, bald eagle, osprey, great blue heron and kingfisher. River otters also occur in the Big Quilcene River and have the potential to prey on program fish.

Salmon and Steelhead Hatcheries in and around the Watershed[38]

Quilcene National Fish Hatchery (U.S. Fish and Wildlife Service)

The Quilcene NFH occupies approximately 47.4 acres. Its main facilities consist of 39 8-foot x 80-foot raceways, three water intake structures (two on the Big Quilcene River and one on Penny Creek), a pre-settling pond, a pollution abatement pond, a hatchery building (containing the office, laboratory, and tank room), an isolation/quarantine building, and a shop building, all of which are located on the west bank of the Big Quilcene River at RM 2.8. One residence, a small cabin, and a log house are on the hatchery grounds proper, and two other residences for hatchery staff are situated on a hill just north of the hatchery. The hatchery diverts returning adult salmon to holding facilities by means of a graduated-field electrical weir and fish ladder at RM 2.8.

The hatchery is funded by Congressional appropriation of hatchery operations funds to the Service and the Service's hatchery cyclical maintenance fund. The operational budget for FY2008 was $617,343. Costs for monitoring and evaluation (M&E) and fish health in FY2008 were approximately $100,000 and $91,000, respectively. Capital Improvements to the Quilcene NFH have totaled $907,797 during the period 2004- 2008.

Funding Source: FY2008	Amount
Appropriations to USFWS	$497,752

[37] *Pers. comm. Dave Zajac and Larry Telles, Hatchery Review Team, 2008.*

[38] *See Figure 3.*

USFWS –Hatchery Cyclical Maintenance	$119,591
Total	$617,343

Port Gamble (Bay) net pens (Port Gamble S'Klallam Tribe)

There are two net pens, 50' square by 25' deep with ½" mesh. The pens are hung from a stainless steel framework that is supported by foam-filled plastic floats and anchored to the bottom of the bay. A bird net, to protect against bird predators, is suspended above each net pen. Walkways on the framework and along the periphery of the net pens accommodate fish feeding, equipment maintenance, and periodic growth monitoring and fish health sampling. A solar-powered, photocell controlled navigation light is placed on the pens to meet U.S. Coast Guard requirements.

Quilcene Bay net pen (Skokomish Tribe)

The net pen is 50' square by 30' deep with ½" mesh. The pen is hung from a stainless steel framework that is supported by foam-filled plastic floats and anchored to the bottom of the bay. A bird net, to protect against bird predators, is suspended above the net pen. Walkways on the framework, along the periphery of the net pen, accommodate fish feeding, equipment maintenance, and periodic growth monitoring and fish health sampling. A solar-powered, photocell controlled navigation light is placed on the pens to meet U.S. Coast Guard requirements.

Quilcene NFH Coho

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- **Harvest goal:** Support commercial, tribal and sport fisheries coast wide (Alaska, British Columbia, North Coast, Strait of Juan de Fuca) and in the Big Quilcene River, Hood Canal, and Admiralty Inlet. A quantified harvest goal has not been established. On-station releases**:** Based on a desired 5.0% smolt to adult return rate (harvest plus hatchery escapement) and the current program size, the predicted potential harvest would yield 18,800 adult coho per year. Quilcene net pen releases: Assuming that net pen survival to adult is similar to on-station releases, the predicted potential harvest would be 10,000 adult coho per year.

- ***Broodstock escapement goal***: Trap and spawn 600 adult pairs: 600 females and 600 males of which at least 60 are jacks (age 2 males).

- ***Conservation goal***: None identified.

- ***Escapement goal for natural-origin adults***: No escapement goal for natural-origin adults has been identified for coho salmon in the Big Quilcene River. However, Quilcene NFH annually passes up to 600 adult coho of mixed origin above the hatchery weir.[39]

- ***Research, education, and outreach goals***: None identified.

Objectives

- Spawn 600 females and 600 males (including at least 60 jacks that are males) to yield 1.68 million green eggs. Trapped adults in excess of broodstock needs are provided to Washington tribes for subsistence as a first priority.

- Cull eggs from each female parent to yield a total of 1.14 million eyed eggs (eggs are culled randomly from each female so that all female parents are represented approximately equally).

- Transfer 450,000 eyed eggs to George Adams State Hatchery for hatching, rearing, and subsequent transfer to Port Gamble S'Klallam Tribe's net pens. George Adams eggs are taken in the 2 or 3 spawn takes from the peak spawning time to ensure there are enough eggs to ship and to retain on site to maintain overall population integrity.

- Release 400,000 smolts on-station into the Big Quilcene River.

[39] *Zajac, Dave. 2002. An Assessment of Anadromous Fish Habitat Use above Quilcene National Fish Hatchery in the Big Quilcene River. U.S. Fish and Wildlife Service, Western Washington Office, Lacey, Washington.*

- Transfer 200,000 yearling smolts in January-March to the Skokomish Tribal net pen in Quilcene Bay.

- Trapped adults in excess of broodstock needs are provided as a first priority to Washington tribes for subsistence.

- Up to 600 returning adults are passed above the hatchery weir for purposes of natural production and ecosystem functions.

Program Description

This stock has been artificially propagated since 1911 and currently exhibits a range of run timing that is approximately one to two months earlier than other hatchery and natural stocks of Hood Canal coho. The program historically received some eggs from Hoodsport Hatchery, the Skokomish, Duckabush, Skagit (Skagit region), Skykomish (Stillaguamish/ Snohomish region), Dungeness (Eastern Straits region), Quinault (North Coast region) and Clackamas (Oregon) rivers, and Lake Washington (Lake Washington sub-region of Central Puget Sound). These transfers occurred sporadically, and the Quilcene NFH coho stock is believed to largely represent the ancestral lineage of the original Quilcene River stock, although the stock has been propagated artificially for more than 30 coho generations. The last eggs were imported in 1973. The hatchery currently releases 400,000 yearlings on-station. An additional 200,000 smolts are released from floating net pens in Quilcene Bay (Skokomish Tribal program). Adult collection, incubation, and pre-smolt rearing occur on-station.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- Potential spawners are randomly selected from the receiving channel on a set schedule, e.g., 50 pairs the first week, 100 pairs the next, etc., so that an approximately normal distribution curve is described over a six-week period. A Pescalator™ is used to bring fish from the receiving channel to a sorting table and is believed to be non-selective based on fish size. Adults returning to the receiving channel that have been severely wounded in fisheries are typically not retained for broodstock as they are quickly infected with fungus which then spreads to other fish if not controlled.

- Broodstock are collected from coho trapped at the hatchery. Natural-origin coho, if trapped, are not excluded from the broodstock.

- A minimum of 10% of the males spawned are jacks, per HSRG recommendations. A temporary protocol of 20% jacks (480 3-year old males, 120 2-year old males) is currently being implemented over a minimum of 2 generations (broods 2007-2012) to compensate for the previous

exclusion of jacks and the lack of adequate gene flow among broodyears that resulted historically in three genetic broodlines with different characteristics (e.g., return-time profiles).

- Quilcene NFH coho currently exhibit a mean adult return date that is approximately three weeks to one month earlier than other hatchery and natural stocks of Hood Canal coho, induced by hatchery practices.

Hatchery and Natural Spawning, Adult Returns

- The returns to the Quilcene NFH rack have ranged from 1,415 to 28,882 coho between 1986 and 2006. The rack returns averaged 3,359 fish between 1986 and 1993. The average rack returns averaged 11,492 between 1994 and 2006. Closure to the West Coast Vancouver Island Canadian Fishery occurred in the mid 1990's. The average surplus return between 2001 and 2005 was 13,217 adult coho salmon. 54% of the surplus returns were distributed to area tribes for subsistence, 42.6% were sent to processors, and 1.9% were released above the weir.

- Coded-wire tag data from broodyears 1993-2002 were used to determine stray rates of Quilcene NFH stock coho to Big Beef Creek from the releases that occur at Port Gamble Bay net pens, Quilcene Bay net pens, and on-station at Quilcene NFH. The stray rates were calculated as a percentage of harvest and as a percentage of fish released. Quilcene stock coho salmon reared at George Adams and transferred to Port Gamble Bay net pens strayed at substantially higher rates (7.06% of harvest; 0.12% of release) than coho reared at Quilcene NFH and released either from the hatchery (1.37% of harvest; 0.01% of release) or Quilcene Bay net pen (1.76% of harvest; 0.02% of release)[40]. Insufficient data are available to estimate stray rates to other locations or for other stocks of coho salmon reared at any of these facilities.

- The commercial fishery for coho salmon in Quilcene Bay is predominantly a tribal fishery, but a small all-citizens commercial fishery also occurs. Fisheries in the Big Quilcene River include an all-citizens sport fishery and tribal subsistence and commercial fisheries. Excess adults to the hatchery rack support local tribal subsistence programs and are provided to the Grays Harbor Food Bank.

- Genetic study of Hood Canal coho indicated that wild populations of coho salmon in Hood Canal retain a level of population structure and levels of genetic diversity that are typical of those exhibited by this species in other parts of the Pacific Northwest. Comparison of the presented results suggests that the hatcheries in Hood Canal have not genetically homogenized natural populations in Hood Canal. However, levels of genetic divergence among the three adult broodlines propagated at Quilcene NFH are equal to or greater than the divergence among natural populations in Hood Canal. [41]

- A minimum of 1,200 hatchery-origin adults (600 pairs) are needed to meet current release and transfer objectives.

- Fish passage above Quilcene NFH has been controlled since the facility was constructed.

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[40] *These estimates are primarily based on coded-wire tag data collections at Big Beef Creek where intensive monitoring occurs. Data extracted from the Regional Mark Information System, www.rmpc.org.*

[41] *U.S. Fish and Wildlife Service. 2007. Genetic Analyses of Coho Salmon Populations in Hood Canal: How similar genetically are hatchery and natural populations? Final Report. Abernathy Fish Technology Center. Longview, WA.*

- Before 1984, approximately 800 adult coho were passed upstream each year. Starting in 1991, no adults were passed, but 25,000 fingerlings were outplanted above the weir. In 1997, adult passage resumed at up to 600 adult coho per year.

- Currently, up to 600 adult coho are passed upstream on Big Quilcene River above the hatchery weir (based on a rough estimate of spawning habitat availability), regardless of sex ratio, hatchery- or natural-origin, or other characteristics.[42]

- In 1990, the current weir was constructed, virtually eliminating all volitional passage by adult fish past the weir at Quilcene NFH during low flows. The bypass ladder, intended to facilitate fish passage, has not been operable since a few years after the weir was constructed due to infill by gravel that migrated downstream and accumulated above the weir. In the summer of 2009, gravel will be removed and the ladder modified to improve the potential for fish passage.

- To protect the hatchery's water supply and manage broodstock collection and fish passage, during coho and chum adult returns the electronic portion of the weir is activated if the river flows are high enough to allow fish to pass over the weir's concrete apron. Chum are restricted from passage above the weir due to the disease risk they pose to fish reared at the hatchery (IHN has been isolated virus at Quilcene NFH in summer and fall chum). However, the hatchery sees very few chum as far upstream as the hatchery since no chum have been reared and released from the hatchery since 2003 and both summer and fall summer chum stocks prefer to spawn in the lower reaches of the river. Currently, no attempt is made to restrict the passage of adult steelhead. However, there has been no effort directed at assessing the disease risk posed to the hatchery by steelhead.

- Little over-wintering habitat is available for natural populations of coho in the Big Quilcene River.

- Three reproductively distinct brood lines of coho have evolved at Quilcene NFH as a result of the past practice of excluding two-year old males (jacks) from the broodstock, thus resulting in the artificial spawning of nearly 100% three-year old adults for several coho generations. The three broodlines now exhibit characteristically different return time profiles with about one week of separation between the broodline mean dates of return and up to two weeks separation between the early and late broodline mean dates of return.

- The earliest returning coho each year may be held for up to 4-6 weeks before they are sexually mature and spawned.

- The adults are treated with hydrogen peroxide dripped into the adult raceway (running at 250 gallons per minute of water flow) at 250 parts per million for 30 minutes 3 times per week to prevent the onset of fungal infection.

- Broodstock are spawned without selecting for size.

- Coho are spawned by combining the gametes of one male and one female (protocol since 1989) in each three-gallon stainless steel bucket.

- All spawning equipment is rinsed in iodine solution before use on other fish.

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[42] *Zajac, Dave. 2002. An Assessment of Anadromous Fish Habitat Use above Quilcene National Fish Hatchery in the Big Quilcene River. U.S. Fish and Wildlife Service, Western Washington Office, Lacey, Washington.*

- Eggs are then pooled after one to five minutes (eggs from six females) into one stainless steel bucket and taken to the hatchery building for rinsing. Rinsing consists of adding Penny Creek water and pouring off any fish tissues, blood, debris, etc. This procedure is repeated until the eggs are clean.

- Penny Creek, since it is an anadromous-fish free water source with a lower silt load than other sources available, is used for cleaning and mixing the eggs and milt during spawning.

- The last egg rinse is with a 75 parts per million solution of iodine to prevent dilution of the stock solution. The eggs are then placed into wire baskets that are suspended in a stainless steel trough with 75 parts per million iodine solution for 30 minutes. Each wire basket holds eggs from twelve females.

- Jacks have been incorporated into broodstock since 1991. In 2003, the use of jacks was increased to 10% of males in accordance with a recommendation of the HSRG. Jacks were excluded from the broodstock for 80 years. Starting in 2008, jack use was increased to 20% of returning males and will continue at this level for the next 5 years. This is a response to the discovery that the coho population had evolved into three separate broodlines resulting in 3 different return timings. The restoration of jacks into the broodstock should result in unifying the hatchery coho population once again into more naturally homogenous broodlines.

Incubation and Rearing

- The eggs are then placed in deep egg troughs for incubation at 10 gallons per minute of Penny Creek water. Enough eggs are taken on each spawning day to allow culling and/or removal of unneeded eggs and still allow for a representation of that spawning day in the timing of the run.

- Eggs are treated for fungus control with formalin three times a week until the eyed stage. Formalin is introduced at the head of the trough and again at the mid-point to maintain a full concentration level of 167 parts per million.

- The eggs are then placed in deep egg troughs for incubation at 10 gallons per minute of Penny Creek water.

- Eggs are kept in baskets in deep troughs until development to the eyed stage (eye-up) at which time the eggs are shocked, sorted, and placed into vertical stack incubators at 5,000 eggs per tray with Vexar substrate. A counter is used to enumerate the eggs. Each vertical stack incubator is operated at 4 gallons per minute.

- Green to eyed egg survival is about 92.03% (1997-2007); eyed egg to hatch survival averages about 98% and fry to smolt release survival average is about 87% (this is the average before the raceways were otter-proofed).

- USFWS transfers 450,000 eyed eggs to George Adams at eye up in November-December. This group represents one to three spawn-take days. Either 100% of the adults spawned on each day or a designated subsample of adults are sampled for viral pathogens. Transfer occurs after passing viral screening and after shocking and enumerating at the eyed stage. These fish will be reared then transferred to the Port Gamble Bay net pens operated by the Port Gamble S'Klallam Tribe.

- Culling occurs at two points to yield the 1.14 million eyed eggs for the program, at the beginning of incubation and at ponding.

- After hatched fry have absorbed their yolk sac ("buttoned up"), they are placed directly into outdoor 8-foot x 80-foot concrete raceways.

- Fry are initially ponded into the 9 "A" bank raceways at around 75,000 fry per raceway.

- The coho are fed five times per day until they are transferred from "A" bank to 9 "B" and 6 "D" bank raceways, after which they are fed twice daily.

- Sample counts are performed three times per month when the fish are fry, two times per month in the summer during more rapid growth and only one time per month in the winter when growth is slower.

- An inventory is performed when fish are transferred between the "B" and "D" bank raceways using a Vaki counter combined with the Heathro fish pump. The fish are also counted when they are passed through the marking trailer to be adipose-fin clipped and/or coded-wire tagged. Since otter predation has been largely abated and bird predation is not great (at present), no further inventories are performed to minimize handling stresses to the fish.

- The fish are split for the last time in June, after the previous year class has been released and the raceways have been pressure-washed and disinfected with a 100 parts per million solution of chlorine which is usually applied on dry, sunny days to assure rapid breakdown in sunlight.

- Every attempt is made to split the fish into their final pond configuration in advance of the density index reaching 0.20. Splits occur between "A" (approximately 7 of 11 raceways utilized), "B" (approx. 10 of 10 raceways utilized) and "D" (approx 7 of 10 raceways utilized) banks.

- The Quilcene NFH program, at full production, can exceed the Service's maximum "recommended" density index (lbs/cubic ft / mean total fish length in inches) for coho, which is 0.2 DI At full production, densities can reach up to 0.3 DI in early spring (February – April) when both the direct-stream release (400,000) and Quilcene Bay net pens (200,000) coho are reared on station.

- Flows are approximately 500 to 600 gallons per minute per raceway. The maximum flow index (lbs/gallons per minute flow/mean total fish length in inches) is 0.7 with a water turnover rate of once every 19 minutes per raceway.

- Lack of water availability requires that a large number of fish be reared on untreated, serial reuse water for much of their hatchery residence. The serial reuse system transfers water from bank "A" to "B" and then to "D", or from "C" to "D". All banks are able to use first pass water; however, for about nine months out of the year, only banks "A" and "C" can be operated on first pass water and "B" and "D" on re-use water. Re-use water is not available on "C" bank raceways.

- Fish destined for transfer to the Quilcene Bay net pen are reared in "A" bank until the fall when river flows increase to a point where there is an adequate amount of water available to rear the fish on first pass water in "C" bank. The fish are moved from "A" bank to make room for young-of-

year coho. The on-station release portion of the program uses 9 "B" bank raceways and 6 "D" bank raceways.

- Marking and tagging occurs in September.

- Coldwater disease occurs annually but varies in intensity. Cold water disease is primarily avoided by the careful monitoring of densities and frequent flushing/cleaning to prevent the buildup of a large pathogen population. Antibiotics are rarely used.

- Regular cleaning, improved feeds, and regular diagnostic checks by OFHC are measures taken to reduce disease risks.

- Raceway densities are reduced by 10% to 20% for each serial reuse (e.g. fish in "B" bank are maintained at a density that is 10 % to 20% less than "A" bank and "D" bank has a density index that is 10% to 20% less than "B" bank).

- All pond brushes, brooms, and nets are disinfected in iodine solution between ponds.

- Each raceway is cleaned on Monday, Wednesday, and Friday, with hand brooms. The tails, or bottom one third of each raceway is cleaned Monday-Friday when utilizing reuse water.

- Predation by birds and otters has been a problem at Quilcene NFH over the last few years, but a significant improvement against otter predation was made in the last year when a metal barrier was erected around all the raceways.

Release and Outmigration

- Unfed fry in excess of program needs were historically discarded into the Big Quilcene River at the top of the adult ladder. Quilcene NFH recently discontinued this practice. Surplus eyed-eggs are buried prior to hatch.

- The on-station production occupies about 15 raceways in "B" and "D" banks. Four unique coded-wire tag groups of 10,000 each and four more unique double index-tag (DIT) groups[43] of 10,000 each are tagged into four separate raceways (one pair of clipped and tagged and tagged only (DIT)). Usually three in "B" bank and one in "D" bank. The ponds are selected so that as many spawn takes as possible are represented by the tags. The remaining fish are adipose clipped (mass marked).

- Coho destined for the transfer to the Quilcene Bay net pen occupy seven raceways in "A" bank. In this case since the fish are ultimately going to be moved to a single saltwater pen, one unique code and adipose clip is applied to 40,000 fish in two of the raceways. No DIT group is applied to the net pen releases. The remaining fish are adipose clipped (mass marked).

- Fish are force released at the end of April or beginning of May. The fish are released passively by removing the dam boards at the end of the raceways so that fish will migrate at night through the tail races of "B" and "D" banks through the adult receiving channel (which is also the tail box of "D" bank). After about 12 hours, those fish that remain in the raceway are forced out.

[43] *(DIT) groups, fish with internal tags but no visible marks that indicate they are hatchery origin.*

- Six to eight weeks prior to transfer of the coho yearlings to the net pens and eggs to George Adams (adults/parents are examined in this case), the Service performs standard pre-transfer fish health examinations.

- Approximately 200,000 coho in "C" bank are transferred to the Quilcene Bay net pen in February or March. The fish are pumped out of the raceways into WDFW transport trucks and hauled to the marina at Quilcene Bay where they are transferred to a tribal barge and hauled to the net pen. They are bath-vaccinated against "*Vibrio*" en route and salt water slowly displaces freshwater in the barge. Three to four weeks prior to the intended transfer date, phytoplankton sampling in Quilcene Bay is initiated. Samples are collected every 1-2 weeks, or more intensively if harmful algal blooms (HAB) spp. are detected. Plans to move the fish out can be adjusted in accordance with the findings; if HAB spp. are detected at elevated levels that could harm the fish, a delay in the transfer date is considered. One week prior to moving all of the fish out, 100 fish are transferred to a small net enclosure within the net pen and monitored up until the entire group of fish is moved out. Monitoring the test fish includes observing their behavior for signs of distress, occurrence of mortality and microscopic examination of the gills of a subset of fish to determine if plankton is damaging the gills. Phytoplankton samples are also collected during this period. If mortality due to HAB spp., damage to gills, or rapidly increasing levels of HAB spp. are observed, the plans to move the fish are adjusted accordingly. Once the fish are in the net pen, fish health and phytoplankton monitoring continues throughout the rearing period. The coho are released either in June when they reach 10 fish per pound or when HAB spp. exceeds critical levels.

- Starting in 2004, the above management strategy was implemented that relied on the results of phytoplankton monitoring in Quilcene Bay and survival of sentinel fish placed in the net pen to determine the transfer date to Quilcene Bay net pen that would pose the lowest risk of HAB-related problems. In general, this strategy has resulted in transferring fish later in March. From 1995 through 2003 and in 2006 the transfer occurred in February (range February 2 – 23). In 2004, 2005, and 2007 the transfer occurred between March 8-26.

Facilities and Operations

- Up to 15 raceways are either left empty throughout the year, or some are utilized for holding adults.

- The weir currently poses a physical barrier to migrating fish during periods of low flow. Though it is shut off after January 1, steelhead could only access the Big Quilcene River upstream of the hatchery during periods of high water since access upstream via the weir's bypass ladder was blocked by gravel deposited above the weir and in the ladder. The bypass ladder was successfully opened in March 5, 2009.

- The weir impedes downstream transport of gravel and diverts gravel into the fish bypass, requiring regular maintenance. However, gravel deposits have not been removed for some time, preventing the use of the fish bypass ladder and disturbing the hydrology of the stream. Additionally, stream bank protection is required due to the placement of the weir.

- Quilcene NFH's water right for water coming directly from the Big Quilcene River (No. S2-28170) requires that 50 cfs remain in the Big Quilcene river bypass area from July 1 through February 28 (29) and 83 cfs from March 1 through June 30. Due to this bypass requirement, Quilcene NFH cannot withdraw more than 15 cfs from the Big Quilcene River during certain times of the year.

- The Penny Creek water right is 40 cfs. Penny Creek is the sole water source for the incubation building and is also used for the raceways.

- Currently, hatchery staff use a temporary spawning facility, including an unheated canopy structure, mobile Pescalator™ for retrieving broodstock, and tables that are erected next to the receiving channel during spawning. The spawning area is also not conducive to visitor traffic. Visitors interested in the spawning process are not protected from the work area. The area is especially unsafe when hatchery staff are operating a forklift to move totes of surplus coho onto waiting trucks.

- Incidental spawning material (blood and slime) is hosed down through a drain that enters directly into the river.

- Until recently, there were no shade covers over the raceways. One shade structure was erected over one of the "A" bank raceways in 2008; however, the other raceways remain uncovered.

- Intake screen mesh size does not comply with NOAA Fisheries guidelines (3/32"). The current mesh size is ¼".

- The intake screen is located at the outlet of the pre-settling pond versus the inlet which is standard at most facilities. This allows a population of entrained fish to persist in the pre-settling pond, which is a fish health concern.

- The adult exclusion device on the pollution abatement pond is insufficient. The device utilizes a flexible "tide gate" type hose fitting which expands during discharge and opens wide enough to allow access to returning adult fish but does not close sufficiently to exclude adult fish.

- The location of the hatchery entrance road is hazardous. The entrance road is off of highway 101. The location of the highway bridge over the Big Quilcene River in proximity to the entrance road limits the distance drivers can see when they exit the hatchery.

- Vehicle access for tribal fishing on Quilcene NFH grounds below the weir is inadequate.

- The total deferred maintenance for the facility is $3,459,920 (SAMMS, 2008).

Research, Education, and Outreach

- Public visitation opportunities are provided via the "camp host" program where the hosts maintain the visitor's center and guide tours. A trailer pad and accommodations are available for volunteers who help maintain the facility and provide visitor services as part of the Camp Host program which runs from May to September.

- Specific educational opportunities are coordinated with local schools. Several school groups visit the hatchery, especially during the spawning season. The hatchery has also established a relationship with Islandwood, an environmental learning center on Bainbridge Island which reaches 4th, 5th, and 6th grade children in the greater Puget Sound area.

- Quilcene coho were the subject of an extensive genetic analysis by Abernathy Fish Technology Center. The analysis concluded that the three broodlines at Quilcene NFH are nearly as divergent genetically as the wild populations in Hood Canal. Natural populations of coho salmon in Hood

Canal retain spatial structure, indicating that they have not been homogenized genetically by hatchery-origin fish. However, levels of genetic diversity within each broodline at Quilcene NFH are significantly less than within-population levels of genetic diversity for each of the wild populations analyzed.

- A Penny Creek fish passage feasibility study was completed. No evidence was found regarding whether Penny Creek was accessible to anadromous fish or not prior to the construction of the hatchery. The study concluded that there is some suitable habitat upstream that may produce up to about 400 coho for harvest and return. However, there are also two other obstructions (culverts) upstream of the hatchery. Consequently, the HET has recommended that fish passage into Penny Creek not be pursued at this time.

- The visitor facilities are limited with little or no signage or explanatory material.

- Housing has been made available to WDFW enforcement during emphasis patrols (during coho and summer chum returns) and to accommodate visiting researchers.

- Tissues (fin samples from 100 adults) are collected annually and archived for future analysis of genetic trends/changes in the population

- Marking and tagging is conducted to assess survival and contribution to fisheries.

- A web site has been developed with a goal to periodically update and improve it, and focus reports are available to the public that provide an update on the status of the programs.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[44] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- For Quilcene NFH coho released at the hatchery, the program confers significant sport, tribal, and commercial harvest benefits as well as returns to the hatchery that are used for broodstock and subsistence. For broods 1993-2002, on average approximately 16,500 coho are recovered annually. The distribution of those recoveries is: 62% (10,200) recovered at the Quilcene NFH; 2% (300) from US commercial fisheries; 15% (2,500) from US sport fisheries; 19.0% (3,100) from treaty tribal fisheries; 1% (150) from Canada commercial fisheries; 1% (150) from Canada sport fisheries; 0.2% (30) from spawning ground surveys; and 0.03% (5) recovered from research type activities.[45]

[44] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[45] *These data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were few and are not expected to significantly change the proportions reported above. The spawn ground recoveries occurred from Big Beef Creek (70%), Little Quilcene River, Duckabush River, Fulton Creek, John Creek, Jorsted Creek, Lilliwaup River, and Walcott Slough.*

- For Quilcene NFH coho released at the Port Gamble net pens, the program confers significant sport, tribal, and commercial harvest benefits. For broods 1993-2002, on average approximately 5,900 coho are recovered annually. The distribution of those recoveries is: 4% (235) recovered at various hatcheries; 6% (350) from US commercial fisheries; 30% (1775) from US sport fisheries; 50% (2950) from treaty tribal fisheries; 0.6% (35) from Canada commercial fisheries; 2% (100) from Canada sport fisheries; 8% (475) from spawning ground surveys; and 0.03% (2) recovered from research type activities.[46]

- For Quilcene NFH coho released at the Quilcene Bay net pen, the program confers significant sport, tribal, and commercial harvest benefits. For broods 1993-2002, on average approximately 4,000 coho are recovered annually. The distribution of those recoveries is: 54% (2,200) from Quilcene NFH; 1% (40) from US commercial fisheries; 21% (850) from US sport fisheries; 23% (900) from treaty tribal fisheries; 0.3% (10) from Canada sport fisheries; 0.5% (20) from spawning ground surveys; 0.05% (2) recovered at various hatcheries other than Quilcene; and 0.07% (3) recovered from research type activities[47]

- Due in part to the early return time (mid-August through November), the Big Quilcene River coho sport fishery has become extremely popular in recent years.

- The early return time makes coho a highly valued species to local tribes because Quilcene coho are available before other stocks are available for harvest.

- The estimated total annual economic value of commercial and sport caught coho reared at Quilcene NFH is approximately $1,500,000.[48]

Conservation Benefits

- None identified.

Research, Education, Outreach and Cultural Benefits

- The program confers significant tribal harvest, ceremonial, and subsistence benefits via coho caught by the tribes or surplus coho taken at Quilcene NFH. The average surplus return between 2001 and 2005 was 13,217 adult coho salmon. Fifty-four percent of the surplus returns were distributed to area tribes for subsistence.

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[46] *These data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were few and are not expected to significantly change the proportions reported above. The spawn ground recoveries occurred from Big Beef Creek (89%), Blackjack Creek, Dewatto River, Dogfish Creek, Gamble Creek (8%), Martha John Creek, Lilliwaup Creek, McTaggert Creek, Queets River, Seabeck Creek, Skokomish River, and Steele Creek. The "other" hatchery recoveries were from Cowling Creek, Garrison, George Adams (28%), Grovers Creek, Hoodsport Hatchery (57%), Lower Elwha, Minter (4%), Portage Bay, Quinault, and Quilcene (6%).*

[47] *These data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were few and are not expected to significantly change the proportions reported above. The spawn ground recoveries occurred from Big Beef Creek (75%), John Creek, Seabeck Creek, Big Quilcene River, Eagle Creek, Hamma Hamma River, Johnson Creek, Little Quilcene River, Pierce Creek, and Rocky Brook. The "other" hatchery recoveries were from George Adams, Hoodsport, and Minter.*

[48] *Caudill, USFWS, pers. comm. 2008.*

- The program provides educational opportunities to school groups visiting the hatchery.

- Residents appreciate upstream passage of adults related to wildlife viewing. Wildlife is attracted to the area to take advantage of adult carcasses.

- Recovery of coded-wire tags from hatchery-origin adults provides long-term assessments of trends in marine survivals and harvest rates, but this is not a benefit unique to this program or stock.

- The long history of artificial propagation of Quilcene NFH coho provides a potential resource for assessing the long-term genetic effects of artificial propagation and domestication selection on populations of Pacific salmon. For example, Quilcene NFH exemplifies the predicted, based on theoretical considerations, long-term genetic effects of selectively excluding jacks from the broodstock: that is, the evolutions of three distinct broodlines with significant genetic and phenotypic divergence among them.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[49] the Review Team identified the following benefits of this program:

Harvest Benefits

- Ocean harvest outside of Hood Canal occurs in the Strait of Juan de Fuca, along the north coast of Washington, in Canada, and in Alaska.

- The average exploitation rate for broodyears 1987–2002 was 41% to U.S. commercial, 21% to Canada commercial, 22% to U.S. sport, 6% to Canada sport, and 10% to Treaty Tribal.

Conservation Benefits

- The adults passed upstream provide a conservation benefit to the Big Quilcene River ecosystem in terms of providing marine derived nutrients and direct forage for scavenging birds, mammals, and invertebrates.

Research, Education, Outreach and Cultural Benefits

- The program confers harvest, ceremonial, and subsistence benefits to tribes outside of the Hood Canal basin.

- Quilcene NFH has participated in fish health studies that support drug registration efforts at a national level.

- Double-index tagging contributes to the evaluation of selective fisheries and provides harvest exploitation rates on wild stocks in Hood Canal assuming similar marine survivals.

[49] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[50] the Review Team identified the following risks of the hatchery program:

Genetic Risks

- Past management practices appear to have resulted in three genetically distinct broodlines. This appears to be correlated with reduced amounts of within-broodline genetic diversity relative to natural populations in the Hood Canal area.

- The operation of the Quilcene NFH coho program for nearly 100 years likely resulted in the functional extirpation of a natural population of coho in the Big Quilcene River. This, in effect, has reduced the spatial structure and genetic diversity of coho in Hood Canal as a whole.

Demographic Risks

- Lack of shade covers over the raceways concentrates fish in shaded areas along raceway walls during summer months, increasing densities, potential stress, and disease risks.

- Serial reuse between the different banks of raceways poses a fish health risk.

Ecological Risks

- Fish passed upstream pose an increased fish health risk to the propagated stock.

- Occasional loss to predation occurs.

- Occasionally steelhead and other fish native to the Quilcene River enter the raceways, posing an increased fish health risk.

- Algae blooms in Quilcene Bay in some years prevent timely transfer of coho to the net pens. This could result in increased rearing densities since coho would be kept on station until the blooms recede, posing a fish health risk.

Physical Risks

- Inadequate spawning facilities pose a safety risk to staff. During spawning, staff are exposed to freezing weather and work with temporary equipment that could pose safety risks.

- The location of the entrance to the hatchery at the bottom of a long steep grade on a major U.S. highway (U.S. 101) with extensive truck and recreational traffic results in a traffic safety risk to visitors and employees exiting or entering the facility premises, particularly in the fog or rain. A combination of high speed and limited sight distance (due to the angle of approach to the Big Quilcene bridge) create an increased risk of accidents for motorists as they exit the Quilcene National Fish Hatchery

[50] *Ibid.*

- The vehicle access road to hatchery property on the east bank of Quilcene River, immediately south of the highway 101 bridge over the river, poses a traffic safety risk to tribal fishers and buyers.

- The electric weir poses an inherent human safety risk to employees performing weir maintenance or fishermen and other people trespassing across the weir.

Research, Education, Outreach and Cultural Risks

- None identified.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[51] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- The Quilcene NFH program may pose a genetic risk to other coho populations in Hood Canal, limited to the degree of overlap in spawn time between the earlier returning Quilcene NFH coho and the later returning Hood Canal coho population, and limited by the degree of straying that occurs. Stray rates are higher for the net pen reared fish than for fish released on-station.

Demographic Risks

- The release of untreated effluent from the spawning area poses health risks to fish and other species downstream of Quilcene NFH.

- Incidental take on summer chum salmon in the coho directed fishery poses a demographic risk to the ESA-listed Hood Canal summer chum population. Extreme terminal area exploitation ranged from 0.2% to 39.4% (17.7% average) for Quilcene unit summer chum.[52] Incidental catch of summer chum is exacerbated by the early hatchery coho return timing that was induced by hatchery practices. The level of incidental take is within NOAA Fisheries recovery guidelines for Hood Canal summer chum.

- Human trampling of summer chum redds during the in-river recreational coho fishery poses a demographic risk to the native Big Quilcene summer chum population.

- The weir and nonfunctioning weir bypass inhibits volitional upstream migration of winter steelhead and other wild fish populations native to the Big Quilcene River.

Ecological Risks

- The Quilcene NFH program may pose an ecological risk to other coho populations in Hood Canal. Early emerging coho progeny of naturally spawning Quilcene NFH coho may have a competitive advantage compared to later emerging natural-origin Hood Canal coho. However, the hatchery

[51] *Ibid.*

[52] *Table 3-6 on page 33 of WDFW and PNPT Tribes (2007). <http://wdfw.wa.gov/fish/chum/chum.htm>*

coho may be less fit than natural coho owing to potential effects of hatchery domestication and thus the potential impact from competitive advantage owing to early emergence may be reduced or nonexistent.

- The potential for offspring of hatchery strays to compete with local natural populations is greater from the net pen programs than from the Quilcene NFH.

Research, Education, Outreach and Cultural Risks

- None identified.

Recommendations for Current Program[53]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

Issue QL1: Present program goals for Quilcene NFH coho are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QL1: Restate program goals to identify the number of harvestable adult coho desired and achievable from this program in the ocean and in nearshore waters. For example, for on-station releases, the current program size and post-release survivals leads to a mean harvest of approximately 8,000 adult coho per year (brood year 1989-2000). Release and return data (including harvest) could be used to develop the program goal.

Work with comanagers to establish goals (e.g. actual number, percent of total catch, etc.) for the net pen programs dependent upon Quilcene NFH coho so that the Quilcene NFH coho program can continue to be sized appropriately.

[53] *The Review Team believes that the Quilcene NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

Issue QL2: There is no clearly defined escapement goal for natural coho production in the Big Quilcene River. *Currently up to 600 coho adults of mixed origin are passed above the hatchery weir annually. There is no attempt to differentiate hatchery and natural origin returns. These fish and their progeny provide ecosystem functions such as nutrient enhancement and forage for other species. Progeny also contribute to subsequent adult coho returns but the current level of natural production is unknown*

Recommendation QL2: Consult with comanagers to determine whether there is a desired natural production goal in the Big Quilcene River, and if so, quantify the goal. This may lead to modification of the present numerical passage goal and composition of adult coho passed upstream. See also QL5.

Broodstock Choice and Collection

Issue QL3: Past management practices appear to have resulted in three genetically distinct broodlines. *This appears to be correlated with reduced amounts of within-broodline genetic diversity. A temporary protocol requiring that two-year old males (jacks) constitute at least 20% of all spawned males is currently being implemented over a minimum of two generations to compensate for the previous exclusion of jacks and the lack of adequate gene flow among broodyears.*

Recommendation QL3a: Continue to the support effort to reduce genetic divergence among the broodlines.

Recommendation QL3b: Compare the survival, ages, and body sizes of progeny of two-year old males versus the progeny of three-year old males to determine if there is a genetic component to age and size at sexual maturity.

Issue QL4: The present objective is to operate Quilcene NFH coho as a segregated hatchery population. Current broodstock selection includes both marked and unmarked adults, and fish passed upstream include both marked and unmarked adults. *Although there is a double index tag group included in the Quilcene NFH program resulting in some hatchery-origin adults returning unmarked, broodstock collection may include natural-origin adults in the broodstock, and hatchery-origin adults are passed upstream and could spawn naturally* **.**

Recommendation QL4: In conjunction with discussions regarding management objectives for natural production in the Big Quilcene River (Issue/Rec QL2), evaluate the extent to which coho spawn naturally in the Big Quilcene River upstream of the weir. If it is determined that there is significant reproductive success, improve broodstock and adult passage management practices to better segregate the hatchery population. See also QL5.

Hatchery and Natural Spawning, Adult Returns

Issue QL5: Passing coho above the weir represents a tradeoff between natural production and fish health risks to the hatchery. *Coho are passed above the weir to utilize potential coho spawning habitat, for nutrient enhancement and to provide direct forage for scavengers. The present management strategy to pass up to 600 adults upstream above the weir assumes an even sex ratio and does not distinguish between hatchery and wild. The number of fish was*

calculated by assuming a production of 2.5 smolts per linear yard of available spawning gravel. Management intent is also to pass winter steelhead above the hatchery weir and that practice is expected to continue regardless of future passage strategy for coho.

Recommendation QL5a: Revisit the carrying capacity of the watershed. Clarify the present intent of coho passage upstream and, if needed, modify the fish passage strategy based upon the outcome of discussions regarding management objectives for natural production in the Big Quilcene River (see QL2 and QL4).

Recommendation QL5b: Assess the magnitude of fish health risks to hatchery-produced fish at Quilcene NFH associated with upstream passage. This will require consultation with comanagers to clearly articulate goals and desired benefits for upstream passage as identified in QL2 and QL4 in order to better define passage strategies. Investigate disinfection methods to the incoming surface water supply if deemed necessary based on upstream passage strategies for migratory species including coho and steelhead.

Issue QL6: The Quilcene NFH Penny Creek intake creates a fish passage block up Penny Creek.

Recommendation QL6: The Review Team supports the recommendations of the Hatchery Evaluation Team (HET) at Quilcene NFH to not pursue – at this time - removal of the fish passage block created by the hatchery intake structure to Penny Creek. The HET reviewed the feasibility report by R2 Resource Consultants, Inc.[54] and concurs with its conclusions: removing blockages would increase fish health risks, complicate coho stock management, would not significantly increase harvest benefits relative to current benefits, and would be quite costly in terms of facility modifications. The Review Team is also unaware of any historical evidence of anadromous fish passage upstream of the current location of the hatchery's water intake. The report estimated that adult coho production that might be realized from Penny Creek would range between 71-404 based on habitat and assumed smolt survival of 4.61 %.

Issue QL7A: Straying of Quilcene NFH stock hatchery coho released from the Quilcene Bay net pen poses genetic and ecological risks to natural-origin coho populations in Hood Canal.
These issues include potential ecological interactions between natural-origin juveniles resulting from successful spawning of hatchery and natural origin adults (see HSRG white paper number 7[55]).

Recommendation QL7A(a): A study should be conducted to better quantify stray rates of coho released from Quilcene Bay net pen. The study should include intensive monitoring of several natural populations distributed throughout Hood Canal.

Recommendation QL7A(b): If stray rates from the Quilcene Bay net pen exceed NOAA Fisheries and HSRG risk guidelines (more than 5% of the natural spawners in a particular

[54] *R2 Resource Consultants. 2008. Penny Creek Fish Passage Feasibility Study- phase 2: Assessment of Penny Creek Anadromous Salmonid Production Potential and Fish Passage Technical Considerations. Prepared for U.S. Fish and Wildlife Service under contract to MWH Americas, Inc.*

[55] *Hatchery Scientific Review Group. 2009. Columbia River Hatchery Reform Project Final System-wide Report – Appendix A: White Paper No. 7. www.hatcheryreform.us.*

population are Quilcene NFH-origin hatchery fish), then comanagers should consider releasing all of the coho on station at Quilcene NFH and/or reducing the number released from the net pens to a level where the 5% guideline was satisfied.

Issue QL7B: Straying of Quilcene NFH stock hatchery coho released from net pens in Port Gamble Bay poses genetic and ecological risks to natural-origin coho population in the north Hood Canal. *Stray rates of Quilcene NFH stock coho salmon reared at George Adams and transferred to Port Gamble Bay net pens strayed at substantially higher rates (7.01% of harvest; 0.12% of release) than coho reared at Quilcene NFH and released either from the hatchery (0.82% of harvest; 0.01% of release) or Quilcene Bay net pen (1.6% of harvest; 0.02% of release). Greater than 10% of the total escapement to Big Beef Creek consists of hatchery-origin coho adults in some years (SaSI). However, it should be noted that these estimates are primarily based on data collections at Big Beef Creek where intensive monitoring occurs. These issues include potential ecological interactions between natural-origin juveniles resulting from successful spawning of hatchery and natural origin adults.*

Recommendation QL7B(a): A study should be conducted to better quantify stray rates of coho released from Port Gamble Bay net pens. The study should include intensive monitoring of several natural populations distributed throughout Hood Canal.

Recommendation QL7B(b): If stray rates from the Port Gamble Bay net pens exceed NOAA Fisheries and HSRG risk guidelines (more than 5% of the natural spawners in a particular population are Quilcene NFH-origin hatchery fish) , then comanagers should address the stray issue by: (a) developing a new integrated broodstock (e.g., derived from Big Beef Creek coho) and/or (b) reducing the number of fish released from the net pens that would reduce the genetic risks associated with straying.

Incubation and Rearing

Issue QL8: Lack of shade covers for the raceways increases crowding of fish, particularly during the summer months, potentially increasing stress and disease risks to the coho*. One shade structure was installed over one raceway in 20008; however, the other raceways remain uncovered.*

Recommendation QL8: Construct covers over raceways as a best management practice.

Issue QL9: The Service has not been able to operate the Quilcene NFH coho program within the Service's recommended flow and density indices thresholds without exceeding the provision within the hatchery's existing water right for withdrawal from the Big Quilcene River. *The water right (No. S2-28170) requires that 50 cfs remain in the Big Quilcene river bypass area from July 1 through February 28 (29) and 83 cfs from March 1 through June 30. Due to this bypass requirement, Quilcene NFH cannot withdrawal more than 15 cfs from the Big Quilcene River during certain times of the year. Current coho salmon production and associated water management practices can exceed the hatchery's water right restriction during the period of peak production from February to April, when the hatchery is rearing coho both for on-station releases (up to 400,000) and those destined for the Quilcene Bay net pen program (200,000). In some years, due to harmful algal blooms (HAB) in Quilcene Bay, the coho destined for Quilcene Bay net pens have remained on station past their intended*

transfer date in March, increasing the water demand (see QL10). Water in excess of the 15 cfs available has been used in the past in attempt to stay within the Service's recommended flow and density index thresholds. The Service's recommended rearing thresholds are a density index < 0.2, flow index< 1.0, and an exchange rate of < 30. In addition, when serial re-use is implemented these loading and densities are reduced by 20% in receiving ponds (Piper, 1982, pp.70)

Recommendations QL9a: Reassess water management practices to determine how many coho Quilcene NFH can produce without exceeding the Service's recommended upper rearing thresholds and Quilcene NFH's water right restriction. Consider infrastructural changes when reassessing water management practices. Based on current information, the Review Team believes that 600,000 coho (400,000 coho for release on station and 200,000 coho for release from Quilcene Bay net pens) can be reared on-station until mid-March without exceeding rearing thresholds or water right restrictions by utilizing some Penny Creek water and three more ponds in D bank that are currently not used. Under this scenario, the 200,000 coho destined for the Quilcene Bay net pen should be transferred by mid-March to meet fish health rearing guidelines.

Recommendation QL9b: If HAB species are at levels that threaten fish health in Quilcene Bay, then perform a risk evaluation to determine if up to all 200,000 coho should be retained on station at densities that exceed fish health guidelines or transferred to and retained in the net pens for release after the April 15 requirement (to protect ESA-listed summer chum).

Issue QL10a: The current smolt production level, both on-station and in the Quilcene Bay net pen, coupled with harvest restrictions in Canada, result in adult returns to the hatchery that exceed terminal harvest and subsistence capabilities, especially late in the run when fish quality has deteriorated. *The current combined smolt production goal for Quilcene NFH and Quilcene Bay is 600,000. The Canadian fisheries that harvested Quilcene NFH coho were severely restricted circa 1994 and closed circa 1998. From 1990 to 1994 excess coho at the hatchery averaged less than 3,000 fish annually and nearly all were used for subsistence. Since then the average excess is about 13,000 fish annually. On average approximately 65% or 8,000 plus fish are provided as subsistence and 34% or 4,000 plus fish are provided to a processor.*

Issue QL10b: Harmful algal blooms (HAB) in Quilcene Bay in some years prevent timely transfer of coho from Quilcene NFH to the net pen. *This has resulted in increased rearing densities and water demand associated with keeping coho on station until the blooms recede, posing a fish health risk.*

Issue QL10c: HAB in Quilcene Bay can occur after the coho are transferred from Quilcene NFH to the Quilcene Bay net pen posing a serious fish health risk resulting in severe mortalities or early releases. *In 2003 nearly all production was lost due to severe mortality caused by HAB. In 2008 the fish were released early as a result of significant mortality due to HAB.*

Recommendation QL10: Work with comanagers to develop the best production and release strategy from the Quilcene NFH and Quilcene Bay net pen. Weigh the benefits versus the risks of continuing to rear the coho on station at a reduced level of production versus transferring the coho to the net pens. Consider reducing on-station release by up to 200,000 and only transfer coho to net pens in years when HAB is not an issue. Then, when HAB is an

issue, all of the production (exact level to be determined) can be reared to full term and released on station, and remain within Quilcene NFH's carrying capacity (see Recommendation QL9 and Alternative 2).

Release and Outmigration

No issues identified.

Facilities/Operations

Issue QL11: The hatchery intake fish screen mesh is 1/4"; however, the NOAA screen standard is 3/32" where subyearling fish are present. NOAA screen criteria compliance also includes consideration of approach velocity, sweeping velocity, and screen angle. *Fish enter the raceways through the intake, posing a fish health risk.*

Recommendation QL11: Redesign and replace the screen so that it is compliant with current NOAA criteria. If practical, relocate the screen so that it is at the entrance of the pre-settling basin, versus the exit.

Issue QL12: The release of untreated effluent from the spawning area poses an unknown but potential water quality risk and health risk to fish and other species downstream of Quilcene NFH. *The health risk is believed to be small since Quilcene NFH coho originate from adult returns to the Big Quilcene River and maintain the same disease profile as naturally spawning fish. However, the discharge of spawning material (e.g. ovarian fluid, milt, blood) in a more concentrated form than what occurs naturally may increase the risk of disease transmission.*

Recommendation QL12: As a best management practice, investigate retaining or redirecting spawning effluent to the pollution abatement pond or to a special containment area with possible effluent disinfection.

Issue QL13: The current weir structure inhibits upstream migration of fish (esp. listed steelhead) during periods of low flows. The bypass ladder has repeatedly been rendered useless due to gravel deposition above the weir. Accumulated gravel was most recently removed in the spring of 2009. The weir design and placement also obstructs the downstream movement of gravel, has resulted in bank erosion, and poses a flood risk to the area downstream of the weir.

Recommendation QL13a: At a minimum, remove gravel from the ladder on a regular basis. Investigate correcting or replacing the bypass ladder so that it functions properly without continual gravel accumulation. If feasible, investigate options for modifying or replacing the weir.

Recommendation QL13b: Evaluate the fish health risks associate with upstream passage, especially regarding the passage of steelhead. Consider disinfection methods for the hatchery's water supply, if deemed necessary.

Issue QL14a: The spawning facility at Quilcene NFH is inadequate. Currently, the spawning shed consists of a temporary shelter. *During spawning, staff are exposed to freezing weather and work with temporary equipment that could pose safety risks.*

Issue QL14b: Excess adults are removed from water and allowed to suffocate.

Recommendation QL14: Establish a permanent spawning facility and automate the spawning process. Include euthanasia for the excess adults (e.g. carbon dioxide, electro-anesthesia, hydraulic ram).

Issue QL15a: The location of the entrance to the facility poses a traffic safety risk to drivers exiting the facility premises.

Issue QL15b: The location of the fishing access road, immediately south of the highway 101 bridge, poses a traffic safety risk to tribal fisherman and buyers

Recommendation QL15: Contract with a traffic engineer to improve the safety of the entrance and access road. Consider working with Washington DOT to determine whether the Highway 101 bridge over the Big Quilcene River can be realigned so that it is no longer a visual obstruction. This bridge is past due for replacement as it was built in 1936 with a potential design life of 50 years.

Research, Monitoring, and Accountability

Also see QL7A and B above

Issue QL16: The Olympic Peninsula NFH's and the Service's Western Washington Fish and Wildlife Office (Lacey, WA) do not have a standardized database for tracking certain operational data such as green egg to eyed egg and eyed egg to fry mortality rates. *Each hatchery records their data via individually tailored spread sheets. The existing data management system used for evaluation of the Olympic Peninsula NFHs is the Fisheries Resource Evaluation Database (FRED). A standardized database will facilitate data sharing and program analyses region wide.*

Recommendation QL16: Convene a group of Olympic Peninsula NFH management staff and WWFWO hatchery assessment staff to consider developing a common database that could be used to address all hatchery operational, evaluation, and reporting requirements. The group should review the CRIS and FRED systems and their utility for collecting and reporting these types of data and information-Regularly collect average water temperatures, fish growth data, current numbers, mortalities, and a summary of fish health activities. Track this information in conjunction with all fish production activities in a standardized database, including, numbers, tagging, fish moves, fish and egg distribution, egg mortalities, survival to various life stages, feed, fry ponding data, fish length, condition factor, feed conversion ratio, adult fish removal by species, spawning data by take, etc. The database should be capable of creating summaries of current pond inventories including flow and density indices for each rearing unit, spawning summaries, egg summaries, lot history production summaries, hatchery production summaries and distribution summaries.

Issue QL17:In-season management of the incidental take of summer chum salmon in the Quilcene Bay coho directed fishery is based on post-harvest daily assessments. *The Review Team understands that in-season harvest management during the Quilcene Bay coho fishery includes daily comanager communications with the buyer to assess summer chum catch. This daily post-harvest assessment presents a risk of unusually high harvest of summer chum on a specific day that may contribute to exceeding exploitation rates for the season. WDFW has commented that this is no longer an issue, stating "since the comanagers initiated regular in-season discussions, incidental harvest of summer chum has been limited and generally been meeting management guidelines."*[56]

Recommendation QL17: If this remains an issue, work with comanagers to review the current method of assessing summer chum harvest to determine whether it is sufficient. If not, consider alternative methods such as deploying observers in Quilcene Bay during the fisheries who either have the authority to close the fishery upon observing unusually high harvest of summer chum or can relay catch information to comanagers to consider immediate closures.

Issue QL18: Natural production in the Big Quilcene River is not well understood. Spawning ground surveys for coho are lacking, but little spawning of coho is believed to occur downstream of the hatchery weir*[57]*.

Recommendation QL18: See Issue/Recommendation QL4.

Issue QL19: The facility has no clearly defined M&E program.

Recommendation QL19: Develop a consistent and clearly defined M&E program as a best management practice and review on an annual basis (prior to ponding and coded-wire tagging of a broodyear).

Issue QL20: There is no established plan for regularly scheduled interagency/comanager coordination meetings. *Currently, comanagers are contacted regarding potential program changes and current activities on an ad-hoc basis.*

Recommendation QL20: Schedule coordination meeting(s) on an annual basis. A plan for regularly scheduled meetings will help ensure that meetings continue as staff changes occur.

Issue QL21: The Quilcene NFH Hatchery Evaluation Team (HET) meets on a regular basis, at least twice a year (before spawning and after release). *The meetings are generally coordinated by a representative at the Fisheries Resource Office. Additional meetings are also scheduled on an as-needed basis. All topics in regards to facility and program management are discussed and the HET is the primary recommending body for facility and programmatic changes.*

Recommendation QL21: The Review Team supports the current approach for utilizing the HET process, which is in line with the Vision Action Plan. The Review Team is recommending that the HET process be standardized region wide by 2010.

[56] *See WDFW comments in Appendix C.*

[57] *Pers. comm. Thom Johnson, WDFW, 2008.*

Issue QL22: The Quilcene NFH weir and intake diversion in the Big Quilcene River may impede the natural migration of lampreys, and the operation of the weir and intake may result in an unknown level of mortality. *For example, juvenile lampreys could become trapped in the intake settling basins. Pacific lampreys are culturally important to Pacific Northwest tribes. They were also petitioned to be listed as threatened under the Endangered Species Act in 2003.*

Recommendation QL22: Initiate a monitoring program to determine the species of juvenile lamprey, migration periods of the lamprey, and the degree of impact the weir and intake diversion may have on the Big Quilcene River lamprey population(s). Use the information to determine if further actions are necessary to minimize impacts to pacific lamprey.

Education and Outreach

Issue QL23: The facility has limited infrastructure and signage to accommodate visitors. *Currently, there is no dedicated visitor center. Interpretive signage is also inadequate. Given that Quilcene NFH is located on a highly traveled tourist route, improved outreach facilities could be very beneficial for public education and conveying the mission of the Quilcene NFH and the Service's fisheries program.*

Recommendation QL23: The Team recommends that facilities be improved to expand visitation and education/outreach opportunities.

Issue QL24: The current education and outreach program is limited. Most other NFH's hold annual events such as Kid's Fishing Day, are involved in salmon festivals, and participate in national initiatives such as Connecting People with Nature. *Given the facility's location and easy access off of a major tourist route, education and outreach should be emphasized. Additionally, 2011 is Quilcene NFH's 100 year anniversary.*

Recommendation QL24a: Improve the education and outreach program at Quilcene NFH. Include at least one major annual event at the facility.

Recommendation QL24b: Make plans to celebrate the facility's upcoming centennial.

Issue QL25: Distribution of excess coho to the tribes is coordinated by the hatchery manager. *This has or can cause some perceived inequities in the frequency and numbers of carcasses distributed to the several tribes in the area.*

Recommendation QL25: Find an equitable manner of distributing coho among the tribes.

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing coho program at Quilcene NFH, including the Quilcene Bay net pen production and developed alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current program with recommendations

Rear a minimum of 400,000 yearling coho for release on station and transfer up to 200,000 to the Quilcene Bay net pen for a combined release of up to 600,000. The Service has identified that current coho salmon production levels and associated water management practices can exceed the instream water right restriction for Quilcene NFH during certain time periods. If water management practices and infrastructure are optimal, transfer 200,000 of the current coho program to Quilcene Bay net pen when flow requirements for the facility would otherwise exceed the water right.

Pros

- Maintains the tribal, commercial, and sport harvest opportunity for coho.
- Maintains the surplus available for subsistence and ceremonial purposes at its current level.
- Clarifies management goals for coho salmon production that will lead to improved efficiency of the operations at Quilcene NFH, ensures that harvest needs are met, and reduces ecological and genetic interactions.
- Maintains the Quilcene Bay net pen program.

Cons

- Returns exceed terminal harvest and subsistence capabilities late in the run when fish quality has deteriorated.
- Density thresholds may be exceeded on station between March and April if the presence of HAB in Quilcene Bay prevents the 200,000 transfer to the net pen.
- The 200,000 coho transferred to Quilcene Bay net pen may not survive to release due to HAB.
- Fish may need to be released from the Quilcene Bay net pen prior to the target release date, which could reduce survival, and increase incidence of interactions with ESA listed summer chum.

Alternative 2: Reduce the current program from a 600,000 to a 400,000 smolt release

The Service has found that the recommended flow and density indices for rearing coho at the current program size would have to be exceeded in order to stay within Quilcene NFH's instream water right. Additionally, ~10,000 surplus coho salmon return to the hatchery each year. This alternative would reduce the program from 600,000 smolts (400,000 at Quilcene NFH and 200,000 at QBNP) to 400,000 to provide the flexibility to rear all production at the Quilcene NFH in the event that HAB preclude

transfer to the Quilcene Bay net pen. Up to half of the coho could be released in the net pens dependent upon local conditions and comanager priorities.

The program size of 400,000 recommended above is based upon the observed capability of the facility and may be adjusted based on additional information. The recommended program size is dependent upon the Service's ongoing assessment of the water management practices and infrastructure to determine how many coho Quilcene NFH can produce on station without exceeding the Service's recommended upper rearing thresholds and Quilcene NFH's water right restriction (as recommended in QL9).

Pros

- Reduces the number of the surplus coho salmon returning to and being handled at the hatchery.
- Allows the program to meet the Service's recommended maximum flow and density indices given the existing water right.
- Eliminates mortality associated with HAB unless an algal bloom occurs 'after' coho are transferred to the net pen.
- Reduces feed, marking, and tagging costs.
- Provides opportunities to contribute to conservation programs for populations of salmon and steelhead in the Hood Canal basin at certain times of the year.
- Maintains the Quilcene Bay net pen program.

Cons

- Reduces the total number of coho available for harvest and subsistence, although it may not reduce the number of coho harvested.

Alternative 3: Reduce or terminate the coho program to support the conservation of at-risk salmon and steelhead populations in the Hood Canal basin

Quilcene NFH is located in an area with a large number of conservation needs and priorities. The reduction in coho production would be commensurate with the needs of the conservation programs initiated at Quilcene NFH. This likely involves reducing the coho program below 400,000. Also see alternatives 3 and 4 in the Quilcene NFH Hood Canal Steelhead section.

Pros

- Provides the greatest opportunity for Quilcene NFH to contribute to conservation programs for populations of salmon and steelhead (including summer chum, mid-Hood Canal Chinook and steelhead) in the Hood Canal basin.
- Contributes to the long-term conservation and recovery goals for listed salmon and steelhead populations in the Hood Canal basin.

- Reduces feed, marking, and tagging costs for coho.
- Reduces the likelihood of incidentally taking summer chum in the Quilcene Bay coho fishery to the degree the coho program is reduced.
- Reduces or eliminates the straying of Quilcene NFH coho into natural production areas in the Hood Canal basin.

Cons

- Reduces or eliminates the number of coho available for harvest and subsistence, and limits opportunity for harvest when other opportunities for salmon harvest are not available.
- May require additional investments in infrastructure, which may include disinfection of the water supply, greater compartmentalization of rearing units, etc.
- Eliminates a unique, early run Quilcene NFH coho broodstock, if the program is terminated.
- Eliminates the coho available for transfer to George Adams for rearing and release at the Port Gamble Bay net pens, if the program is terminated.

Alternative 4: Terminate the coho program and other Quilcene NFH programs and decommission the facility

Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Pros

- Eliminates the incidental take of summer chum in the Quilcene Bay coho fishery.
- Eliminates the straying of Quilcene NFH coho into natural production areas in the Hood Canal basin.
- Reduces costs associated with maintaining and operating capital infrastructure.

Cons

- Eliminates the number of coho available for harvest and subsistence, and limits opportunity for harvest when other opportunities for salmon harvest are not available.
- Tribal expectations for coho harvest and subsistence opportunities would not be met and termination of the program would be inconsistent with the present provisions in the Hood Canal Management Plan (US v. Washington).
- Eliminates a unique, early run Quilcene NFH coho broodstock.
- Eliminates the coho available for transfer to George Adams for rearing and release at Port Gamble Bay net pens.

- Reduces outreach capabilities and Service collaboration with other agencies/organizations focusing efforts in the Hood Canal basin.

Recommended Alternatives

The Review Team recommends implementing Alternative 2. The combined effect of the presence of excessive levels of HAB in Quilcene Bay during winter and spring months, the large number of surplus coho returning to the hatchery rack, and the current production levels exceeding the Service's recommended flow and loading indices at maximum production all support the program reduction from a 600,000 to 400,000[58] combined on-station and Quilcene Bay net pen coho smolt release. Adopting this alternative would allow the hatchery to continue to contribute significantly to local tribal, sport and commercial fisheries and still operate within the constraints of the Big Quilcene River water right. This alternative also allows more flexible use of the net pen. If HAB presents a problem, all 400,000 coho could remain on-station without exceeding the water right restrictions. Conversely, when HAB is not an issue, up to half the fish in production could be transferred to and released from the net pen. This would reduce feed and workloads at the hatchery and could, under some circumstances present opportunity for the hatchery to participate in conservation and recovery programs of aquatic species in the Hood Canal area. This alternative would also address the number of surplus adult coho salmon returning to the hatchery. While it may reduce the total number of coho *available* for harvest, if current harvest rates and rules remain in place there should be no reduction in the number of fish currently being harvested.

The Review Team did not consider the development of an integrated program a viable alternative because, based on current information, the Team believes that the Big Quilcene River has limited potential for the natural production of coho. Naturally spawning coho are not, and likely never were, present in the Big Quilcene River in large numbers due to the lack of over-wintering habitat. The earliest records of broodstock collected by the hatchery for its initial stocking (dating from 1912 to 1917) indicated the presence of coho in the Big Quilcene in the period from October 20 to February. However, no more than 200 adults were recorded in the river in a single year.[59] Furthermore, the return timing of the hatchery stock has been advanced over many generations and is now significantly earlier than naturally spawning coho in Northern Hood Canal watersheds. .

[58] *The recommend program size is dependent upon the outcome of recommendation QL9.*

[59] *These records could reflect selective fishing at the weirs or floods which may have impacted the weirs, hence, the use of these records to only indicate "presence" or "absence" of coho in the period from 1912 to 1917.*

Quilcene NFH Hood Canal Steelhead

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: There is no harvest goal associated with this recovery program.
- ***Broodstock escapement goal***: There is no broodstock escapement goal. However, the goal is to collect 9,566 eyed eggs from redds in the Dewatto and 8,620 from eggs in the Duckabush.
- ***Conservation goal***: Increase the abundance of ESA listed (*threatened*), naturally spawning natural-origin winter steelhead in the Dewatto and Duckabush Rivers. Maintain or increase the genetically effective population size.
- ***Escapement goal for natural-origin adults***: An increase in the number of naturally spawning natural-origin spawners in supplementation streams compared to control streams. Numeric escapement goals are pending, dependent upon the outcome of Technical Recovery Team recommendations.
- ***Research, education, and outreach goals***: The research goal is to observe the effects of hatchery supplementation on the productivity or demographic, life-history, and genetic characteristics of natural steelhead populations in Hood Canal before, during and after the period of supplementation. The experiment includes three supplemented streams (Dewatto, Duckabush, and South Fork Skokomish Rivers), three control streams (Big Beef Creek, Tahuya, Dosewallips/Little Quilcene, and one post-supplementation monitoring stream (Hamma Hamma River[60]).

Objectives

- Incubate eyed embryos, then rear fry to 30 days post initial ponding to allow for pathology screening (in compliance with *The Salmonid Disease Control Policy of the Fisheries Comanagers of Washington State*[61]).

Program Description

The Hood Canal Steelhead Project is a NOAA-led multi-agency collaborative study to quantify the effects of conservation hatchery programs on the productivity, abundance, life history and genetic diversity of natural steelhead populations in Hood Canal. The study involves supplementing three populations (South Fork Skokomish River, Dewatto River, and Duckabush River) and monitoring three control populations that receive no hatchery fish. Data are being collected from supplemented and control populations prior to the release of any hatchery fish, and monitoring will continue during

[60] *The Hamma Hamma River has a current supplementation program that will terminate in 2007, with the final natural spawning of age-5 hatchery-origin adults occurring in 2010.*

[61] *<http://www.nwifc.wa.gov/enhance/documents/Disease_Policy_1998.pdf>*

the period (eight years) when hatchery fish are spawning naturally, and after the program has terminated. For each supplemented population, eyed embryos are removed from redds constructed by naturally spawning steelhead. Embryos are incubated and juveniles are reared in captivity and released at two life-history stages: smolt and mature adult.

Fish destined for smolt release are reared under feeding regimes to achieve body size characteristics similar to those of wild fish from a stream in the same region for which substantial seasonal size data is available (Snow Creek, Jefferson County, WA). To achieve these growth profiles, feed schedules will be developed based on water temperature and size-specific feed conversion rates. Feeding will occur three to five times per week

The goal is to produce age-2 smolts. However, some fish may achieve a threshold smolt size (approximately 150 mm) in one year. Those fish are released as yearlings and the remaining fish are reared to age-2. A portion of the fish from each river will be reared to age-4 adult and will be released for natural spawning (hereafter referred to as the 'adult release group', ARG). The details of the smolt and adult rearing program and all monitoring efforts have been described in a study plan and HGMP.

While this program is a large-scale test of supplementation, it is also considered as an effort to assist in rebuilding the depressed Hood Canal steelhead populations. A similar effort on the Hamma Hamma River in Hood Canal has resulted in increased spawning activity and maintenance of genetic diversity in the steelhead population.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection (Eyed egg collection)

- There is no broodstock selection or collection associated with this program.
- Eyed eggs are collected from redds constructed by naturally spawning steelhead for two steelhead generations (eight years based on a typical 4-year life history).
- The Service at times participates in eyed-egg collection on the Duckabush River. An hydraulic egg sampler is used to remove eyed eggs from the redds. Egg collections occur approximately once per week; however, timing is ultimately determined by timing of redd construction, temperature monitoring, and estimated embryo development.

Hatchery and Natural Spawning, Adult Returns

- There is no hatchery spawning associated with this program. Eyed eggs are collected from redds produced by naturally-spawning steelhead.

- Weekly redd surveys for both treatment/supplementation and control streams, performed project participants, occur from mid-February through early June.

- The wild steelhead populations in Hood Canal are depressed and listed as *threatened* as part of the Puget Sound steelhead ESU.

- The research project is in its second year. First year (2007) redd counts for the Dewatto and Duckabush Rivers were 17 and 5, respectively. Additionally, the number of redds representing the eggs collected for supplementation for the Dewatto and Duckabush Rivers were 16 and 4, respectively. Typically, only a portion of the eggs in each redd are collected for supplementation.

Incubation and Rearing

- From March-June, eyed eggs collected from the Dewatto and Duckabush Rivers are transported to the Egg Isolation/Quarantine facility at Quilcene NFH. They are placed in Heath Incubator trays until they hatch. Eggs are placed into individual Heath trays by redd.

- Egg transfers occur on the day of collection and are coordinated by phone and through the project management web site between the USFWS, LLTK (for the Duckabush) and HCSEG (for the Dewatto).

- Eyed eggs are disinfected at 100 parts per million of iodine for a minimum of 10 minutes

- For pathology screening, each lot transferred off-station must be lethally sampled at a certain rate (60 fish per lot transferred). Early egg takes are chilled to consolidate takes and reduce the number of transfer lots.

- After button-up, the resulting fry are transferred to small oval rearing tanks in the isolation incubation building and combined according to the day the eggs were collected from their natal streams.

- The fry are reared for at least 30 days, until a subsample of the fry have been tested and pass virus screening, performed by the USFWS Olympia Fish Health Center and the WDFW fish health lab.

- Fry are transferred from Quilcene NFH to LLTK's Lilliwaup Hatchery for rearing until two-year smolt or adult size before release.

Release and Outmigration

- Quilcene NFH is not responsible for the grow-out and release component of this program.

Facilities and Operations

- The only facility at Quilcene NFH used for this program is the Egg Isolation/Quarantine building.

- Condensation builds up in the roof insulation of the isolation incubation building thus promoting the growth of mold and spores which can be a vector for air-borne contaminants and pathogens.

- The isolation building water source is a 47ft well. The well water supply is pathogen-free.

- Two Jacuzzi pumps supply well water to the isolation building at up to 50 gallons per minute each (100 gallons per minute total). However, the disinfection unit for effluent treatment, using chlorine tablets, capacity is currently only 32 gallons per minute. In 2008, Quilcene NFH switched to liquid chlorine which resolved this issue.

- Six small chillers are available to chill water either to control growth or to mark otoliths.

- The isolation building has 8 half-stack Heath incubators and 20 small oval early rearing tanks.

- The effluent is disinfected with chlorine at about 2.0 parts per million. The effluent is dechlorinated with sodium thiosulfate before entering the river.

Research, Education, and Outreach

- This 16-year program is designed to test the capabilities of artificial propagation to assist with the recovery of natural populations.

- See education and outreach considerations in the Quilcene NFH coho program section.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[62] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- None currently identified as part of the project.

Conservation Benefits

- This 16-year project (2007-2022) is in its early stages; however, the intent of the project is to increase abundance, productivity, and maintain or increase the genetic and life-history diversity of the Hood Canal winter steelhead population, listed as *threatened* as part of the Puget Sound Steelhead ESU. The pilot project on the Hamma Hamma River has shown neutral to positive results.[63]

- For example, total spawner abundance is expected to increase in the supplemented streams, starting with the fourth year of the project when hatchery-reared steelhead begin to spawn. Consequently, natural spawner abundance is expected to increase after supplementation is discontinued (from years 12-16).

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[62] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[63] *1) Berejikian, B., T. Johnson, R. Endicott, and J. Lee. 2008. Increases in steelhead redd abundance resulting from two conservation hatchery strategies in the Hamma Hamma River, WA. Canadian Journal of Fisheries and Aquatic Sciences 65:754-764. 2) Van Doornik, D. M., B.A. Berejikian, and L. Campbell. (In prep). The effect of a supplementation program on the genetic and life history characteristics of an* Oncorhynchus mykiss *population. Intended for Can. J. Fish. Aquat. Sci.*

Research, Education, Outreach and Cultural Benefits

- This project involves the participation of over 35 staff from eight agencies/organizations (NOAA Fisheries, WDFW, Point-No-Point Treaty Tribes, Skokomish Tribe, US Forest Service, USFWS, LLTK, and the HCSEG).

- Quilcene NFH is involved in research associated with this project, and will likely be involved in future research that is established as this project proceeds. For example, data on viability of eyed eggs collected by hydraulic redd sampling is currently being presented at regional fisheries symposia and data will be included in a publication on the effectiveness of hydraulic redd sampling.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[64] the Review Team identified the following benefits of this program:

Harvest Benefits

- None identified.

Conservation Benefits

- None identified.

Research, Education, Outreach and Cultural Benefits

- The findings of this research could be used to analyze the effects of a conservation hatchery program on the abundance, productivity, and genetic and life-history diversity of winter steelhead populations.

- Potentially provides a model for assisting with the recovery of ESA-listed steelhead populations in Puget Sound, the Columbia River Basin, and the central valley of California.

- Provides information on hatcheries as called for by recent scientific review panels (The Northwest Power and Conservation Council's Independent Scientific Advisory Board and the Northwest Fisheries Science Center's Recovery Science Review Panel)

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[65] the Review Team identified the following risks of the hatchery program:

[64] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[65] *Ibid.*

Genetic Risks

- Genetic risks associated with variability and effective population size are minimized by representing a large portion of the adult population and releasing fewer than 10,000 fish per population per year over an 8 year period.

- Genetic risk associated with domestication; however, the project attempts to minimize this effect by rearing the steelhead according to a natural life-history pattern, then releasing the fish as two-year old smolts. Rearing age-4 and age-5 adults has the potential to cause some domestication selection.

Demographic Risks

- The project poses some demographic risks to the natural populations in the treatment streams by removing eyed steelhead eggs and disrupting redds visa vie hydraulic pumping. The disruption of redds can lead to increased predation (e.g., by sculpins) and subsequent dislodging of incubating eggs and pre-emerging alevins during freshets following spring rains. However, this project attempts to mitigate those risks by avoiding excess egg collections and precise triangulation of each redd to minimize human impacts.

- Unknown mortality associated with redd pumping to eggs not collected but disturbed by pumping.

- Hook-and-line sampling can result in incidental mortality.

- Potential for catastrophic loss in the hatchery or during transport.

- Greater proportion of loss associated with fish pathology screening compared to other programs due to the small population sizes and inability to screen parents for the presence of virus.

Ecological Risks

- Hatchery-reared steelhead may have greater vulnerability to predation than naturally-produced smolts.

Physical Risks

- None identified for Quilcene NFH.

Research, Education, Outreach and Cultural Risks

- None identified.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[66] the Review Team identified the following risks from the hatchery program:

[66] *Ibid.*

Genetic Risks

- None identified.

Demographic Risks

- Hydraulic pumping of redds and hook-and-line sampling can result in incidental take of other species in the watersheds.

Ecological Risks

- None identified.

Research, Education, Outreach and Cultural Risks

- None identified.

Recommendations for Current Program[67]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

None identified.

Broodstock Choice and Collection

Not applicable. Service staff are not responsible for collecting eyed steelhead eggs from the treatment streams.

Hatchery and Natural Spawning, Adult Returns

Not applicable.

[67] *The Review Team believes that the Quilcene NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

Incubation and Rearing

Issue QL26: Steelhead reared in the isolation incubation building cannot be compartmentalized to an extent that prevents the transfer of disease between fry, if the steelhead are brought to the incubation building after hatch.

Recommendation QL26: Work with project collaborators to evaluate the need and ability to compartmentalize the incubation building to accommodate receiving fry.

Release and Outmigration

Not applicable. Quilcene NFH does not participate in releases.

Facilities/Operations

Issue QL27: The isolation incubation building roof design results in condensation in the roof insulation, water logging the insulation. *The problem lies in the design of the building's ceiling/roof interface. The warm moist air of the interior condenses between the insulation and the cold metal roof, water-logging the insulating bats. Makah NFH addressed this problem with external insulation.*

Recommendation QL27: Consult with the Service engineering division and the Makah NFH maintenance crew to correct this problem and improve future designs of egg isolation units.

Issue QL28: There is no back-up water supply to the isolation/quarantine building. A well supplies water to the building via two pumps in a single casing. *Currently, only one pump is used at a time so the second acts as a backup. The pumps are regularly alternated to ensure that they are exercised on a regular basis. There is also a back-up generator. However, there is no other means to supply water if the well, pumps, or generator fail. The building is currently being used to support research involving listed steelhead.*

Recommendation QL28: A regular schedule of preventative maintenance should be instituted. Explore the possibility of plumbing disinfected Penny Creek water into the Egg Isolation/Quarantine Building.

Research, Monitoring, and Accountability

Issue QL29: Incubation and early rearing data collection is not standardized.

Recommendation QL29: Standardize the incubation and early rearing data collection and centralize reporting on the Hood Canal Steelhead project management web site.

Education and Outreach

See Quilcene NFH coho section.

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing coho program at Quilcene NFH and developed four alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current program with recommendations

Continue incubating and early rearing up to 18,186 steelhead from the Dewatto and Duckabush rivers. The recommendations include minor improvements to the current program.

Pros

- Improved data quality and transfer
- Preservation and improvement of the quarantine facility
- Ensures continuous pathogen free water supply to embryos and fry

Cons

- None

Alternative 2: Develop the capability to rear a portion of the steelhead beyond the early rearing stage

Currently, both the Dewatto and Duckabush smolt and adult release group (ARG) steelhead are reared at Long Live the Kings Lilliwaup Hatchery and the Skokomish smolt release group is being reared at WDFW McKernan Hatchery. The Skokomish adult release group currently does not have a designated rearing location. Additionally, there is a greater risk of catastrophic loss associated with rearing steelhead of these small, ESA-listed populations at individual facilities versus spreading the risk out among facilities. The following lists four possible scenarios for use of Quilcene NFH to contribute to the Hood Canal Steelhead Project.

Table 14. Potential uses of the Quilcene National Fish Hatchery to support the Hood Canal Steelhead Project.

Scenario one is the status quo, and the other three scenarios would require a change to the current program.

Source	Location 1	Location 2	Location 3	Change to current program
Scenario 1 Current	Incubate 8,000 Duckabush eggs and 9,000 Dewatto eggs in isolation at Quilcene NFH	Transfer all to Lilliwaup for rearing to smolt and adult	Release into Duckabush and Dewatto Rivers	None
Scenario 2	Incubate 460 eyed eggs from the Skokomish River to 30 d fry in isolation at Quilcene NFH	Transfer to Lilliwaup for rearing to adult	Release into Skokomish River	Incubate an additional 460 eggs from one additional population (Skokomish). Eggs would be sourced every other year.
And	Incubate 8,000 eyed eggs from the Duckabush River to 30 d fry at Quilcene NFH as is currently done	Rear 7,000 smolts at Quilcene NFH. (*this frees capacity at Lilliwaup for the 400 adults from Skokomish*)	Release into Duckabush River	Rear 7,000 smolts
Scenario 3	Incubate 460 eyed eggs from the Skokomish River to 30 d fry in isolation at Quilcene NFH	Transfer to Lilliwaup for rearing to adult	Release into Skokomish River	Incubate an additional 460 eggs from one additional population (Skokomish). Eggs would be sourced every other year.
And	Incubate 8,000 eyed eggs from the Duckabush River and 9000 from the Dewatto River to 30 d fry at Quilcene NFH as is currently done	Rear 3500 Duckabush smolts and 4000 Dewatto smolts at Quilcene NFH. (*this frees capacity at Lilliwaup for the 400 adults from Skokomish*) and serves as a spread-the risk	Release into Duckabush and Dewatto Rivers	Rear 3,500 smolts (Duckabush) and 4,000 smolts (Dewatto)
Scenario 4	Incubate 460 eyed eggs from the Skokomish River to 30 d fry in isolation at Quilcene NFH	Rear 400 steelhead to sexual maturity (age-4 and age-5) every odd brood year	Release into Skokomish River	Incubate 460 eggs and rear 400 adults from one additional population (Skokomish River). Eggs would be sourced every other year

Fish Health issues related to the above scenarios:

Scenario 1 (Current Program):

- No additional risks.

Scenarios 2 and 3:

Skokomish Fry Component

- Skokomish fry would have to be screened for regulated viral pathogens at the 5% Assumed Pathogen Prevalence Level (APPL) prior to their transfer to the Lilliwaup Hatchery. *The Salmonid Disease Control Policy of the Fisheries Comanagers of Washington State* requires a higher testing level (2% APPL), this would require receiving an exemption from the comanagers. A 5% APPL on a population of 460 comes out to lethally testing 55. There are no additional risks as long as these fry are held in the isolation unit at Quilcene NFH.

Duckabush and Dewatto eyed egg to smolt component:

- Duckabush and Dewatto fry would have to be screened at swim-up for regulated viral pathogens as they are currently tested (2 or 5% APPL based on lot size). An exemption would be required from *The Salmonid Disease Control Policy of the Fisheries Comanagers of Washington State* if the test level was at the 5% APPL.

- Projected water requirements to rear 8,000 fish from eggs to smolt size (either all Duckabush or a mix of Duckabush and Dewatto) at Quilcene NFH = 230 gallons per minute. This assumes the following:

# of fish	Stage	Avg. size in May (fish per pound)	Average length (inches)	Biomass	Flow	Flow Index (lbs/gallons per minute/in)
8,000	Zero	100	2	80	40	1.0
8,000	Yearling	6	7	1,333	190	1.0
	TOTAL			1393	230	

- Rearing the Duckabush (Scenario 2) or Duckabush and Dewatto (Scenario 3) components from the fry to smolt stage would require a pathogen-free water supply and a minimum of two dedicated rearing containers that are in a secured rearing area to prevent the introduction of pathogens from other fish on site. The options for a secure water supply would be either using Penny Creek water or incorporating some type of disinfection unit (UV, ozone, chlorination) to Quilcene River water.

Scenario 4:

- Skokomish fry would have to be screened for regulated viral pathogens at the 5% APPL at swim up. An exemption would be required to be able to use a lower testing level than required in *The Salmonid Disease Control Policy of the Fisheries Comanagers of Washington State*. A 5% APPL on a population of 460 comes out to lethally testing 55.

- Rearing the Skokomish fish from fry to age 4 and 5 at Quilcene NFH would pose several facility challenges. There would be up to five year classes on station at any one time, but the adult release groups (ARG) would only be retained from odd numbered broodyears. This program would require a maximum of 115 gallons per minute inflow from a pathogen-free water source (Penny

Creek or disinfected Quilcene River water) and at least five rearing containers (Table 15 below). This scenario requires only half of the flow required by the smolt rearing scenario.

Table 15. Numbers of steelhead that would be reared for an adult release group (ARG) of 400 steelhead (60 euthanized for pathology, 300 released at age-4 and 100 released at age-5).
The table reflects fish entering the program at age-2 (e.g., 460 BY 2007 entering the program in spring of 2009). This table does not include subyearling or yearling fish that would also be reared at Quilcene NFH; however, they are estimated to require a cumulative amount of 14 gallons per minute per year. Adult release groups would be initiated with age-2 smolts only on odd years.

	Calendar year								
Brood year	2009	2010	2011	2012	2013	2014	2015	2016	2017
2007	460	460	100	0	0	0			
2008									
2009			460	460	100	0	0	0	
2010									
2011					460	460	100	0	0
2012									
2013							460	460	100
Total N	460	460	560	460	560	460	560	460	100
Biomass (lbs)	1,380	2,300	2,180	1,380	2,180	2,180	1,380	2,300	2,180
Mean length (in)	18	24	22	24	22	24	22	24	30
Flow required (flow index 1.0)	77	96	99	58	99	91	63	96	73

Summary:

All of the scenarios are possible, but each would require prioritizing the following:

- Prioritizing water use from Penny Creek or adding some type of disinfection unit for Quilcene River water,
- Dedicating rearing containers in a secure area that is isolated from the rest of the hatchery, and
- Obtaining an exemption from *The Salmonid Disease Control Policy of the Fisheries Comanagers of Washington State* for a reduced virus testing level on the various stocks.

In addition, if Quilcene River water were to be used for rearing the steelhead, we also recommend doing additional annual testing in the watershed for IHN virus over and above the current testing that is done on coho broodstock annually. This could possibly involve testing summer chum adults because the IHN virus was detected in them in two previous years.

Pros

- Increases the contribution of the Quilcene NFH towards a basin-wide recovery effort for ESA-listed steelhead in Hood Canal with the intention of recovering the steelhead population to the point of de-listing.

- Increases the contribution of the Quilcene NFH towards a long-term study to determine the effects of culture-based rebuilding efforts for steelhead that could be applied to other recovery efforts.

Cons

- Additional investment in infrastructure may be required to provide up to 115 gallons per minute or 230 gallons per minute (up to 3% of the available Quilcene River water (at 15 cfs) depending upon the scenario adopted) continuous disinfected or pathogen free water and to provide rearing containers that would accommodate the unique needs of the program.

- The increased space and water needs for steelhead may require a reduction to the coho program.

Alternative 3: Develop a conservation hatchery program for Big Quilcene winter steelhead, in line with the Hood Canal Steelhead Project (could be combined with other alternatives)

The status of the Big Quilcene River steelhead population is not well quantified but is believed to be at very low levels. On-going management processes including implementation of the WDFW Steelhead Management Plan and recommendations being formulated by the Puget Sound Technical Recovery Team, could lead to culture-based rebuilding efforts in the Big Quilcene River. The program would likely be developed in a similar manner to the hatchery programs currently part of the Hood Canal Steelhead Project, which would involve collection of eyed eggs from naturally constructed redds, rearing and release at the smolt and mature adult stages. Other variations of this approach are also possible (e.g., collecting and spawning returning adults) because of the presence of the hatchery weir.

Pros

- Contributes to recovery efforts for *threatened* steelhead in Hood Canal.

- Data developed from the Hood Canal steelhead Project could be used to guide the implementation and monitoring of the program.

- A pathogen-free water source would not be required to rear and release fish within the Big Quilcene River Basin

- Increases the contribution of the Quilcene NFH towards a basin-wide recovery effort for ESA-listed steelhead in Hood Canal with the intention of recovering the steelhead population to the point of de-listing.

- Increases the contribution of the Quilcene NFH towards a long-term study to determine the effects of culture-based rebuilding efforts for steelhead that could be applied to other recovery efforts.

Cons

- Additional investment in infrastructure may be required to provide adequate water and rearing containers that would accommodate the unique needs of the program.

- The increased space and water needs for Quilcene steelhead may require a reduction to the coho program.

- The increased space and water needs for Quilcene steelhead may prevent the implementation of Alternative 2.

Alternative 4: Use the isolation incubation facility to support hatchery production for the restoration of other naturally spawning populations in the region (could be combined with other alternatives)

Quilcene NFH is located in an area with a large number of conservation needs and priorities. Currently the incubation facility supports the Hood Canal Steelhead Project by incubating and rearing (to 30 d post ponding). Restoration of Chinook salmon, summer chum salmon or other stocks of steelhead at some point may be prioritized as a greater need, requiring an isolation facility

Pros

- Provides the greatest opportunity for Quilcene NFH to contribute to conservation programs for populations of salmon and steelhead (including summer chum, mid-Hood Canal Chinook and steelhead) in the Hood Canal basin.

- Contributes to the long-term conservation and recovery goals for listed salmon and steelhead populations in the Hood Canal basin.

- The isolation and incubation facility is currently well suited to provide quarantine while juveniles destined for other hatcheries are tested for viral pathogens.

Cons

- May require additional investments in infrastructure to increase biosecurity measures if more than one species were incubated simultaneously.

Alternative 5: Terminate the Hood Canal Steelhead program

Pros

- Allows the isolation incubation building to be used for programs focused on restoring other naturally spawning populations in the region.

- Eliminates the cost and the logistically complicated effort associated with the steelhead program.

Cons

- Eliminates the important contribution the Quilcene NFH makes towards a basin-wide recovery effort for ESA-listed steelhead in Hood Canal.

- Eliminates the contribution of the Quilcene NFH towards a long-term study to determine the effects of culture-based rebuilding efforts for steelhead that could be applied to other recovery efforts.

Recommended Alternatives

Short term 0-5 years.

The Team recommends that Quilcene NFH support the Hood Canal Steelhead Project (HCSP) through completion of the supplementation phase of the project (2014). The current program includes incubation and rearing to 30 days post-ponding for two populations of steelhead (Dewatto and Duckabush) to supply fry for rearing to smolt and adult at the Long Live the Kings Lilliwaup Hatchery. This contribution is critically important to the success of the Hood Canal Steelhead Project.

The Team recommends developing the capability for Quilcene NFH to rear Hood Canal steelhead beyond the early rearing stage based upon the scenarios provided in Alternative 2. This capability would provide for complete implementation of the HCSP by rearing 400 adult steelhead or rearing approximately 8000 smolts, depending on the scenario chosen. Thus, the team supports the following upgrades to the Quilcene NFH: 1) prioritizing water use from Penny Creek or adding some type of disinfection unit for Quilcene River water, 2) dedicating rearing containers in a secure area provides isolation from the rest of the hatchery and adequate biosecurity, and 3) obtaining an exemption from *The Salmonid Disease Control Policy of the Fisheries Comanagers of Washington State* for a reduced virus testing level because of the listed status of the stocks and small size of the program. However, the team would recommend doing additional annual testing in the watershed for IHN virus over and above the current testing that is done on coho broodstock annually.

Long-term goal (5-15+ years):

The infrastructure upgrades required to implement Alternative 2 may, over the long-term, increase Quilcene NFHs ability to contribute to the restoration and/or conservation of other naturally spawning populations (Alternatives 3 and 4). For example, the Big Quilcene steelhead stock, Hood Canal Chinook salmon, and summer chum salmon are all listed as Threatened under ESA. A pathogen free water source and rearing space to support conservation hatchery programs would provide the Hood Canal Basin a valuable resource that could contribute to recovery efforts.

IV. Quinault River and Hoh River Watersheds (North Coast)

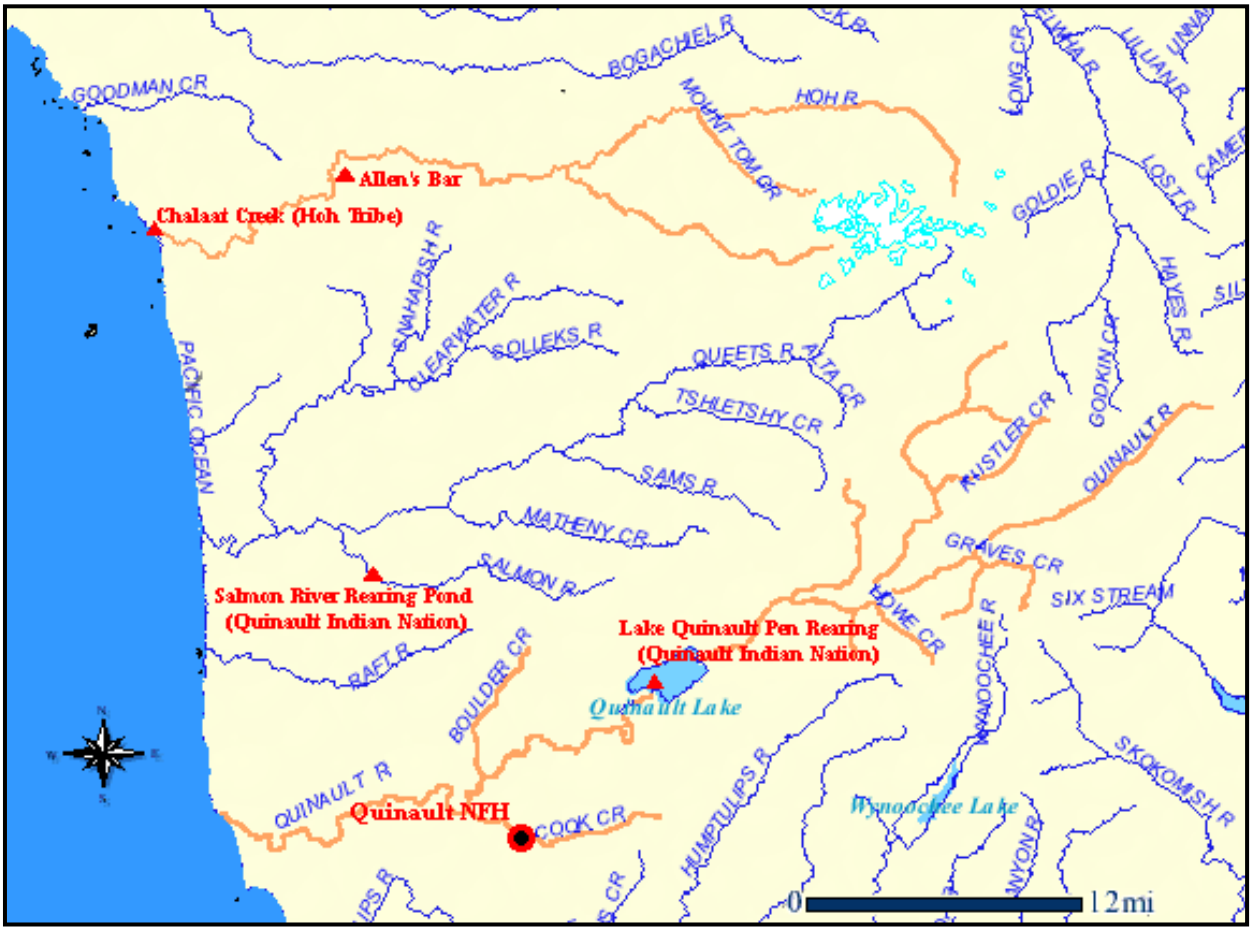

Figure 5. Quinault River and Hoh River watersheds, including Quinault NFH and associated facilities[68]

[68] *Modified figure from Streamnet- http://map.streamnet.org/website/snetmapper/viewer.htm.*

Quinault and Hoh Rivers Overview

Watershed Description

The Quinault River originates from Anderson Glacier on the south side of Mount Anderson in the Olympic Mountains at an approximate elevation of 7,250 feet. The river flows southwesterly just over 70 miles to the Pacific Ocean at Taholah village. The upper river flows through the Enchanted valley nestled between peaks in the Olympic National Park and continues through the Olympic National Forest before entering Lake Quinault at approximate river mile 36. The lower Quinault River leaves Lake Quinault in the Quinault Indian Reservation at approximate river mile 33 and remains within the reservation as it flows through a gradually widening valley. The Lake itself is 3.8 miles long and 2.0 miles wide. There are many tributaries throughout the basin with the largest being the North fork of the Quinault River which joins the mainstem at approximate river mile 47. Lands outside of the National Park have been managed for timber production. The average annual precipitation reported at the Quinault Ranger Station is 146 inches. The National Park Service, US Forest Service, and Quinault Indian Nation are the primary land managers within the basin.

Cook Creek originates from Quinault Ridge on the west slope of the Olympic Mountains in the Olympic National Forest. The creek flows through a patchwork of USFS and Rayonier Timberlands Operating Company lands before leaving the USFS property and entering the Quinault Indian Reservation at about river mile (RM) 5.2 (Figure 2). Tribal and Rayonier Timberlands Operating Company lands are managed for timber harvest. Most USFS land in the Cook Creek watershed is designated as "Late-Successional Reserve" in order to protect and enhance old-growth forest ecosystem conditions. There is no harvest in stands older than 80 years. Younger stands may be thinned to create and maintain late-successional forest conditions. Minor portions of USFS land in the Cook Creek watershed are designated as "Adaptive Management Areas." The goal of this designation is to develop and test technical and social approaches to land management that achieve desired ecological and economic objectives (Martha Krueger, USFS, per. comm., 2001).

Historically, the Cook Creek watershed was intensively managed for timber production. Major logging occurred during the early 1930s. As a result of the earlier logging, and continued harvesting, pure stands of even-age single-story conifer trees make up 50 percent to 75 percent of the lowland land cover, with some alder stands adjacent to the creek itself. Artificially reforested stands range from 0 to 60 years in age and consist primarily of Douglas fir and western hemlock. Approximately 13 percent of the combined Cook/Boulder Creek watershed remains as late-mid-seral and late-seral forest (USFS et al. 1996).[69]

Cook Creek main stem length is about 12.8 miles. There are also approximately 25 miles of tributaries entering Cook Creek. There are some known impasses to upstream fish migration. They include seasonally established beaver dams and log jams, possibly the culvert on the Moclips Highway at RM 10.3, the hatchery intake (which is fitted with a bypass ladder), and the hatchery weir when it is operating.

[69] *U.S. Forest Service, U.S. Geological Survey, U.S. Fish and Wildlife Service, U.S. Bureau of Indian Affairs, Quinault Indian Nation Business Council, Washington Department of Natural Resources, and Rayonier. 1996. Boulder and Cook Creek Watershed Analysis. Quinault, WA.*

Hoh River: The Hoh River lies in WRIA 20 and originates from Hoh glacier on Mount Olympus about 56 miles from the Pacific Ocean. Most the land base within this WRIA consists of private timberlands, Indian reservations, and Olympic National Park. The region is sparsely inhabited, with the City of Forks representing the largest population center. The region is characterized by a cool maritime climate with annual precipitation increasing as one moves inland or upward in elevation. Annual precipitation typically ranges from 80-130 inches in the headwaters. This region is often exposed to high wind and heavy rainstorms, which play important roles in current habitat problems located in disturbed (logged or developed) areas. This WRIA has a significant portion of land that is located in the Olympic National Park, and this land has never been logged. The upper 60% of the Hoh River lies within the Park. In these undisturbed areas, temperate rainforest of coniferous old-growth forests are dominated by Sitka spruce in the lowlands and western hemlock with silver fir in the higher elevations. Bigleaf maple is also a component of the rainforests. The old-growth conifers can reach up to 200 feet in height, and are characterized by somewhat open canopies and low densities.

Fisheries

Quinault River: The Quinault Indian Nation regulates tribal commercial gill net and tribal "guided" sport fisheries in the Quinault River for coho, Chinook, and chum salmon, and for steelhead trout. These fisheries are generally operated through the fall and winter months. The Quinault River watershed once supported fisheries in every month of the year; however, the current status of some populations, in particular Quinault sockeye, limits fishing opportunity during the spring/summer months. The Quinault Indian Nation regulates sport fishing on Lake Quinault, which is located within the reservation boundary.[70]

The entire East Fork Quinault and North Fork Quinault rivers are within the boundaries of the Olympic National Park. The National Park Service is the land manager for that area, which includes managing fisheries that occur there. The Washington Department of Fish and Wildlife fishing regulations for Olympic Peninsula rivers allow the public to retain one wild steelhead per angler per year, whereas adipose-fin clipped hatchery steelhead retention is 2 fish allowed per day per angler. Olympic National Park fishing regulations within the park's boundaries allow the public to retain two hatchery steelhead per day but require that all wild steelhead be released.

Cook Creek: Cook Creek itself supports a major tribal guided steelhead sport fishery during the winter months below the hatchery. The fishermen typically access Cook Creek from the hatchery.

Hoh River: The upper 60% of the Hoh River is within the boundaries of the Olympic National Park. The National Park Service is the land manager for that area, which includes managing fisheries that occur there. National Park Service regulations generally promote selective harvest of hatchery fish and catch-and-release of wild salmon and steelhead (see regulations description for Olympic Peninsula rivers in the Quinault River section above).

Conservation

Bull Trout are the only ESA-listed salmonid in the Quinault and Hoh River watersheds. The hatchery is currently permitted through subpermit #FWSWWFO-11 to conduct weir operations for fish

[70] *Pers. comm. Ed Johnstone, Quinault Indian Nation, 2009.*

propagation purposes and to collect tissues from Bull Trout if they are encountered during those operations. Otherwise no other fish conservation type programs are being employed at Quinault NFH.

Habitat[71]

Quinault River: Historically, the mainstem river contained large logjams, often associated with side channel development. The river was a pool-riffle channel type (Montgomery and Buffington 1993) given its low gradient and alluvial bedform. The low gradient unconfined tributary channels also were pool-riffle channels, with abundant large woody debris and over fifty percent of the surface area in pool habitat. The large woody debris was comprised of very large western red cedar, and Sitka spruce logs based on the available vegetation. Given the presence of black cottonwood in the riparian area, this species was represented as large woody debris as well. Large western hemlock were also represented since this species was common along stream channels. While the logjams were likely formed by large spruce or cedar trees, it is probable that these jams contained substantial quantities of western hemlock and red alder logs. Alder also was present in smaller channels, and off-channel areas due to its prevalence in disturbed areas. The tributary streams within this watershed contained high volumes of woody debris (Grette 1985), and had greater than 50% of their surface area in pool habitat. The steeper portions of these streams likely continued to contain high volumes of large woody debris, but the pool area likely declined somewhat to just below 50% of the area. Very large woody debris was common through the watershed with the wood greater than 20 inches diameter (50 cm) comprising 40% to 80% of the in-stream large woody debris (Ralph et al. 1994). The mainstem contained large possibly channel spanning log jams, and a series of secondary and abandoned channels. The pool area in the mainstem was formed by log jams, and erosion (scour) at channel bends.

Currently, the tributary streams generally contain abundant pool habitat and large woody debris. The channels are relatively low in gradient (<4%) with gravel and cobble substrate. Boulders are rare and found in localized areas. The mainstem habitat is defined through the channel processes of channel migration and avulsion. The mainstem river contains substantial off-channel habitats and river adjacent wetlands.

Cook Creek: Generally, habitat quality of Cook Creek is good. Large woody debris is common, and spawning gravels and riffles are abundant and interspersed with resting pools. Riparian vegetation consists of stands of alder and conifers, as well as areas of smaller plants such as vine maple and salmon berry. The creek is also connected to multiple tributaries and some additional wetland areas that would provide over-winter habitat for juvenile salmonids. Except for the headwaters, the creek gradient is less than 2 percent throughout its course and water temperatures at the hatchery generally average from 42° F (5.5° C) in December to 54° F (12.2° C) in July. Summer low flows typically fall below 10 cfs at the hatchery (Glenn Green, USFWS, per. comm., 2000).

The USFS reports 48 pieces of large woody debris (>12-inch diameter and 25-foot length) per 1,000 feet of stream length in the 3.5-mile reach from the hatchery intake to the Rayonier access road (RM 5.0 to 8.5) (Figure 2) (USFS et al. 1996). The Washington Forest Practices Board rates this as fair for fish habitat (USFS et al. 1996). The USFS also reports a pool area of 29% and substrate consisting of gravel (sizes 0.08-2.5 inches) and cobble (sizes 2.5-10 inches). This is a size range that serves well as spawning gravel.

[71] *Pers. comm. Rob Rhodes, Quinault Indian Nation, 2008.*

During a site visit by Service staff to the same reach (RM 5.0 to 8.5) in September 2000, observations of gravel bar abundance, morphology, and sediment structure appeared to indicate substantial bedload sediment movement with concomitant tendencies for scour and bar instability (Paul Bakke, USFWS, per. comm., 2000). The reach most likely experiences a "flashy" hydrologic pattern, providing high sediment transport capacity over brief, but frequent, floods. Fresh hydraulic erosion on exposed cut banks in glacial outwash terraces provides ample gravel supply and currently, much recruitment potential for moderately large wood (mostly red alder). Active cut bank erosion and large wood interactions are causing localized channel widening, scour pools, and development of secondary high-flow channels. Similar bar development is present in the creek from the hatchery to its confluence with the Quinault River. These conditions were not observed by Service staff in the reach between RM 8.5 to 9.3.

Hoh River: Habitat in the Hoh River basin has been largely protected since 60% of the upper river lies within Olympic National Park. However, habitat in other main-stem and tributary reaches in private timber lands have been compromised as a result of road building and timber harvesting practices.

In an effort to restore "at-risk" acres in the Hoh Basin the Hoh River Trust in partnership with Western Rivers Conservancy and the Wild Salmon Center has acquired nearly 50% of these acres. These acquisitions, in conjunction with lands protected within the Park represent 90% of the entire Hoh River basin (Hoh River Trust web site, 2009).

Current Status of Salmonid Stocks

The Review Team, in conjunction with the Quinault Indian Nation, identified sixteen salmonid stocks that are either in the Quinault River watershed or are affected by fish reared at Quinault NFH. Bull trout is the only salmonid stock listed in the watershed. A stock table for Hoh River winter steelhead is included due to the potential for interaction between natural-origin steelhead and the Quinault NFH steelhead outplanted in the Hoh River watershed:

- Quinault NFH winter steelhead (segregated hatchery)
- Quinault River winter steelhead (integrated hatchery, Lake Quinault Pen Rearing)
- Lower Quinault River winter steelhead (natural)
- Upper Quinault River winter steelhead (natural)
- Quinault River fall Chinook (natural + integrated hatchery, Quinault NFH and Lake Quinault Pen Rearing)
- Quinault NFH coho salmon (segregated hatchery)
- Quinault River coho salmon (natural)
- Quinault NFH chum salmon (segregated hatchery)
- Quinault River chum salmon (natural)
- Quinault River spring/summer Chinook (natural)

- Quinault River sockeye (natural)
- Quinault River cutthroat trout (natural)
- Quinault River native char (Dolly Varden/Bull trout) (natural, threatened)
- Hoh River winter steelhead (natural)
- Hoh River summer steelhead (natural)
- Hoh River native char (Dolly Varden/Bull trout) (natural, threatened)

The following tables summarize the current status and management premises of those stocks as identified by the Quinault Indian Nation and WDFW. The principal sources of information provided in these tables were: personal communications with Larry Gilbertson of the Quinault Indian Nation; communications with Tyler Jurasin of the Hoh Tribe; WDFW's Salmon Stock Inventory (SaSI) and subsequent annual escapement estimates[72]; and the Puget Sound and Coastal Washington Hatchery Scientific Review Group's recommendations for the North Coast[73]. Other sources include the publication "Historic Steelhead Abundance: Washington NW Coast and Puget Sound"[74] and personal communications with WDFW staff.

[72] *SaSI and escapement data available through WDFW's Salmonscape web utility http://wdfw.wa.gov/mapping/salmonscape/.*

[73] *Hatchery Scientific Review Group. March 2004. Hatchery Reform Recommendations for the Puget Sound and Coastal Washington Hatchery Reform Project. Seattle, WA. www.hatcheryreform.org.*

[74] *McMillan, B. and N. Gayesk. May 2006. Historic Steelhead Abundance: Washington NW Coast and Puget Sound. Prepared for the Wild Salmon Center, Portland, OR. http://www.wildsalmoncenter.org/pubs/mcmillan_gayeski.php*

Table 16. Quinault NFH winter steelhead (Quinault NFH)

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological Significance	*Low (HSRG 2004).* Quinault NFH winter steelhead represent a segregated hatchery stock that was selectively bred and currently managed for early within-season return timing to support harvest.
Population Viability	*High (HSRG 2004).* Smolt-to-adult return rates (harvest and hatchery return) averaged 1.7% for the 1996/97 through 2005/06 return years, resulting in high numbers of adult recruits per hatchery-spawned fish (R/S).
Habitat	*High* (HSRG 2004). The Quinault River and Cook Creek provide high quality habitat for outmigrating smolts and adult steelhead returning to the Quinault NFH.
Harvest	*High (HSRG 2004).* An average of approximately 43% of all returning adults from on-station releases are harvested annually in sport and tribal fisheries. Based on expanded coded-wire tag data for brood years 1993-2002, a mean of approximately 3,700 steelhead were harvested or recovered annually at the hatchery. The distribution of those recoveries was: 56% (2,100) recovered at the Quinault NFH; 13% (500) from US sport fisheries; 38% (1,400) from treaty tribal fisheries; 0.02% (1) from spawning ground surveys; 0.1% (4) from hatcheries other than the Quinault NFH; and 0.02% (1) recovered from research activities. In addition, a mean of approximately 2,110 adult steelhead per year (1990-2007) were harvested in the Hoh River for return years 1990-2007 (range = 916 to 3,747 fish) with an average of 1,492 (738 to 3,067) and 618 (76 to 1,518) steelhead harvested annually in tribal and sport fisheries, respectively.
Hatchery Program	
Facilities	Quinault National Fish Hatchery (USFWS) and Chalaat Creek Hatchery (Hoh Tribe).
Type	*Segregated*.
Authorization and Funding	U.S. Fish and Wildlife Service and the Hoh Tribe/Bureau of Indian Affairs.
Primary Purpose	*Harvest*.
Secondary Purposes	None.
Broodstock Origin(s)	Natural-origin steelhead trapped in Cook Creek in the early 1970's beginning in 1972. The hatchery currently relies on adults returning back to the hatchery for broodstock.

Table 17. Quinault River winter steelhead (upper and lower river natural stocks + Lake Quinault Pen Rearing)

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological Significance	*Medium (HSRG 2004*) *to High (Quinault Indian Nation)*. The HSRG and Quinault Indian Nation treat natural-origin steelhead in the Quinault River and hatchery origin steelhead from the Lake Quinault Pen Rearing facility as components of one stock (integrated hatchery program). The Quinault Indian Nation divides natural populations into two stocks, upstream and downstream, respectively, of Lake Quinault. WDFW similarly identifies two winter steelhead stocks in the Quinault River Basin. According to WDFW's Salmon Stock Inventory (SaSI), the upper stock is considered *Healthy* and the lower stock was downgraded from Healthy in 1992 to *Depressed* 2002 because of declining abundance trends. Run timing of these natural populations is protracted for nearly seven months, and returning adults are composed of many age classes with variable ages at maturity, thus increasing the biological significance of these stocks.
Population Viability	*Medium (HSRG 2004)*. From 1978-2005, the estimated mean number of natural-origin adults returning to the lower and upper regions of the Quinault River (excluding harvest) has averaged 1,904 (462 to 3,646) and 1,466 (772 to 2,877) adults, respectively. The Quinault Indian Nation believes that both the upper and lower Quinault River stocks are robust and relatively stable. WDFW (SaSI) rates the viability of the upper stock as "healthy" but downgraded the viability of the lower stock from "healthy" in 1992 to "depressed" in 2002 because of declining abundance trends. From 1978-2005, escapement of hatchery fish, after harvest in the Quinault River, averaged 4,256 (2,292-8,278 range).
Habitat	*Low (Quinault Indian Nation) to Medium to High (HSRG 2004).* Spawning and rearing habitats across the entire system are degraded due mostly to historic damage from timber harvest in the watershed and development on the mainstem floodplain. Habitat conditions are improving, especially on the lower Quinault Basin, as a result of improved land use regulations and practices. Habitats in the upper river will continue to deteriorate without intervention. However, these latter habitat assessments do not appear to be consistent with current trends in steelhead abundance which suggest stable stock abundance upstream of Lake Quinault and declining abundance downstream of Lake Quinault. The Quinault River provides high quality habitat for outmigrating smolts and adult steelhead returning to lake Quinault.
Harvest	*High (HSRG 2004).* From 1978-2005, harvests of natural-origin steelhead in the Quinault River have averaged 1,690 (523 to 3,902) and 1,543 (354 to 2,914) adults in the lower and upper regions, respectively. These harvests represent approximately half of the natural population on an annual basis. *High (HSRG 2004)*. From 1978-2005 in the Quinault River, hatchery stock harvest (including both the net pen reared and Quinault NFH reared steelhead) has ranged from 1,127 to 16,512 (7,629 avg.) and upper stock harvest has ranged from 354 to 2,914 (1,543 avg.).
Hatchery Program	

Facilities	Lake Quinault Pen Rearing (Quinault Indian Nation)
Type	*Integrated*. Natural origin Quinault River winter steelhead continue to be included with the broodstock, although natural-origin fish are not included in the broodstock according to a defined proportion.
Authorization and Funding	Quinault Indian Nation: Bureau of Indian Affairs.
Primary Purpose	*Harvest*. The program is intended to mitigate for fishery losses in the Quinault River resulting from habitat degradation.
Secondary Purposes	None.
Broodstock Origin(s)	Steelhead native to the Quinault River. Gill nets are used each year to collect broodstock in Lake Quinault, and wild fish may be included.

Table 18. Quinault River fall Chinook salmon (natural + hatchery)

Management Premises and Goals	
ESA Status	Not listed.
Biological Significance	*Medium (HSRG 2004).* The Lake Quinault Pen Rearing program's management intent is to be integrated with the natural population. The Quinault NFH Chinook program regularly relies upon the net pen program for fish and eggs.
Population Viability	*Medium (HSRG 2004).* The estimated number of fall Chinook spawning naturally in the Quinault River, which includes both natural and hatchery-origin fish, averaged approximately 5,000 (range = 1,413 to 11,013) fish per year, 1996-2005.,.
Habitat	*Medium/High (HSRG 2004).* Habitat quality varies by location. The habitat is limiting but where it is functioning, it is healthy. The lower Quinault River is fairly stable; however, the stream banks in the upper Quinault habitat above Lake Quinault and below the boundary of Olympic National Park are unstable, the quality is highly variable and the upper river's habitat trend is likely downward.
Harvest	*High (HSRG 2004).* From 1936-1973 natural stock harvest in the Quinault River averaged 2,330 (617 to 7,318) adults. For the latest ten year period from 1996-2005 harvest in the Quinault River averaged 2,413 (1,151 to 5,738) natural-origin adults and 3,053 (1,474 to 5,219) hatchery-origin adults. Fall Chinook also contribute to ocean fisheries.
Hatchery Program	
Facilities	Lake Quinault Pen Rearing (LQ) (600,000 at 15 fpp – 100% adipose-fin clipped) Quinault NFH (Quinault NFH) (400,000 at 40 fpp – 100% adipose-fin clipped, 200,000 code-wire tagged for a total of 600,000)
Type	*Integrated*. The Lake Quinault Pen Rearing program's management intent is to be integrated with the natural population. The Quinault NFH Chinook program regularly relies upon the net pen program for fish and eggs. The management desire is for hatchery and natural-origin fall Chinook in the Quinault River to represent one stock genetically.
Authorization and Funding	Lake Quinault Pen Rearing (Quinault Indian Nation funded) and Quinault NFH (USFWS funded).
Primary Purpose	Harvest. The program is intended to mitigate for fishery losses in the Quinault River basin resulting from habitat degradation and marine harvests of natural-origin fall Chinook originating from the Quinault River.
Secondary Purposes	None.
Broodstock Origin(s)	Fall Chinook native to the lower Quinault River. Broodstock are now captured in Lake Quinault.

Table 19. Quinault NFH coho salmon (Quinault NFH)

Management Premises and Goals	
ESA Status	Not Listed.
Biological Significance	*Low (HSRG 2004)*. The Quinault NFH coho stock was crossbred with fish from the Skagit River in 1975. Coho salmon from the Queets River were released into Cook Creek/Quinault River basin with the 1983 brood. Since then, all broodstock are from returns to the hatchery.
Population Viability	*High (HSRG 2004)*. The average total smolt to adult survival is 2.3 % (broods 94-03) Adult returns have averaged approximately 14,000 fish per year (harvest plus recaptures at the hatchery).
Habitat	*Medium/High (HSRG 2004)*. The Quinault River and Cook Creek provide medium/high quality habitat for outmigrating smolts and adult coho returning to the Quinault NFH.
Harvest	*High (HSRG 2004).* For broods 1993-2002, on average approximately 14,000 coho are recovered annually. The distribution of those recoveries is: 42% (5,900) recovered at the Quinault NFH; 0.5% (70) from US commercial fisheries; 7% (1,000) from US sport fisheries; 49% (6,800) from treaty tribal fisheries; 0.2% (30) from Canada commercial fisheries; 1% (140) from Canada sport fisheries; 0.03% (42) from spawning ground surveys; 0.005% (1) from hatcheries other than the Quinault NFH; and 0.02% (3) recovered from research type activities.
Hatchery Program	
Facilities	Quinault NFH.
Type	Segregated.
Authorization and Funding	U.S. Fish and Wildlife Service.
Primary Purpose	Harvest. The program is intended to mitigate for fishery losses in the Quinault River resulting from habitat degradation.
Secondary Purposes	None.
Broodstock Origin(s)	Natural-origin coho trapped in Cook Creek beginning in 1968. Fish were crossbred in 1975 with coho salmon from the Skagit River. The stock is currently maintained with hatchery-origin fish returning to Quinault NFH.

Table 20. Quinault River coho salmon

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological Significance	*Low (HSRG 2004) to Medium (Quinault Indian Nation).* Quinault Indian Nation surveys indicate that from 1977 to 2005, on average, 20% (range 3% to 49%) of the natural spawners may be hatchery fish in the Quinault River. According to the Quinault Indian Nation, coho spawning in the upper Quinault River tend to be larger and spawn later than coho in the lower river.
Population Viability	*Medium*. The Quinault Indian Nation has rated the viability of coho salmon populations in the Quinault River as "medium". In contrast, the HSRG (2004) rated viability as "high". However, this latter rating was based on the initial assumption that the Quinault NFH was an "integrated" program and, thus, resulted in a higher viability rating than indicated for the naturally spawning population. From 1981-2005 natural stock spawners averaged 4,030 (636-12,515 range) and hatchery stock spawning naturally averaged 1,075 (24-4,017 range)
Habitat	*Medium to High (HSRG 2004).* There are no data or information regarding the historic distribution of Quinault coho salmon spawning locations and aggregations. Spawning and rearing habitats across the entire system are currently degraded due mostly to historic damage from timber harvest on the watershed and development on the mainstem floodplain. Habitat conditions are improving, especially on the lower Quinault Basin, as a result of improved land use regulations and practices. Habitats in the upper river will continue to deteriorate without intervention (BOR 2005).
Harvest	*High (HSRG 2004).* Historic catch of natural coho in the Quinault River from 1936-1960 averaged 17,789 (6,691-44,444 range). More recent catch of natural stock coho in the Quinault River from 1981-2005 averaged 3,956 (137-9,761range).

Table 21. Quinault NFH chum salmon (Quinault NFH)

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological Significance	*Medium (HSRG 2004).* Mix of native plus Hood Canal (Walcott Slough) stock.
Population Viability	*Medium (USFWS).* Mean recruits-per-spawner for Quinault NFH chum hatchery rack returns exceeds 1.0. The HSRG (2004) rated the viability the population as "high".
Habitat	*Medium* (HSRG 2004).
Harvest	*High (HSRG 2004) to unknown.* The proportion of the total harvest contributed by hatchery-origin fish is unknown. Basin wide catch of chum salmon in the Quinault River from 1981-2005 averaged 3,130 (583-8,623 range).
Hatchery Program	
Facilities	Quinault NFH.
Type	Segregated.
Authorization and Funding	U.S. Fish and Wildlife Service.
Primary Purpose	Harvest.
Secondary Purposes	None.
Broodstock Origin(s)	The broodstock originated from some indigenous stocks, but Walcott Slough (Hood Canal) eggs were frequently imported and incorporated into the program.

Table 22. Quinault River chum salmon

Management Premises and Goals	
ESA Status	*Not Listed*.
Biological Significance	*Low (HSRG 2004) to Medium (Quinault Indian Nation).*
Population Viability	*Low (HSRG 2004).* Abundance is low and population complexity and diversity are weak. Although run sizes and escapements have been stable since 1990, the contribution of hatchery production to this stability is not certain. 1981-2005 escapement after harvest averaged 4,867 (1,404-11,486 range).
Habitat	*Medium (HSRG 2004)*. Although chum spawning habitat quality in the lower river has improved, it is still damaged from timber harvest and development on the floodplain and less productive than historic conditions.
Harvest	*High (HSRG 2004)*. Historic catch of natural chum salmon in the Quinault River from 1936-1960 averaged 14,760 (898-89,062 range). More recent basin wide catch of chum salmon in the Quinault River from 1981-2005 averaged 3,130 (583-8,623 range). The proportion of the total harvest contributed by hatchery-origin fish is unknown.

Table 23. Quinault River spring/summer Chinook salmon

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological Significance	*Unknown.* The HSRG (2004) did not recognize this stock. The Team does not know whether this is a native population or a stock introduced through hatchery production.
Population Viability	*Low.* From 1983-2005, escapement after harvest averaged 459 (118-1,685 range). The extant data from 1952 through 2005 indicate the population is continuing to decline even though harvests in the terminal fisheries have been reduced to very low levels. The low abundance and small escapements of the last ten years, and the apparent lack of compensatory responses, makes this population potentially vulnerable to depensatory processes in the environment and further decline.
Habitat	*Low.* Current spawning locations for this stock are limited to a few main channel and large tributary locations in the Upper Quinault River, especially in the East Fork.
Harvest	*Low.* From 1983-2005, average harvest was 126 (0-530 range).

Table 24. Quinault River sockeye salmon

Management Premises and Goals	
ESA Status	*Not Listed*.
Biological Significance	*High (HSRG 2004).*
Population Viability	*Low (Quinault Indian Nation) to Medium (HSRG 2004).* The risk of further catastrophic decline, and even virtual extinction, of the Quinault sockeye salmon is rated as high The population is at or near levels that make it vulnerable to depensatory processes and the associated risk of collapse. In fact, 17 of the last 26 (65%) escapements have not replaced themselves (i.e., total brood year return was less than the parent escapement). From 1998-2007 the average escapement after harvest was 23,109 (3,080-56,612 range). However, the Quinault Indian Nation is concerned with the declining trend in returns. Since 2003, returns have declined from 93,743 to 5,035 in 2007. These numbers include both harvest and escapement. Only 35 sockeye were harvest in 2007. The 2002 WDFW SaSI report indicates a 'healthy' sockeye salmon population in Lake Quinault.
Habitat	*Low to Medium (Quinault Indian Nation) to Medium to High (HSRG 2004).* The Quinault Indian Nation has determined that the overall condition of habitats that sustain sockeye production in the Quinault system is poor and getting worse.
Harvest	*Medium (HSRG 2004)*. From 1998-2007 the average harvest was 7,329 (35-37,131 range).

Table 25. Quinault River cutthroat trout

Management Premises and Goals	
ESA Status	Not listed.
Biological Significance	*Low (HSRG 2004).* HSRG (2004) did not specifically rate Quinault River populations. HSRG (2004) rated North Coast and Moclips/Copalis Sea-run cutthroat.
Population Viability	*Medium (HSRG 2004).* Observations through incidental catch appear to indicate the population is healthy (pers. comm. L. Gilbertson, Quinault Indian Nation, 2008).
Habitat	*Medium (HSRG 2004)*.
Harvest	*None for North Coast (HSRG 2004) to High (HSRG 2004 for Moclips/Copalis).* Harvested under sport fishing regulations. Catch per effort in Lake Quinault is high (L. Gilbertson pers. com.).

Table 26. Quinault River native char (Dolly Varden/Bull trout)

Management Premises and Goals	
ESA Status	Bull trout were listed as threatened in 1999 (64 FR 58910).
Biological Significance	*Medium (HSRG 2004).* The Quinault Indian Nation does not distinguish between Dolly Varden and bull trout. The Coastal-Puget Sound Distinct Population Segment (DPS) is biologically significant to the species as a whole because it contains the only anadromous forms of bull trout in the coterminous United States, thus, occurring in a unique ecological setting (May 2004 draft recovery plan).
Population Viability	*Low (HSRG 2004) to Medium (Quinault Indian Nation).* The USFWS considers the potential for recovery to be high for the DPS as a whole. Observations in the Quinault River indicate a strong population with good size distribution (L. Gilbertson pers. com.).
Habitat	*Medium (HSRG 2004).* Past logging and gravel operations have impacted habitat in the Quinault basin. Riparian shade and large woody material are at historical levels within Olympic National Park and the upper watershed, but decrease in direct proportion to the history of timber harvest activities downstream of the park boundary. Known passage barriers include Quinault NFH on Cook Creek (May 2004 draft recovery plan).
Harvest	*None (HSRG 2004) to Low (Quinault Indian Nation).* Most of the Quinault River has been closed to fishing for bull trout/Dolly Varden since 1994 except that there is a four fish daily limit for bull trout/Dolly Varden in tribal waters within the Quinault reservation. The Olympic National Park has catch and release regulations (SaSI 1998).

Table 27. Hoh River winter steelhead

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological Significance	*Medium (HSRG 2004).*
Population Viability	*Medium (HSRG 2004).*
Habitat	*Medium (HSRG 2004).*
Harvest	*High (HSRG 2004).*

Table 28. Hoh River summer steelhead

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological Significance	*Medium (HSRG 2004).* According to HSRG (2004), this naturally spawning populations is composed of less than 50% "native genes".
Population Viability	*Low (HSRG 2004).*
Habitat	*Medium (HSRG 2004).*
Harvest	*High (HSRG 2004).*

Table 29. Hoh River native char (Dolly Varden/Bull trout)

Management Premises and Goals	
ESA Status	Bull trout were listed as threatened in 1999 (64 FR 58910).
Biological Significance	*Medium (HSRG 2004).* Coastal-Puget Sound Distinct Population Segment is significant to the species as a whole because it contains the only anadromous forms of bull trout in the coterminous United States, thus, occurring in a unique ecological setting (May 2004 draft recovery plan).
Population Viability	*Medium (HSRG 2004).* The USFWS considers the potential for recovery to be high for the DPS as a whole.
Habitat	*Medium to High (HSRG 2004).*
Harvest	None (HSRG 2004) to Low incidental catch.

Other Species of Concern

Table 30. Additional salmonid and non-salmonid native fish species present in the Quinault River watershed[75]

Common name	Scientific Name
Pacific lamprey	*Lampetra tridenata*
Sculpins	*Cottus sp*
Cutthroat trout	*Oncorhynchus clarki*
Mountain whitefish	*Prosopium williamsoni*
Threespine stickleback	*Gasterosteus aculeatus*
Largescale sucker	*Catostomus macrocheilus*
Olympic mudminnow	*Novumbra hubbsi*

Avian predators commonly observed include starlings, bald eagle, osprey, great blue heron and kingfisher. River otters also occur in the Quinault River and prey on program fish.

Salmon and Steelhead Hatcheries in and around the Watershed[76]

Quinault National Fish Hatchery (U.S. Fish and Wildlife Service)

The Quinault NFH was authorized on July 7, 1964 by Appropriation Act (78 Stat.283) and Fish and Wildlife Act of 1956 (70 Stat. 1119) and began operations in 1968 "to restore and enhance depleted runs of salmon and steelhead on the Quinault Indian Reservation and adjacent federal lands."

The Quinault NFH occupies 79.45 acres. Its main facilities consist of thirty-six, 16-foot-wide by 80-foot-long raceways (converted Burrows), two water re-use pumps, a pollution abatement pond, and three water intake structures. The main intake structure is located on Cook Creek, and a smaller one on Hatchery Creek. A third intake structure siphons water from a large pond on property leased from the Bureau of Indian Affairs adjacent to the Moclips Highway approximately 2 miles northeast of the facility. The hatchery diverts returning adult salmon to holding facilities by means of an electrical fish barrier and fish ladder. The facility also includes an administration building, which houses the main office, a conference room and a visitor's center with interpretational information and displays. A separate hatchery building contains a room that holds the incubation trays and fry start tanks, a lunch room and a gear locker room. Additionally, the facility has an electric weir control building, an egg isolation/quarantine building, a service/shop/feed building, a welding-metal craft/vehicle and equipment storage building that also houses the emergency power generator room, hazardous materials storage, and domestic water pumps. All buildings are situated on the north side of Cook Creek. There are three permanent government residences and five temporary residential trailer pads. Permanent residences are reserved for required-occupancy staff. Temporary residential pads are used

[75] *Pers. comm. Dave Zajac, Hatchery Review Team, 2008.*

[76] *See Figure 5.*

by camp-host volunteers and non-required occupancy staff. All residences are located adjacent to the north portion of the facility.

Initial hatchery operations were funded by the Bureau of Sport Fisheries and Wildlife and coordinated via a Memorandum of Agreement with the Quinault Indian Nation. However, from 1984 to 1988 funding was provided by the Bureau of Indian Affairs and hatchery operations were coordinated by the Quinault Indian Nation. Funding responsibility was transferred back to the Service around 1989 and hatchery operations have been coordinated with the Quinault Indian Nation via a Cooperative Agreement since 1991.

The hatchery is funded by Congressional appropriation of hatchery operations funds to the Service and the Service's hatchery cyclical maintenance fund. The operational budget for FY2008 was $798,251. Costs for monitoring and evaluation (M&E) and fish health in FY2008 were approximately $200,000 and $115,000, respectively. Capital Improvements to the Quinault NFH have totaled $1,586,167 during the period 2004-2008.

Funding Source: FY2008	**Amount**
Appropriations to USFWS	$669,490
USFWS –Hatchery Cyclical Maintenance	$128,761
Total	$798,251

Lake Quinault Pen Rearing (Quinault Indian Nation)

Lake Quinault Tribal Hatchery (Pen Rearing) is owned and operated by the Quinault Indian Nation. The facility is located on the southwest shore of Lake Quinault (WRIA number 21.0398) on the Olympic Peninsula. Lake Quinault is part of the mainstem Quinault River at river mile 33. There are 3 buildings on the site, including incubation facilities, with a net pen complex approximately 1000 feet off shore of the hatchery/office complex.

Salmon River Hatchery (Quinault Indian Nation)

The Salmon River Fish Culture Facility is owned and operated by the Quinault Indian Nation. The facility is sited at river mile 4.0 on the Salmon River (WRIA 21.0139), a lower main tributary to the Queets River (WRIA 21.0016). The Queets River is located near the middle of Washington States north coast. There are two buildings on the site housing feed storage, office space, employee quarters and hatchery incubation units.

Chalaat Creek Hatchery (Hoh Tribe)

Chalaat Creek Hatchery is owned and operated by the Hoh Tribe. This facility is located on the Hoh reservation in the Hoh River watershed. It has some incubation capacity and some limited above ground small rectangular tanks. Chalaat Creek is "fenced" to create an imprint area for the steelhead transferred from Quinault NFH and released into the Hoh River.

Quinault NFH Winter Steelhead, Cook Creek Program

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: The purpose of the program is to mitigate for tribal and sport fisheries in the Quinault River and Cook Creek where production has declined due to loss of habitat. A specific harvest goal has not been established. However, based on the current program size and a desired 2.0% smolt to adult return rate (2001-2005) (harvest plus hatchery escapement), the program goal would be to achieve a mean harvest of 3,250 adult steelhead per year.

- ***Broodstock escapement goal***: Provide an escapement back to the hatchery of 550 hatchery-origin adult steelhead for a segregated broodstock program. Achieve a 0.29% survival from smolt to adult return rate to the hatchery to maintain broodstock.

- ***Conservation goal***: No specific conservation goal exists for the Quinault NFH steelhead program.

- ***Escapement goal for natural-origin adults***: No specific escapement goal exists for natural-origin steelhead in Cook Creek.

  According to the Washington Department of Fish and Wildlife SaSI Report, the escapement goal for natural-origin Quinault River steelhead adults back to the spawning grounds is 1,200 for the portion of the river upstream of Lake Quinault. No escapement goal exists for the Quinault River downstream of Lake Quinault.

- ***Research, education, and outreach goals***: Maintain public visitation opportunities via the *Camp Host* program where the volunteer hosts maintain the visitor's center and guide tours. Coordinate specific educational opportunities with local schools. Maintain the facility's web site with the goal to provide timely information to the public regarding hatchery operations and program benefits.

Objectives

- Spawn 450 adult steelhead to yield approximately 900,000 green eggs to maintain both the Cook Creek/Quinault River and Hoh River release programs. Eggs are taken from 225 females to maintain an adequate, effective population size. Eggs are then culled to approximately 350,000 to meet the program needs.

- Cook Creek/Quinault River Releases:
  - Release 20,500 steelhead fry/fingerlings into Cook Creek at 500 fish per pound upstream of the hatchery in April.
  - Release 190,000 yearling smolts at 5.5 fish per pound annually from the hatchery into Cook Creek after April 15 each year.

- Hoh River Transfers/Releases **(*See the Quinault NFH, Hoh River Release section for a review of this program component)***

    - Transfer 50,000 yearling pre-smolts at 15 fish per pound to the Chalaat Creek Hatchery in the Hoh River watershed (Hoh Tribe) during February each year for acclimation prior to release.
    - Transfer and direct-stream release 50,000 smolts at 5.5 fish per pound into the Hoh River at Allen's Bar (at river mile 15) after April 15.

Program Description

The current steelhead hatchery stock was founded in 1972 from natural-origin adults captured in Cook Creek. The hatchery currently produces 190,000 winter steelhead smolts for release into Cook Creek. The program also includes a 20,500 steelhead fry release upstream of the hatchery in Cook Creek.

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Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- The broodstock originated from naturally spawning Cook Creek or Quinault River winter steelhead.

- Quinault NFH winter steelhead return earlier than the wild population. This separation in run timing is most likely due to domestication selection for early return and spawn timing of adults associated with producing smolts at one year of age.

- The program is considered segregated from the wild population because natural-origin fish are not purposefully included with the broodstock. Moreover, hatchery and wild fish have distinctly different run timing distributions, thus facilitating management of hatchery and wild fish as two distinct stocks. Cook Creek/Quinault NFH hatchery steelhead have the earliest return time, followed by the Lake Quinault hatchery returns, and then the wild returns (pers. comm. Larry Gilbertson July 2008).

- Steelhead are collected throughout the return, from October to February, after which the adult ladder is closed.

Hatchery and Natural Spawning, Adult Returns

- A Smith-Root design electric barrier weir directs returning adults into the fish ladder. Fish ascend the ladder into the "outflow" channel from E-bank ponds. One of the ponds is set up to attract fish

into it for holding purposes. Once a week, the fish are pushed out of the pond into the channel and manually crowded up the channel to an electric lift basket inside the spawning building that lifts the fish into a carbon dioxide anesthetic vat. A hydraulic basket then lifts the fish from the anesthetic to a slide that leads to the sorting table.

- The weir is normally operated from October 1 to April 1 to prevent upstream passage of adult salmon and steelhead in Cook Creek and into the hatchery's water supply. The hatchery intake is located in Cook Creek above the weir. Adult salmon and steelhead are currently not allowed upstream due to fish health concerns (including the transmission of IHN virus), primarily related to the Hoh River steelhead transfer. However, the weir is not 100% effective.

- In June of 2008, a Columbia River strain of IHN (MD strain) virus was detected in juvenile Lake Quinault winter steelhead being reared in net pens in Lake Quinault. This was the first detection of this "nonendemic" strain, highly virulent to steelhead, in the Quinault River basin. There exists an endemic strain of IHN (U strain) in the Lake Quinault sockeye population, which, to this point, has not posed a problem with any of the hatchery-reared stocks in the basin.

- Natural-origin steelhead trapped at the hatchery are not purposefully excluded from the broodstock during spawning.

- The broodstock are sorted for "ripeness". Ripe fish are spawned and non-ripe fish are returned to the holding pond or surplused. Fish are killed using a pneumatic driven M-3 "fish stunner".

- Fish not needed for the steelhead programs are available to tribal members for subsistence and some are picked up by a processing company via an agreement with the Grays Harbor Food Bank.

- The total estimated run size of natural-origin steelhead in the Quinault River in 1952 was approximately 19,000 adults. The recent five-year average is 4,892 natural-origin steelhead[77].

- From 1978-1992, hatchery and natural-origin combined escapement of steelhead into the Quinault River, primarily below Lake Quinault, ranged from 1,716 to 3,646 fish (SaSI 1992).

- The Quinault Indian Nation has divided the natural stock into upper and lower Quinault River. After harvest, from 1978-2005, lower stock escapement has ranged from 462 to 3,646 (1,904 avg.) and upper stock escapement has ranged from 772 to 2,877 (1,466 avg.).

- From 1978-2005 in the Quinault River, hatchery stock harvest has ranged from 1,127 to 16,512 (7,629 avg.) and upper stock harvest has ranged from 354 to 2,914 (1,543 avg.)

- The average Quinault NFH steelhead smolt-to-adult return rate to the Quinault River (harvest and hatchery return) is 1.7% (1996/97 – 2005/06).

- The Quinault Indian Nation also has a hatchery steelhead program in Lake Quinault. The Nation collects their own broodstock and rears the juvenile steelhead in net pens in Lake Quinault. Steelhead releases occur downstream of Lake Quinault. The release goal is 200,000 smolts annually.

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[77] *Table 29, Part 3 of McMillan B. and N. Gayesk. 2006. Historic Steelhead Abundance: Washington Northwest Coast and Puget Sound. Wild Salmon Center. Portland, OR.*

- Some natural steelhead spawning occurs in Cook Creek downstream from the hatchery. Additionally, stable, persistent spawning aggregations exist in relatively isolated habitats in widespread locations across the entire Quinault River watershed.

- A significant tribal guided sport fishery occurs in Cook Creek immediately downstream from the hatchery. Harvest numbers are unknown.

- About 225 adult steelhead pairs are needed for broodstock each year to maintain the Quinault NFH program.

- Steelhead are spawned one day per week. The number of adults spawned each week reflects the relative proportion of the predicted annual run trapped during the preceding week

- Fish used for spawning may include hatchery and naturally produced fish.

- During sorting, the fish are anesthetized in water injected with carbon dioxide and oxygen. Currently, carbon dioxide is metered into the anesthetic tank at 4-5 liters per minute and oxygen is metered in at 1 liter per minute. This ratio was arrived at by trial and error and would be dependent on temperature and chemistry of the water used. This was developed to reduce the amount of thrashing that is experienced when fish are normally anesthetized with carbon dioxide exclusively. MS-222 is not used so that spawned out carcasses can be made available for human consumption.

- The adults are generally spawned pair wise, one female to one male. If females outnumber males, males may be spawned with more than one female.

- Broodstock are spawned randomly without selecting for size.

- Adult virus testing: Adults are tested for viruses at a minimum of the 2% assumed pathogen prevalence level. This involves testing ovarian fluid from at least 150 females and kidney/spleen tissue from at least 60 males. No regulated viral pathogens have been detected in the adult steelhead broodstock at Quinault NFH.

- Eggs are rinsed with a 1.4% sodium bicarbonate solution to facilitate fertilization.

- The eggs are placed into a stainless steel bucket, milt is added, and additional sodium bicarbonate solution is added and mixed.

- Buckets and colanders are disinfected with at least 100 parts per million iodine between uses.

- Eggs deemed non-viable are discarded during spawning.

- No steelhead are intentionally passed upstream of the Quinault NFH. Fish passage can occur when the barrier is turned off, when the weir malfunctions, during extreme high water events, or during transition from low water to high water when the main deck is not energized due to safety concerns. A new operational regime is being implemented which is expected to reduce unintentional passage.

- Bull trout natural production upstream of the weir on Cook Creek is believed to be limited due to high water temperatures. USFWS Western Washington Fish and Wildlife Office staff observed 3

bull trout (1 adult, 1 sub-adult, 1 juvenile) on June 8, 2000 during a brief snorkel training exercise immediately below the hatchery weir, and hatchery staff encountered 1 bull trout during steelhead spawning operations on January 23, 2002 and during coho spawning operations in 2008. There have been no other reports of observations, although no other surveys have been performed. The Quinault NFH section 10 permit[78] for the handling and sorting of fish requires that all bull trout trapped at the hatchery be passed upstream.

Incubation and Rearing

- Fertilized eggs are rinsed in a trough supplied with Cook Creek water, then disinfected and water hardened in 75 parts per million iodine solution for 30 minutes in the incubation trays.

- Incubation and rearing water temperatures fluctuate seasonally. During the winter, incubation temperatures range in the mid 30s to mid 40s Fahrenheit. Rearing temperatures in the summer range from the mid 40s to high 50s.

- Formalin 1:600 (1667 parts per million) for 15 minutes starting at least 24 hours after fertilization is used to control fungus on the eggs. Formalin is applied 7 days a week for about 7 weeks then discontinued before hatching.

- The green eggs are incubated in vertical stack trays at 12,000 steelhead eggs per tray (eggs from three females per tray) and supplied with 3-5 gallons per minute water. At eye-up, eggs are picked and trays reloaded to approximately 8,000 per tray.

- Eye-up survival ranges from 65% to 90%, but has improved over time. In the most recent two years, the survival has been 89% to 90%. Over the last few years, modifications were made that may have contributed to the increase in survival. For example, bad eggs are now discarded at spawning, a bicarbonate rinse occurs at fertilization, an oxygen injection is used in conjunction with carbon dioxide before spawning, the iodine concentration for water hardening has been reduced from 100 parts per million to 75parts per million, and the spawning process time has been reduced (see other bullets in this section for details).

- Eggs are shocked about 30 days post fertilization. Dead eggs are then removed about 12-24 hours after they are shocked.

- Eggs excess to program needs are discarded from mixed batches during shocking so that all females are represented in the resulting smolt production.

- The fry are started in 16’ x 3’ x 3’ fiberglass nursery rearing tanks after yolk absorption. Tanks are initially loaded at approximately 24,000 fish per tank and flows are set at approximately 30 gallons per minute per tank. The tanks used for initial rearing of steelhead are located in the nursery building. The maximum density index in these tanks is 0.25.

- When all fry reach approximately 700 fish per pound, they are initially ponded into C-Bank. At the first subsequent inventory, the steelhead destined for release into Cook Creek/Quinault River are moved to two, 16’ x 80’ x 34 inch deep concrete Burrows ponds in E bank and the steelhead destined for release into to the Hoh River are initially moved to one 16’ x 80’ modified Burrows pond in D bank.

[78] *Permit TE-702631, Sub-permit No. FWSWWFWO-11*

- The Burrows ponds in the E-bank may be on reuse water during lower summer flows (water from the other banks into a common outflow pipe) from August to October (about 8-12 weeks). E-bank is the only bank of ponds that can operate on reuse water. Currently, recirculation is limited to that portion of the yearling steelhead program that is placed in E-bank.

- There appears to be a great deal of size variance in the steelhead reared at Quinault NFH, however length samples are not currently taken to quantify the magnitude of the problem. Steelhead are currently not graded and reared separately by size.

- Adipose-fin clipping and coded-wire tagging occurs in November-December when the larger steelhead are approximately 20 fish per pound (this is about 50% of the steelhead as there is a great deal of size variation in the population). The fish are clipped and tagged manually because many of the fish are too large to use an automatic trailer.

- Generally, ponds are cleaned daily using the brush and drain method.

- Initially fry are fed at least six times per day, seven days per week. Feed frequency gradually drops to twice per day at the yearling stage.

- Pond cleaning equipment is disinfected with iodine between ponds to prevent horizontal transmission of disease.

- Every attempt is made to divide fish among Burrows Ponds in advance of the density index reaching 0.20 or a flow index reaching 1.0. Infrequently, on low water years, flow index may be exceeded. Occasionally operational constraints may cause density indices to be exceeded if splits are delayed too long into the fall season.

- For steelhead, density indexes do reach 0.25 in E-bank prior to release. However, density indices may not be accurate as they are calculated without taking samples to establish average total lengths. Flow indices infrequently exceed 1.0 and at extremely low water occurrences may reach 1.2 during that time, but are subject to the same inaccuracies as noted above.

- Fish in each raceway are sampled monthly to monitor growth rates (number of fish per pound) and feed is adjusted accordingly.

- Inventories are performed when the steelhead are moved among the various rearing containers. After hatch, the steelhead are enumerated gravimetrically (# of fish per pound). Quinault NFH recently purchased a Vaki fish counter that will be used in addition to the traditional gravimetric method.

- The facility has predator control, including a fence and bird wires; however, predation by crows, starlings, and otters is a continuing problem.

- Formalin bath treatments to control external parasites (including *Trichodina, Gyrodactylus*, and *Ichthyobodo sp.*) on all species of fish are common. Depending on the parasite and the water temperature, this may be a one-time treatment or it may be performed on multiple days either consecutively or alternately. Baths are generally one hour long at 1:6000 to 1:4000 (167 – 250 parts per million) and conform to the Food and Drug Administration (FDA) and EPA guidelines

and labels. The parasites which cause the most significant problems in steelhead at Quinault NFH are *Ichthyobodo sp.* and *Trichodina sp.*

- Systemic infections of bacterial coldwater disease occur on some broodyears and require medicated feed to control. Coldwater disease caused by the bacterium *Flavobacter psychrophilum* has been isolated from juvenile steelhead and has been treated with feed medicated with oxytetracycline or florfenicol within drug label guidance or under the Investigational New Animal Drug (INAD) permit in compliance with FDA regulations.

Release and Outmigration

- Quinault NFH steelhead released on-station into Cook Creek/Quinault River are force released. This procedure generally starts with removing screens and dam boards late in the afternoon and crowding the fish out into the outflow channel. The fish are taken off feed two days prior to release.

- Steelhead are released in April with the goal of releasing the fish at six fish per pound. The steelhead are released at this size and time with the expectation that this will reduce residualism.

- The steelhead on-station smolt release is not electronically inventoried. However, Quinault NFH recently purchased a Vaki fish counter that will improve the enumeration of fish at some point during rearing prior to release.

- Steelhead are released on-station after April 15 in conjunction with a one week separation from chum releases. The chum may be released either before or after the steelhead.

- 20,500 steelhead fry at approximately 500 fish per pound are released into Cook Creek upstream of the hatchery in lieu of adult passage to utilize available habitat. This alternative is presumed to reduce the risk of an IHN virus outbreak at Quinault NFH or pathogens that could be transferred into the hatchery's water source compared to passing adult steelhead upstream of the weir . Nonetheless, some adults have been observed in the upper drainage that have bypassed the weir.

- Surplus fry beyond program objectives are planted into the Raft and Moclips Rivers, north and south of the Quinault River, respectively. A representative sample is tested by fish health before transfer.

- Attempts are to release the Quinault NFH steelhead on-station at the same time as the Quinault Indian Nation's Lake Quinault steelhead release to minimize the impacts on juvenile sockeye and chum salmon in the Quinault River.

Facilities and Operations

- Quinault NFH is located on the Quinault Indian Nation reservation.

- From October through February, steelhead, coho, chum, and Chinook adults used for broodstock are held in two of the E-bank Burrows ponds, directly adjacent to ponds where juvenile steelhead are reared. A fence was installed between the ponds to prevent adults from jumping into the pond with the steelhead juveniles. However, water from the pond holding the adults can still spray into the juvenile rearing ponds, presenting a disease transmission risk. Currently, the Quinault NFH

staff leaves the pond directly adjacent to the adult holding pond empty during broodstock collection to reduce the risk of disease transmission.

- Adult holding space (E Bank) is limited. Adults are not separated by sex or species.

- Adults enter the facility up the fish ladder and through the E-bank outflow channel. There are no mechanical crowders in the outflow channel or the pond where adults are held. Adults are crowded manually.

- There are three water supplies for Quinault NFH: Cook Creek (above the weir), Hatchery Creek, and Duck Pond. Hatchery Creek and Duck Pond water enter the facility through the same pipe; however, water from either source can be used exclusively or the sources mixed together. There are no anadromous fish in Duck Pond and Hatchery Creek and they are used as a pathogen free water source for the nursery building and the exclusive water source for the isolation incubation building. However, Duck Pond water is the preferred source for the isolation incubation building because it contains less sediment. Cook Creek water can also be used in the nursery building and is used in the spawning building. All three water sources are available for the Burrows ponds.

- In late summer water from A and D banks is mixed and reused in E bank. A 15 hp pump delivers water from a sump area to the E bank ponds. Approximately 10% new water is delivered to E bank as well to reduce the risk of catastrophic loss if the pumps fail. Water may be reused in the late spring as well.

- The recirculation/reuse pump is worn and needs to be replaced. Quinault NFH is currently repairing the existing recirculation pump and purchasing a backup.

- Intake screens are checked daily and cleaned as needed.

- Intake screen mesh size is NOAA Fisheries compliant (3/32”).

- The settling basin on the Cook Creek intake system used for pre-settling was not designed for the volume of water used (SAMMS work order #2007713724).

- The physical size and internal environment of the spawning building are inadequate (size, heat, etc.) to accommodate all the personnel necessary for spawning fish, biosampling spawned fish, and assessing fish health (SAMMS work order #19132726).

- The fiberglass nursery tanks are degrading and some bow so screens and separators do not seal well. Current modifications have temporarily addressed the problem.

- There are no shade covers over the outdoor rearing ponds or the nursery tanks located outside.

- A-D bank ponds are “modified burrows” with very little slope in the bottom of the pond. The ponds also have “uneven” flow characteristics in the upper 10 feet of the raceway relative to raceways because the inflow structure was not redesigned when the ponds were modified.

- A Smith-Root design electric barrier weir was installed in 2002. Since then, the weir has malfunctioned on several occasions, killed fish and mammals, and poses human safety risks since fishing occurs right around the weir (SAMMS work order #2008863571).

- Incidental spawning material (blood and slime) is hosed down through a drain that enters directly into Cook Creek.

- Steelhead of all sizes/ages have been found in the effluent pipes under the hatchery facility. Hatchery staff believe these fish are hatchery-origin. It is assumed that these are hatchery steelhead that residualize in the pipe after release, or are fish that escape when the ponds are cleaned.[79]

- The roofs on quarters number 1 and 2 need to be replaced (SAMMS work order #'s 200715625 and 200715626).

- The total deferred maintenance for the facility is estimated to be $1,806,291 (SAMMS, 2008).

- River otters and avian predators such as starlings, bald eagle, osprey, great blue heron and kingfisher prey on the fish reared at Quinault NFH. Trappers have been contracted to address otter problems near Quinault NFH.

Research, Education, and Outreach

- Steelhead released from Quinault NFH are not mass marked. Mass marking did occur in 2004 and 2005. Mass marking was discontinued due to lack of funds. A representative group of juvenile steelhead are coded-wire tagged and adipose-fin clipped each year to estimate adult contribution/survival rates to the Quinault River fisheries for in-season harvest management, and timing relative to the natural returns to the Quinault River. 20,000 steelhead from the on-station release are coded-wire tagged and adipose-fin clipped. One code is used and it is spread proportionally among the ponds.

- There is no monitoring and evaluation program on the fry outlplants upstream of the hatchery to assess the smolt contribution or adult contribution.

- Discussions with Tribal staff indicate that due to lack of funding, little or no assessment or monitoring is done on natural spawning or rearing in Cook Creek, other tributaries or the mainstem Quinault River.

- Tribal members and students visit the facility on a regular basis. Local students visit the facility to learn about the presence of salmon as an important component of tribal culture. Specific educational opportunities are coordinated with the local schools, usually during the fall spawning season.

- A "Camp Host" program is in place to facilitate visitor tours and questions. A trailer pad and accommodations are available for volunteers who help maintain the facility as part of the Camp Host program.

- The facility's educational and display materials are dated.

- The facility has a website which is periodically maintained and improved.

[79] *Pers. comm. Dave Zajac, Hatchery Review Team, 2008.*

- Quinault NFH hosted a Kid's Fishing Day event at the facility for several years. The event was discontinued in 2004. Juvenile steelhead were held in two ponds and reared to a catchable size. Quinault NFH is considering hosting the event again in 2009.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[80] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- For Quinault NFH winter steelhead released into Cook Creek, the program confers significant sport, tribal, and commercial harvest benefits as well as returns to the hatchery that are used for broodstock and subsistence. Based on coded-wire tag data, for broods 1993-2002, approximately 3,700 steelhead were recovered annually. The distribution of those recoveries is: 52.5% (1,940) recovered at the Quinault NFH; 12.5% (460) from US sport fisheries; 35% (1,300) from treaty tribal fisheries; 0.02% (1) from spawning ground surveys; 0.1% (4) from hatcheries other than the Quinault NFH; and 0.02% (1) recovered from research type activities.[81]

- The program provides an in-river sport fishery in Cook Creek below the hatchery and on the mainstem Quinault River. The sport fishery on tribal lands (the Quinault River below Lake Quinault) can only be accessed with a tribal fishing guide. The guiding services provide an economic benefit to the local community.

- The hatchery fish from the Quinault River that are commercially caught in the tribal fishery are being processed and marketed commercially by Quinault Tribal Enterprises under the "Quinault Pride" label. Quinault Pride products are considered sustainable seafood according to the Seafood Choices Alliance.[82]

- The total economic net benefit of Quinault NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $3.3 million annually.[83]

Conservation Benefits

- None identified.

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[80] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[81] *Some of these data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were few and are not expected to significantly change the proportions reported above. The sport fishery recovery data are poor estimates based on WDFW punch card reports and assume that approximately 50% of that catch was from Quinault NFH vs. Quinault Lake Pens. The few spawning ground recoveries occurred from Hoh River. The other hatchery recoveries occurred at Salmon River Hatchery.*

[82] *http://www.seafoodchoices.com/resources/documents/SCA%20Directory%20Final.pdf.*

[83] *Pers. comm. James Caudill, USFWS, 2008.*

Research, Education, Outreach and Cultural Benefits

- Spawned out carcasses and surplus adults trapped at the facility are provided to the Quinault Indian Nation for subsistence and ceremonial purposes. The tribe also provides some excess carcasses to the general public for consumption. The procedure for distributing carcasses was established by the Quinault Indian Nation.

- Quinault NFH is located on a major tourist route and receives a great deal of visitor traffic. Approximately 3,500 people visit the facility on an annual basis.

- Quinault Tribal Enterprises employs several tribal members, providing a significant economic benefit to the community.

- The facilities location on tribal lands provides a significant educational and cultural opportunity for the local tribal community.

- The facility currently provides 4 full-time and 250 staff days of seasonal employment for Quinault Indian Nation tribal members.

- Quinault NFH steelhead have been a source of fish for research.[84]

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[85] the Review Team identified the following benefits of this program:

Harvest Benefits

- The Hoh River is a popular sport fishing destination for anglers from outside the region.

See the Quinault NFH Steelhead, Hoh River Releases section for additional information

Conservation Benefits

- None identified.

Research, Education, Outreach and Cultural Benefits

- Quinault NFH provides educational and outreach benefits to tourists visiting the area. Quinault NFH is located on a major tourist route and receives a great deal of visitor traffic. Approximately 3,500 people visit the facility on an annual basis.

[84] *Berejikian et al. 1996 "Effects of hatchery and wild ancestry and rearing environments on the development of agonistic behavior in steelhead trout (O. mykiss) fry".*

[85] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[86] the Review Team identified the following risks of the hatchery program:

Genetic Risks

- None identified.

Demographic Risks

- Lack of shade covers over the raceways concentrates fish in shaded areas along pond walls, increasing effective densities, potential stress, and disease risks.
- Reuse system failure could cause catastrophic loss of an entire broodyear of steelhead when juveniles are reared in E-bank.
- Dependence upon the reuse system poses an increased risk of fish health issues compared to single pass water.
- Based on current calculations, density indices in the outdoor rearing pond exceed .20 DI during the final stages of rearing, posing a fish health risk. At this facility, the current fish health recommendations are that steelhead and coho do not exceed a DI of 0.2 based on a partial density study done on site with coho.
- Hatchery steelhead vary greatly in size during rearing and at release. Steelhead released below target size could reduce the smolt-to-adult survival rate, and thus the broodstock needs and harvest benefits of the hatchery population. High size variation can also increase the rate of residualism.
- Relying on surface water supply without disinfection (e.g., U.V.) introduces fish health risks.

Ecological Risks

- Adult steelhead held in ponds adjacent to the ponds where juvenile steelhead are reared pose a disease transmission risk because water can splash between the ponds.
- Incidental passage of adults above the weir into the hatchery's water source due to weir malfunction or natural occurrences (e.g. high flows) poses a disease transmission risk to fish reared on station.[87] The IHN virus is of special concern given its presence in the Quinault River basin (i.e. Lake Quinault winter steelhead).
- Quinault NFH steelhead that residualize in the Quinault River basin pose a competition risk to wild steelhead.

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[86] *Ibid.*

[87] *Zajac, Dave. 2004. An Assessment of Potential Anadromous Fish Habitat Use and Fish Passage above Quinault National Fish Hatchery in Cook Creek. U.S. Fish and Wildlife Service, Western Washington Office, Lacey, Washington.*

- Predator exclusion and control devices are inadequate, posing a risk of disease transmission into the hatchery and between ponds.

Physical Risks

- The operation of an electric weir in an area where sport fishing occurs poses a human safety risk.

- Fish are manually crowded from the holding pond through the channel and into the electronic lift. Manual crowders are heavy, difficult to operate and must be used during periods where conditions may lead to injury (i.e. icy conditions), posing a human safety risk.

Research, Education, Outreach and Cultural Risks

- None identified.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[88] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- On-station Release: Segregated hatchery programs pose an inherent genetic risk to wild stocks in the basin in which they are released. This risk is reduced since the run-timing is different from the wild stock and by only releasing fish on-station. Based on available information, it appears there is high homing fidelity and low straying to other watersheds, portions of the Quinault Basin and hatchery facilities where observations occur.

See the Quinault NFH Steelhead, Hoh River Releases section for additional information.

Demographic Risks

- Harvest targeting Quinault NFH steelhead poses a demographic and genetic risk to natural-origin steelhead. Given the existing run-time separation between the Quinault NFH hatchery and Quinault River natural-origin returns, intensive harvest targeting Quinault NFH steelhead may have reduced the early-timed component of the natural-origin steelhead run and may prevent the reestablishment of this component of the run.

- The release of untreated effluent from the spawning area poses potential health risks to fish and other species downstream of Quinault NFH.

- The Quinault NFH weir and intake diversion in Cook Creek impede the natural migration of salmon, steelhead, and other species of fish, including cutthroat, lamprey and limited numbers of bull trout, posing a demographic risk to these migratory stocks.

See the Quinault NFH Steelhead, Hoh River Releases section for additional information.

[88] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

Ecological Risks

- Hatchery programs pose inherent ecological risks (e.g. competition, predation, disease) to wild stocks in the basin in which they are released. This risk is reduced by releasing full-term smolts on station. Based on available information, it appears there is high homing fidelity and low straying to other portions of the Quinault River Basin and hatchery facilities where observations occur. Steelhead are more likely to residualize than other species.

- Steelhead that residualize pose a competition and predation risk to other species in the Quinault River basin including coastal cutthroat and bull trout.

- Outplanting of "surplus" steelhead fry in the Raft and Moclips rivers poses disease and other ecological risks to natural-origin salmon and steelhead residing in those watersheds.

See the Quinault NFH Steelhead, Hoh River Releases section for additional information

Research, Education, Outreach and Cultural Risks

- None identified.

Recommendations for Current Program[89]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

Issue QN1: Present program goals for Quinault NFH steelhead are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN1: Restate program goals to identify the number of harvestable adult steelhead desired and achievable from this program in the Quinault River. For example, the current program size and post-release survivals leads to a mean harvest of approximately

[89] *The Review Team believes that Quinault NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

3,700 adult steelhead per year (brood year 1993-2002). This data could be used to develop the program goal.

Broodstock Choice and Collection

None identified

Hatchery and Natural Spawning, Adult Returns

Issue QN2: The distribution and potential stray rate of Quinault NFH steelhead returning to the Quinault River is unknown, thus leading to much uncertainty regarding genetic risks to the natural steelhead population in the lower Quinault River. *The lower Quinault River system is considered the primary spawning habitat for wild Quinault steelhead. However, Cook Creek is the only tributary to the lower Quinault River that the Quinault Indian Nation Fisheries Department currently conducts structured surveys to assess the distribution and abundance of naturally spawning steelhead (both wild and hatchery). Quinault NFH steelhead is a segregated stock that has a run time that is substantially earlier than the majority of the wild population which reduces the likelihood of direct interbreeding between hatchery and wild steelhead but does not preclude significant genetic influences one generation earlier if large numbers of hatchery fish spawn successfully.*

Recommendation QN2: Assess the distribution and abundance of naturally spawning steelhead in the lower Quinault River Basin (QN23), and assess the extent of straying of Quinault NFH steelhead that occurs in the lower Quinault River basin. This may require mass-marking the steelhead released from Quinault NFH. Genetic studies should also be performed to evaluate levels of genetic divergence between hatchery and wild steelhead populations in the Quinault River; however, the shared ancestry of the two stocks historically may limit the usefulness of genetic markers for evaluating current genetic contributions of hatchery-origin fish to natural reproduction.

Issue QN3a: In response to a Congressional mandate, mass marking by adipose-fin clip did occur in broodyears 2005-2006, but was discontinued due to reduced funding and a determination that there was no intent to implement a selective fishery which is often an intended benefit to mass marking.

Issue QN3b: Without the mass marking of hatchery steelhead, hatchery and wild steelhead cannot be distinguished during broodstock collection, monitoring and evaluation of genetic and ecological risks to natural populations, and during harvest where mark-selective fisheries are in place (although limited numbers of hatchery steelhead are marked in the Quinault River basin, the Olympic National Park manages the recreational harvest of steelhead within the park boundaries--the entire East and North Forks of the Quinault River and 60% of the Hoh River--as a selective fishery). *Although considered a low risk, wild steelhead incorporated in the hatchery broodstock (since the hatchery brood are unmarked and cannot be distinguished) could pose a risk to the wild population by reducing run-time separation between the hatchery and wild population. In addition, releasing unmarked hatchery steelhead may postpone changes in management strategies (e.g. increasing wild harvest, moving to an integrated program if the wild population becomes depressed, initiating a mark-selective fishery, etc).*

Recommendation QN3: Budget to allow mass marking of Quinault NFH steelhead to occur on an annual basis, in accordance with Congressional mandates and Service best management practices. Although the Congressional mandate is focused on harvest management and requires a visible mark applied to the fish, the Team's primary concern is broodstock management and monitoring and evaluation. Therefore, the mark does not have to be an adipose-fin clip.

Issue QN4: An emerging strain of the IHN virus from the Columbia River basin has recently caused epidemics in rainbow and steelhead stocks in several locations along the North Coast of Washington (including steelhead in the Lake Quinault Pen Rearing facility). The presence of this strain in the Quinault system increases the risk of its transmission. This is of special concern with Quinault NFH steelhead given the transfers to the Hoh River, where the virus has not been found yet, and the importance of the on-station steelhead releases to sport and tribal harvest in Cook Creek and the Quinault River basin. The facility currently depends upon the weir as its only method of protecting the water supply.

A. *The design of the existing electric weir reduces its effectiveness at preventing fish from passing upstream when compared to some other positive barrier weir designs. Fish have migrated above the weir in the past. Current weir operations have been improved significantly. However, limited numbers of salmon, steelhead and cutthroat swim upstream of the weir into the hatchery's water supply, posing a risk of disease transmission to the fish reared at the hatchery.*

B. *The weir is currently operated throughout the time adult salmon and steelhead return to Cook Creek (from October 1st through April 1st) to exclude the passage of adults upstream into the hatchery's water supply to reduce the potential for disease transmission to fish reared in the hatchery. However, salmon, steelhead and cutthroat swim upstream of the weir between April 2nd and September 30th while the weir is off. Although, during this period creek flows are low and it is highly unlikely that fish can migrate above the intake structure into the hatchery water supply.*

Recommendation QN4a: To minimize the chance of transferring disease to the Hoh River basin and to protect the on-station steelhead program from infection during rearing, explore disinfecting the water supply (e.g. UV or ozone treatment) and/or reconfiguring the water supply so that Duck Pond and Hatchery Creek can be utilized. As a priority, protect the on-station release steelhead from infection during hatch and early rearing when the fish are most susceptible to IHN virus infection, and disinfect any water used for rearing steelhead for transfers outside the Quinault River basin (currently to the Hoh River) (see recommendation QN34).

<u>For additional protection of the entire water supply</u>, consult with Engineering to modify the weir so that it provides maximum control of fish passage upstream. This may involve constructing a physical blockade at the existing weir site or another location further upstream on Cook Creek, such as just below the intake (see the recommendation for modifying the weir to address human safety issues.)

<u>The Team recognizes the importance of fish passage above the Cook Creek weir and recommends that the action taken to prevent disease transmission through the water supply allow for controlled fish passage to conserve and restore natural fish populations in the Cook</u>

Creek basin. Therefore, the Team prioritizes disinfection, reconfiguring the water supply to utilize pathogen free water, relocating a physical blockade, or reconstruction and/or modifying management strategies of the weir at its existing location so that it allows for the passage of natural-origin fish.

Recommendation QN4b: In the interim implement the HET recommendations for improving the weir operations with a few caveats. Operate the weir year round, except in late summer/early fall, when the reach between the intake and screen chamber is dry, until treatment is implemented or the risk of infection by the IHN virus has decreased to a level where the benefits of allowing fish upstream outweigh the risk of disease transmission to fish reared in the facility. In conjunction, Cook Creek habitat should be assessed to determine precisely what the natural production benefits of passing fish upstream are (see recommendation QN23).

Consult with USFWS Ecological Services staff, Olympic National Park staff and the Quinault Indian Nation to see if Cook Creek can be included in the Service's assessment of bull trout abundance and demographics in the Quinault River basin. In the interim, operate the ladder year round to allow for upstream passage of bull trout, and other native species that do not pose a disease risk to fish on station. If assessment results indicate few bull trout utilize Cook Creek for forage habitat, revaluate the benefits of operating the ladder year round versus the effort involved in doing so.

Issue QN5: There is a risk of pathogen spread to the hatchery and fish from sports fishermen who use the Quinault NFH as the access point to sport fishing in Cook Creek below the hatchery. *Currently, fishermen walk through the hatchery grounds and sometimes into buildings with their harvest. Harvested fish can shed pathogens when body fluids drip during transport. .*

Recommendation QN5: Explore alternative access points to the fishing area below the hatchery in Cook Creek. Alternative sites could include the NFH property located on the opposite side of the Creek from the hatchery or possibly other Quinault Indian Nation properties across the creek. The focus is to provide access from the south side of the creek and away from the hatchery proper. If alternative access points are not feasible, then a marked path with appropriate warning signage from the hatchery parking lot to Cook Creek should be developed. Additional mitigation measures to reduce disease risks could be implemented.

Incubation and Rearing

Issue QN6: Quinault NFH steelhead have experienced poor survival rates from green to eyed-egg stage when compared to other hatchery steelhead programs. Typical green to eyed-egg survival rates for other hatchery steelhead programs is 85-90%. *Eye-up survival ranges from 65% to 90%, but has improved over time. In the most recent two years, the survival has been 89%-90%. Over the last few years, modifications were made that may have contributed to the increase in survival. For example, bad eggs are now discarded at spawning, a bicarbonate rinse occurs at fertilization, an oxygen injection is used in conjunction with carbon dioxide before spawning, the iodine concentration for water hardening has been reduced from 100 parts per million to 75parts per million, and the spawning process time has been reduced.*

Recommendation QN6: Continue to investigate and implement methods to further increase and ensure green to eyed-egg survival stays consistently high. For example, investigate different fertilization methods, egg rinsing solutions such as 1% saline, egg loading densities (see QN7), etc.

Issue QN7: Egg loading densities in incubation trays (3 females per tray or approximately 12,000 eggs/tray) exceed loading density protocols for steelhead at other NFH's. *Additionally, Integrated Hatchery Operation Team (IHOT) guidelines developed for steelhead reared in the Columbia River basin are not to exceed 9,000 eggs per tray from the fertilized-to-eyed egg stage and 8,000 eggs per tray from the eyed egg to fry stage. This practice may be contributing to the poor steelhead egg to fry survival rate at Quinault NFH.*

Recommendation QN7: Reduce initial loading densities to a maximum of 2 females per tray or approximately 8,000 eggs per tray. This may ultimately increase green to eyed-egg survival.

Issue QN8a: Quinault NFH hatchery steelhead vary greatly in size during rearing and at release. The current coefficient of variation (CV) for Quinault NFH steelhead is not available. Current Washington Department of Fish and Wildlife standards is a CV of less than 10%. *High size variation results in steelhead released below target size (WDFW standard is a mean of 205mmand less than 5 % smaller than 180 mm), which could reduce the smolt-to-adult survival rate (and thus the broodstock needs and harvest benefits) of the hatchery population. High size variability may also increase the risk of residualism, which could pose ecological risks to wild fish in the Quinault River basin.*

Issue QN8b: Accurate growth management (feeding strategies) is difficult due to high size variability within each rearing container.

Recommendation QN8: Closely monitor steelhead size by taking length (total length) measurements from a representative sample at least quarterly throughout the rearing cycle. Samples should include a minimum of 100 individuals randomly dipped from a crowded/pooled group of fish in one or two raceways. Use this data to calculate CV in order to track size variation in the steelhead program.

Subsequently, sort (grade) the steelhead among the raceways by size so that they can be reared to meet target size at release with lower CVs. Differentially coded-wire tag the sorted groups to evaluate survival for each group and, thereby, the effectiveness of sorting. To reduce the need for grading, investigate fish culture practices and implement changes to reduce the CV to less than 10%. For example, combine female egg lots by size, chill eggs during incubation, etc.

Issue QN9: Density indices and flow indices are currently calculated without adequate steelhead size data, water flows, or volume measurements. *Average length measurements are not taken and flow is roughly estimated.*

Recommendation QN9: Closely monitor steelhead size by taking length (total length) measurements from a representative sample at least quarterly throughout the rearing cycle. Samples should include a minimum of 100 individuals randomly dipped from a crowded/pooled group of fish in one or two raceways. Flow measurements should be taken

any time flows are adjusted and periodically throughout the rearing cycle. Flow measurements could be improved by performing multiple (3+) crest measurements and/or pond displacement measurements and using the average of those measurements.

Issue QN10: Density indices (DI) in the outdoor rearing pond may exceed .20 and flow indices may exceed 1.00 during the final stages of rearing, posing a fish health risk. *This risk is increased since the steelhead are on reuse water. Current information indicates steelhead reared in E-bank raceways can reach .25 DI and the flow index may reach 1.2 . However, the indices have been developed without properly calculating average length (QN7).Additionally, current fish health history indicates that in the months prior to release, only intermittent parasite infestations have occurred and relatively few treatments are required. Fin condition has been observed to be less than ideal, but no demonstrable serious health effects have been noted.*

Recommendation QN10: Flow and densities should be properly calculated to determine the extent to which this is an issue. If density indices exceed .20 and flow indices exceeds 1.00, then either the number of steelhead reared should be reduced or rearing capacity for steelhead should be expanded (through reductions to other programs or increasing the facility's physical capacity).

Release and Outmigration

Issue QN11: The 20,500 subyearling fry released into Cook Creek, and the surplus fry released into the Moclips and Raft rivers pose an ecological and genetic detriment to natural-origin steelhead populations, and low potential harvest benefits. *Studies indicate that outplants at the subyearling fry stage have shown extremely low survivals to adulthood. Additionally, the domesticated Quinault NFH steelhead stock, released as subyearlings, pose genetic and ecological risks to the natural-origin steelhead populations in the Quinault Basin and the Moclips and Raft rivers.*[90]

Recommendation QN11: Discontinue all fry outplants. Eliminate the program objective of releasing 20,500 yearling fry into Cook Creek.

Facilities/Operations

Issue QN12a: The operation of the electric weir on Cook Creek where sport fishing occurs poses a human safety risk. *Improvements have been made over the last few years including signage, lights, and fencing. The HET is currently recommending further improvements to reduce risks, including a warning cable spanning the creek below the weir.*

Issue QN12b: The operation of the electric weir on Cook Creek poses a risk to wildlife. *Improvements have been made over the last few years including concentrating flows over the bypass ladder so that the main deck does not have to be electrified in shallow water. The HET is currently recommending further improvements to reduce risks to wildlife, including*

[90] *Kostow, K., A. Marshall, and S.R. Phelps. 2003. Natural Spawning Hatchery Steelhead Contribute to Smolt Production but Experience Low Reproductive Success. Transactions of the American Fisheries Society 132: 780-790.*

modification to the "deflection wall" on the upstream edge of the weir. This wall is designed to concentrate flows to the bypass channel. The current wall was a temporary installation.

Recommendation QN12: Immediately, implement the HET recommendations to reduce human safety risks and risks to wildlife. Consider alternative weir designs for further reducing safety risks such as the weirs on the Chiwawa (Wenatchee Basin) and Twisp rivers (Methow Basin), as described in the "Quinault NFH Electric Fish Barrier Replacement Hydraulic Analysis".[91] A new weir may also provide additional protection for the water supply (see recommendation QN4).

Issue QN13: Operation of manual crowders during broodstock collection poses a safety risk to staff. *Fish are manually crowded from the holding pond through the channel and into the electronic lift. Manual crowders are heavy, difficult to operate and must be used during periods where conditions may lead to injury (i.e. icy conditions), posing a human safety risk.*

Recommendation QN13: Automate the crowder system to reduce the risk of injury to staff.

Issue QN14: The spawning building is inadequate to accommodate spawning, fish health and mark sampling. The existing fish anesthetic method is inefficient for handling adult fish and an electric anesthetic device should be considered. The mechanical lift baskets are antiquated and should be replaced with a mechanical Archimedes screw type mechanism (e.g. Pescalator ^{TM}) or other more efficient device. The sorting table is composed of fiberglass which shows significant wear and needs replacement with stainless steel or similar durable material. The manual fish crowder is antiquated and in need of replacement with a more efficient device that is safer (meets OSHA standards) to operate by staff.

Recommendation QN14: Rehabilitate the spawning building according to SAMMS work order #19132726.

Issue QN15: The release of untreated effluent from the spawning area poses an unknown but potential water quality risk and health risk to fish and other species downstream of Quinault NFH. *The health risk is believed to be small since Quinault NFH stocks originate from adult returns to Cook Creek and maintain the same disease profile as naturally spawning fish. However, the discharge of spawning material (e.g. ovarian fluid, milt, blood) in a more concentrated form than what occurs naturally may increase the risk of disease transmission.*

Recommendation QN15: As a best management practice, investigate retaining or redirecting spawning effluent to the pollution abatement pond or other special containment area with possible effluent disinfection.

Issue QN16: Recirculation/reuse pump #2 is in disrepair and needs to be rebuilt.

Recommendation QN16: Rebuild the recirculation/reuse pump #2. Additionally, scheduled preventative maintenance should be instituted.

[91] *Finnegan, T., B. Cutting, and D. Whitbeck. March 14, 2008. Quinault NFH Electric Fish Barrier Replacement Hydraulic Analysis. Montgomery Watson Harza. Seattle, WA.*

Issue QN17: Lack of shade covers for the raceways increases crowding of fish, particularly during the summer months, potentially increasing stress and disease risks to the coho and steelhead.

Recommendation QN17: Construct covers over raceways as a best management practice.

Issue QN18: Adults coming up the channel and held in ponds adjacent to where the juvenile steelhead are reared poses a disease transmission risk due to water splashing between ponds.

Recommendation QN18: Install a splash guard between the pond where juvenile steelhead are reared and the channel and pond where adults are held. Alternatively, continue to leave the pond between the juvenile steelhead and the adults held for broodstock empty. The steelhead from this pond could be transferred to D-bank after flows increase in the fall before broodstock collection begins (usually in November).

Issue QN19: The Burrows Ponds were not modified completely so that the ponds function as true raceways. *A-D bank ponds are "modified burrows" with very little slope in the bottom of the pond. The ponds also have "uneven" flow characteristics in the upper 10 feet of the pond relative to raceways because the inflow structure was not redesigned when the ponds were modified. To date, the pond design has not led to fish health issues.*

Recommendation QN19: Consult with maintenance staff and Engineering to consider modifications to completely convert the Burrows Ponds to raceways in order to better distribute fish in the available pond space and to move waste through the pond more efficiently.

Issue QN20: The modified Burrows Ponds' concrete is eroding.

Recommendation QN20: Consult with the HET and Engineering to repair and maintain the structures. SAMMS Work Order #'s 2007715631 and 2007715627.

Issue QN21: Fisherman access Cook Creek through the Quinault NFH. Fisherman walking through the facility could carry pathogens from fish in the creek to fish reared on station. *During peak fishing season, enough fisherman access in this manner to fill the parking lot.*

Recommendation QN21: Develop an alternative or additional access point to limit the number of fisherman crossing the facility grounds. Consider making the new access point Americans with Disabilities Act (ADA) compatible. Add signage and install rolls of plastic bags to all access points to make anglers aware of the risk of pathogen transfer to the hatchery and provide a way of transporting the fish in a safe manner.

Research, Monitoring, and Accountability

Issue QN22: The facility has no clearly defined M&E program.

Recommendation QN22: Develop a consistent and clearly defined M&E program as a best management practice and review on an annual basis (prior to ponding and coded-wire tagging of a broodyear).

Issue QN23: The Quinault Indian Nation annually estimates harvest and spawning escapement; however, the natural production vs. hatchery production component is largely unknown. Also the unknown level of hatchery straying from the National Fish Hatchery and tribal net pens may have some impact on natural production of steelhead in the Quinault River *Smolt production from natural production is unknown. Additionally, genetic information on naturally produced steelhead does not exist.*

Recommendation QN23: Work with the Quinault Indian Nation to **c**onduct smolt trapping to estimate juvenile production for Cook Creek and the Quinault River. Use this information along with genetic assignment tests to better define natural production, impact from hatchery fish and habitat protection and restoration measures. See also recommendation QN2. Support Quinault Indian Nation in their effort to estimate natural and hatchery escapement and harvest basin-wide.

Issue QN24: Residualized hatchery steelhead can have negative ecological consequence to wild fish in the Quinault River basin. *Steelhead have increased potential to residualize in the Quinault River due to the available habitat downstream of Quinault NFH.*

Recommendation QN24: Determine the extent to which steelhead released from Quinault NFH residualize in the Quinault River basin. Depending upon monitoring and evaluation results, determine whether different management actions reduce the risk of residualism. See recommendation QN8.

Issue QN25: The Quinault NFH weir and intake diversion in Cook Creek can impede the natural migration of lampreys, and the operation of the weir and intake results in an unknown level of mortality. *Adult pacific lampreys have been killed by the electric weir. Additionally, juvenile lampreys occasionally become trapped in the intake screen chamber, located upstream of the weir; however, the species of lamprey (brook vs. pacific) is unknown. Pacific lampreys are culturally important to Pacific Northwest tribes, including the Quinault Indian Nation. They were also petitioned to be listed as threatened under the Endangered Species Act in 2003.*

Recommendation QN25: Initiate a monitoring program to determine the species of juvenile lamprey, migration periods of the lamprey, and the degree of impact the weir and intake diversion are having on the Cook Creek lamprey population(s). Use the information to determine if further actions are necessary to minimize impacts to pacific lamprey.

Issue QN26: The Olympic Peninsula NFH's and the Service's Western Washington Fish and Wildlife Office (Lacey, WA) do not have a standardized database for tracking certain operational data such as green egg to eyed egg and eyed egg to fry mortality rates. *Each hatchery records their data via individually tailored spread sheets. The existing data management system used for evaluation of the Olympic Peninsula NFHs is the Fisheries Resource Evaluation Database (FRED). A standardized database will facilitate data sharing and program analyses region wide.*

Recommendation QN26: Convene a group of Olympic Peninsula NFH management staff and WWFWO hatchery assessment staff to consider developing a common database that could be used to address all hatchery operational, evaluation, and reporting requirements. The group should review the CRIS and FRED systems and their utility for collecting and reporting these types of data and information. Regularly collect average water temperatures, fish growth data, current numbers, mortalities, and a summary of fish health activities. Track this information in conjunction with all fish production activities in a standardized database, including, numbers, tagging, fish moves, fish and egg distribution, egg mortalities, survival to various life stages, feed, fry ponding data, fish length, condition factor, feed conversion ratio, adult fish removal by species, spawning data by take, etc. The database should be capable of creating summaries of current pond inventories including flow and density indices for each rearing unit, spawning summaries, egg summaries, lot history production summaries, hatchery production summaries and distribution summaries.

Issue QN27: A USFWS bull trout ESA consultation for operation of the steelhead and other propagation programs at Quinault NFH has not occurred. *A section 10 permit exists for operations and sampling associated with operation of the weir. Hatchery programs should be reviewed to ensure that the impacts of all hatchery operations have been evaluated for possible impacts to listed species.*

Recommendation QN27: Determine whether a Section 7 consultation for the programs at Quinault NFH is needed. If so, the Review Team recommends that the Service develop a *Hatchery and Genetic Management Plan* (HGMP) for each hatchery program at Quinault NFH. The standardized template provided by NOAA Fisheries, and implemented by the Service at other facilities where salmon and/or steelhead are listed in the watershed, has been shown to be useful. An HGMP provides a comprehensive summary of the operational details of a hatchery program useful to parties other than those providing ESA consultations.

Issue QN28: The Quinault NFH Hatchery Evaluation Team (HET) meets on a regular basis, at least twice a year (before spawning and after release). *The meetings are generally coordinated by a representative at the Fisheries Resource Office. Additional meetings are also scheduled on an as-needed basis. All topics in regards to facility and program management are discussed and the HET is the primary recommending body for facility and programmatic changes.*

Recommendation QN28: The Review Team supports the current approach for utilizing the HET process, which is in line with the Vision Action Plan. The Review Team is recommending that the HET process be standardized region wide by 2010.

Issue QN29: IHN virus epidemics have occurred recently in the Grays Harbor, Queets, and Lake Quinault areas. The epidemics have been caused by a strain of IHN virus (IHNV M-D) that has not been observed in the area in the past. *Comanagers have agreed on interim guidelines and procedures to help prevent this IHN strain from becoming established.*

Recommendation QN29: Work with comanagers to develop and participate in a Washington coast-wide monitoring and evaluation plan to assess and address the emerging strain of IHN virus.

Issue QN30: The number of steelhead harvested annually in the guided sport fishery in Cook Creek is unknown. *As a result, the harvest benefits of the steelhead program, which is the intended purpose of the program, are not fully quantified.*

Recommendation QN30: Conduct angler and creel surveys in Cook Creek annually to quantify the recreational harvest benefit of the program.

Education and Outreach

Issue QN31: Educational materials at Quinault NFH are outdated. .

Recommendation QN31: Update the educational displays and materials. Explore opportunities for coordinating with the Quinault Indian Nation to show how the USFWS and tribe work together to maintain culturally significant fisheries and sustain local fish populations. This could be anything from brochures and/or an information kiosk at the museum to hatchery tours coordinated through the museum.

Issue QN32: Quinault NFH hosted a Kid's Fishing Day event at the facility for several years. The event was discontinued in 2004. *Juvenile steelhead were held in two ponds and reared to a catch-able size. Quinault NFH is considering hosting the event again in 2009.*

Recommendation QN32: The Review Team supports reinstituting Kids Fishing Day and/or some other appropriate open house outreach effort. For example, the Quinault Indian Nation may wish to consider a tribal ceremony and salmon barbecue, open to the public, at the hatchery in September/October in celebration of the return of fall Chinook salmon back to the Quinault River

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing on-station release steelhead program at Quinault NFH and developed 4 alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current on-station release program with recommendations

Rear 190,000 smolts for release on station. Discontinue all off station fry releases. Explore utilizing pathogen-free water for on-site steelhead rearing from hatch through early rearing. Improve weir operation.

Pros

- Provides significant harvest to both sport and commercial fishers in the Quinault watershed.
- Cook Creek steelhead stock continues to remain free of IHN virus and pose little disease risk to other hatchery or wild stocks.
- The stock is derived from the Quinault watershed and is also fairly segregated from other Quinault stocks so poses little genetic or ecological risks to other Quinault steelhead populations.
- This stock has been an acceptable replacement stock for other coastal programs (e.g. Makah NFH and Lake Quinault Pen program).
- Provides ceremonial and subsistence fish through hatchery surplus.

Cons

- The distribution and potential stray rate of Quinault NFH steelhead returning to the Quinault River is unknown, thus leading to much uncertainty regarding genetic risks to the natural steelhead population in the Quinault River (refer to QN2).

Alternative 2: Increase steelhead production by terminating the coho program

Discontinue the current Quinault NFH coho program in favor of increased steelhead production. Produce up to 850,000 steelhead for release on station.

Pros

- Provides significant harvest to both sport and commercial fishers in the Quinault watershed.
- The Quinault NFH steelhead stock continues to remain free of IHN virus and pose little disease risk to other hatchery or wild stocks.
- The stock is derived from the Quinault watershed and is also fairly segregated from other Quinault stocks so poses little genetic or ecological risks to other Quinault steelhead populations.
- This stock has been an acceptable replacement stock for other coastal programs (e.g. Makah NFH and Lake Quinault Pen program).
- Provides ceremonial and subsistence fish through hatchery surplus.
- Reduces tagging costs now associated with the coho program.

Cons

- Eliminates the only and very successful hatchery based coho harvest in the Quinault River and the associated marine areas.
- Increases mass marking costs for steelhead

- May increase predation on other species (e.g. Sockeye).

- Higher costs are associated with developing pathogen-free water for increased steelhead production to reduce risk of disease.

Alternative 3: Hatchery production for restoration of naturally spawning populations in the region (emphasis on Quinault River sockeye), depending on availability of space (could be combined with other alternatives)

Utilize Quinault NFH to support the conservation of at-risk populations in the Quinault River basin and surrounding watersheds. The Quinault Indian Nation has indicated that Quinault River sockeye and spring/summer Chinook populations are at low abundance, and their abundance continues to decline. The Nation's primary concern is restoring the sockeye population since they believe that this population has the greatest risk of extinction.[92] Restoration of ESA-listed bull trout is also of concern although artificial propagation has not been identified as a preferred strategy.

Quinault NFH's isolation incubation facility, in particular, provides a unique opportunity for rearing in-basin or out-of-basin stocks through the incubation and early rearing phase with minimal fish health risks to the other fish reared on station.

Pros

- Contributes to the long-term conservation and recovery goals for listed or otherwise depleted salmon and steelhead populations on the Olympic Peninsula.

- Hatchery would propagate species of greatest conservation need (e.g. sockeye, potentially bull trout, etc).

- Gives hatchery flexibility to respond to changing priorities and mandates (e.g. recovery, conservation).

Cons

- May reduce the amount of rearing space available for the current production of fish for harvest, including valuable tribal and sport fisheries.

- May displace current programs that utilize the isolation incubation facility (i.e. Quinault NFH Steelhead, Hoh River release and Chinook eggs imported from the Lake Quinault Pen Rearing facility).

- Does not necessarily meet the defined harvest mitigation responsibility.

[92] *Pers. comm. Larry Gilbertson, Quinault Indian Nation, September 2008.*

Alternative 4: Terminate the program (and other programs located at Quinault NFH) and decommission the facility

Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Pros

- Eliminates the support for the Hoh River program and the associated genetic and ecological risks.
- Eliminates potentially negative ecological and genetic interactions with the natural Quinault River steelhead population.
- Eliminates the cost of operating the current facility in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.
- Eliminating the production and subsequent harvest targeting Quinault NFH steelhead may allow the Quinault River natural-origin steelhead population to restore its historic, natural run time.

Cons

- Eliminates the harvest of Quinault NFH steelhead.
- Eliminates replacement stock opportunities for other coastal programs
- Eliminates the current program that provides ceremonial and subsistence fish through hatchery surplus.
- Eliminates a source of local employment and multiplier effect on local economy and causes high Human Resources impact.

Recommended Alternatives

The Review Team recommends continuation of the current on-station steelhead program at Quinault NFH with implementation of all recommendations (Alternative 1). The Team also recommends that the Service explore opportunities to utilize the facility to support the conservation of at-risk populations in the Quinault River basin, including sockeye.

Quinault NFH Winter Steelhead, Hoh River Program

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: The purpose of this program is to mitigate for tribal and sport fisheries in the Hoh River where production has declined due to loss of habitat. However, no quantified harvest goals for this stock in the Hoh River watershed have been identified. If the smolt-to-adult survival rate is similar to the steelhead released on-station at Quinault NFH (2.0%), the expected harvest would approach 2,000 fish.

- ***Broodstock escapement goal***: See the Quinault NFH Steelhead Section.

- ***Conservation goal***: See the Quinault NFH Steelhead Section.

- ***Escapement goal for natural-origin adults:*** According to the Washington Department of Fish and Wildlife SaSI report, the escapement goal for natural-origin Hoh River steelhead adults back to the spawning grounds is 2,400 fish.

- ***Research, education, and outreach goals***: See the Quinault NFH Steelhead Section.

Objectives

- Transfer 50,000 yearling pre-smolts at 15 fish per pound from Quinault NFH to the Chalaat Creek Hatchery in the Hoh River watershed (Hoh Tribe) during February each year for acclimation prior to release. Transfer and direct-stream release 50,000 smolts at 5.5 fish per pound into the Hoh River at Allen's Bar (at river mile 15) after April 15.

Program Description

The Quinault NFH was originally established to restore fisheries to the Quinault Reservation and to adjacent Federal lands. As part of this general commitment a Quinault NFH steelhead pre-smolt transfer to the Hoh Reservation and a smolt release into the Hoh River was initiated in the mid-1980s in consultation with the Hoh Tribe, the Quinault Indian Nation, and the state of Washington. 50,000 steelhead smolts are reared for release into Hoh River, and 50,000 pre-smolts for transfer, imprint, and subsequent release from Chalaat Creek hatchery (Hoh River).

The Team understands that the Quinault NFH steelhead releases into the Hoh River are very important to the livelihood of the Hoh Tribe, as the tribe has limited economic opportunities.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

See the Quinault NFH Steelhead Section for operational considerations regarding Broodstock Choice and Collection

Hatchery and Natural Spawning, Adult Returns

See the Quinault NFH Steelhead Section for additional operational considerations regarding Hatchery and Natural Spawning, Adult Returns

- Broodstock used for the Hoh program are spawned in late December and early January. Generally, the Hoh program needs are met in two sequential egg takes. The December and early January window for spawning are targeted to produce fish that will return to the Hoh River at a time between the return periods of wild coho and wild steelhead, thus supporting a tribal fishery during that interim period.

- The historic run size of steelhead in the Hoh River ranged from 7,938 to 13,230 fish for the period 1948-1961. The recent five-year average is 4,501 fish. The Hoh River winter steelhead run is currently 56% to 34% of the 1948-1961 run size[93].

- From 1990-2007, run-size of natural-origin steelhead into the Hoh River ranged from 2,539 to 5,351 fish. Of this, 1,480 to 3,689 escaped to the spawning grounds and 288 to 2,584 were harvested[94].

- In the Hoh River gill-net fishery that targets Quinault NFH steelhead, some incidental take of bull trout has been reported.[95]

- All parents whose progeny are destined for the Hoh River are tested for viruses. The adults must test negative for regulated viruses and an exemption to *The Salmonid Disease Control Policy of the Fisheries Comanagers of Washington State* is required for the steelhead progeny to be transferred to and released in the Hoh River.

- Limited coded-wire tag recovery data from 1993-2002 suggest that adult stray rates for unacclimated Quinault NFH steelhead released at Allen's Bar demonstrate a somewhat lower return rate to the area of release than the acclimated releases from the Chalaat Creek facility though recovery rates are inconsistent and there is substantial year to year variability in results.

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[93] *Table 29, Part 3 of McMillan B. and N. Gayesk. 2006. Historic Steelhead Abundance: Washington Northwest Coast and Puget Sound. Wild Salmon Center. Portland, OR.*

[94] *pers. comm. Tyler Jurasin, Hoh Tribe. 2008*

[95] *Brenkman, S.J. and S.C. Corbett. 2005. Extent of Anadromy in Bull Trout and Implications for Conservation of a Threatened Species. Northwest American Journal of Fisheries Management vol. 25. p. 1073-1081.*

This preliminary result also suggests higher stray rates into non-target areas from the Allen's Bar releases.

- Unacclimated releases of steelhead outplanted by other hatchery programs have generally shown higher incidence of straying than acclimated releases.

Incubation and Rearing

See the Quinault NFH Steelhead Section for additional operational considerations regarding Incubation and Rearing

- Eggs and juvenile fish for the Hoh River releases are reared separately from those for the Cook Creek/Quinault releases.

- When fry reach approximately 500 fish per pound, they are ponded into C-Bank. At the first subsequent inventory, the steelhead destined for release into Cook Creek/Quinault River are moved to two, 16’ x 80’ x 34 inch deep concrete Burrows ponds in E bank and the steelhead destined for release into to the Hoh River are initially moved to one 16’ x 80’ modified Burrows pond in D bank.

Release and Outmigration

See the Quinault NFH Steelhead Section for additional operational considerations regarding Release and Outmigration

- Transportation to both Hoh River release sites is about one hour. Fish are loaded at 1.3 pounds of fish per gallon of water. No chemicals or drugs are added to the water. Fish are taken off feed two days prior to transfer. The truck tank is disinfected prior to loading fish and disinfected at the hatchery upon return from the Hoh River.

Facilities and Operations

See the Quinault NFH Steelhead Section for operational considerations regarding Facilities and Operations

- Predation on steelhead juveniles by birds and mammals including mergansers and otters is reported to be significant at the Chalaat Creek site. The Chalaat Creek rearing site has no predation fencing or bird netting for their acclimation pond.

Research, Education, and Outreach

See the Quinault NFH Steelhead Section for additional operational considerations regarding Research, Education, and Outreach

- Steelhead are also coded-wire tagged and adipose-fin clipped each year to estimate adult contribution/survival rates to the Hoh River fisheries for in-season harvest management, and timing relative to the natural returns to the Hoh River. One hundred percent of the Quinault NFH steelhead transferred to the Hoh River are adipose-fin clipped. Ten thousand fish are also coded-wire tagged for each unique Hoh release site (the direct-stream release at Allen’s Bar and the Chalaat Creek transfer). The tag codes are unique to the specific release group.

- Our understanding is that the Hoh Tribe conducts extensive smolt trapping, providing information on smolt production, distribution, and size. They also have conducted snorkel-surveys in major tributary habitat since 2005 to gather information on rearing habitat availability, quality, and utilization by juvenile salmonids. However, this information has not been shared with the Review Team.

- The Wild Salmon Center has performed extensive surveys of several Hoh River tributaries in the lower river outside of the National Park boundaries to determine the productivity of the habitat and prioritize restoration activities. Their research ranks the tributaries depending upon whether they are considered critical habitat for salmon and steelhead: Winfield (critical), Owl (important), Elk (important), Nolan (important), and Willoughby (moderately important) are moderate to critical habitat for natural origin steelhead. The report concluded, regarding steelhead, that Owl Creek had the most degraded habitat.[96]

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[97] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- The program confers significant sport and tribal harvest benefits in the Hoh River. From return years 1990-2007, approximately 2,110 Quinault NFH steelhead were recovered in the Hoh River annually (range 916 to 3,747). Of this an average of 1,492 (738 to 3,067) and 618 (76 to 1,518) were harvested in tribal and sport fisheries, respectively. [98]

- The Hoh River steelhead sport fishery is extremely popular due to its accessibility and number of hatchery and wild steelhead available for angling opportunities over an extended time period. The number of steelhead anglers utilizing the Hoh River ranges between 2,000 and 3,000 annually (WDFW 2006 – 2008 Winter Steelhead Reports). The WDFW fishing regulations for Olympic Peninsula rivers allow the public to retain one wild steelhead per angler per year, whereas adipose-fin clipped hatchery steelhead retention is 2 fish allowed per day per angler.

- The Hoh Tribe considers the harvest of Quinault NFH steelhead returning to the Hoh River as an important source of income to tribal members because the harvest opportunity is consistent when compared to other returns to the Hoh River (e.g. Chinook and coho) that are intercepted in ocean fisheries.

Conservation Benefits

- None identified.

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[96] *Identification and Prioritization of Salmon Tributaries for Conservation in the Hoh River Basin, Washington State. June 2008. <http://www.wildsalmoncenter.org/programs/north_america/hoh_report.php>*

[97] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[98] *Pers. comm. Tyler Jurasin, Hoh Tribe. 2008.*

Research, Education, Outreach and Cultural Benefits

See the Quinault NFH Steelhead section for Research, Education, Outreach, and Cultural Benefits.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[99] the Review Team identified the following benefits of this program:

Harvest Benefits

- The Hoh River provides a popular sport fishery for anglers from outside the region.

Conservation Benefits

- None identified.

Research, Education, Outreach and Cultural Benefits

See the Quinault NFH Steelhead section for Research, Education, Outreach, and Cultural Benefits.

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[100] the Review Team identified the following risks of the hatchery program:

Genetic Risks

See the Quinault NFH Steelhead section for Genetic Risks

Demographic Risks

- No bird netting or predator fencing is in place at the Chalaat Creek rearing/acclimation pond.

See the Quinault NFH Steelhead section for additional Demographic Risks

Ecological Risks

See the Quinault NFH Steelhead section for Ecological Risks

Research, Education, Outreach and Cultural Risks

- None identified.

[99] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*
[100] *Ibid.*

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[101] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- There are no terminal recovery areas for Quinault steelhead returning to the Hoh River, posing a genetic risk to the natural-origin Hoh River steelhead population depending upon the relative abundance of hatchery and natural origin steelhead and the extent to which hatchery steelhead stray into tributaries where natural spawning occurs. Genetic samples have been collected to help assess this risk. Results are pending[102].

Demographic Risks

- The transfer and release of Quinault NFH steelhead into the Hoh River that have been exposed to Cook Creek water (which is not a pathogen-free water source) poses a fish health risk to stocks in the Hoh River.

- Harvest targeting Quinault NFH steelhead poses a demographic and genetic risk to natural-origin Hoh River steelhead. Given the existing run-time separation between the Quinualt NFH hatchery and Hoh River natural-origin returns, intensive harvest targeting Quinault NFH steelhead may have largely reduced the early-timed component of the natural-origin steelhead run and may prevent the reestablishment of this component of the run.

- Harvest targeting Quinault NFH steelhead poses a demographic risk to bull trout.

Ecological Risks

- The transfer and release of Quinault NFH steelhead in the Hoh River poses a competition risk to native Hoh River steelhead (especially those hatchery steelhead that may residualize).

- Hatchery programs pose inherent ecological risks (e.g. competition, predation, disease) to wild stocks in the basin in which they are released. This risk is reduced by acclimating and releasing full term smolts from locations with adult recapture facilities. Since steelhead are more likely to residualize than other stocks reared, the risk is increased.

- Steelhead that residualize pose a competition risk to other species in the Hoh River basin including coastal cutthroat and bull trout.

Research, Education, Outreach and Cultural Risks

- None identified.

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[101] *Ibid.*

[102] *pers. comm. Tyler Jurasin, Hoh Tribe, 2008.*

Recommendations for Current Program[103]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

Issue QN33: Present program goals for Quinault NFH steelhead released in the Hoh River are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN33: Restate program goals to identify the number of harvestable adult steelhead desired and achievable from this program in the Hoh River as modified by other recommendations. For example, the current program size and post-release survivals leads to a mean harvest of approximately 2,110 adult steelhead per year (brood year 1990-2007). This data could be used to develop the program goal.

Broodstock Choice and Collection

Issue QN34a: The continual release of Quinault NFH steelhead into the Hoh River (a) is inconsistent with the principles of local adaptation and managing hatchery stocks for maximum viability, (b) poses biological risks to natural salmon and steelhead populations in the Hoh River, and (c) poses straying risks within the Hoh River basin. *Quinault NFH steelhead are released at locations along the mainstem of the Hoh River without adult collection capabilities (e.g. a hatchery facility or adult collection facility on a tributary to the mainstem). Although they are known to return earlier than the wild population, Quinault NFH steelhead that are not intercepted have the potential to interact with wild Hoh River steelhead on the spawning grounds, posing risks to the wild steelhead population. Genetic samples have been collected to help assess the risk of genetic introgression. Results are pending.*[104]

Issue QN34b: Releasing unacclimated Quinault NFH steelhead upstream in the river system poses greater ecological and genetic risks than acclimated releases from Chalaat Creek. *Upon return, fish tend to congregate where they are released. Most of the tribal fishery occurs at the*

[103] *The Review Team believes that Quinault NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

[104] *Pers. comm. Joe Gilbertson, Hoh Tribe, 2008.*

mouth of the Hoh River, adjacent to Chalaat Creek, whereas the harvest of Allen's Bar releases is spread out along 15 miles of river and may not be as effective at removing Quinault NFH steelhead from the Hoh River.

Recommendation QN34a: Discontinue the 50,000 direct stream releases at Allen's Bar. Continue rearing 50,000 for acclimation and release at Chalaat Creek, or other identified acclimation facilities. Consideration could be given to increasing the Chalaat Creek/lower Hoh River release above the 50,000 level (not to exceed 100,000 total) in order to reduce any adverse effect of this recommendation on the tribal fishery so long as the acclimation site will adequately accommodate the larger release group. In conjunction with QN25, utilize existing stray information when determining the best site for acclimation and adult recapture facilities.

Recommendation QN34b: If the transfer of Quinault NFH steelhead to the Hoh River continues due to priority by tribal and state comanagers (see Recommended Alternative), then acclimation facilities with adult recapture capabilities[105] should be developed at release sites to reduce risks to natural populations (e.g. sites that increase homing and reduce straying). Implementation of this recommendation may necessitate new release sites. Acclimation and adult recapture capabilities could facilitate the development of a local broodstock for the Hoh River that remains segregated from the wild population and continues to provide harvest benefits during the period when wild fish are not returning. Adult recapture capabilities would also assist with assessing adult return rates and potential benefits of the program. The Review Team also recommends continued mass marking of the locally adapted stock for harvest and broodstock collection. [See also the Team's discussion regarding alternative broodstock management strategies for the Hoh River component of the Quinault NFH steelhead program.

Hatchery and Natural Spawning, Adult Returns

See QN33 & QN34 above

Incubation and Rearing

See the Quinault NFH Steelhead section for issues and recommendations regarding Incubation and Rearing.

Release and Outmigration

Issue QN35: The transfer and release of Quinault NFH steelhead into the Hoh River that have been exposed to Cook Creek water (which does not meet the definition of a pathogen-free water source) poses a fish health risk to stocks in the Hoh River. *This is of special concern given the emerging strain of IHN virus from the Columbia River basin that has recently caused epidemics in several locations along the North Coast of Washington (including the Lake Quinault Pen Rearing facility) Additionally, if the IHN virus is identified at Quinault NFH prior to transfer to the Hoh River, the transfer cannot occur, which would result in the loss of a year's release group.*

[105] *The Hoh Tribe has reported that few steelhead return to Chalaat Creek. Chalaat Creek may not be a suitable site for adult collection since the confluence is in brackish water and the flow out of the river is low, both of which may reduce attraction.*

Recommendation QN35a: Secure a pathogen free Cook Creek water supply at Quinault NFH for Hoh program incubation and rearing. See Recommendation QN4A.

Recommendation QN35b: Develop a contingency plan for obtaining smolts from a pathogen-free State facility in the event that IHNV is discovered at Quinault NFH. Consistent with recommendation QN36, these releases should only occur at Chalaat Creek or other appropriate acclimation facilities.

Facilities/Operations

See the Quinault NFH Steelhead section for additional issues and recommendations regarding facilities and operations.

Issue QN36: It has not been determined whether adult recapture capabilities can be developed at the Chalaat Creek acclimation site, or if the currently unused infrastructure could be modified or infrastructure added to improve the site's rearing capabilities*. The Hoh Tribe has reported that few Quinault NFH steelhead released into the Hoh River return to Chalaat Creek. This may be a result of a highly efficient harvest. However, Chalaat Creek may not be a suitable site for adult collection since the site is located very close to the range of tidal influence and the flow out of the creek is low, both of which may reduce attraction.*

The Chalaat Creek site is also at risk of intermittent flooding since it is located low in the floodplain, which may hinder the development of extended rearing capabilities.

Recommendation QN36: The Service should work with the Hoh Tribe to assess the feasibility of further developing the Chalaat Creek facility for adult broodstock collection and additional rearing. Research should be done to determine the most effective method of collection and location for adult recapture.

Issue QN37: Predation on steelhead juveniles by birds and mammals including mergansers and otters is reported to be significant at the Chalaat Creek site. *No bird netting or predator fencing is in place at the Chalaat Creek rearing/acclimation pond.*

Recommendation QN37: The Service should assist the Hoh Tribe in obtaining and placing bird netting over the Chalaat Creek pond and consider the feasibility of upgrading the present fencing around the pond as an additional predator deterrent.

Research, Monitoring, and Accountability

Also see QN22, QN26, QN27, and QN28 in the Quinault Steelhead Section.

Issue QN38 Natural production of steelhead in the Hoh River is not well documented. *Smolt production information is lacking. The genetic information on Hoh River steelhead has been collected and analysis is pending*[106].

[106] *Same footnote as for QN25.*

Recommendation QN38: Work with the Hoh Tribe, WDFW, and the National Park Service to conduct escapement estimates and smolt trapping to estimate juvenile production for the Hoh River. Use this information to better define natural production and habitat protection and restoration measures. Analyze genetic data to determine whether genetic introgression from the Quinault NFH steelhead to the Hoh River steelhead population is occurring. Utilize this genetic and biological information to determine whether Quinault NFH steelhead are successfully producing juvenile fish that could compete with wild Hoh River fish populations.

Issue QN39: Residualized steelhead can have negative ecological consequence to wild fish in the Hoh River basin. *Hatchery steelhead have the potential to residualize in the Hoh River, particularly those released 15 miles upstream of the ocean.*

Recommendation QN39: Determine the extent to which Quinault NFH steelhead released into the Hoh River residualize. Depending upon monitoring and evaluation results, determine whether different management actions reduce the risk of residualism. See recommendation QN7.

Issue QN40: Limited effort and opportunity to monitor steelhead in coastal streams makes it difficult to accurately estimate steelhead stray rates. *Coded-wire tag studies have been conducted at Quinault NFH that indicated few tags were recovered outside of the Quinault River basin. However, recovery efforts during that time period in all coastal streams were limited.*

Recommendation QN40: The Service should advocate for a coast-wide tagging and tag recovery program for steelhead.

Education and Outreach

Issue QN41: Hoh Tribal staff have limited experience in fish culture methods and procedures. *Additional training would increase effectiveness of Tribal staff in caring for juvenile fish at the Chalaat Creek facility, allow them to more readily anticipate potential problems, and propose ways of increasing the success of the program in the future.*

Recommendation QN41: The Service should provide or assist with a training internship for a Hoh Tribal staff member at Quinault NFH or other appropriate facility.

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing Hoh River steelhead program at Quinault NFH and developed six alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives. As this program is primarily conducted in support of

management objectives of the Hoh Tribe, all alternatives will be reviewed with the Hoh Tribe. Any subsequent decisions will also involve formal consultations with the Hoh Tribe. The Chalaat Creek acclimation facility is maintained and operated by the Hoh Tribe. Several alternatives below could involve the development and operation of additional facilities in the Hoh River Basin by the Tribe.

Alternative 1: Current Hoh River release program with recommendations

Continue producing up to 100,000 early run steelhead for the Hoh River. Rear steelhead destined for the Hoh River on pathogen-free water while at Quinault NFH. Discontinue releases from Allen's Bar and utilize acclimation and adult recapture capabilities on the Hoh River to reduce risks to natural salmon and steelhead populations in the Hoh River.

Pros

- Supports an important Hoh Tribal commercial harvest
- Supports a mark-selective sport fishery.
- Isolates the early run steelhead hatchery program in the lower Hoh Basin where the potential for interacting with naturally spawning wild steelhead is reduced.

Cons

- Requires modification of the Chalaat Creek facility to include adult recapture capabilities, if feasible[107], or the establishment of new acclimation and adult recapture facilities on the lower Hoh River.
- Creates ecological and genetic risks to the Hoh River wild steelhead population and to other nearby watersheds as well due to straying of hatchery steelhead.
- Represents a fish health related risk due to transfers of fish from a watershed positive for the M-D strain of IHN virus (Quinault) to an IHN negative watershed (Hoh).
- Securing a pathogen-free water supply to reduce the fish health risk to the Hoh system may be cost prohibitive.

Alternative 2: Develop a localized early-run steelhead broodstock utilizing Quinault NFH brood-origin returns to the Hoh River, reared at Quinault NFH

Develop a localized early-run steelhead broodstock by capturing Quinault NFH stock steelhead returning to the Hoh River. Continue incubation and early rearing at Quinault NFH with acclimation and release at Chalaat Creek or other appropriate acclimation site in the lower Hoh River Basin. Rear up to 100,000 steelhead destined for the Hoh River on pathogen-free water while at Quinault NFH.

[107] *See footnote about potential for developing adult recapture at Chalaat Creek, or mention in recommended alternatives.*

Pros

- Supports an important Hoh Tribal commercial harvest
- Supports a mark-selective sport fishery.
- Isolates the early run steelhead hatchery program in the lower Hoh Basin where the potential for interacting with naturally spawning wild steelhead is reduced.
- The alternative could be readily implemented in conjunction with discontinuation of releases at Allen's Bar and increased use of acclimation facilities with adult recapture capabilities in the Hoh River.
- Alternative 2 would be the next logical step after implementation of Alternative 1 and development of adult recapture capabilities in the Hoh River.
- Alternative 2 could be "tested" as an intermediary step prior to implementation of Alternative 3, assuming fish disease risks associated with transfers from Quinault NFH to the Hoh River can be resolved (e.g., by establishment of a water disinfection system for Cook Creek water used to rear steelhead for release into the Hoh River).

Cons

- Requires the establishment of adult recapture capability and possibly an alternative acclimation site in the lower Hoh River.
- Would require additional use of the isolation incubation facility and may cause conflicts with other programs
- Continues fish disease risks of transferring juvenile steelhead from Quinault NFH to the Hoh River if a water disinfection system in not developed for Cook Creek water at Quinault NFH.
- This may not reduce strays to the Quinault Basin since the steelhead will still be reared at Cook Creek.
- Maintains ecological and genetic risks to the Hoh River wild steelhead population and to other nearby watersheds as well due to straying of hatchery steelhead.
- Securing a pathogen-free water supply to reduce the fish health risk to the Hoh system may be cost prohibitive.

Alternative 3: Develop an integrated hatchery program derived from Hoh River natural-origin steelhead broodstock, reared at Quinault NFH.

Utilize natural-origin steelhead returning to the Hoh River for broodstock. Continue incubation and early rearing at Quinault NFH with acclimation and release at Chalaat Creek or other appropriate acclimation site in the lower Hoh River Basin. Rear steelhead destined for the Hoh River on pathogen-free water while at Quinault NFH.

This alternative would require appropriate new broodstock collection and acclimation sites in the Hoh River Basin. This program would be sized to not exceed 100,000 smolts released annually but may be limited by availability of natural-origin broodstock

Pros

- Supports an important Hoh Tribal commercial harvest
- Supports a mark selective sport fishery.
- Reduces the genetic and ecological risks to that natural-origin Hoh River steelhead population that were associated with the hatchery program by eliminating the release of early-run steelhead into the Hoh River that were derived from an out-of-basin source.

Cons

- Requires the establishment of new rearing and adult recapture facilities on the Hoh River.
- The fishing opportunity associated with the earlier run-time of Quinault NFH steelhead would be lost.
- Operating an integrated hatchery program for the purpose of providing fish for harvest may result in an increased risk to the natural-origin Hoh River steelhead population.
- Producing yearling smolts from spring spawning natural-origin winter steelhead makes developing an integrated program for steelhead more difficult than developing an integrated program for salmon.
- The Hoh River steelhead population is sufficiently viable so that the conservation benefits that may be associated with an integrated program are minimal or do not exist.
- Continues fish disease risks of transferring juvenile steelhead from Quinault NFH to the Hoh River if a water disinfection system is not developed for Cook Creek water at Quinault NFH.

Alternative 4: Chalaat Creek/Hoh River Segregated Program

Terminate transfers of Quinault NFH steelhead to the Hoh River and work with the Hoh Tribe in the development of a facility designed to rear and release up to 100,000 early-run steelhead smolts derived from Quinault NFH steelhead returning to the Hoh River, and a hatchery program that does not, over the long-term, rely on out-of-basin transfers and out-of-basin rearing. This alternative would utilize Chalaat Creek or appropriate alternate juvenile rearing, acclimation, and adult capture facilities located in the lower Hoh River. While the Chalaat Creek site has unused incubation and rearing capability which could be renovated, it is unclear if water supply limitations and flooding risk would preclude renovation of this site for a full term steelhead program.

Pros

- Supports an important Hoh Tribal commercial harvest

- Supports a mark-selective sport fishery.
- Eliminates the fish health related risk associated with transfers between fish health zones (Quinault Basin to Hoh Basin).
- Results in increased steelhead and/or coho production capability in the Quinault watershed.
- Further reduces risk of straying of returning adults as compared to Alternatives 1 or 2 as out-of-basin juvenile rearing is eliminated

Cons

- Requires the establishment of spawning, incubation, juvenile rearing and adult recapture capability at Chalaat Creek or an alternate site in the lower Hoh River.
- Requires significant new Service and/or Tribal funding for facility renovation, development, and operation of Hoh River facilities.
- Creates ecological and genetic risks to the Hoh River wild steelhead population due to the use of an early run steelhead broodstock derived from an out-of-basin source.

Alternative 5: Hoh River integrated hatchery program derived from natural-origin Hoh River steelhead

Terminate transfers of Quinault NFH steelhead to the Hoh River and work with the Hoh Tribe and Washington Department of Fish and Wildlife in the development of a facility designed to rear and release up to 100,000 steelhead smolts utilizing broodstock derived from natural origin Hoh River steelhead.

Pros

- Supports continued tribal commercial harvest as well as mark-selective sport harvest
- Further reduces risk of straying of returning adults as compared to Alternative 3 as out-of-basin juvenile rearing is eliminated
- Reduces the genetic and ecological risks to wild steelhead by releasing early run steelhead into the Hoh River

Cons

- Requires management of Tribal commercial and mark selective sport harvest so that incidental take of wild steelhead is at a sustainable level
- Alters the timing of harvest of returning hatchery fish and reduces the total period of time during which fish are available for harvest by reducing or eliminating early returns.
- Requires significant new Service, State and/or Tribal funding for facility renovation, development, and operation of new Hoh River facilities.

- If an alternate out-of-basin rearing site were utilized to implement this program then the fish health risk associated with inter-basin juvenile transfers remains

- See additional cons of Alternative 3.

Alternative 6: Terminate the program and manage salmon and steelhead in the Hoh River for natural reproduction only

Terminate the release of hatchery steelhead in the Hoh River in favor of natural production only and utilize alternative mitigation strategies such as habitat restoration and passage improvements.

Pros

- Eliminates ecological and genetic risks to the Hoh River wild steelhead population and to other nearby watersheds associated with an early run steelhead program in the Hoh River.

- Eliminates the fish health related risk due to transfers between fish health zones (Quinault Basin to Hoh Basin).

- Requires no new investments in renovation, construction, or operation of acclimation, rearing, or adult collection facilities in the Hoh River basin.

- Additional funds may become available for habitat restoration and habitat improvements.

- Expected to provide increased tribal and recreational harvest opportunities on naturally produced steelhead in the long term.

- Eliminating the production and subsequent harvest targeting Quinault NFH steelhead may allow the Hoh River natural-origin steelhead population to restore its historic, natural run time.

Cons

- Eliminates an important Hoh Tribal commercial harvest opportunity in the short term.

- Eliminates a mark selective sport fishery in the short term.

Recommended Alternatives

Short-term (0-5 years): Implement Alternative 1 for five years. The Review Team is concerned about both the continued IHN virus disease risks associated with this program and the consequences of straying of early run steelhead released in the Hoh River. To reduce IHN virus risk, the Team recommends implementing treatment of the water supply for Hoh Program rearing ponds at Quinault NFH. The Allen's Bar release into the Hoh River should be immediately terminated as this release of non-acclimated fish poses the largest stray risk of any alternative. Consideration could be given to increasing the Chalaat Creek/lower Hoh River release above the 50,000 level (not to exceed 100,000 total) in order to reduce any adverse effect on the tribal fishery, so long as the acclimation site will adequately accommodate the larger release group (recommendation QN33a).

Over the five year period, comanagers should strive to reach an agreement on the mid- and long-term approach for steelhead management in the Hoh River. The comanagers should assess feasibility of Alternatives 4 (segregated program), 5 (integrated program), and 6 (no hatchery program) during this time period to help determine their desired mid- and long-term management approach. In addition to the ongoing Owl and Maple Creek feasibility study of possible juvenile rearing sites: explore opportunities for acclimation, release, and adult recapture sites in the lower Hoh River; and conduct a feasibility study to determine whether a locally adapted early returning broodstock can be initiated from present Hoh River releases.

Mid -term (5-15 years): If comanagers choose to pursue a small-scale hatchery production program (up to 100,000 smolts) beyond 5 years for the purpose of supplementing harvest opportunities, the Team suggests isolating releases and recaptures of hatchery-origin steelhead in the lower Hoh River, using a locally adapted steelhead stock intended to reduce the risk of returning hatchery adults straying into natural production areas further upstream. The Service should provide technical support as needed by comanagers during the planning and implementation phases of this management transition. Also, aggressive habitat restoration to meet the recommended long-term objectives should be pursued.

Long-term (15-50 years): The Hoh River may present an unusual opportunity to be managed under a natural production only strategy. Accordingly, the Team recommends Alternative 6 in the long-term.

Quinault NFH Coho

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: The purpose of the program is to mitigate for marine and freshwater fisheries since production has declined in the Quinault River basin due to loss of habitat. The program supports commercial and sport fisheries in both marine and freshwater areas. Based on a goal of 3.0 % smolt to adult return rate (harvest plus hatchery escapement), the program goal would be to achieve 18,900 coho annually to the various fisheries based on the current program size, although no specific harvest goal has been established.

- ***Broodstock escapement goal***: Provide an escapement back to the hatchery of 450 females, 405 males, and 45 jacks for propagation purposes. Achieve a 0.17 % survival from smolt release to return to hatchery to maintain broodstock.

- ***Conservation goal***: No specific conservation goal exists for Quinault NFH coho.

- ***Escapement goal for natural-origin adults***: No specific escapement goal exists for natural origin coho in Cook Creek.

- ***Research, education, and outreach goals***: Maintain public visitation opportunities via the *Camp Host* program where the volunteer hosts maintain the visitor's center and guide tours. Coordinate specific educational opportunities with local schools. Maintain the facility's web site with the goal to provide timely information to the public regarding hatchery operations and program benefits.

Objectives

- Spawn 450 females, 405 males, and 45 jacks to support program production and release. About 1 million green eggs are taken. Eggs are then culled to 810,000 to meet program needs. .

- Release 660,000 coho smolts into Cook Creek below the hatchery. Release 143,000 fry/fingerlings into Cook Creek above the hatchery.

Program Description

The Quinault NFH coho program began in 1968. The original broodstock was from coho returning to Cook Creek. Skagit River gametes were crossed with local coho stock in 1975 and Queets River stock was released into Cook Creek/Quinault River basin with the 1983 brood. Since then all broodstock are from returns to the hatchery. The hatchery currently produces 660,000 coho salmon smolts for release into Cook Creek. An additional 143,000 fry are released upstream of the hatchery into Cook Creek.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- The broodstock origin is mixed. The original broodstock was from coho returning to Cook Creek. Skagit River gametes were crossed with local coho stock in 1975 and Queets River was stock was released into Cook Creek/Quinault River basin with the 1983 brood.

- Broodstock are collected from coho trapped at the hatchery. Natural-origin coho, if trapped, are not excluded from the broodstock.

- A Smith-Root design electric barrier directs returning adults into the fish ladder. Fish ascend the ladder into the "outflow" channel from E-bank ponds. One of the ponds is set up to attract fish into it for holding purposes. Once a week the fish are pushed out of the pond into the channel and manually crowded up the channel to an electric lift basket inside the spawning building which lifts the fish into a carbon dioxide anesthetic vat. A hydraulic basket lifts the fish from the anesthetic to a slide that leads to the sorting table.

- The weir is operated from October 1 to April 1 to prevent upstream passage of adult salmon into the hatchery's water supply. The hatchery intake is located in Cook Creek above the weir. Adult salmon and steelhead are currently not allowed upstream due to fish health concerns (including the transmission of the IHN virus), primarily related to the Hoh River steelhead transfer. It is known that the weir is not 100% effective.

- The broodstock are sorted for "ripeness". Ripe fish are spawned and green fish are returned to the holding pond or surplused. Fish are killed using a pneumatic driven M-3 "fish stunner".

- Coho are collected throughout the return (approx. October – December).

- Surplus fish, beyond what is needed for the coho program, are available to local residents for subsistence and some are picked up by a processing company via an agreement with the Grays Harbor Food Bank.

Hatchery and Natural Spawning, Adult Returns

- About 450 pairs are needed to support the program.

- Coho are spawned one day per week. The numbers of adults spawned per week roughly mirror the relative proportion of the run entering during that period.

- Fish used for spawning may include hatchery and naturally produced fish.

- During sorting, the fish are anesthetized in water injected with carbon dioxide and oxygen. Currently, carbon dioxide is metered into the anesthetic tank at 4-5 liters per minute and oxygen is metered in at 1 liter per minute (liter per minute). This ratio was arrived at by trial and error and would be dependent on temperature and chemistry of the water used. This was developed to reduce the amount of thrashing that is experienced when fish are normally anesthetized with carbon dioxide exclusively. MS-222 is not used so that spawned out carcasses can be made available for human consumption.

- The adults are generally spawned pair wise, one female to one male. Males may be used with more than one female if females outnumber males and there are not enough males to achieve a 1:1 mating ratio.

- Jacks are used as at a rate of 10% of males.

- Broodstock are spawned without selecting for size.

- Adult virus testing: Adults are tested for viruses at a minimum of the 2% assumed pathogen prevalence level. This involves testing ovarian fluid from at least 150 females and kidney/spleen tissue from at least 60 males. No regulated viral pathogens have been detected in the adult coho broodstock at Quinault NFH.

- Eggs are rinsed with a 1.4% sodium bicarbonate solution before fertilization.

- The eggs are placed into a stainless steel bucket, milt is added, and additional sodium bicarbonate solution is added and mixed.

- Buckets and colanders are disinfected with at least 100 parts per million iodine between uses.

- Eggs deemed nonviable are discarded during spawning.

- No coho are intentionally passed upstream at Quinault NFH. Fish passage can occur when the barrier is turned off, when the weir malfunctions, during extreme high water events, or during transition from low water to high water when the main deck is not energized due to safety concerns. A new operational regime is being implemented which is expected to reduce unintentional passage.

- The average total smolt to adult survival is 2.3 % (broods 94-03).

- The estimate of hatchery coho spawning naturally is 20% (range 3% to 49%) for the years 1977 to 2005 (L. Gilbertson pers. com.).[108]

Incubation and Rearing

- The newly fertilized eggs are rinsed in a trough supplied with Cook Creek water, then disinfected and water hardened in 75 parts per million iodine solution for 30 minutes in the incubation trays.

[108] *This 20% stray rate applied by the Quinault Indian Nation to Quilcene NFH coho is an average based on data gathered in the 80s-90s using spawning surveys and carcass sampling (pers. comm. Larry Gilbertson. Quinault Indian Nation. December 2008).*

- Incubation and rearing water temperatures fluctuate seasonally. During the winter, incubation temperatures range in the mid 30 to mid 40 degrees Fahrenheit. Rearing temperatures in the summer range from the mid 40s to high 50s.

- Formalin 1:600 (1667 parts per million) for 15 minutes starting at least 24 hours after fertilization is used to control fungus on the eggs. Formalin is applied 7 days a week for about 7 weeks then discontinued before hatching.

- The eggs are incubated in vertical stack trays with vexar substrate at 2 females per tray and supplied with 3-5 gallons per minute water. Eggs are shocked about 30 days post fertilization. Dead eggs are then removed about 12-24 hours after they are shocked. Trays are then loaded at 6,500 eggs per tray.

- Eggs excess to program needs are discarded from mixed batches during the shocking process so that all females are represented in the resulting smolt production.

- Eye-up survival ranges from 65% to 90%, but has improved over time. In the most recent two years, the survival has been 80%-90%. Over the last few years, modifications were made that may have contributed to the increase in survival. For example, nonviable eggs are now discarded at spawning, a bicarbonate rinse occurs at fertilization, an oxygen injection is used in conjunction with carbon dioxide before spawning, the iodine concentration for water hardening has been reduced from 100 parts per million to 75parts per million, and the spawning process time has been reduced (see other bullets in this section for details).

- Buttoned up fry are moved to 8’ x 80’x34 inch deep concrete raceways in A and B banks. Coho fry are ponded directly to the outside raceways at about 250,000 to 300,000 at approximately 1,200 fish per pound unless there are not enough buttoned up fry to make a direct ponding. This rarely happens, but when it does, fry are started inside the hatchery building at loadings similar to steelhead fry.

- Generally, ponds are cleaned daily using the brush and drain method.

- Fish are fed six days a week. Feeding is restricted to hold back size at release.

- Pond cleaning equipment is disinfected with iodine between ponds to prevent horizontal transmission of disease.

- Every attempt is made to split raceways in advance of the density index reaching 0.20 or flow index of 1.00. The recent maximum density index for coho has been 0.19. However, density indices may not be accurate as they are calculated without taking samples to establish average total lengths. During extreme low water years, the flow index may be exceeded. Density index may be exceeded occasionally if operational constraints delay splits.

- Bottlenecks occur during summer months when water flows are low. Due to insufficient water availability, the coho cannot be subdivided and reared to their release size at time of ponding or at the time of the second split. Currently the coho are ponded, then split in the spring and split again in the fall/early winter before they are released the following spring.

- Sample counts are performed monthly to monitor growth rates and feed is adjusted accordingly.

- Inventories are performed when the coho are moved among the various rearing containers. After hatch, the coho are enumerated gravimetrically (# of fish per pound). Quinault NFH recently purchased a Vaki fish counter that will be used in place of the traditional gravimetric method.

- The facility has predator control, including a fence and bird wires; however, predation by crows, starlings, and otters is a continuing problem.

- Formalin bath treatments to control external parasites (including *Trichodina* and *Ichthyobodo*) on all species of fish are common. Depending on the parasite and the water temperature, this may be a one-time treatment or it may be performed on multiple days either consecutively or alternately. Baths are generally one hour long at 1:6000 to 1:4000 (167 – 250 parts per million) and conform to the Food and Drug Administration (FDA) and EPA guidelines and labels. The parasites which cause the most significant problems in coho at Quinault NFH are *Ichthyobodo* and *Trichodina*.

- Systemic infections of bacterial coldwater disease occur on some broodyears and require medicated feed to control. Coldwater disease caused by the bacterium *Flavobacter psychrophilum* has been isolated from juvenile coho and has been treated by oral administration of oxytetracycline or florfenicol under current label guidelines or the Investigational New Animal Drug (INAD) permit in compliance with FDA regulations. *Furunculosis* has occurred on rare occasions and has been treated effectively; however, there have been cases where resistance to oxytetracycline has occurred.

- Although coho do experience low levels of bacterial kidney disease, it is not considered a significant problem. Historically, BKD levels were significant; however, this was remedied by reducing rearing densities.

Release and Outmigration

- Quinault NFH coho released on-station into Cook Creek/Quinault River are force released. This procedure generally starts with removing screens and dam boards late in the afternoon and crowding the fish out into the outflow channel. The fish are taken off feed two days prior to release.

- The coho on-station smolt release is not electronically inventoried. However, Quinault NFH recently purchased a Vaki fish counter that will improve the enumeration of fish at some point during rearing prior to release. Coho are currently electronically inventoried in November when the fish are marked and tagged, 5 to 6 months prior to release.

- The target release size and date are 15-20 fish per pound in May in conjunction with a one week separation from chum releases. Target size is met annually; however, releases sometimes occur as early as mid-April.

- 143,000 coho fry at approximately 500 fish per pound are released into Cook Creek upstream of the hatchery in March in lieu of adult passage to utilize available habitat. This is considered a better alternative when compared to passing adult coho upstream due to fish health concerns regarding pathogens that could be transferred into the hatchery's water source. Nonetheless, some adults have been observed in the upper drainage that have bypassed the weir.

- Surplus fry beyond program objectives are outplanted into the Raft and Moclips rivers, north and south of the Quinault River, respectively. A representative sample is tested by fish health before transfer.

- Attempts are made to coordinate the Quinault NFH coho on-station release with the Quinault Indian Nation's Lake Quinault steelhead release to minimize the impacts on juvenile sockeye and chum in the Quinault River.

Facilities and Operations

See the Quinault NFH Steelhead – Cook Creek Program section for more information.

Research, Education, and Outreach

- Juvenile coho are coded-wire tagged and adipose-fin clipped each year to estimate adult contribution/survival rates to all fisheries. Double index tag (DIT) groups, fish with internal tags but no visible marks that indicate they are hatchery origin, are also applied to evaluate the effects of selective fisheries and to represent North Coast wild stocks. All other coho production is mass marked.

- The on-station production occupies about 10 raceways in A and B banks. Four unique coded-wire tag groups of 20,000 each and four more unique groups (DITs) of 20,000 each are tagged into four separate raceways (one pair of clipped and tagged and tagged only (DIT)). Usually two in A bank and two in B bank. The ponds are selected so that as many spawn takes as possible are represented by the tags. The remaining fish are adipose clipped (mass marked).

- A coho rearing density study was conducted with brood years 2000-2002. Results have not yet been reported.

- There is no monitoring and evaluation program on the fry outlplants upstream of the hatchery to assess the smolt contribution or adult contribution.

See the Quinault NFH Steelhead – Cook Creek Program section for more information.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[109] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- For Quinault NFH coho released into Cook Creek, the program confers significant sport, tribal, and commercial harvest benefits as well as returns to the hatchery that are used for broodstock and subsistence. For broods 1993-2002, on average approximately 14,000 coho are recovered annually. The distribution of those recoveries is: 42% (5,900) recovered at the Quinault NFH;

[109] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

0.5% (70) from US commercial fisheries; 7% (1,000) from US sport fisheries; 49% (6,800) from treaty tribal fisheries; 0.2% (30) from Canada commercial fisheries; 1% (140) from Canada sport fisheries; 0.03% (42) from spawning ground surveys; 0.005% (1) from hatcheries other than the Quinault NFH; and 0.02% (3) recovered from research type activities[110]

- The hatchery fish from the Quinault River that are commercially caught in the tribal fishery are being processed and marketed commercially by Quinault Tribal Enterprises under the "Quinault Pride" label. Quinault Pride products are considered sustainable seafood according to the Seafood Choices Alliance.[111]

- The total economic net benefit of Quinault NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $3.3 million annually.[112]

Conservation Benefits

- None identified.

Research, Education, Outreach and Cultural Benefits

See the Quinault NFH Steelhead - Cook Creek Program section for other Research, Education, Outreach and Cultural Benefits.

- Quinault NFH coho have been a source of fish for research.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[113] the Review Team identified the following benefits of this program:

Harvest Benefits

- Few fish outside the local area are harvested. This reflects adjustments that have been made in the last decade to reduce ocean harvest.

Conservation Benefits

- None identified.

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[110] These data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were few and are not expected to significantly change the proportions reported above. The spawn ground recoveries occurred from Quinault River (40) and Oregon (2). The other hatchery recoveries occurred at Salmon River, Minter, and George Adams

[111] < http://www.seafoodchoices.com/resources/documents/SCA%20Directory%20Final.pdf>

[112] Pers. comm. James. Caudill, USFWS, 2008.

[113] See Section II, "Components of This Report", for a description of these potential benefits and risks.

Research, Education, Outreach and Cultural Benefits

- Double-index tagging contributes to the evaluation of selective fisheries and provides harvest exploitation rates on wild stocks in Hood Canal assuming similar marine survivals.

- Quinault NFH provides educational and outreach benefits to tourists visiting the area. Quinault NFH is located on a major tourist route and receives a great deal of visitor traffic. Approximately 3,500 people visit the facility on an annual basis.

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[114] the Review Team identified the following risks of the hatchery program:

Genetic Risks

- None identified.

Demographic Risks

- Lack of shade covers over the raceways concentrates fish in shaded areas along pond walls, increasing effective densities, potential stress, and disease risks.

- Relying on surface water supply has inherent risks, including the risk of disease transmission, contamination, and affects resulting from organisms in the Cook Creek watershed.

Ecological Risks

- Incidental passage of adults above the weir into the hatchery's water source due to weir malfunction or natural occurrences (e.g. high flows) poses a disease transmission risk.

- Predator exclusion and control devices are inadequate, posing a risk of disease transmission into the hatchery and between ponds.

Physical Risks

See the Quinault Steelhead – Cook Creek program section for Physical Risks.

Research, Education, Outreach and Cultural Risks

- None identified

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[115] the Review Team identified the following risks from the hatchery program:

[114] *Ibid.*

Genetic Risks

- From 3% up to 49% of the coho spawning naturally are believed to be hatchery origin (20% average). If so, this poses a significant genetic risk to the wild population. Segregated hatchery programs pose an inherent genetic risk to wild stocks in the basin in which they are released. This risk is reduced by only releasing fish on-station.

Demographic Risks

- The release of untreated effluent from the spawning area poses health risks to fish and other species downstream of Quinault NFH.

- The Quinault NFH weir and intake diversion impede the natural migration of other species of fish, including cutthroat, lamprey and limited numbers of bull trout.

Ecological Risks

- From 3% up to 49% of the coho spawning naturally are believed to be hatchery origin (20% average). If so, this poses a significant ecological risk to the wild population. Offspring of these naturally spawning hatchery-origin adults are likely to compete with offspring of the natural population, reducing their productivity. Studies have shown higher levels of aggression in hatchery stocks of coho salmon[116] and reduced productivity of natural populations that receive releases of hatchery-reared coho salmon smolts[117].

- Hatchery programs pose inherent ecological risks (e.g. competition, predation, disease) to wild stocks in the basin in which they are released. This risk is reduced by releasing full term smolts on station. Based on available information, it appears there is high homing fidelity and low straying to other portions of the Quinault River Basin and hatchery facilities where observations occur. Steelhead are more likely to residualize; however, coho tend to smolt and quickly leave the watershed, reducing ecological risks.

- Research indicates that coho released as fry displace natural-origin young of the year coho in the preferred rearing habitat of nursery streams, thus reducing substantially the fry to adult survival of natural-origin coho.[118] Coho fry are currently outplanted into upper Cook Creek, the Raft and Moclips rivers. However, ecological risks are considered minimal in Cook Creek since natural-origin adult coho are not passed above the weir.

Research, Education, Outreach and Cultural Risks

- None identified

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[115] *Ibid.*

[116] *Swain, D. P., and Riddell, B. E. 1990. Variation in agonistic behavior between newly emerged juveniles from hatchery and wild populations of coho salmon, /Oncorhynchus-kisutch/. Can. J. Fish. Aquat. Sci. 47:566-571.*

[117] *Nickelson, T. 2003. The influence of hatchery coho salmon (/Oncorhynchus kisutch/) on the productivity of wild coho salmon populations in Oregon. Canadian Journal of Fisheries and Aquatic Sciences *60:*1050-1056*.**

[118] *Ibid.*

Recommendations for Current Program[119]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

Issue QN42: Present program goals for Quinault NFH coho are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN42: Restate program goals to identify the number of harvestable adult coho desired and achievable from this program in the Quinault River. For example, the current program size and post-release survivals leads to a mean harvest of approximately 14,000 adult coho per year (brood year 1993-2002). This data could be used to develop the program goal.

Broodstock Choice and Collection

None identified

Hatchery and Natural Spawning, Adult Returns

Issue QN43: Quinault NFH coho returning to the Quinault River may pose a genetic risk to the wild Quinault coho population. *Quinault NFH coho are released into the lower Quinault River system, primary spawning habitat for wild Quinault coho. Quinault NFH coho is a segregated stock. If the Quinault NFH coho stray in the lower Quinault River system, there is potential for interaction with wild coho thus posing a genetic or ecological risk to the wild population. The Quinault Indian Nation estimates that on average 20% of the naturally spawning fish are hatchery origin. However, based on coded-wire tag recoveries, it is assumed the stray rate is low as there have been few off-hatchery recoveries on spawning grounds or at other hatcheries. (note, however, there are no tag recovery efforts on the spawning grounds.)*

[119] *The Review Team believes that Quinault NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

Recommendation QN43: Better define the distribution and abundance of naturally spawning coho in the lower Quinault River Basin (see QN47). Assess the extent of straying of Quinault NFH coho that occurs in the lower Quinault River basin. This may require structured tag recovery efforts from the spawning areas. Alternatively, baseline genetic studies could be performed to evaluate levels of genetic divergence between hatchery and wild coho populations in the Quinault River to determine if genetic markers can be used as individual fish tags.

Incubation and Rearing

Issue QN44: Quinault NFH coho have experienced poor survival rates from green to eyed-egg stage when compared to other hatchery coho programs. Typical green to eyed-egg survival rates for other hatchery coho programs is 85-90%. *Eye-up survival ranges from 65% to 90% at Quinault NFH, but has improved over time. In the most recent two years, the survival has been 80%-90%. Over the last few years, modifications were made that may have contributed to the increase in survival. For example, nonviable eggs are now discarded at spawning, a bicarbonate rinse occurs at fertilization, an oxygen injection is used in conjunction with carbon dioxide before spawning, the iodine concentration for water hardening has been reduced from 100 parts per million to 75parts per million, and the spawning process time has been reduced.*

Recommendation QN44: Continue to investigate and implement methods to further increase and ensure green to eyed-egg survival stays consistently high. For example, investigate different fertilization methods, egg rinsing solutions such as 1% saline, egg loading densities, etc.

Issue QN45: Density indices and flow indices are currently calculated without adequate size data, water flows or volume measurements. *Average length measurements are not taken and flow is roughly estimated.*

Recommendation QN45: Closely monitor coho size by taking length (total length) measurements from a representative sample at least quarterly throughout the rearing cycle. Samples should include a minimum of 100 individuals randomly dipped from a crowded/pooled group of fish in one or two raceways. Flow measurements should be taken any time flows are adjusted and periodically throughout the rearing cycle. Flow measurements could be improved by performing multiple (3+) crest measurements and/or pond displacement measurements and using the average of those measurements.

Release and Outmigration

Issue QN46: The 143,000 coho fry released into Cook Creek upstream of the hatchery, and the surplus fry released into the Moclips and Raft rivers pose an ecological and genetic detriment to natural-origin coho populations, and low potential harvest benefits. *Studies indicate that outplants at the subyearling fry stage have shown extremely low survivals to adulthood.*[120] *Additionally, the domesticated Quinault NFH coho stock, released as*

[120] *Nickelson, T. 2003. The influence of hatchery coho salmon (/Oncorhynchus kisutch/) on the productivity of wild coho salmon populations in Oregon. Canadian Journal of Fisheries and Aquatic Sciences *60:*1050-1056*.*

subyearling pose genetic and ecological risks to the natural-origin coho populations in the Quinault Basin and the Moclips and Raft rivers.

Recommendation QN46: Discontinue all fry outplants. Eliminate the program objective of releasing 143,000 coho fry into Cook Creek.

Facilities/Operations

See the Quinault NFH Steelhead – Cook Creek Program section for issues and recommendations regarding facilities or operations.

Research, Monitoring, and Accountability

Also see QN22, QN26, QN27, and QN28 in the Quinault NFH Steelhead - Cook Creek Program Section.

Issue QN47: Natural production of coho in the lower Quinault River is not well documented.

Spawning surveys and smolt production information is lacking. Additionally, genetic information on naturally produced coho does not exist. Based on information provided by the Quinault Indian Nation, the addition of a dominant hatchery stock, with some straying into natural spawning populations, has likely caused genetic immigration into the natural aggregations and some weakening of diversity. From 1981-2005 natural stock spawners averaged 4,030 (636-12,515 range) and hatchery stock spawning naturally averaged 1,075 (24-4,017 range)

Recommendation QN47: Work with the Quinault Indian Nation to conduct spawning ground surveys and smolt trapping to estimate juvenile production for Cook Creek and the lower Quinault River, and hatchery-wild genetic assignment tests. Use this information to better define natural production, extent of hatchery fish spawning naturally and habitat protection and restoration measures. Also see QN43.

Education and Outreach

See the Quinault NFH Steelhead On-station Release section

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing coho program at Quinault NFH and developed four alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current program with recommendations

Rear 660,000 smolts for release on station. Discontinue all off-station fry releases.

Pros

- Provides a significant harvest benefit within the Quinault River and marine areas.
- Provides fish for ceremonial and subsistence purposes.
- Current program produces smolts that have a relatively low disease profile that pose little risk to hatchery and wild stocks.

Cons

- Hatchery fish spawning naturally may pose a significant ecological and genetic risks to the wild population.

Alternative 2: Terminate or transfer the coho program to the Lake Quinault Pen Rearing facility and replace with Lake Quinault pen reared steelhead for a portion of the rearing period when steelhead would be most susceptible to disease risks in the net pens.

Pros

- Reduces Service tagging costs associated with rearing coho.
- Maintains current harvest of coho in the Quinault River and marine areas if the coho program is transferred to the Lake Quinault Pen Rearing facility.
- Simplifies fish culture at Quinault NFH so that only three species (Chinook, steelhead, and chum) are reared on station.

Cons

- If terminated, it would eliminate harvest of hatchery coho within the Quinault system and marine areas
- Movement of steelhead to Quinault NFH would increase risk of pathogen and disease transfer from Quinault Lake.
- Would increase demands on the Quarantine – Isolation building and potentially cause conflicts with other uses.
- Increased disease risk to those coho moved to the net pen rearing site.
- Increased operational costs at the Lake Quinault Pen Rearing facility.

- Increased risk of coho smolts preying on depressed natural juveniles (especially sockeye).

Alternative 3: Terminate or transfer the coho program to the Lake Quinault Pen Rearing facility and transfer the Lake Quinault pen reared steelhead to Quinault NFH (comanagers to determine the broodstock(s) to use for steelhead (e.g. Lake Quinault and/or Cook Creek)).

Quinault Indian Nation believes that the Lake Quinault steelhead stock has certain characteristics that increase its value compared to the Quinault NFH steelhead stock.

Pros

- Reduces IHN virus transmission risks and losses associated with rearing steelhead at Quinault net pens by rearing steelhead on a more protected water source.
- Reduces ecological risks to steelhead and other salmonids in the mainstem Quinault due to moving the steelhead production downstream to an off-channel site.
- Reduces amplification of the IHN virus at the Lake Quinault Pen Rearing facility and subsequent exposure to steelhead and salmonids downstream in the lower Quinault River system. Thereby, reducing the likelihood of establishing a new strain of IHN virus in the Quinault River system.
- Simplifies the fish culture program at Quinault NFH by reducing the number of species produced.
- Reduces predation effect on sockeye if releases from the Lake Quinault Pen Rearing facility are discontinued.

Cons

- Complicates fish culture at Quinault net pens.
- Complicates harvest of steelhead in Cook Creek below Quinault NFH due to increased fishing effort.
- Increases genetic risks to wild coho in the Quinault River basin since hatchery coho will home to the net pens, further upstream in the basin than Quinault NFH.
- Increases the ecological risks to wild coho in the Quinault River basin since hatchery coho will home to the net pens, further upstream in the basin than Quinault NFH.
- Increases the risk of disease-associated mortality in coho (historically 20%) during rearing at Quinault net pens.
- Reduces the hatchery steelhead sport and tribal fishing opportunity in the Quinault River basin upstream of Cook Creek if releases from the Lake Quinault Pen Rearing facility are discontinued. .

Alternative 4: Terminate the program (and all other programs at this facility) and decommission the facility

Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Pros

- Eliminates the cost of operating the current facility in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Cons

- Eliminates harvest on hatchery coho within the system and surrounding marine areas.
- Eliminates replacement stock opportunities for other coastal programs.
- Eliminates a source of local employment and multiplier effect on local economy and causes high Human Resources impact.

Recommended Alternatives

The Review Team recommends continuation of the current coho program at Quinault NFH with implementation of all recommendations (alternative 1). This alternative includes the elimination of all fry releases. Quinault NFH has had good success in rearing coho and the program provides a significant harvest benefit to the Quinault Indian Nation.

Quinault NFH Fall Chinook

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: The purpose of the program is to mitigate for marine and freshwater sport and tribal fisheries since production has declined in the Quinault River basin due to loss of habitat. Based on a goal of 0.50% smolt to adult return rate (harvest plus hatchery escapement), the program goal would be to achieve 2,670 Chinook annually to the various fisheries based on the current program size, although no specific harvest goal has been established.

- ***Broodstock escapement goal***: The numeric broodstock goal is 165 pairs of adult Chinook. However, this goal is never met exclusively with returning adults that are trapped at Quinault NFH. The broodstock goal of 165 pairs is taken from adults trapped at the hatchery and at the Lake Quinault Pen Rearing facility (Quinault Indian Nation). Adults collected at the net pens may consist of both hatchery and natural origin Chinook.

- ***Conservation goal***: No specific conservation goal exists for Quinault NFH fall Chinook.

- ***Escapement goal for natural-origin adults***: No specific escapement goal exists for natural-origin fall Chinook in Cook Creek or for Lake Quinault and the upper Quinault River basin.

- ***Research, education, and outreach goals***: Maintain public visitation opportunities via the *Camp Host* program where the volunteer hosts maintain the visitor's center and guide tours. Coordinate specific educational opportunities with local schools. Maintain the facility's web site with the goal to provide timely information to the public regarding hatchery operations and program benefits.

Objectives

- Spawn 165 pairs of Chinook from adults returning to both Quinault NFH and Lake Quinault Pen Rearing (Quinault Indian Nation) to obtain a minimum of 700,000 fertilized eggs.

- Release 600,000 smolts on station annually at 40 fish per pound around July 31.

Program Description

The Quinault NFH fall Chinook program began in 1968 to mitigate for declines in production due to habitat loss. Broodstock sources included Quinault returns, other Washington coastal stocks including Nemah and Willapa, and the Green River (Puget Sound). Funding for this and other programs are through the USFWS Fish Hatchery System. Original stated goals were to enhance and restore coastal fisheries, specifically those tied to the Quinault Indian Nation. The hatchery currently has a production goal of 600,000 fall Chinook smolts for release into Cook Creek. Most of the eggs for this program are currently taken from adults returning to the Lake Quinault Pen Rearing facility (Quinault Indian

Nation) because of poor adult returns to Cook Creek and the hatchery. Imports of eggs from stocks outside the basin ended in approximately 1985.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- Broodstock sources since inception of the program have included adult returns to Quinault NFH and the Lake Quinault Pen Rearing facility, and imported fish or eggs from the Nemah, Willapa, and Green rivers.

- A Smith-Root design electric barrier directs returning adults into the fish ladder. Fish ascend the ladder into the "outflow" channel from E-bank ponds. One of the ponds is set up to attract fish into it for holding purposes. Once a week, the fish are pushed out of the pond into the channel and manually crowded up the channel to an electric lift basket inside the spawning building which lifts the fish into a carbon dioxide anesthetic vat. A hydraulic basket lifts the fish from the anesthetic to a slide that leads to the sorting table.

- The weir is operated from October 1 to April 1 to prevent upstream passage of adult salmon into the hatchery's water supply. The hatchery intake is located in Cook Creek above the weir. Adult salmon and steelhead are currently not allowed upstream due to fish health concerns (including the transmission of the IHN virus), primarily related to the Hoh River steelhead transfer. It is known that the weir is not 100% effective.

- The broodstock are sorted for "ripeness". Ripe fish are spawned and green fish are returned to the holding pond. Fish are killed using a pneumatic driven M-3 "fish stunner".

- Broodstock are collected from Chinook trapped at the hatchery. Natural-origin Chinook, if trapped, are not excluded from the broodstock.

- Chinook are collected throughout the return (approximately October – December).

- The numeric broodstock goal is 165 pairs of adult Chinook. However, this goal is never met with Quinault NFH returns. Therefore, the broodstock goal of 165 pairs is to be taken from the NFH and the Lake Quinault Pen Rearing facility (Quinault Indian Nation) and may consist of both hatchery and natural origin Chinook. The Service attempts to take no more than 100 pairs from Lake Quinault Pen Rearing; however, this has been exceeded on occasion.

Hatchery and Natural Spawning, Adult Returns

- Eggs from about 165 pairs are needed to support the program to meet the 700,000 egg take goal.

- Up to 450,000 green eggs have been transferred in from the Lake Quinault Pen Rearing program to meet the 700,000 egg take goal. Gametes (eggs and sperm) collected from broodstock at the Lake Quinault Pen Rearing facility are transferred in sealable containers to Quinault NFH. Eggs are fertilized in the Quarantine Building and water hardened in 75 parts per million iodine solution for 30 minutes. Eggs are held in quarantine until the viral test results are completed. No cross-spawning occurs between adults trapped at Quinault NFH and adults trapped at the Lake Quinault Pen Rearing facility.

- Chinook are spawned weekly. Due to low returns, all returning Chinook are spawned.

- Chinook released from Quinault NFH, upon return, remain in the river mainstem and few migrate up Cook Creek and to the adult ladder.

- All fish, regardless of whether they are hatchery or natural-origin are used for spawning at Quinault NFH and the Lake Quinault Pen Rearing facility. The proportion of hatchery versus natural-origin Chinook utilized for broodstock is not recorded or managed in any manner.

- Chinook are netted from the lake at the Lake Quinault Pen Rearing facility and held briefly in tanks within their hatchery building until they become ripe. Eggs taken for Quinault NFH are taken as gametes and moved to the Quarantine/Isolation building at Quinault NFH. All adults used for that program are sampled and the egg groups are identified and correlated to the sample. Eggs are fertilized within the quarantine area and placed into numbered trays. Pathogen testing then can determine which egg groups may pose a disease risk and eggs remain in quarantine until testing is completed. Any eggs deemed unacceptable due to pathogen testing are moved back to net pen Rearing in consultation with the Tribe.

- During sorting at Quinault NFH, the fish are anesthetized in water injected with carbon dioxide and oxygen. Currently carbon dioxide is metered into the anesthetic tank at four to five liters per minute and oxygen is metered in at one liter per minute. This ratio was arrived at by trial and error and depends on water temperature and chemistry. This was developed to reduce the amount of thrashing that is experienced when fish are normally anesthetized with carbon dioxide exclusively. MS-222 is not used so that spawned fish can be made available for human consumption.

- Males and females are spawned pairwise. At Quinault NFH, in any one particular day, males (including jacks) may be used more than once if females outnumber males. This is done to maximize the number of fertilized eggs derived from Chinook returning to Quinault NFH versus fertilized eggs imported from the Lake Quinault Pen Rearing facility.

- Broodstock are spawned randomly with respect to size.

- Adult virus testing: Adults spawned at Quinault NFH are tested for viruses at the 2% assumed pathogen prevalence level. Ovarian fluid is sampled from as many adults as possible because returns rarely provide 150 females and kidney/spleen tissue from up to 60 males. Adults spawned at the Lake Quinault Pen Rearing facility are tested for viruses at the 100% level. Ovarian fluid is sampled from all females and kidney/spleen from all males. No regulated viral pathogens have been detected from either site in these stocks. However, there have been detections of a

Paramyxovirus sp. in Chinook broodstock at the Lake Quinault Pen Rearing facility in 1990, 93, 94, and 2006 and an *Aquareovius sp*. in 2003 and 2005.

- Eggs are rinsed with a 1.4% sodium bicarbonate solution to facilitate fertilization.
- The eggs are placed into a stainless steel bucket, milt is added, and additional sodium bicarbonate solution is added and mixed.
- Buckets and colanders are disinfected with at least 100 parts per million iodine between uses.
- Eggs deemed nonviable are discarded during spawning.
- No Chinook are intentionally passed upstream at Quinault NFH. Fish passage can occur when the barrier is turned off, when the weir malfunctions, during extreme high water events, or during transition from low water to high water when the main deck is not energized due to safety concerns. A new operational regime is being implemented which is expected to reduce unintentional passage.
- Some natural spawning occurs in Cook Creek below the hatchery(personal observation, Zajac). The Quinault Indian Nation Fisheries Department conducts spawning ground tag recovery on a segment of Cook Creek below the hatchery; however, few tags are recovered.
- Based on coded-wire tag data, the average total smolt-to-adult survival (harvest and escapement) for Quinault NFH Chinook is 1.0 %.
- For the latest ten year period from 1996-2005, spawning escapement (natural + hatchery) has ranged from 1,413 to 11,013 (4,999 avg.) for the entire Quinault River watershed.[121]

Incubation and Rearing

- Incubation and rearing water temperatures fluctuate seasonally. During the winter, incubation temperatures range in the mid 30s to mid 40s Fahrenheit. Rearing temperatures in the summer range from the mid to high 50s.
- The newly fertilized eggs taken at Quinault NFH are rinsed in a trough supplied with Cook Creek water, then disinfected and water hardened in 75 parts per million iodine solution for 30 minutes in the incubation trays.
- The eggs are incubated in vertical stack trays at one female per tray (or approximately 4,500 eggs per tray) and supplied with 3-5 gallons per minute water. No vexar substrate is used
- Eggs are shocked about 30 days post fertilization. Dead eggs are then removed about 12-24 hours after they are shocked. Eyed eggs are reloaded to 5,000 eggs per tray. No vexar substrate is used.
- Green to eyed-egg survival is greater than 90% annually.
- When the fry reach button-up stage, they are moved to two of the modified Burrows Ponds in D bank.

[121] *Pers. Comm. Larry Gilbertson, Quinault Indian Nation, 2008.*

- Generally, ponds are cleaned daily using the brush and drain method.

- Fish are fed seven days a week at a feeding frequency appropriate to life stage and recommended feeding guides.

- Pond cleaning equipment is disinfected with iodine between ponds to prevent horizontal transmission of disease.

- Every attempt is made to split fish in the Burrows Ponds in advance of the density index reaching 0.20 or flow index of 1.00. Infrequently, on low water years, the flow index guideline may be exceeded. Occasionally operational constraints may cause density indices to be exceeded if splits are delayed during the fall season.

- Fish in each pond are sampled monthly to monitor fish health and growth rates (number of fish per pound), and feed is adjusted accordingly.

- Inventories are performed when the Chinook are moved among the various rearing containers. Eggs are counted and, after hatch, the juveniles are enumerated gravimetrically by counting a weighed sample then weighing the remaining fish using a hanging scale. Quinault NFH recently purchased a Vaki fish counter that will be used in place of the traditional gravimetric method.

- Bacterial coldwater disease is detected occasionally, but intervention is rarely required.

- Formalin bath treatments to control external parasites (including *Trichodina, Gyrodactylus*, and *Ichthyobodo sp.*) on all species of fish are commonly applied. Depending on the parasite and the water temperature, this may be a one-time treatment or it may be performed on multiple days either consecutively or alternately. Baths are generally one hour long at 1:6000 to 1:4000 (167 – 250 parts per million) and conform to the Food and Drug Administration (FDA) and EPA guidelines and labels. The parasites which cause the most significant problems in Chinook at Quinault NFH are *Ichthyobodo sp.* and *Trichodina sp.*

- Survival from eyed-egg to release is greater than 90% annually.

Release and Outmigration

- Quinault NFH Chinook are released on station into Cook Creek/Quinault River. This procedure generally starts with removing screens and dam boards late in the afternoon and crowding the fish out into the outflow channel. The fish are taken off feed two days prior to release.

- The Chinook on-station smolt release is not electronically inventoried. However, Quinault NFH recently purchased a Vaki fish counter that will improve the enumeration of fish at some point during rearing prior to release. The fish are now also counted through the tagging trailer.

- The target release size and date are 40 fish per pound in July.

- Due to limited water availability in some years, Chinook may be released before July. Over the last ten years, releases have occurred from July 1 to July 30. In years of early release, the Chinook typically do not reach the target release size.

- The on-station production usually occupies four raceways in D bank. Four unique coded-wire tag groups of 50,000 each are tagged into the four raceways. The remaining fish are adipose-fin clipped (mass marked).

Facilities and Operations

- The facility has predator control, including a fence and bird wires; however, predation by crows, starlings, and otters is a continuing problem.

See the Quinault NFH Steelhead – Cook Creek Program section for additional information.

Research, Education, and Outreach

- All Chinook are given an adipose fin clip prior to release. 200,000 fish are also given a coded-wire tag each year to estimate adult contribution and survival rates to all fisheries.

- Based on a coded-wire tag data evaluation of fall Chinook released from the Lake Quinault Pen Rearing facility, Chinook released in August/September at a larger size survived at much higher rates than Chinook released in May/June. The Quinault NFH release goal of 40 fish per pound in July is based on this survival information. Quinault NFH cannot hold their Chinook at the current program size until August/September due to limited water availability.

- Other stocks and stock crosses used for broodstock in the 1973 were evaluated using coded-wire tags. Data indicated that success was variable and ranged from 0.21 % SAR for Hoodsport x Cook Creek stock to 2.65 % Willapa stock (this latter group was released as large juveniles in October). (USFWS 1982).

See the Quinault NFH Steelhead – Cook Creek Program section for additional information.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[122] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- For Quinault NFH fall Chinook released at the hatchery, the program confers significant sport, tribal, and commercial harvest benefits as well as returns to the hatchery that are used for broodstock and subsistence. For brood years 1993-2002, an average of 1,150 hatchery origin fall Chinook were recovered annually. The distribution of those recoveries is: 5% (60) recovered at the Quinault NFH; 18% (200) from US commercial fisheries; 3% (35) from US sport fisheries; 49% (575) from treaty tribal fisheries; 8% (90) from Canada commercial fisheries; 4% (45) from

[122] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

Canada sport fisheries; 17% (200) from spawning ground surveys; 0.09% (1) from other fish hatcheries; and 0.1% (10) recovered from research type activities.[123]

- The program provides an in-river sport fishery on the mainstem Quinault River. The sport fishery on tribal lands (the Quinault River below Lake Quinault) can only be accessed with a tribal fishing guide. The guiding service provides an economic benefit to the local community

- The hatchery fish from the Quinault River that are commercially caught in the tribal fishery are being processed and marketed commercially by Quinault Indian Nation's Quinault Tribal Enterprises under the "Quinault Pride" label. Quinault Pride products are considered sustainable seafood according to the Seafood Choices Alliance.[124] Quinault Pride Seafood is located on the Quinault Indian Nation Native American reservation in Taholah, WA.

- The total economic net benefit of Quinault NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $3.3 million. .[125]

Conservation Benefits

- None identified

Research, Education, Outreach and Cultural Benefits

- Spawned out carcasses trapped at the facility are provided to the Quinault Indian Nation and other local residents for subsistence and ceremonial purposes. The procedure for distributing carcasses was established by the Quinault Indian Nation.

See the Quinault NFH Steelhead – Cook Creek Program section for other Research, Education, Outreach and Cultural Benefits.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[126] the Review Team identified the following benefits of this program:

Harvest Benefits

- Quinault NFH fall Chinook are harvested in Alaska and British Columbia. See details above.

Conservation Benefits

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[123] *These data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were few and are not expected to significantly change the proportions reported above. 98% of the spawn ground recoveries were from the Quinault River. The other spawn ground recoveries came from Anderson and Hell Roaring Creeks (Hoh River). The other hatcheries recoveries were from Lake Quinault Pen Rearing and Mokelumne (California – one fish).*

[124] *http://www.seafoodchoices.com/secure/alliance-profile-supplier.php?id=398#*

[125] *Pers. comm. James Caudill, USFWS, 2008.*

[126] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

- None identified.

Research, Education, Outreach and Cultural Benefits

- Quinault NFH provides educational and outreach benefits to tourists visiting the area. Quinault NFH is located on a major tourist route and receives a great deal of visitor traffic. Approximately 3,500 people visit the facility on an annual basis.

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[127] the Review Team identified the following risks of the hatchery program:

Genetic Risks

- The apparent lack of cross-breeding between adults trapped at Quinault NFH and the Lake Quinault Pen Rearing facility may be posing a genetic risk to the hatchery stock by reducing within-stock genetic variation and heterozygosities. Adults constituting the broodstock each year are not randomly mated but are spawned separately according to trapping location. This can potentially create two spatially segregated "broodlines" depending on the parental origin of hatchery fish returning to each of the two locations. Considerable uncertainty regarding this risk exists at this time.

- High stray rates of returning hatchery-origin fall Chinook from Quinault NFH into natural spawning areas of the Quinault River pose a genetic domestication risk to Quinault River Fall Chinook. There is no practical way to control natural spawning of hatchery-origin fish in the mainstem Quinault River upstream and downstream of the confluence of Cook Creek. In addition, most natural spawning occurs downstream of the broodstock collection point at Lake Quinault. This poses a genetic risk to Quinault River Fall Chinook because the proportion of the hatchery broodstock composed of natural-origin fish is presumed to be substantially less than the proportion of natural spawners composed of hatchery-origin fish, thus resulting in the hatchery environment having a greater influence than the natural environment on the genetic constitution of the stock as a whole (hatchery + wild). As a consequence, the proportions of hatchery versus natural-origin fish utilized as broodstock and/or left to spawn in the mainstem are not managed according to the guidelines for an integrated program.

Demographic Risks

- Lack of shade covers over the raceways concentrates fish in shaded areas along pond walls, increasing effective densities, potential stress, and disease risks.

- Rearing multiple stocks at Quinault NFH on a limited water supply limits water availability for Chinook. Therefore, Chinook are often released earlier than the target size and time of release, possibly lowering smolt- to-adult survival rates.

[127] *Ibid.*

Ecological Risks

- Predator exclusion and control devices are inadequate, posing a risk of horizontal disease transmission into the hatchery and between ponds.

- Relying on surface water supply has inherent risks, including the risk of disease transmission, chemical contamination, and other potential effects resulting from enzootic organisms in the watershed.

Physical Risks

See the Quinault NFH steelhead – Cook Creek Program section for Physical Risks.

Research, Education, Outreach and Cultural Risks

- None identified.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[128] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- None identified. Stray rates of Quinault NFH and Lake Quinault pen-reared fall Chinook to locations outside the Quinault River drainage are presumed to be low.

Demographic Risks

- The release of untreated effluent from the spawning area poses health risks to fish and other species downstream of Quinault NFH.

- The Quinault NFH weir and intake diversion impede the natural migration of other species of fish, including cutthroat, lamprey and limited numbers of bull trout.

Ecological Risks

- Hatchery programs pose inherent ecological risks (e.g. competition, predation, disease) to wild stocks in the basin in which they are released. This risk is reduced by releasing full term smolts on station; however, fall Chinook, more so than other salmonid species, are likely to spend time residing in the lower portions of the river basin before migrating out to the ocean.

Research, Education, Outreach and Cultural Risks

- None identified.

[128] *Ibid.*

Recommendations for Current Program[129]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

Issue QN48: Present program goals for Quinault NFH fall Chinook are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN48: Restate program goals to identify the number of harvestable adult fall Chinook desired and achievable from this program in the Quinault River and in ocean fisheries. For example, the current program size and post-release survivals leads to a mean harvest of approximately 1,150 adult Chinook per year (brood year 1993-2002). This data could be used to develop the program goal.

Broodstock Choice and Collection

Issue QN49: The Quinault NFH fall Chinook program is not managed as properly integrated or segregated*. The proportions of hatchery versus natural-origin fish utilized as broodstock and/or left to spawn in the mainstem are not managed according to the guidelines for an integrated program. Additionally, there is no practical way to segregate the program since spawning occurs in the mainstem above and below the confluence of Cook Creek and most of the spawning occurs downstream of the broodstock collection point at Lake Quinault. The hatchery broodstock is intended to be integrated genetically with the natural population of fall Chinook in the Quinault River. To be properly integrated, the proportion of the broodstock composed of natural-origin fish must exceed the proportion of natural spawners composed of hatchery-origin fish. In this context, natural-origin smolts and hatchery-origin smolts released from Quinault NFH and the Lake Quinault Pen Rearing facility are intended to represent a single genetic stock with a long-term goal that the natural environment will have a greater influence on the genetic constitution of the population than the hatchery environment.*

[129] *The Review Team believes that Quinault NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

Recommendation QN49: Determine the proportion of naturally spawning fall Chinook composed of hatchery-origin fish in the Quinault River. Similarly, document the proportions of hatchery and natural-origin adults for both Quinault NFH and Lake Quinault Pen Rearing origin Chinook utilized for broodstock for at least one full generation (five consecutive brood years). Use this information to determine possible future broodstock management strategies consistent with genetic guidelines for managing hatchery-origin fall Chinook in the Quinault River as a properly integrated population. A genetic broodstock management plan should be developed that (a) identifies the minimum proportion of the hatchery broodstocks (Quinault NFH and Lake Quinault Pen Rearing) that need to be composed of natural-origin fish based on the mean proportion of natural spawners (among spawn years) composed of hatchery-origin fish, and (b) outlines a methodology for meeting those objectives for fish released from Quinault NFH and the Lake Quinault Pen Rearing facility.

Issue QN50: The Quinault NFH program is not self-sustaining. Fall Chinook released from Quinault NFH, upon return, remain in the mainstem and only enter Cook Creek in small numbers. The program relies on returns to the Lake Quinault Pen Rearing facility to maintain its 600,000 release goal

Recommendation QN50: As long as the Quinault NFH fall Chinook program is maintained at Cook Creek, continue to utilize eggs from adults returning to the Lake Quinault Pen Rearing facility as the primary source of broodstock , augmented by the fall Chinook returning to Quinault NFH. See alternative 2 for further information regarding the Team's overall conclusions affecting this program.

Hatchery and Natural Spawning, Adult Returns

Issue QN51: Adults collected for broodstock at Quinault NFH and the Quinault net pens are not randomly mated or interbred. Gametes from adults trapped at each facility are combined separately by location and are not intermixed between facilities. *As a result, two spatially segregated broodlines could develop depending on the parental origins of hatchery fish trapped at each facility. One goal of the hatchery program is to manage Quinault NFH and Lake Quinault net pen fall Chinook as one genetic stock.*

Recommendation QN51: Determine the parental facility of origin (Quinault NFH or Lake Quinault NFH) of hatchery origin fall Chinook trapped at Quinault NFH and the Lake Quinault Pen Rearing facility for broodstock at the two respective facilities based on coded wire tags (CWTs). This will require that different tag codes are applied to the progeny of adults trapped at Quinault NFH and the progeny of adults trapped at the Lake Quinault Pen Rearing facility when both groups of progeny are released from Quinault NFH. A portion of the progeny released from the net pens should also be given CWTs as part of this evaluation. Alternatively, new spawning protocols could be developed that include direct cross-fertilization (i.e. interbreeding) between gametes obtained from adults trapped at Quinault NFH and adults collected in Lake Quinault near the net pens. Random mating among adults used for broodstock at Quinault NFH would circumvent the need to ascertain the parental origins of hatchery-origin fall Chinook trapped for broodstock at Quinault NFH.

Incubation and Rearing

None identified.

Release and Outmigration

Issue QN52: Information indicates that best survival and return rates are achieved utilizing an August/September release as practiced at the Lake Quinault Pen Rearing facility. *The survival rates of these later released fish are approximately three times better than standard releases at Quinault NFH*

Recommendation QN52: Adjust the species composition and program size at Quinault NFH in order to achieve desired survival and return rates for the Quinault NFH fall Chinook program. See alternatives 3 and 4 for further information regarding the Team's overall conclusions affecting this program.

Facilities/Operations

See the Quinault NFH Steelhead – Cook Creek Program section for issues and recommendations regarding facilities or operations.

Research, Monitoring, and Accountability

Also see QN22, QN26, QN27, and QN28 in the Quinault NFH Steelhead – Cook Creek Program section.

Issue QN53: Natural production of fall Chinook in the Quinault River is not well documented. *Spawning surveys and smolt production information is lacking. Additionally, genetic information on naturally produced Chinook does not exist.*

Recommendation QN53: Work with the Quinault Indian Nation to conduct spawning ground surveys, smolt trapping to estimate juvenile production for Cook Creek and the Quinault River, and hatchery-wild genetic assignment tests. Use this information to better define natural production, extent of hatchery fish spawning naturally and habitat protection and restoration measures. Also see QN49.

Education and Outreach

See the Quinault NFH Steelhead – Cook Creek Program section for issues and recommendations regarding education and outreach.

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing fall Chinook program at Quinault NFH and developed five alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current program with recommendations

Rear 600,000 smolts for release on station.

Pros

- Provides in-river and marine fall Chinook harvest opportunities.

Cons

- Not enough broodstock return to hatchery thus requiring the importation of gametes from the Lake Quinault Pen Rearing facility.
- Increased risk of introduction of pathogens to the hatchery from gamete transfers from the Lake Quinault Pen Rearing facility.
- Increased pathogen risk, requires incubating eggs from net pen rearing in the Quarantine/Isolation Building.

Alternative 2: Terminate the fall Chinook program at Quinault NFH and transfer all fall Chinook hatchery production in the Quinault River watershed to the Lake Quinault Pen Rearing facility (dependent upon agreement with tribal comanager)

All fall Chinook rearing in the Quinault River basin would occur at the Lake Quinault Pen Rearing facility.

Pros

- Facilitates broodstock management if all broodstock are collected at one location
- Reduces stray rates of hatchery-origin fall Chinook into natural spawning areas of the Quinault River immediately upstream and downstream of Cook Creek
- Eliminates tagging and marking costs for Chinook at Quinault NFH.
- Frees up space in Quarantine/Isolation building for other important programs.

- Eliminates disease transfer risk from Quinault Lake to Quinault NFH

Cons

- Increases the impact to hatchery Chinook production within the Quinault system if there were a catastrophic event at the Lake Quinault Pen Rearing facility.

Alternative 3: Continue program at 600,000 and move release date of current program to August – September (same as Lake Quinault Pen Rearing) and adjust the steelhead and/or coho programs to accommodate needed space and water requirements

Pros

- May increase smolt-to-adult returns and resulting increased harvest benefits

Cons

- Hatchery releases in August and September may be difficult due to low flows in Cook Creek during this time period.
- Reduces harvest benefits associated with the current level of coho and/or steelhead production.
- Continues a program that is unable to obtain an adult recruit per spawner back to the hatchery greater than 1.0.
- Continues potentially high stray rates into natural spawning areas of the Quinault River watershed.
- May increase incidence of jacks and could potentially result in precocious "mini-jacks" that mature sexually at one year of age and/or residualize in the Quinault River after release.

Alternative 4: Reduce the program to 200,000 and move release date of current program to August – September (same as Lake Quinault Pen Rearing)

Pros

- Maintains current coho and steelhead production and resultant harvest benefits
- Reduces the potential for gene flow from hatchery-origin fish (released from Quinault NFH) into the naturally spawning population by substantially reducing the number of fish released from the hatchery.

Cons

- Hatchery releases in August and September may be difficult due to low flows in Cook Creek during this time period.

- Continues a program that is unable to obtain an adult recruit per spawner back to the hatchery greater than 1.0.
- Continues potentially high stray rates into natural spawning areas of the River watershed.
- May increase incidence of jacks and could potentially result in precocious "mini-jacks" that mature sexually at one year of age and/or residualize in the Quinault River after release.

Alternative 5: Terminate the program (and all other programs at this facility) and decommission the facility

Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Pros

- Eliminates the cost of operating the current facility in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Cons

- Eliminates harvest on hatchery Chinook within the system and surrounding marine areas
- Eliminates replacement stock opportunities for other coastal programs
- Eliminates a source of local employment and multiplier effect on local economy and causes high Human Resources impact.

Recommended Alternatives

Subject to agreement by the tribal comanager, the Team recommends transfer of the fall Chinook program at Quinault NFH to the Lake Quinault Pen Rearing facility (Alternative 2). Quinault NFH has experienced difficulty in collecting broodstock in Cook Creek for the fall Chinook program and is dependent on broodstock captured at Lake Quinault. In addition, the net pen program has experienced much higher return rates due to the later time of release and larger size at release. It is not practical to make a similar adjustment to the Quinault NFH fall Chinook program due to conflicts with other on-station programs for space and available water. The team believes that this change makes best use of available facilities in meeting management needs.

Quinault NFH Chum

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: The purpose of the program is to mitigate for tribal fisheries in the Quinault River since production has declined due to loss of habitat. No specific numeric harvest goal exists. However, from 1996 to 2005 the average catch in the Quinault River was 1,995 per year. The harvest probably includes both hatchery and natural origin chum.

- ***Broodstock escapement goal***: Provide an escapement back to the hatchery of 600 pairs of adult chum for production purposes. Achieve a 0.08 % survival from smolt release to return to hatchery to maintain broodstock. The average return to the hatchery from 1996 to 2005 was 1,332 per year.

- ***Conservation goal***: No specific conservation goal exists for Quinault NFH chum.

- ***Escapement goal for natural-origin adults***: No specific escapement goal for exists for natural origin chum in Cook Creek.

- ***Research, education, and outreach goals***: Maintain public visitation opportunities via the *Camp Host* program where the volunteer hosts maintain the visitor's center and guide tours. Coordinate specific educational opportunities with local schools. Maintain the facility's web site with the goal to provide timely information to the public regarding hatchery operations and program benefits.

Objectives

- Spawn 600 pairs to support the production program.

- Release 1.5 million smolts into Cook Creek below the hatchery.

Program Description

The Quinault NFH fall Chum program began in 1969 to mitigate for declines in production due to habitat loss. Broodstock sources included Quinault returns and other Washington stocks including Walcott Slough (Quilcene NFH - Puget Sound). Funding for this and other programs are through the USFWS Fish Hatchery System. Original stated goals were to enhance and restore coastal fisheries, specifically those tied to the Quinault Indian Nation. The hatchery currently has a production goal of 1,500,000 chum smolts for release into Cook Creek. Most of the eggs for this program are currently taken from adults returning to the hatchery. Imports of eggs from stocks outside the basin ended in approximately 1985.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- The broodstock originated from some indigenous stocks, but Walcott Slough (Hood Canal) eggs were frequently imported and incorporated into the program. These imports were terminated around 1985.

- A Smith-Root design electric barrier directs returning adults into the fish ladder. Fish ascend the ladder into the "outflow" channel from E-bank ponds. One of the ponds is set up to attract fish into it for holding purposes. Once a week, the fish are pushed out of the pond into the channel and manually crowded up the channel to an electric lift basket inside the spawning building which lifts the fish into a carbon dioxide anesthetic vat. A hydraulic basket lifts the fish from the anesthetic to a slide that leads to the sorting table.

- The weir is operated from October 1 to April 1 to prevent upstream passage of adult salmon into the hatchery's water supply. The hatchery intake is located in Cook Creek above the weir. Adult salmon and steelhead are currently not allowed upstream due to fish health concerns (including the transmission of the IHN virus), primarily related to the Hoh River steelhead transfer. It is known that the weir is not 100% effective.

- The broodstock are sorted for "ripeness". Ripe fish are spawned and green fish are returned to the holding pond or surplused. Fish are killed using a pneumatic driven M-3 "fish stunner".

- Chum are collected throughout the return (October – November).

Hatchery and Natural Spawning, Adult Returns

- About 600 pairs are needed to support the program.

- Chum are spawned weekly. Generally, all returning chum are spawned.

- Fish used for spawning may include hatchery and naturally produced fish.

- During sorting, the fish are anesthetized in water injected with carbon dioxide and oxygen. Currently, carbon dioxide is metered into the anesthetic tank at 4-5 liters per minute and oxygen is metered in at 1 liter per minute. This ratio was arrived at by trial and error and would be dependent on temperature and chemistry of the water used. This was developed to reduce the amount of thrashing that is experienced when fish are normally anesthetized with carbon dioxide exclusively. MS-222 is not used so that spawned out carcasses can be made available for human consumption.

- Broodstock are spawned without selecting for size.

- Adult virus testing: Adults spawned at Quinault NFH are tested for viruses at a minimum of the 2% assumed pathogen prevalence level. Ovarian fluid is sampled from a minimum of 150 females and kidney/spleen tissue sampled from a minimum of 60 males. This testing level occurs if sufficient numbers of adults return to the hatchery. No viruses have been detected in the chum broodstock. One male is spawned with one female. Males (including jacks) may be spawned with more than one female if females outnumber males.

- Eggs are rinsed with a 1.4% sodium bicarbonate solution to facilitate fertilization.

- The eggs are placed into a stainless steel bucket, milt is added, and additional sodium bicarbonate solution is added and mixed.

- Buckets and colanders are disinfected with at least 100 parts per million iodine between uses.

- Eggs deemed nonviable are discarded during spawning.

- No chum are intentionally passed upstream at Quinault NFH. Fish passage can occur when the barrier is turned off, when the weir malfunctions, during extreme high water events, or during transition from low water to high water when the main deck is not energized due to safety concerns. A new operational regime is being implemented which is expected to reduce unintentional passage.

- Some natural spawning occurs in Cook Creek below the hatchery.

- Average total survival is unknown.

- Although run sizes and escapements of chum salmon in the Quinault River have been stable since 1990, the contribution of hatchery production to this stability is not certain. 1981-2005 escapement after harvest averaged 4,867 (1,404-11,486 range).

Incubation and Rearing

- The newly fertilized eggs are rinsed in a trough supplied with Cook Creek water, then disinfected and water hardened in 75 parts per million iodine solution for 30 minutes in the incubation trays.

- Incubation and rearing water temperatures fluctuate seasonally. During the winter, incubation temperatures range in the mid 30s to mid 40s Fahrenheit. Rearing temperatures in the summer range from the mid high 50s.

- Eggs are incubated in vertical stack trays at 5,000-6,000 eggs per tray and supplied with 3-5 gallons per minute water. Vexar substrate is used.

- Eggs are shocked about 30 days post fertilization. Dead eggs are then removed about 12-24 hours after shock. Eyed survival is better than 90%. Eyed eggs are reloaded at 6000 eggs per tray.

- At button up stage, the fry are moved to 8’ x 80’ concrete raceways in D bank at approximately 500,000 fish per raceway.

- Generally, ponds are cleaned daily using the brush and drain method.

- Fish are fed seven days a week at a feeding frequency appropriate to life stage and recommended feeding guides.

- Pond cleaning equipment is disinfected with iodine between ponds to prevent horizontal transmission of disease.

- Every attempt is made to split fish in the Burrows Ponds in advance of the density index reaching 0.20 or flow index of 1.00. Infrequently, on low water years, flow index may be exceeded, but chum are usually released before low flows occur.

- Sample counts are performed monthly to monitor fish health and growth rates, and feed is adjusted accordingly.

- Inventories are performed when the chum are moved among the various rearing containers. Eggs are counted and, after hatch, the chum are enumerated gravimetrically by counting a weighed sample then weighing the remaining fish using a hanging scale. Quinault NFH recently purchased a Vaki fish counter that will be used in place of the traditional gravimetric method.

- The facility has predator control, including a fence and bird wires; however, predation by crows, starlings, and otters is a continuing problem.

Release and Outmigration

- Quinault NFH chum released on-station into Cook Creek/Quinault River are force released. This procedure generally starts with removing screens and dam boards late in the afternoon and crowding the fish out into the outflow channel. The fish are taken off feed two days prior to release.

- The chum on-station smolt release is not electronically inventoried. However, Quinault NFH recently purchased a Vaki fish counter that will improve the enumeration of fish at some point during rearing prior to release.

- The target release size and date are 454 fish per pound (1 gram) in April.

- The on-station production occupies three raceways in D bank. The fish are not marked.

Facilities and Operations

See the Quinault NFH Steelhead – Cook Creek Program section for more information.

Research, Education, and Outreach

- The Quinault NFH chum are not marked or tagged and program success as it relates to the propagated stock or to the status of the natural stock is not quantifiable.

See the Quinault NFH Steelhead – Cook Creek Program section for Education and Outreach information.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[130] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- The hatchery fish from the Quinault River that are commercially caught in the tribal fishery are being processed and marketed commercially by Quinault Tribal Enterprises under the "Quinault Pride" label. Quinault Pride products are considered sustainable seafood according to the Seafood Choices Alliance.[131] The average annual harvest of hatchery and naturally produced chum from 1996 to 2005 was 1,995 fish. The proportion of the total harvest contributed by hatchery-origin fish is unknown.

- The total economic net benefit of Quinault NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $3.3 million annually.[132]

Conservation Benefits

- None identified.

Research, Education, Outreach and Cultural Benefits

- Spawned out carcasses trapped at the facility are provided to the Quinault Indian Nation and local residents for subsistence and ceremonial purposes. The procedure for distributing carcasses was established by the Quinault Indian Nation.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[133] the Review Team identified the following benefits of this program:

Harvest Benefits

- None identified

Conservation Benefits

- None identified

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[130] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[131] *< http://www.seafoodchoices.com/resources/documents/SCA%20Directory%20Final.pdf>*

[132] *Pers. comm. James Caudill, USFWS, 2008.*

[133] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

Research, Education, Outreach and Cultural Benefits

- None identified

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[134] the Review Team identified the following risks of the hatchery program:

Genetic Risks

- None identified

Demographic Risks

- Lack of shade covers over the raceways concentrates fish in shaded areas along pond walls, increasing effective densities, potential stress, and disease risks.

Ecological Risks

- Predator exclusion and control devices are inadequate, posing a risk of disease transmission into the hatchery and between ponds.

- Relying on surface water supply has inherent risks, including the risk of disease transmission, contamination and affects resulting from organisms in the Cook Creek watershed.

Physical Risks

See the Quinault NFH Steelhead – Cook Creek Program section for Physical Risks.

Research, Education, Outreach and Cultural Risks

- None identified

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[135] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- Potential mass spawning of hatchery-origin chum in the Quinault River poses a genetic risk to the natural population in the Quinault River. The inability to distinguish hatchery and natural origin chum increases this risk and uncertainties regarding its magnitude.

[134] *Ibid.*

[135] *Ibid.*

Demographic Risks

- The inability to distinguish hatchery and natural origin chum salmon poses a demographic, over harvest risk to the natural chum population in the Quinault River.

- The release of untreated effluent from the spawning area poses health risks to fish and other species downstream of Quinault NFH.

- The Quinault NFH weir and intake diversion impede the natural migration of other species of fish, including cutthroat, lamprey and limited numbers of bull trout.

Ecological Risks

- Hatchery programs pose inherent ecological risks (e.g. competition, predation, disease) to wild stocks in the basin in which they are released. This risk is reduced in chum by releasing smolts on station that are small and held for a short period of time.

Research, Education, Outreach and Cultural Risks

- None identified

Recommendations for Current Program[136]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

Issue QN54: Present program goals for Quinault NFH chum are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN54: Restate program goals to identify the number of harvestable adult fall chum desired and achievable from this program in the Quinault River and in ocean

[136] *The Review Team believes that Quinault NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

fisheries. For example, the current program size and post-release survivals leads to a mean harvest of approximately 1,995 adult chum per year (brood year 1996-2005). This data could be used to develop the program goal.

Broodstock Choice and Collection

Issue QN55: The Quinault NFH chum program is not managed as properly integrated or segregated*. The proportions of hatchery versus natural-origin fish utilized as broodstock and/or left to spawn in the mainstem are not managed according to the guidelines for an integrated program. Additionally, there is no practical way to segregate the program since spawning occurs in Cook Creek below the hatchery. However, the current management goal for the program is to manage the broodstock as a genetically segregated population relative to the naturally spawning population in the Quinault River. Spawning activity and areas in the mainstem and other tributaries are not known.*

Recommendation QN55: Evaluate the proportion of natural-origin chum currently utilized for broodstock versus the proportion of hatchery-origin fall chum on the spawning grounds. Hatchery-origin chum should be otolith-marked prior to release to allow assessments of natural spawning stray rates and potential inclusion of natural-origin chum into the broodstock each year Use this information to determine possible future broodstock management strategies.

Issue QN56: Significant numbers of adults stay in the creek and do not ascend the ladder and are not available for spawning*. Several hundred chum have been observed spawning about a quarter mile below the hatchery ladder.*

Recommendation QN56: Evaluate other means of trapping and collecting chum adults in years when the broodstock escapement goal back to the hatchery is substantially less than the desired 600 pairs. Consider options such as: a temporary weir downstream in Cook Creek; relocating the permanent fish weir downstream or utilizing an off site broodstock collection facility elsewhere in the basin.

Hatchery and Natural Spawning, Adult Returns

Issue QN57*. Interactions of hatchery and natural spawners is currently unknown. This makes it impossible to determine best management practices to consider.*

Recommendation QN57: Evaluate the chum population spawn timing and locations within the larger basin. Determine interactions with hatchery populations/activities on natural occurring populations.

Incubation and Rearing

None identified.

Release and Outmigration

None identified

Facilities/Operations

See the Quinault NFH Steelhead – Cook Creek Program section for issues and recommendations regarding facilities or operations.

Research, Monitoring, and Accountability

Also see QN22, QN26, QN27, and QN28 in the Quinault NFH Steelhead – Cook Creek Program section.

Issue QN58: Natural production of chum salmon in the Quinault River is not well documented.

Spawning surveys and smolt production information is lacking. Additionally, genetic information on naturally produced chum salmon does not exist. Based on information provided by the Quinault Indian Nation, abundance is low and there is good reason to suspect population complexity and diversity are weak. Although run sizes and escapements have been stable since 1990, the contribution of hatchery production to this stability is not certain. 1981-2005 escapement after harvest averaged 4,867 (1,404-11,486 range).

Recommendation QN58: Work with the Quinault Indian Nation to conduct spawning ground surveys, smolt trapping to estimate juvenile production for Cook Creek and the Quinault River, and hatchery-wild genetic assignment tests. Use this information to better define natural production, extent of hatchery fish spawning naturally and habitat protection and restoration measures. Also see QN55.

Issue QN59: The Quinault NFH chum are not marked or tagged and program success as it relates to the propagated stock or to the status of the natural stock is not quantifiable.

Recommendation QN59: Initiate a marking program (e.g. otolith, genetic markers, etc.)

Education and Outreach

See the Quinault NFH Steelhead – Cook Creek Program section for more information (i.e. outdated materials)

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing chum program at Quinault NFH and developed four alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is

the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current program with recommendations

Rear and release 1,500,000 smolts on-station.

Pros

- Provides harvest specifically for the Quinault Indian Nation.
- Provides a ceremonial and subsistence benefit to Tribal members.
- Rearing times and methods for chum are relatively short and simple compared to other species.

Cons

- None identified.

Alternative 2: Increase program to historic program goal of 3 million.

Pros

- Increases the number of chum available for harvest.
- Does not require a reduction in other programs.

Cons

- Requires collecting broodstock downstream to meet egg take goals, which may require establishing a formal collection facility downstream.
- Chum have a lower market value than coho, Chinook, and steelhead, which can be harvested around the same time period; therefore, they are less attractive to fishermen.

Alternative 3: Terminate the chum program.

Pros

- Eliminates genetic and ecological risks to the natural-origin Quinault River chum population.

Cons

- Does not free up any water or space for rearing of other species.
- Reduces or eliminates harvest opportunity for chum .
- May lead to the extirpation of the Quinault NFH chum

- Eliminates surplus hatchery chum available for subsistence and ceremonial purposes .

Alternative 4: Terminate the program (and all other programs at this facility) and decommission the facility

Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Pros

- Eliminates the cost of operating the current facility in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Cons

- Eliminates harvest on hatchery fish within the system and surrounding marine areas
- Eliminates replacement stock opportunities for other coastal programs
- Eliminates a source of local employment and multiplier effect on local economy and causes high Human Resources impact.

Recommended Alternatives

The Team recommends continuation of the current chum program at Quinault NFH with implementation of all recommendations (alternative 1). The Team did find that Quinault NFH is currently capable of operating the chum program at its historic size (3 million release) and concluded that Alternative 2 - increase the size of the program from 1.5 to 3.0 million subyearling smolts - would most likely increase benefits without increasing risks if an alternative broodstock collection site can be developed. However, chum currently have limited value in tribal commercial fisheries which may discourage significant program changes.

V. Sooes River and Waatch River Watersheds (North Coast)

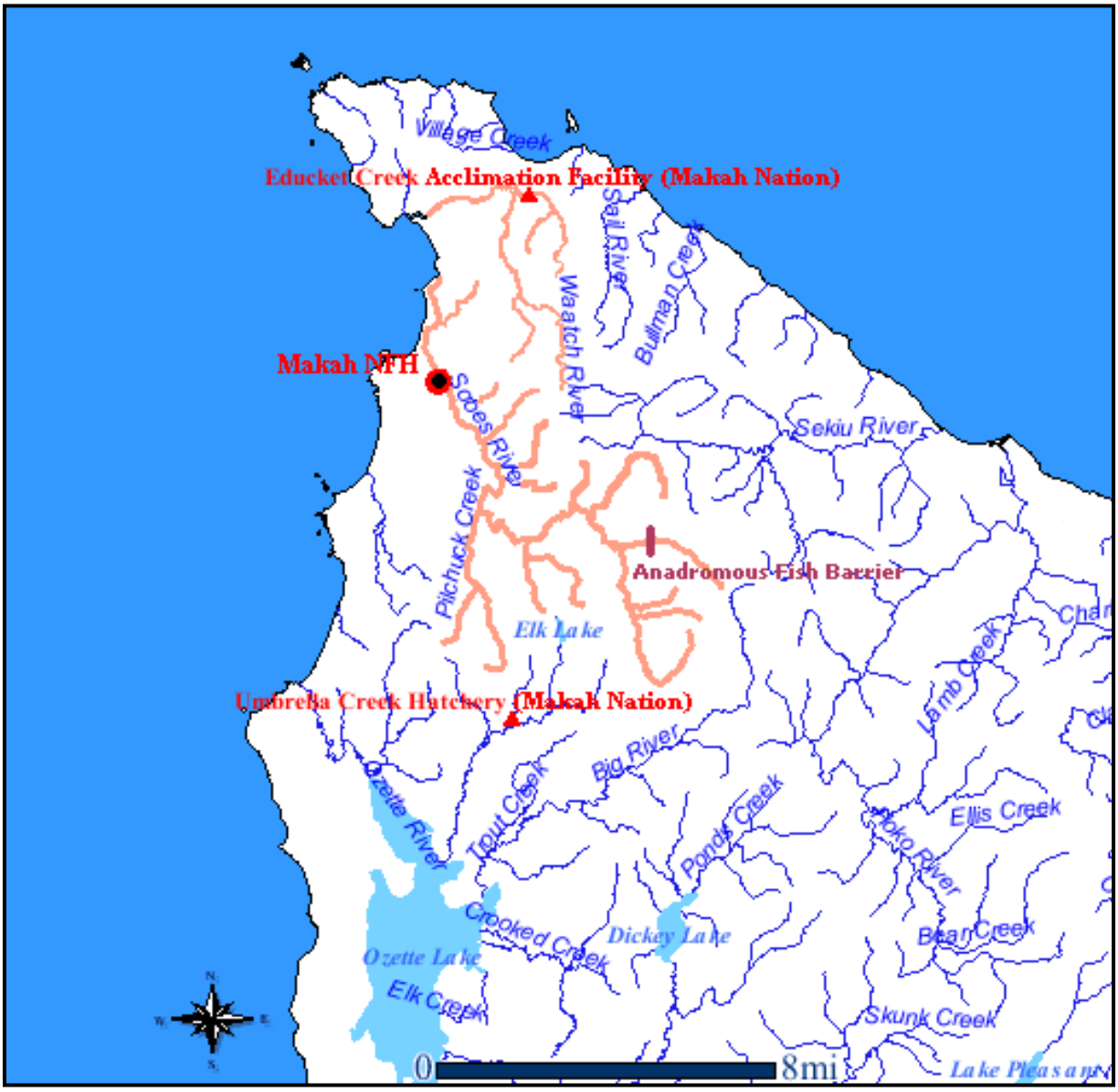

Figure 6. Sooes River Watershed, including Makah NFH and associated facilities in the region. [137]

[137] *Modified figure from Streamnet- http://map.streamnet.org/website/snetmapper/viewer.htm*

Sooes and Waatch Rivers Overview

Watershed Description

Sooes River: The Sooes River originates in the foothills of the northwest slope of the Olympic Mountains. The river flows through timberlands owned by the Olympic Range Tree Farm and managed by Green Crow, or owned and managed by the Makah Nation until it reaches the Makah Nation boundary at about river mile (RM) 4.2 (Figure 7). All of the lands are managed for timber harvest.

The Sooes River watershed is intensively managed for timber production within all ownerships. Major logging occurred during the 1970s. Consequently, most stands are less than 30 years old. Forest conifer composition is about 60 percent hemlock, 30 percent spruce, and 10 percent fir (all in the Pinaceae family). Alder (Butulaceae) stands are common along the streams. The conifer harvest rotation period is 45 years, although thinning occurs between 25 and 30 years (Frank Silvernail, Crown Pacific Timber Company, per. comm., 2000).

The Sooes River mainstem length is about 16 miles. There are also approximately 39 miles of tributaries entering the Sooes River. However, there is an impassible waterfall on the Sooes River at RM 13.8 and salmonids reportedly use only 14 miles of the tributaries. There are no other known impasses to fish migration except for the hatchery weir itself during operation. Thermal and low water flow barriers exist early in the migration season (August, early September), but dissipate with the onset of the Fall rains, typically mid to late September.

Waatch River: The Waatch River originates from a series of low peaks near the south border of the Makah Indian Reservation. The entire basin lies within the reservation boundaries. The mainstem is 7.8 miles long and tributaries add another 11.2 miles for a total of about 19 miles. Educket Creek flows into the Waatch at river mile 3.2 and is 3 miles long. Most of the Waatch basin is in timber production. Although there are some residential areas in the very lowest reach.

Fisheries

The Makah Tribe operates a commercial gill net fishery in both the Sooes and Waatch Rivers for hatchery coho, Chinook, and steelhead that is supported by releases and transfers from the Makah NFH. Generally, the coho and Chinook returns overlap and since the Chinook program is in a "building phase" pre and in-season communications between hatchery management and Tribal harvest managers regarding fishery openings are frequent to maximize coho harvest while allowing Chinook to escape to the hatchery for broodstock and to the upper Sooes River to utilize natural spawning habitat. A smaller but significant sport harvest occurs as well.

Conservation

There are no ESA listed salmon or steelhead in the Sooes and Waatch Rivers. The only salmon or steelhead produced at the Makah NFH that are descendants of Sooes River stocks are the Chinook. A run of native Sooes steelhead returns in the late spring and is not cultured at the Makah NFH. The

Makah NFH is involved in ESA-listed Lake Ozette sockeye recovery. Eggs are incubated in the isolation/quarantine facility and returned to the Lake Ozette system in the eyed stage.

Habitat[138]

Sooes River: Generally, habitat quality of Sooes River and its tributaries is poor. Large woody debris is uncommon and immediate natural recruitment potential is low because of past intensive logging practices in riparian areas. However, spawning gravels and riffles are abundant and are interspersed with resting pools. Riparian vegetation and canopy consist of young stands of alder and conifers.

Observations made during a site visit by Service staff to the Sooes River watershed in October 2000 indicated a dynamic, mobile gravel bed with substantial bar development in some reaches (Paul Bakke, Service, per. comm., 2000). Observations of sediment structure in several spot-samples revealed a coarsened, but not embedded, gravel surface over a subsurface enriched with coarse sand but little or no fine sand or silt. This composition is generally easy for spawning fish to excavate and provides ample intra-gravel flow. However, it is also easily mobilized during high flows. Since there is little in-channel large wood to dissipate hydraulic energy, gravel bars are exposed to substantial hydraulic shear stress during floods, with concomitant scour and bar mobility. Also, the Sooes River experiences a "flashy" hydrologic pattern, providing high sediment transport capacity over brief, but frequent, floods. Mass wasting is also evident in some parts of the watershed, which results in substantial movement of fine and coarse sediment to downstream areas.

Except for the headwaters, the Sooes River gradient is less than 1% throughout its course and water temperatures generally average from 42° F (5.5° C) in January to more than 65° F (18.3° C) in August at the hatchery. Tribal staff believe that water temperatures are generally cooling as a result of improving canopy cover and riparian conditions (Mike Haggerty, Makah Nation, per. comm., 2000). Summer low flows typically fall to about 9 cubic feet per second at the hatchery (Al Jensen, Service, per. comm., 2001).

Habitat deficiencies in the watershed are being addressed. Currently, the Makah Nation is working cooperatively with Crown Pacific Timber Company to identify and replace problem culverts. Together they are experimenting with adding large wood to the Sooes River (View 4). Also, streamside buffer protection should, after a number of years, provide a source of large wood for stream enhancement.

Waatch River: The Waatch River basin is adjacent the Sooes River basin and thus shares the same climate, topography, gradient characteristics as well as similar land management practices (e.g. timber production) as the Sooes. Consequently, water temperature, erosion, sedimentation, and large wood features in the Waatch are similar to the Sooes River. The Waatch main-stem also has an impassible falls near river mile 4.0 further limiting its current capacity to support anadromous fish populations.

Current Status of Salmonid Stocks

The Review Team, in conjunction with Service managers and the Makah Nation, identified eight salmonid stocks that are either: in the Sooes River watershed; reared at Makah NFH; or are affected by Makah NFH programs. There are no listed salmonid stocks in the Sooes River watershed. Lake Ozette sockeye, incubated at Makah NFH, are ESA-listed as threatened. Naturally spawning populations of

[138] *source.*

fall Chinook, coho, and steelhead that spawn in the Waatch River have not been formally surveyed, and their biological statuses are largely unknown.

- Sooes River fall Chinook salmon (integrated hatchery + natural)
- Makah NFH coho salmon (segregated hatchery)
- Makah NFH steelhead (segregated hatchery)
- Sooes River steelhead (natural)
- Lake Ozette sockeye salmon (natural + hatchery supplemented) (threatened)
- Waatch River steelhead (natural)
- Waatch River fall Chinook salmon (natural)
- Waatch River coho salmon (natural)

The following tables summarize the current status and management premises of those stocks as identified by Makah Nation, WDFW and NOAA. The principal sources of information provided in these tables were: personal communications with Makah Nation fisheries staff; communications with Makah NFH Service manager Caroline Peterschmidt; Washington Department of Fish and Wildlife's (WDFW) Salmon Stock Inventory (SaSI)[139] and subsequent annual escapement estimates; and the Puget Sound and Coastal Washington Hatchery Scientific Review Group's recommendations for the North Coast[140]. Other sources include Puget Sound (and coastal Washington) Technical Recovery Team (PSSTRT) documentation[141]; and personal communications with WDFW staff and Tim Tynan of NOAA.

[139] *SaSI and escapement data available through WDFW's Salmonscape web utility http://wdfw.wa.gov/mapping/salmonscape/.*

[140] *Hatchery Scientific Review Group. March 2004. Hatchery Reform Recommendations for the Puget Sound and Coastal Washington Hatchery Reform Project. Seattle, WA. www.hatcheryreform.org.*

[141] *http://www.nwfsc.noaa.gov/trt/puget.cfm*

Table 31. Sooes River fall Chinook salmon (hatchery + natural)

Management Premises and Goals	
ESA Status	*Not listed.*
Biological Significance	*Medium (HSRG 2004).* Fall Chinook native to the Sooes River are not known to have any unique biological attributes relative to fall Chinook stocks elsewhere in the North Coast region of the Olympic Peninsula. In addition, the naturally-spawning population is believed to be heavily influenced genetically by hatchery-origin fish passed upstream of the hatchery. The Makah Tribe has rated the biological significance of this stock as "high".
Population Viability	*Low (HSRG 2004).* Sooes River fall Chinook are largely sustained by the hatchery program. A mixture of hatchery and natural-origin Chinook adults in excess of broodstock needs are passed upstream of the weir to utilize available spawning habitat on the upper Sooes River. Adults have been passed upstream sporadically since at least 1984. An average of 380 females (range 1-1162), 659 males (range 4-2243), and 175 jacks (range 0-620) were passed upstream from return years 1999-2007. The population dynamics and viability of the stock as a whole depend largely on the hatchery program. Recruit per spawner for hatchery-spawned fish has averaged approximately R/S =4.0 for the period 1999-2007. An average of 554 females (range 131-766), 509 males (range 110-750) and 44 jacks (range 15 to 91) were spawned annually at the hatchery from return years 1999-2007. Hatchery smolt to adult survival (to hatchery and harvest) ranges from .03 - .50% (CHMP draft page 42). Chinook returns to the Sooes River (to the hatchery and harvest) have ranged from 619 to 14,435 with an average of 4,365 from return years 1999-2007.
Habitat	*Low.* Spawning and rearing habitat for Chinook salmon in the Sooes River is highly degraded because of past land use practices (e.g., logging).
Harvest	*High (HSRG 2004).* For return years 1997-2007, an average of 1,934 Chinook were harvested annually in the Sooes River (range 1-8,349), primarily in the tribal gillnet fishery. There are two catch estimates: <u>Based on catch records</u> for the Sooes and Waatch Rivers, for return years 1997-2007, an average of 1,934 Chinook were harvested annually in the Sooes River (range 1-8,349), primarily in the tribal gillnet fishery. Chinook harvest in the Waatch River has been sporadic, based on how many Chinook are transferred and released from the Educket Creek Acclimation Facility. For return years 1997-2007, an average of 84 Chinook were harvested in the Waatch River primarily in the tribal gillnet fishery <u>Based on recovery of coded wire tags</u> ($n \approx 4{,}400$) for brood years 1993-2002, approximately 60% (2,600) of the returning adults were recovered at the Makah NFH; 15% (650) from US commercial fisheries; 3% (150) from US sport fisheries; 6% (250) from treaty tribal fisheries; 11% (500) from Canada commercial fisheries; 5% (200) from Canada sport fisheries; 0.3% (15) from spawning ground surveys; and 0.02% (1) recovered from research activities.[142]

[142] *These data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were*

Hatchery Program	
Facilities	Makah NFH (US Fish and Wildlife Service). Educket Creek Acclimation Pond on Waatch River (Makah Nation)
Type	*Integrated.* Hatchery and natural origin Chinook salmon in the Sooes River are intended to represent one stock. Natural-origin Chinook are not separated from hatchery-origin Chinook during broodstock selection, although the proportion of hatchery- and natural-origin fish is currently unknown. The Educket Creek Acclimation Program represents an outplanting site from which no broodstock are collected.
Authorization and Funding	Makah NFH: US Fish and Wildlife Service. Educket Creek Acclimation Pond: Makah Nation, Bureau of Indian Affairs funded.
Primary Purpose	*Harvest.*
Secondary Purposes	*Conservation*. One goal of the Makah NFH Fall Chinook program is to maintain the native population of Sooes River fall Chinook at some level of viability, by reducing demographic risks to the population.
Broodstock Origin(s)	Chinook salmon native to the Sooes River. The broodstock is currently maintained by an unknown mixture of hatchery and natural-origin adults trapped in the Sooes River at the hatchery.

few and are not expected to significantly change the proportions reported above. All spawn ground recoveries occurred from Browne's Creek (Hoko River at mile ten).

Table 32. Makah NFH coho salmon (Makah NFH)

Management Premises and Goals	
ESA Status	*Not listed.*
Biological Significance	*Low (HSRG 2004).* Makah NFH coho salmon represent an introduced stock derived primarily from coho returning to Quilcene and Quinault NFHs.
Population Viability	*High.* Annual hatchery coho returns to the Sooes River averaged 8,567 (range = 892 to 15,841) adults, 1997–2007. During the same time period, an average of 232 females (range 164-292), 226 males (range 156-315), and 18 jacks (range 5-45) were spawned annually, thus resulting in an approximate R/S = 18. When returns from harvest are included (see below), R/S ≈ 25. Smolt to adult survival (to hatchery and harvest) ranges from 2.0% to 4.8% with a five-year mean of 3.2% (Zajac 2007). The HSRG (2004) evaluated Makah NFH coho as an *integrated* population. As a result, they based their evaluations of status on the viability of the naturally spawning population which they rated as "low".
Habitat	*The HSRG rated the habitat low to medium (HSRG 2004).* High summer water temperatures in the Sooes River can lead to fish health problems at Makah NFH.
Harvest	*High (HSRG 2004).* For return years 1997-2007, an average of 4,132 coho were harvested annually in the Sooes River (range 35-10,610), primarily in the tribal gillnet fishery. Recovery of coded wire tags (n = 4,700) were distributed as follows: 72% (3,400) recovered at the Makah NFH; 3.6% (170) from US commercial fisheries; 8% (375) from US sport fisheries; 10% (470) from treaty tribal fisheries; 0.5% (25) from Alaska commercial fisheries; 4% (190) from Canada commercial fisheries; 1.5% (70) from Canada sport fisheries; 0.08% (4) from Oregon commercial fisheries; 0.5% (25) from Oregon sport fisheries; and 0.02% (1) recovered from research type activities.[143] Coho harvest in the Waatch River has ranged from 31 to 1,718, with an average of 669 (return years 1997 – 2007), primarily captured in the tribal gillnet fishery.
Hatchery Program	
Facilities	Makah NFH (USFWS). Educket Creek Acclimation Pond on the Waatch River (Makah Nation)
Type	*Segregated.* Although natural and hatchery origin coho are not distinguished during broodstock selection and spawning, the hatchery stock is assumed to represent an introduced, non-native stock that is propagated as a distinct population from wild stocks but has potentially influenced the naturally spawning population in the Sooes River genetically.
Authorization and Funding	Makah NFH: US Fish and Wildlife Service. Educket Creek Acclimation Pond: Makah Nation, Bureau of Indian Affairs funded.
Primary Purpose	*Harvest.*

[143] *These data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were few and are not expected to significantly change the proportions reported above.*

Secondary Purposes	None.
Broodstock Origin(s)	Quilcene and Quinault NFH coho. There may be some level of influence from native Sooes River coho; however, hatchery production has driven the population for quite some time. The broodstock is currently maintained with adult fish trapped at the hatchery.

Table 33. Makah NFH steelhead (Makah NFH)

Management Premises and Goals	
ESA Status	*Not Listed*.
Biological Significance	*Low (HSRG 2004)*. This hatchery stock was derived from hatchery-origin steelhead trapped at Quinault NFH.
Population Viability	*Medium (HSRG 2004)*. Smolt-to-adult survival of broods 2001-03 averaged between about 1.0 to 1.5 % (Tipping and Zajac 2007 draft).
Habitat	*Medium (HSRG 2004).* High summer water temperatures in the Sooes River can lead to fish health problems at Makah NFH.
Harvest	*Medium.* Annual hatchery steelhead catch on the Sooes River averaged 1,946 (range = 446 to 3,516) adult fish per year (1995 – 2006). The HSRG (2004) rated the harvest of hatchery-origin steelhead in the Sooes River as "high". Annual harvest of hatchery-origin steelhead in the Waatch River averaged 100 (range = 23 to 301) adult fish per year, 1997 – 2007.
Hatchery Program	
Facilities	Makah NFH (USFWS) Educket Creek Acclimation Pond (Makah Nation).
Type	Segregated. The Makah NFH steelhead population is managed as a distinct hatchery stock within the Sooes River watershed.
Authorization and Funding	Makah NFH: US Fish and Wildlife Service. Educket Creek Acclimation Pond: Makah Nation; Bureau of Indian Affairs.
Primary Purpose	Harvest.
Secondary Purposes	None.
Broodstock Origin(s)	Hatchery-origin steelhead from Quinault NFH.

Table 34. Sooes River steelhead

Management Premises and Goals	
ESA Status	*Not Listed.*
Biological	*Low (HSRG 2004).* The Makah Tribe rated the biological significance of the naturally

Significance	spawning population of steelhead in the Sooes River as "high", although no unique biological attributes have been identified.
Population Viability	The viability of the natural Sooes River winter steelhead population has not been formally assessed although the population appears stable based on annual weir counts.
Habitat	The historic and current habitat capacity and productivity are largely unknown.
Harvest	*Low*. Natural-origin steelhead in the Sooes River are harvested incidentally in fisheries targeting early-returning hatchery-origin steelhead.

Table 35. Lake Ozette sockeye salmon (natural + hatchery)

Management Premises and Goals	
ESA Status	*Threatened*
Biological Significance	*High (HSRG 2004).* NOAA Fisheries has classified Lake Ozette sockeye salmon as a distinct ESU of the species.
Population Viability	*Medium (HSRG 2004).* Recent run-sizes of Lake Ozette sockeye have ranged from 1,000 to over 2,200 adults from the period of 1997-2000[144].
Habitat	*Low (HSRG 2004). Beach spawning habitat has been degraded by increased sediment production in the tributaries of Lake Ozette. Decreased channel stability and flood plain alterations from logging activities contribute to the sedimentation.*
Harvest	*None.* No directed harvest of Lake Ozette sockeye salmon has occurred since 1984.
Hatchery Program	
Facilities	Makah NFH egg isolation unit. Eyed eggs transferred to the Umbrella Creek and Stony Creek tribal facilities.
Type	*Integrated.*
Authorization and Funding	Makah NFH: US Fish and Wildlife Service. Umbrella Creek and Stony Creek facilities: Makah Nation; Bureau of Indian Affairs.
Primary Purpose	*Conservation.* The primary goal of the hatchery program is to recover the natural population to a level of self-sustainability that would warrant delisting under the ESA and eventually provide some harvest.
Secondary Purposes	*Research*
Broodstock Origin(s)	Natural-origin sockeye salmon native to Lake Ozette.

[144] *Ozette Sockeye HGMP.*

Other Species of Concern

Table 36. Additional salmonid and non-salmonid native fish species present in the Sooes River watershed[145]

Common name	Scientific Name
Chum salmon	*Oncorhynchus keta*
Cutthroat trout	*Oncorhynchus clarki*
Threespine stickleback	*Gasterosteus aculeatus*
Pacific Lamprey	*Lampetra tridentata*

Avian predators commonly observed include gulls, bald eagles, osprey, great blue herons, mergansers, crows and kingfishers. River otters also occur in the Sooes River and have demonstrated the potential to prey on program fish.

Salmon and Steelhead Hatcheries in and around the Watershed[146]

Makah National Fish Hatchery (U.S. Fish and Wildlife Service)

The Makah NFH began operations in 1981 to restore and enhance depleted runs of salmon and steelhead on the Makah Indian Reservation. The Makah NFH is located, approximately eight miles southwest of the town of Neah Bay, Washington on the northwest tip of the Olympic Peninsula. The facility is situated on approximately 80 acres that are leased from the Makah Nation, on the west shore of the Sooes River. Its main facilities consist of twenty-nine 11-foot-wide by 80-foot-long raceways, four 4-foot -wide by 40-foot-long raceways, a pump house building, and a two-story hatchery building. The pump house building is equipped with traveling screens, and water management structures include an aeration/sedimentation pond, a pollution control pond, and a 1.2-mile-long serpentine abatement channel. The upper level of the two-story hatchery building houses administrative offices and a visitor's center. The lower level of the two-story building includes a crew break room, gear locker room, trough and egg incubation tray nursery, feed storage room, metal shop, general shop, sand filters, and a generator room. Directly attached to the hatchery building is the recently enclosed spawning facility, which contains five adult holding ponds, hydraulic crowders, a Pescalator™, two anesthetic tanks, a sorting table and a series of connecting pipes to relocate acquired fish. A separate building includes parking stalls for Service vehicles, a hazardous materials room, tool storage facilities and a woodworking shop. There are three permanent government residences for required-occupancy staff (two quarters for residences and one that serves as a guest house). Other satellite structures include storage buildings, a fire shed, a sewage treatment plant and an egg isolation/quarantine building.

The Sooes River mainstem is approximately 16 miles long however a barrier to anadromous fish exists at river mile 13. The hatchery is located at river mile 3. There is an additional 39 miles of tributary length of which 14 are reportedly used by salmon.

[145] *Pers. comm. Dave Zajac, Hatchery Review Team, 2008.*

[146] *See Figure 6.*

The hatchery is funded by Congressional appropriation of hatchery operations funds to the Service and the Service's hatchery cyclical maintenance fund. The operational budget for FY2008 was $743,859. Costs for monitoring and evaluation (M&E) and fish health in FY2008 were approximately $290,000 and $115,000, respectively. Capital Improvements to the Makah NFH have totaled $2,512,120 during the period 2004-2008.

Funding Source: FY2008	Amount
Appropriations to USFWS	$593,740
USFWS –Hatchery Cyclical Maintenance	$150,119
Total	$743,859

Educket Creek Acclimation Facility (Makah Nation)

Educket Creek Acclimation Facility is located on the Makah Nation reservation, just south of Neah Bay on the "back track" road on Educket Creek (tributary to the Waatch River). A small creek impoundment serves as an acclimation and release site for steelhead, coho and Chinook from Makah National Fish Hatchery. The facility also has some incubation capacity although this has not been used since the isolation building at MNFH was modified to accommodate Ozette Sockeye. The facility was constructed in 1986 with funds provided by the Bureau of Indian Affairs. The land is leased from Crown Pacific.

Umbrella Creek Hatchery (Makah Nation)

The Umbrella Creek, Elk Lake, and Stony Creek facilities are located in remote areas classified as commercial forest and have few amenities such as electricity or land line phone service. These facilities are operated by the Makah Tribal Council. The water source are Umbrella Creek (WRIA 20.0056) and Big River (WRIA 20.0058). The facility was constructed in 1982 and began operations in 1983. The land is leased from Crown Pacific. The Nation was granted permission for the Stony Creek remote site incubator (RSI) site by a private land owner. The Elk Lake RSI came on line in 2003 with BY'02 eggs, and the Stony Creek RSI came on line in 2001 with BY'00 eggs.

Hoko Falls Hatchery (Makah Nation)

This hatchery is located on the Hoko River (river mile 10.0). It is operated by the Makah Tribal Council. The water sources are Rights Creek (WRIA 19.0174) and Brownes Creek (WRIA 19.0170). The hatchery was constructed from1982–1991 and began operations in 1984. Hatchery facilities and equipment include an incubation building, hatchery office, shop/garage, two covered, concrete block raceways, and a subdivided, one-half acre, asphalt rearing pond. The facility is on ten acres leased from Rayonier Timberlands. Hoko Fall Chinook and a locally adapted segregated stock of winter run steelhead are spawned and reared here.

Makah NFH Fall Chinook

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: Support commercial and sport fisheries in both marine and freshwater areas. Based on a goal of 0.75 % smolt to adult return rate (harvest plus hatchery escapement), the program goal would be to achieve 16,150 Chinook annually to the various fisheries (including the Waatch) based on the current program size, although no specific harvest goal has been established. The Waatch River fishery is viewed as a secondary harvest opportunity to the Sooes River fishery.

- ***Broodstock escapement goal***: Provide an escapement back to the hatchery of 550 females and 550 males for propagation purposes. Achieve a minimum of 0.05 % smolt release to hatchery return rate to maintain an adequate supply of broodstock.

- ***Conservation goal***: Maintain a viable population of Sooes River fall Chinook.

- ***Escapement goal for natural-origin adults***: There is no specific escapement goal for natural origin adults. However, there is an estimated capacity in the Sooes River to support 500 Chinook spawners.[147] Currently, an average of 1,200 Chinook of an assumed mix of both hatchery and natural origin fish have been passed upstream to spawn naturally and contribute to ecosystem functions if it is projected the broodstock needs will be met. In years of low adult returns, broodstock needs have a higher priority than natural spawning escapement, and fewer or no fish are passed upstream.

- ***Research, education, and outreach goals***: Provide visitation to the general public and assorted tour groups mostly during the summer tourist season. Provide educational tours, particularly during the spawning season.

Objectives

- Spawn 550 females and 550 males to yield 2.75 million green eggs.

- Pass up to 250 Chinook pairs (500 total) upstream into the Sooes River throughout the run if it is projected the broodstock needs will be met.

- Release 2,200,000 smolts annually at 75 fish per pound in May.

- If on-station release needs are met, transfer 100,000 smolts annually to the Educket Creek Acclimation Facility (Makah Nation) on the Waatch River at 75 fish per pound in May.

[147] *Zajac, Dave. 2002. An Assessment of Potential Anadromous Fish Habitat Use and Fish Passage above Makah National Fish Hatchery in the Sooes River. U.S. Fish and Wildlife Service, Western Washington Office, Lacey, Washington.*

Program Description

A variety of fall Chinook stocks were introduced into the Sooes River prior to the construction of the hatchery in 1981. Since the construction of the hatchery, only fall Chinook returning to the Sooes River have been used for the Makah NFH fall Chinook program. The program was initiated with a handful of returning adults in 1981 and increased as more adults returned each year. By 1990, smolt releases were approaching 1 million. The peak release occurred in 1997 with over 3.5 million fall Chinook juveniles released to the Sooes and Waatch Rivers. The hatchery also temporarily reared Hoko River fall Chinook which were released into the Hoko River, but this program was terminated when the Hoko hatchery (Makah Tribe) gained the capacity to incubate its own eggs.

The hatchery currently produces 2,200,000 Chinook smolts for release into the Sooes River at the hatchery and an additional 100,000 smolts for transfer and subsequent release at the Educket Creek Acclimation Facility (Waatch River). Currently, four unique groups of coded-wire tags are applied to the Sooes River release. Fish not tagged are mass marked for both the Sooes River release and Educket Creek transfer.

Broodstock are collected from returns to the hatchery. The run has been increased since the inception of the hatchery using Sooes River Chinook only. The goal is to spawn 550 females and 550 males. Additional fish not needed for broodstock are passed upstream to use the available habitat.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- The hatchery program was founded from a few dozen pairs of adults returning to the Sooes River in the mid 70's. Since then, only Sooes River fall Chinook have been used for broodstock. This broodstock protocol was adhered to even when fish reared on-station were eradicated due to the detection of the *Viral Hemorrhagic Septicemia* (VHS) virus in 1989. At that time, the VHS virus was considered exotic to North America.

- The current stock is not listed under ESA.

- Fall Chinook entry timing ranges from September to November with a mean entry date of October 8th. Age at return ranges from two to six years, but primarily consists of four year old adults (FOCUS 2006, broods 1985-2005). Chinook enter the hatchery via a fish ladder associated with a suspended-electrode weir that spans the Sooes River. Adults ascend the ladder and enter a holding pond. All five of the adult holding ponds are used for adult collection and holding purposes.

- Broodstock are collected from fall Chinook trapped at the hatchery. Natural-origin Chinook are not separated from hatchery-origin Chinook during broodstock selection or upstream passage.

- A mixture of hatchery and wild origin Chinook adults in excess of broodstock needs are passed upstream of the weir to utilize available spawning habitat on the upper Sooes River. Fish have been passed upstream sporadically since at least 1984. From return year 1999-2007, an average of 380 females (range 1-1162), 659 males (range 4-2243), and 175 jacks (range 0-620) were passed upstream.

- Fish in excess of broodstock and escapement needs are given to the Makah Nation for subsistence and ceremonial purposes.

- Broodstock entry is sometimes delayed due to low flows and high water temperatures which limits adult collection and holding and poses a risk to meeting broodstock needs. Adults left in the river at times spawn below the weir.

Hatchery and Natural Spawning, Adult Returns

- The broodstock goal is to spawn 550 females and 550 males from Chinook returning to the hatchery. From 1999-2007, an average of 554 females (range 131-766), 509 males (range 110-750) and 44 jacks (range 15 to 91) were spawned annually.

- Treatment for disease control has not been needed for adults collected for broodstock.

- Jacks (2 year old males) are included in the broodstock and make up 3.3% to 17.3% of males used (1997 – 2006, mean = 7.3%).

- Broodstock are spawned randomly without selecting for size, including the use of jacks in the broodstock.

- Spawning ratio is one female to one male. Eggs from one female are deposited into a colander and rinsed with a 1.4% sodium bicarbonate solution, then poured into a dry bucket with sperm from one male added immediately. The sperm and egg mixture is gently stirred with more bicarbonate solution being added. Fall Chinook eggs are then rinsed several times with filtered Sooes River water. Chinook eggs are not pooled prior to loading into the incubation trays.

- Following rinsing, the eggs are placed in Heath trays containing 75parts per million iodine solution for 60 minutes to water harden and disinfect. Sooes River water is then turned on to the stacks for the remainder of the incubation period. Water supplied to the stacks has been processed through a sand filter, but is not otherwise treated or temperature adjusted.

- Stray rates are assumed to be low since few marked Makah NFH Chinook are recovered in other watersheds.

- Smolt to adult survival (to hatchery and harvest) ranges from .03 - .50% (CHMP draft page 42).

- Chinook returns to the Sooes River (to the hatchery and harvest) have ranged from 835 to 14,435 with an average of 4,365 (Return Year 1997 – 2007).

- Of the total number of adults harvested, 41% are caught in Canadian waters, 47% in Alaska, and 12% in Washington waters. (Broodyears 1985-2002).

- Spawned or surplus carcass outplanting occurs in the Sooes River watershed for nutrient enhancement purposes after tribal subsistence needs are met.

- The status of the natural Sooes River Chinook population is largely unknown. The historic and current habitat capacity and productivity is also largely unknown; however, the current habitat capacity was approximated to be about 500 adults when deciding how many Chinook to pass upstream of the weir.[148]

- In 1989, a substantial number of natural-origin juvenile fish were removed from the Sooes River and destroyed in response to the finding of the VHS virus in coho broodstock and in all species of juveniles in the hatchery.

Incubation and Rearing

- Incubation takes place in Heath trays. Initial loading is one female per tray. After eye-up and pick off of non-viable eggs, egg loadings are 5,000 eggs per tray or less depending on available incubation space. Water delivery flows to each stack are set between 4 and 5 gallons per minute. The eggs are kept in trays until eye-up at which time the eggs are shocked, sorted, and placed back into the Heath tray incubators along with vexar substrate. Water temperatures during incubation range from 39^0F to 55^0F with an average of 45^0F.

- Formalin is administered to control fungus at 1670 parts per million for 15 minutes starting at least 24 hours after fertilization. Formalin is applied every other day then discontinued one week prior to hatching.

- Survival of eggs from green to eyed stage ranges from 78% to 91% with a mean of 85% (1999-2007). Eggs are enumerated at the eyed stage using water displacement (eggs/ounce) with a Von Bayer V-trough.

- When fry have hatched and absorbed their yolk sac (~800-900 fish per pound), the Chinook are ponded directly to outdoor raceways at an initial loading of 170,000 fish per rearing unit. Chinook fry initially occupy 14 raceways and are later thinned to an additional 6 raceways resulting in a total of 20 raceways used for final rearing. Once placed in the outdoor raceways, fish remain there until release. During years when brood stock targets are not met, fry are ponded at lower densities (100-120,000 per raceway) to take advantage of available space.

- The number of fry ponded for brood years 1999-2006 ranged from about 2,000,000 to about 3,500,000. Less than 500,000 fry were ponded in 2007 and 2008 due to broodstock failures in those years (131 females and 108 females, respectively).

- The program size has been reduced in recent years from an on-station release of 3.2 to 2.2 million smolts at 70 fish per pound in response to density, flow and fish health concerns. Previously, flow and density indices exceeded recommended guidelines.

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[148] *Zajac, Dave. 2002. An Assessment of Potential Anadromous Fish Habitat Use and Fish Passage above Makah National Fish Hatchery in the Sooes River. U.S. Fish and Wildlife Service, Western Washington Office, Lacey, Washington.*

- Every attempt is made to split fish among additional raceways in advance of the density index reaching 0.20 or flow index of 1.0. Because fall Chinook are released as subyearlings, water availability and water temperatures are usually not significant issues. Water temperatures during rearing range from 41^0F to 59^0F with an average of 47^0F.

- At a minimum, monthly diagnostic checks by OFHC occur in attempt to identify factors that promote disease. Checks are increased to every other week during the summer when conditions increase the chance of disease outbreaks.

- General pond cleaning is done every two to three days. Pond brushes are disinfected between raceways. Mortalities are removed daily, and twice daily during disease outbreaks.

- Size and growth rate are estimated at the end of each month. Fish are inventoried with an electronic counter during movements between ponds.

- The hatchery operates all of its raceways on first-pass Sooes River water during the fall Chinook rearing cycle.

- Coldwater disease caused by the bacterium *Flavobacter psychrophilum* has been isolated from juvenile Chinook during minor mortality spikes; however the levels of the pathogen have never become high enough to warrant therapeutic treatment. The short rearing cycle, during relatively cool temperatures helps prevent bacterial infections from becoming a problem in the fall Chinook program.

- Formalin bath treatments to control external protozoan parasites on Chinook are common. Depending on the parasite and the water temperature, this may be a onetime treatment or it may be performed on multiple days either consecutively or alternately. Baths are generally one hour long at 125-167 parts per million and conform to the Food and Drug Administration (FDA) and EPA guidelines and labels. The parasite which causes the most significant problems in Chinook at Makah NFH is *Ichthyobodo sp.*

- Predation by crows, kingfishers, and otters is significant throughout rearing.

Release and Outmigration

- Marking of Makah NFH Chinook for the on-station releases includes 1,940,000 adipose-fin clip only and 260,000 coded-wire tag and adipose-fin clip. Educket Creek Acclimation Facility releases are 100% ad-clip only (100,000). Marking occurs when the Chinook are about 500 fish per pound.

- Release of Chinook ideally commences when a size of 60-70 fish per pound is achieved (release timing is usually a function of raceway loading, flows, and water temperature). Chinook are released as subyearlings in late May or early June after approximately six months on station. These fish are released at a time and size when they appear to be fully smolted. Inspections of the river by canoe trip two to three days post release have shown very few remaining smolts.

- Releases coincide with one or more of the following conditions; high tide, high turbidity, and/or nightfall.

- Chinook are at times released early due to the onset of high water temperatures and/or low flows. Releases have occurred as early as April 28th.

- Chinook reared on station are force-released out of the bottom of each raceway through a six inch diameter pipeline that leads to the Sooes River.

- Chinook are volitionally released from Educket Creek Acclimation Facility over a period of two days. The remaining fish are forced out after two days.

- In years when adults were not passed upstream and excess fry were available, fry were released to the Sooes River upstream of Makah NFH in lieu of adult passage.

Facilities and Operations

- The 20 raceways used for Chinook are 11'x 80'and maintained at a depth of about three feet.

- There are four small 4' x 40' raceways with interior stand-alone tanks that are currently not used for production but are useful for research.

- The hatchery water supply is river water, pumped to a pre-settling pond then gravity-fed to the hatchery.

- The facility experiences frequent power outages and is highly dependent upon generators for backup.

- The facility is heavily dependent upon pumps and generators, requiring regular maintenance. Major or emergency repairs are difficult due to the remoteness of the facility.

- Pond depth cannot be adjusted. Unlike weir board systems, the existing raceway tailgates are designed to either drain the pond or maintain a depth of about three feet.

- The existing aeration unit does not significantly increase the level of dissolved oxygen in the water entering the hatchery from the pre-settling basin.

- Existing bird wire over and mesh netting surrounding the raceways has helped curtail predation by larger birds however significant predation problems continue with crows, kingfishers and otters. (SAMMS work order #2006527447).

- There are no shade covers over the raceways.

- The intake settling basin is cleaned as needed. The first major clean-out since construction occurred in the summer of 2007. Accumulated sediments are removed mechanically.

- Intake screens are checked twice a day. Screens are cleaned as needed. There is an alarm system in place to alert staff to potential flow restrictions.

- Intake screen mesh size is not NOAA Fisheries compliant (3/32"). The current screen mesh size is 3/16". (SAMMS work order #2006527460).

- Juvenile fish get by the intake screen seals and are pumped into the settling basin.

- Rotating/traveling intake screens are turned on by manual switch twice daily or more when debris increases.

- The electric weir is turned on in the fall as fish begin to arrive. The weir is operated through February to collect hatchery steelhead, then shut down no later than March 1st to allow wild steelhead to pass upstream. Current studies have shown greater than 99% of the Sooes River wild steelhead arrive after March 1st.

- The weir is a suspended-electrode design and is manually controlled. Due to its design, the weir is less effective at high water flows and extreme high tide conditions during December-January when hatchery steelhead are returning, allowing some hatchery fish to pass upstream. These episodic events are infrequent. (SAMMS work order #2006503701).

- The hatchery building roof leaks over the sand filter area and this flat section of roof needs to be replaced (SAMMS work order #2007726109).

- Spawning building effluent drains are plumbed to drain into the abatement channel; however, often times incidental spawning material (blood and slime) is hosed down into the adult receiving pond which spills into the ladder and out to the river.

- The hatchery discharges effluent water through the abatement channel and into the Sooes River. A NPDES permit is pending with the EPA. Effluent from the hatchery is monitored monthly for settleable and suspended solids, and data is kept on file at the facility.

- The hatchery has flooded in the past. However, dike renovations have reduced the potential for flooding.

- The site is prone to extremely high wind conditions which can effect outside working conditions.

- The electrical service to the main hatchery building is 15 to 20 years out of date and needs to be replaced. There is also a need for a separate circuit breaker to the pump house (SAMMS work order #200726458).

- The residential quarters #2 has numerous problems and needs to be replaced (SAMMS work order #2006540662).

- Total deferred maintenance for the facility is greater than $2,000,000 (SAMMS, 2008).

- Makah NFH is in a tsunami evacuation zone. However, the hatchery has no formal evacuation plan.

Research, Education, and Outreach

- The visitor facility is underdeveloped and lacks adequate interpretive displays. (SAMMS work order #19131663).

- Tribal members and students visit the facility on a regular basis. Local students visit the facility to learn about the presence of salmon as an important component of tribal culture. Specific educational opportunities are coordinated with the local schools, usually during the fall spawning

season. Hatchery staff members are available upon request to make classroom visits to discuss hatchery operations and salmonid life cycles.

- The facility has a website which is periodically maintained and improved.
- Makah NFH partners with the Makah Nation in August to put on an annual Kid's Fishing Day event. Fishing is for adult salmon in the Sooes River. The hatchery also hosts kids fishing events as opportunities present themselves (such as fishing for surplus steelhead broodstock which were transferred to an empty raceway for this event).
- Makah NFH occasionally has a float in the annual Makah Days Parade.
- No trailer pad exists for volunteers (hatchery host), although it is entered as a FONS project since space is available and a hatchery host would be beneficial.
- The effectiveness of the upstream passage program has not been assessed.
- Genetic samples (fin tissue from 100 adults) are collected annually and archived for future analysis of genetic trends/changes in the population.
- The juveniles are mass marked or coded-wire tagged to monitor survival rates.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[149] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- Fall Chinook released at Makah NFH confer significant sport, tribal, and commercial harvest benefits and provide broodstock for the hatchery program as well as fish for tribal subsistence. Based on coded-wire tag data, for brood years 1993-2002, on average approximately 4,400 fall Chinook are recovered annually. The distribution of those recoveries is: 60% (2,600) recovered at the Makah NFH; 15% (650) from US commercial fisheries; 3% (150) from US sport fisheries; 6% (250) from treaty tribal fisheries; 11% (500) from Canada commercial fisheries; 5% (200) from Canada sport fisheries; 0.3% (15) from spawning ground surveys; and 0.02% (1) recovered from research type activities.[150]
- The program provides significant tribal harvest benefits. Based on catch records for the Sooes and Waatch Rivers, for return years 1997-2007, an average of 1,934 Chinook were harvested annually in the Sooes River (range 1-8,349), primarily in the tribal gillnet fishery. Chinook harvest in the

[149] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[150] *These data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were few and are not expected to significantly change the proportions reported above. All spawn ground recoveries occurred from Browne's Creek (Hoko River at mile ten).*

Waatch River has been sporadic, based on how many Chinook are transferred and released from the Educket Creek Acclimation Facility. From return years 1997-2007, between 0 and 648 Chinook were harvested.

- The program also provides an in-river sport fishery below the hatchery. Fishing license sales provide an economic benefit to the Makah Nation.

- The overall total economic net benefit of Makah NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $1.2 million.[151]

Conservation Benefits

- The Makah NFH Fall Chinook program serves as a genetic repository for the Sooes River Fall Chinook population, reducing demographic risks to the population.

- Mass marking may allow for quantifying and potentially managing the number and proportion of hatchery and natural fish on the spawning grounds and in the broodstock. This may lead to future management plans for natural production and integrated broodstock management.

Research, Education, Outreach and Cultural Benefits

- Spawned out carcasses and surplus adults trapped at the facility are provided to the Makah Nation/local residents for subsistence and ceremonial purposes.

- The facilities location on tribal lands provides a significant educational and cultural opportunity for the local tribal community. Over 600 people (a rough estimate at best) visit the facility on an annual basis. In addition, approximately 500 anglers come to the hatchery to access the Sooes River during the steelhead run each year.

- The facility currently employs four Makah tribal members full-time and provides 500 staff days of seasonal employment for Makah tribal members.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[152] the Review Team identified the following benefits of this program:

Harvest Benefits

- Substantial ocean harvest of Makah NFH Chinook occurs in British Columbia thus conferring a significant harvest and economic benefit to commercial fishers and citizens of British Columbia. Of the total number of adults harvested for brood years 1993-2002, 11% were caught in the commercial and 5% in the sport harvest off the British Columbia coast.

Conservation Benefits

[151] *Pers. comm. James Caudill, USFWS, 2008.*

[152] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

- The adults passed upstream provide a conservation benefit to the Sooes River ecosystem in terms of enhancing nutrients and providing direct forage for scavengers.

Research, Education, Outreach and Cultural Benefits

- Makah NFH provides educational and outreach benefits to tourists visiting the Makah Indian Reservation.

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[153] the Review Team identified the following risks of the hatchery program:

Genetic Risks

- Propagation of Sooes River fall Chinook poses a domestication risk relative to the conservation goal to conserve the genetic integrity of the naturally spawning population of fall Chinook in the Sooes River because the proportion of natural spawners composed of hatchery-origin fish is not controlled. Similarly, the proportion of the broodstock composed of natural-origin fish is not controlled.

Demographic Risks

- Passing an unknown number of hatchery versus wild Chinook upstream (of the 500 passed upstream above the weir) could preclude the maintenance of a self-sustaining natural population.

- Makah NFH is more susceptible to catastrophic loss than other facilities due to the risks of floods and tsunamis, disease, low flows, and high water temperatures. Potential mechanical malfunctions or failures increase the potential that an entire broodyear of the Makah NFH Chinook population could be lost.

- Lack of shade covers over the raceways concentrates fish in shaded areas along pond walls, increasing effective densities, potential stress, and disease risks.

- Inadequate predation control (bird wires and mesh nylon netting around the raceways) increases the risk of demographic loss.

- Broodstock management practices, prioritizing the collection of adults for hatchery production over passing adults upstream above the weir to spawn naturally, poses a significant demographic risk to the naturally spawning component of the Sooes River fall Chinook population.

- The facility's mechanism for releasing fish, through a six inch pipe in the bottom of the raceway, may cause mortality during release.

Ecological Risks

- High water temperatures and low flows increase the risk of disease to the propagated stock.

[153] *Ibid.*

Physical Risks

- Environment conditions such as high winds, flooding and tsunami potential, pose a human safety risk to Makah NFH staff.

- Makah NFH has no formal tsunami evacuation plan and warning mechanism, posing a human safety risk to staff.

Research, Education, Outreach and Cultural Risks

- None identified.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[154] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- None identified. Stray rates are low and the Sooes and Waatch River (where fish are outplanted) fall Chinook are managed as one population.

Demographic Risks

- The release of untreated effluent from the spawning area poses health risks to fish and other species downstream of Makah NFH.

- Intake screen inadequacies pose a risk to fish populations in the Sooes River since numerous wild juvenile salmonids end up in the settling basin and cannot return to the river system.

Ecological Risks

- Chinook outplanted to the Waatch River pose a fish health risk to natural fish populations in those areas.

Research, Education, Outreach and Cultural Risks

- None identified.

[154] *Ibid.*

Recommendations for Current Program[155]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

Issue MK1: Present program goals for Makah NFH fall Chinook are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation MK1: Restate program goals to identify the number of harvestable adult Chinook desired and achievable from this program in the ocean and in nearshore waters, including the Sooes and Waatch Rivers. For example, the current program size and post-release survival leads to a mean harvest of approximately 4,400 adult Chinook per year (brood year 1993-2002). This data could be used to develop the program goal.

Issue MK2: There is no clearly defined escapement goal for natural fall Chinook production in the Sooes River. *Although there is an attempt to pass a maximum of 500 adults upstream of the weir, there is no minimum escapement goal for natural production and the number of fish passed upstream is dependent upon first fulfilling hatchery broodstock and harvest needs. Furthermore, in some years, the number of fall Chinook passed upstream exceeds the 500 adult upstream passage goal for fall Chinook.*

Recommendation MK2: In consultation with the Makah Nation, develop a natural escapement and hatchery broodstock management plan for the Sooes watershed based on the relative numbers of hatchery-origin and natural-origin fall Chinook intercepted at the hatchery. The stated goals of the fall Chinook program at Makah NFH are very similar to those for the spring Chinook program at Warm Springs NFH. The overall program design, goal, and objectives for this latter program can serve as a model for developing similar escapement and broodstock goals for fall Chinook at Makah NFH (see recommendation MK3).

[155] *The Review Team believes that Makah NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

Broodstock Choice and Collection

Issue MK3: The capacity and productivity of the Sooes River watershed for maintaining a self-sustaining natural population of fall Chinook are unknown. *The broodstock goal is to manage hatchery fish as a genetically-integrated component of the natural population. However, because of habitat limitations and degradation, the watershed may not be able to support a properly integrated hatchery program for fall Chinook and, at the same time, meet the numeric harvest goals of the hatchery program. The relative composition of hatchery and natural origin fish returning to the Sooes River is currently unknown because, until recently, hatchery-origin fall Chinook were not mass marked prior to release. Fall Chinook salmon released from Makah NFH are now mass marked with an adipose-fin clip allowing the relative composition of hatchery and natural origin fish to be determined starting with return year 2009. At the present time, the current broodstock goal is to spawn a total of 550 female-male pairs in the hatchery (1,100 fish total) and pass 250 female:male pairs (500 fish total) upstream to spawn naturally. In return years when the total number of adult Chinook intercepted at the hatchery is less than the total number of adults necessary to meet both broodstock and escapement goals, the Makah Nation has indicated to the Service that the first priority is to maintain harvest thru the hatchery program as opposed to maintaining a minimum escapement for the natural population. As a result of these strategies and management priorities, the viability of the naturally spawning population, including its ability to support a properly integrated hatchery program in the Sooes River, is unknown. Fall Chinook, both hatchery and natural origin, are believed to largely represent the native Sooes River stock; however, uncertainties regarding the "biological significance" of this stock complicate the ability to develop a scientifically defensible management strategy for both hatchery and wild Chinook in the Sooes River consistent with comanager goals for harvest and conservation.*

Recommendation MK3a: Monitor and evaluate the relative composition of hatchery and natural-origin fall Chinook in the terminal Sooes River fishery and intercepted at the hatchery. After five years (one Chinook generation), evaluate the ability of the watershed to maintain a naturally spawning population under current habitat and harvest conditions.

Recommendation MK3b: During the five-year interim, all unmarked adult Chinook should be passed upstream to spawn naturally, and all marked hatchery-origin fish should be retained for broodstock or surplused to the tribe for subsistence and ceremonial purposes. One full generation (five years) of natural-origin fish escapement will allow the capacity and productivity (mean adult recruit per spawner or R/S) of the naturally-spawning Sooes River population to be estimated from natural-origin recruits one generation later. Also consider smolt monitoring on the Sooes River to provide an early indication of natural production during this period.

Recommendation MK3c: After five years of monitoring and evaluating the composition of hatchery and natural origin fish in the terminal harvest and intercepted at the hatchery, develop a five-year broodstock management and natural population escapement plan consistent with (a) conservation and harvest goals for fall Chinook in the Sooes River and (b) the potential viability of a naturally spawning population in the Sooes River based on current habitat conditions. This plan should: (a) establish a minimum escapement goal for the number of natural-origin fall Chinook passed upstream of the hatchery based on current habitat conditions and productivity; (b) evaluate the relative pros and cons of managing the hatchery

broodstock as either a genetically integrated or genetically segregated population relative to the viability of a naturally spawning population in the Sooes River and the escapement goal established in "(a)"; (c) evaluate and consider alternative harvest strategies (e.g., selective fisheries on hatchery fish) that would facilitate attainment of broodstock management and natural population escapement goals for Sooes River fall Chinook; and (d) outline a broodstock collection and fish passage protocol that follows an integrated or segregated management strategy based on the evaluation described in "(b)". Under this plan, some level of priority should be given to meeting both natural spawning escapement and hatchery broodstock objectives, particularly in years of low adult returns. For example, the number of natural-origin fish retained for broodstock and the number of hatchery-origin fish passed upstream to spawn naturally could be established as "sliding scales" depending on the relative numbers of hatchery and natural-origin fish trapped at the hatchery. These protocols and escapement goals should focus on attainment of both conservation and harvest goals and not simply maximizing the total number of adult returns, hatchery or wild, one generation later. In other words, protocols should be established for maximizing the *viabilities* of both the hatchery and natural population components, with appropriate adjustments in harvest strategies, as opposed to simply maximizing adult returns independent of established population goals. The "All-H Analyzer" (AHA) management tool could be useful for evaluating future, alternative management strategies.

Hatchery and Natural Spawning, Adult Returns

See issue and recommendations MK2 and 3.

Incubation and Rearing

None identified.

Release and Outmigration

None identified.

Facilities/Operations

Issue MK4: The screening structure currently does not meet NOAA design criteria. The screen mesh is 3/16"; however, NOAA recommended screen size is 3/32". Screening criteria also includes consideration of approach velocity, sweeping velocity, and screen angle. Existing screening could be resulting in increased mortality to naturally produced fish becoming impinged in the screen. Additionally, screen seals are inadequate and allow juvenile fish to enter from the Sooes River.

Recommendation MK4: Replace the screen structure so that it meets current design criteria. (There is a SAMMS work order for screen replacement. Initial engineering evaluation and design is currently in progress.)

Issue MK5: The rotating intake screens are turned on and off manually, based on debris load. *River conditions and associated debris load must be monitored to ensure the intake screens are*

operated the appropriate amount of time to keep them clean. ***Staff work overtime throughout the fall and rainy season to manually turn the screens on and off during frequent events of debris loading.***

Recommendation MK5: Automate the rotating screen using a timer or some other mechanism. This could be accomplished in conjunction with MK4.

Issue MK6: The release of untreated effluent from the spawning area poses an unknown but potential water quality risk and health risk to fish and other species downstream of Makah NFH. *The health risk is believed to be small since Makah NFH stocks originate from adult returns to the Sooes River and maintain the same disease profile as naturally spawning fish. However, the discharge of spawning material (e.g. ovarian fluid, milt, blood) in a more concentrated form than what occurs naturally may increase the risk of disease transmission.*

Recommendation MK6: As a best management practice, investigate retaining or redirecting spawning effluent to the pollution abatement channel or other special containment area with possible effluent disinfection.

Issue MK7: Lack of shade covers over the raceways increases crowding of fish, particularly during the summer months, potentially increasing stress and disease risks to the coho and steelhead.

Recommendation MK7: Construct covers over raceways as a best management practice.

Issue MK8: Predator control is inadequate. *The raceways are only surrounded by penetrable nylon mesh and the existing bird wires do not prevent all birds and mammals from preying on fish reared at the facility.*

Recommendation MK8: Improve predator control infrastructure. Do this in conjunction with raceway cover construction (MK7). (There is a SAMMS work order for improving predator control)

Issue MK9: Raceway pond depth cannot be adjusted. *Unlike weir board systems, the existing raceway tailgates are designed to either drain the pond or maintain a depth of about three feet. This is an issue when pond levels need to be adjusted for pond cleaning, marking, moving fish, feeding fish, etc. This has limited management options to lower the water depth to start fish on feed, exercise the fish, or to improve the exchange rate in the raceways.*

Recommendation MK9: Consult with engineering to redesign the raceway depth control structure.

Issue MK10: Makah NFH depends significantly upon pumps and generators that require regular maintenance. A maintenance failure and the associated remoteness of the facility could result in a catastrophic loss.

Recommendation MK10: Continue to closely follow the regular maintenance plan that is currently in place to minimize the potential for catastrophic fish losses. The maintenance plan should be reviewed and updated annually to minimize demographic risks to fish on station.

The Review Team commends the high level of preventative maintenance currently practiced at Makah NFH and concludes that this level of maintenance must be continued.

Issue MK11: Makah NFH has no formal tsunami evacuation plan and warning mechanism, posing a human safety risk to staff. *Although the facility has weather/hazard alert radios inside the office and residences, they are not currently hooked up to the alarm system and cannot be heard outside the office or housing areas.*

Recommendation MK11: Work with engineers to install a tsunami warning system that can be heard throughout the facility. Develop a tsunami evacuation plan and post protocol for evacuating the facility. Periodically perform tsunami evacuation drills.

Research, Monitoring, and Accountability

Issue MK12: The facility has no clearly defined M&E program.

Recommendation MK12: Develop a consistent and clearly defined M&E program as a best management practice and review on an annual basis (prior to ponding and coded-wire tagging of a broodyear).

Issue MK13: Natural production of fall Chinook in the Sooes River is not well understood. *Spawning surveys and smolt production information is lacking making it difficult to determine natural escapement goals and productivity for the Sooes River above the weir.*

Recommendation MK13: Conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Sooes River. Radio-tagging adults could also be used to determine distribution. Use this information to modify or better define the natural escapement goal, which is currently 500 Chinook passed above the weir, and habitat protection and restoration measures. Studies similar to those conducted at Warm Springs NFH and the Warm Springs River could serve as a prototype. Also see MK2 and MK3

Issue MK14: Natural production of fall Chinook in the Waatch River is not well understood. *Spawning surveys and smolt production information is lacking; therefore, the impacts of outplanting Makah NFH fall Chinook into the Waatch River on natural-origin fall Chinook are unknown.*

Recommendation MK14: Conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Waatch River. Use this information to better understand natural escapement and the impacts of the Makah NFH outplants on natural-origin fall Chinook. The results may affect the overall goal of this outplant component of the Makah NFH program.

Issue MK15: Current cooperative agreements between the Makah Nation and the USFWS do not have the detail required to ensure that the Service and Makah Nation can reach agreement on cooperative hatchery and fish management issues. Generally, the existing cooperative agreements address staffing regarding hatchery fish culture and fish marking operations. Also, the lease agreement addresses the water right, hatchery escapement, and carcass distribution. No document addresses fish production operations as a whole.

Recommendation MK15: As a best management practice, work with the Makah NFH steering committee to develop a single cooperative agreement to include elements identified above and other details regarding fish production levels, marking, responsibilities of the parties, and communications.

Issue MK16: The Makah NFH Hatchery Evaluation Team (HET) meets on a regular basis, at least twice a year (before spawning and after release). *The meetings are generally coordinated by a representative at the Fisheries Resource Office. Additional meetings are also scheduled on an as-needed basis. All topics in regards to facility and program management are discussed and the HET is the primary recommending body for facility and programmatic changes.*

Recommendation MK16: The Review Team supports the current approach for utilizing the HET process, which is in line with the Vision Action Plan. The Review Team is recommending that the HET process be standardized region wide by 2010.

Issue MK17: The Olympic Peninsula NFH's and the Service's Western Washington Fish and Wildlife Office (Lacey, WA) do not have a standardized database for tracking certain operational data such as green to eyed egg and eyed egg to fry mortality rates. Each hatchery records their data via individually tailored spreadsheets. The existing data management system used for evaluation of the Olympic Peninsula NFHs is the Fisheries Resource Evaluation Database (FRED). *A standardized database will facilitate data sharing and program analyses region wide.*

Recommendation MK17: Convene a group of Olympic Peninsula NFH management staff and WWFWO hatchery assessment staff to consider developing a common database that could be used to address all hatchery operational, evaluation, and reporting requirements. The group should review the CRIS and FRED systems and their utility for collecting and reporting these types of data and information. Regularly collect average water temperatures, fish growth data, current numbers, mortalities, and a summary of fish health activities. Track this information in conjunction with all fish production activities in a standardized database, including, numbers, tagging, fish moves, fish and egg distribution, egg mortalities, survival to various life stages, feed, fry ponding data, fish length, condition factor, feed conversion ratio, adult fish removal by species, spawning data by take, etc. The database should be capable of creating summaries of current pond inventories including flow and density indices for each rearing unit, spawning summaries, egg summaries, lot history production summaries, hatchery production summaries and distribution summaries.

Issue MK18: The Makah NFH weir and intake diversion in the Sooes River can impede the natural migration of lampreys, and the operation of the weir and intake results in an unknown level of mortality. *For example, juvenile lampreys occasionally become trapped and die in the intake sand filters; however, the species of lamprey (brook vs. pacific) is unknown. Pacific lampreys are culturally important to Pacific Northwest tribes. They were also petitioned to be listed as threatened under the Endangered Species Act in 2003.*

Recommendation MK18: Initiate a monitoring program to determine the species of juvenile lamprey, migration periods of the lamprey, and the degree of impact the weir and intake diversion may have on the Sooes River lamprey population(s). Use the information to determine if further actions are necessary to minimize impacts to pacific lamprey.

Education and Outreach

Issue MK19: The facility has limited infrastructure and signage to accommodate visitors. *Currently, the visitors' center is underdeveloped. Interpretive signage is also inadequate. Makah NFH is located in an area with active summer tourism. Approximately fifteen to twenty-two thousand tourists visit the reservation annually. Improved outreach facilities could be very beneficial for public education, communicating the tribal cultural relevance of the salmon and steelhead populations and associated fisheries, and conveying the mission of Makah NFH.*

Recommendation MK19: Improve the facility to expand visitation and education/outreach opportunities (there is a current SAMMS work order for rehabilitating the visitor facility). Explore opportunities for coordinating with the Makah Museum in Neah Bay to show how the USFWS and Makah Nation work together to maintain culturally significant fisheries and sustain local fish populations. This could be anything from brochures and/or an information kiosk at the museum to hatchery tours coordinated through the museum.

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing fall Chinook program at Makah NFH and developed three alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current program with recommendations

Maintain the existing fall Chinook program with full implementation of all recommended changes. Continue to rear and release 2,200,000 and 100,000 fall Chinook juveniles to the Sooes and Waatch Rivers respectively. This includes evaluating the ability of the watershed to maintain a self sustaining natural population under current habitat and harvest conditions. Based on the results, develop and implement a broodstock management and natural population escapement plan consistent with principles of managing hatchery and natural fish as either an integrated hatchery population or as two distinct populations.

Pros

- Contributes significantly to sport, tribal and commercial fisheries in the marine and freshwater areas in Washington, Alaska, and British Columbia.
- Provides surplus adults for tribal subsistence and ceremonial purposes.
- Passage of Chinook adults upstream provides a significant conservation benefit to the Sooes River ecosystem in terms of enhancing nutrients and providing direct forage for scavengers.

- Current program size does not exceed recommended density or loading thresholds and Chinook juveniles do not experience any significant fish health problems.

- Determining the carrying capacity of the upper watershed and the ability of the watershed to maintain a self-sustaining natural population will help managers determine the number and composition of adults to pass upstream in the future.

- Program maintains the genetic integrity of the Sooes River fall Chinook population while the habitat in the Sooes watershed recovers.

- Re-directing or containing spawning effluent will reduce the fish health risks to hatchery and natural origin fish downstream of the facility and meets NPDES requirements.

- Improving predator control infrastructure will improve in-hatchery survival of Chinook and allow for more accurate tracking of the inventory.

- Re-design of the raceway tailgates to allow for better control of water depth will improve pond cleaning, moving fish among raceways, and fish feeding operations.

Cons

- Adult passage above the weir and adult carcass planting for nutrient enhancement purposes increase fish health risks to fish in the hatchery.

- Restricting the number of fish passed upstream may result in logistical problems with disposal of surplus adult broodstock.

- Increased costs associated with facility improvements and monitoring and evaluation studies.

Alternative 2: Increase fall Chinook production

Increase production of fall Chinook and decrease or eliminate production of either coho or steelhead. The Makah Nation places its highest species priority on fall Chinook; therefore, the Review Team discussed methods for increasing fall Chinook production and came up with the two scenarios outlined below.

Scenario 1: Increase fall Chinook production to 2.65 million and either reduce steelhead production to 90,000 or reduce the coho program to 120,000. Reducing both steelhead and coho each by half would result in an increase to 3.1 million fall Chinook.

Scenario 2: Increase fall Chinook production to 4.2 million by eliminating both the steelhead and coho programs at Makah NFH.

Pros and Cons

See alternative 2 for Makah NFH coho and alternative 2 for Makah NFH steelhead

Alternative 3: Terminate the program (and all other programs at this facility) and decommission the facility

Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Pros

- Removal of the weir would allow unobstructed passage up the Sooes River.
- Eliminates the risk of disease transfer from hatchery reared Chinook, steelhead, and coho to natural steelhead populations and other species within the Sooes River basin.
- Reduces costs associated with maintaining and operating capital infrastructure.

Cons

- Significantly reduces contribution of fall Chinook to sport, tribal and commercial fisheries in Sooes, Waatch and ocean harvest including Washington, British Columbia and Southeast Alaska.
- Surplus Sooes River fall Chinook adults would not be available for tribal subsistence and ceremonial purposes.
- Loss of a genetic repository for the Sooes River fall Chinook population.
- May lead to the extirpation of naturally spawning Sooes River fall Chinook.

Recommended Alternatives

The Team recommends maintaining the current program with full implementation of all recommended changes (Alternative 1). This includes evaluating the ability of the watershed to maintain a self sustaining natural population under current habitat and harvest conditions. Based on the results, develop and implement a broodstock management and natural population escapement plan consistent with principles of managing hatchery and natural fish as either an integrated hatchery population or as two distinct populations.

The Team did not consider discontinuing the Chinook program in favor of rearing other stocks given the importance of the Chinook run to the Makah Nation and the fact that removing the Chinook program would not result in an increase in rearing capacity for other stocks. The coho and steelhead programs are currently limited by summer water availability and temperature, not by rearing space in the late winter/spring months. The Team did consider increasing the Chinook program (Alternative 2). However, given recent low adult returns, this may not be a viable option due to inconsistent broodstock availability.

Makah NFH Coho

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: Support commercial and sport fisheries in both marine and freshwater areas. Based on a goal of 3.0 % smolt to adult return rate (harvest plus hatchery escapement), the program goal would be to achieve 6,750 coho annually to the various fisheries (including the Waatch) based on the current program size, although no specific harvest goal has been established. The Waatch River fishery is viewed as a secondary harvest opportunity to the Sooes River fishery.

- ***Broodstock escapement goal***: Provide an escapement back to the hatchery of 225 females, 203 males, and 22 jacks for propagation purposes. Achieve a 0.22 % survival from smolt release to adult return to the hatchery to maintain broodstock.

- ***Conservation goal***: The current coho hatchery program has no direct conservation goal within the Sooes/Waatch watersheds.

- ***Escapement goal for natural-origin adults***: No specific escapement goal for natural origin adults exists. However, there is an estimated capacity in the Sooes River to support 1,610 coho spawners.[156] Currently, an average of 3,124 coho of an assumed mix of both hatchery and natural-origin coho are passed upstream to spawn naturally and contribute to ecosystem functions if it is projected the broodstock needs will be met.

- ***Research, education, and outreach goals***: Provide visitation to the general public mostly during the summer tourist season.

Objectives

- Spawn 225 females, with 225 males (including 10% jacks that are males) to yield 675,000 green eggs.

- Pass up to 805 coho pairs (1,610 total) upstream into the Sooes River throughout the run if it is projected the broodstock needs will be met.

- Release 200,000 smolts annually at 15-20 fish per pound about May 1.

- Transfer 40,000 smolts annually at 15-20 fish per pound to the Educket Creek Acclimation Facility (on the Waatch River) about March 1.

[156] *Zajac, Dave. 2002. An Assessment of Potential Anadromous Fish Habitat Use and Fish Passage above Makah National Fish Hatchery in the Sooes River. U.S. Fish and Wildlife Service, Western Washington Office, Lacey, Washington.*

Program Description

Efforts to enhance coho runs prior to the construction of the Makah NFH included sporadic fish planting of Quilcene coho. Eyed coho eggs from the Quinault NFH were used to initiate the coho program at Makah NFH. The Makah NFH program was managed to exclude early run coho, presumed to be descendants of Quilcene coho, in favor of later returning coho (Quinault stock) from the Sooes River. The facility initially released just over 100,000 coho smolts in 1982. By 1986, smolt releases were exceeding 500,000. The peak release occurred in 1991 with nearly 900,000 coho juveniles released to the Sooes and Waatch Rivers. In the late 1980's two broods were replaced with Quinault NFH stock after the hatchery had been de-populated when the VHS virus was found in fish reared at Makah NFH.

The hatchery currently produces 200,000 coho smolts for release into the Sooes River at the hatchery and produces 40,000 smolts for transfer and subsequent release at the Educket Creek Acclimation Facility (Waatch River). Broodstock are collected from returns to the hatchery. The goal is to spawn 225 females, 203 males, and 22 jacks. Additional fish not needed for broodstock are passed upstream to use the available habitat.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- The hatchery broodstock is derived from Quinault NFH coho stock.
- Broodstock are collected from coho trapped at the hatchery. Natural-origin coho, if trapped, are not excluded from the broodstock.
- Hatchery-origin Makah NFH coho have been adipose-fin clipped since 1996 and the current broodstock goal is to manage the hatchery population as a genetically segregated stock relative to a potentially naturally spawning population. Under this management scenario, wild, or natural-origin, fish should be excluded from the broodstock and hatchery-origin fish should be excluded from spawning upstream of the hatchery weir. However, hatchery and wild fish appear to be randomly included in the broodstock and randomly passed upstream independent of origin.
- In the late 1980s two broodyears were replaced with Quinault NFH stock after the hatchery had been de-populated when the VHS virus was detected in fish reared at Makah NFH.
- The current stock is not listed under ESA.

- The entry timing for adult coho ranges from September to January with the mean entry date of October 26 (1988-2005). Fish return at age two and three but predominantly return as three-year-olds (1985-2005). Adults ascend a fish ladder associated with a suspended-electrode weir that spans the Sooes River and enter a holding pond. All five of the adult holding ponds are used for adult collection and holding purposes.

- A combination of hatchery- and natural-origin coho adults in excess of broodstock needs are passed upstream of the weir to spawn naturally and contribute to ecosystem functions on the upper Sooes River. Fish have been passed upstream since at least 1984. From return year 1999-2007, an average of 1,550 females (range 31-3,450), 1,320 males (range 19-2,675), and 254 jacks (range 15-440) were passed upstream.

- Fish in excess of broodstock and escapement needs are given to the Makah Nation for subsistence and ceremonial purposes.

- It is possible for adult coho to move upstream past the weir on the infrequent combination of high river flows and high tides. Staff, however, have not observed any significant numbers moving upstream.

Hatchery and Natural Spawning, Adult Returns

- The goal is to spawn 225 females with 225 males (including 10% or 22 jacks that are males) from coho returning to Makah NFH. From 1999-2007, an average of 232 females (range 164-292), 226 males (range 156-315), and 18 jacks (range 5-45) were spawned annually.

- Fry in excess of program needs may be released in the Sooes River at the facility.

- Treatment for disease control has not been needed for adults collected for broodstock.

- Jacks (two year old males) are included in the broodstock when available; however the numbers are highly variable. Between 1997-2006, 1.9% to 10.3% of males used were jacks (mean = 5.1%). The goal is to include 10% jacks in the male spawning population.

- Broodstock are spawned without selecting for size.

- Spawning ratio is one female to one male. Eggs from one female are deposited into a colander and rinsed with a 1.4% sodium bicarbonate solution, then poured into a dry bucket with sperm from one male added immediately. The sperm and egg mixture is gently stirred with more bicarbonate solution being added. The eggs from three females are combined into one stainless steel bucket prior to rinsing with Sooes River water. Following rinsing, the eggs are placed in Heath trays containing a 75 parts per million iodine solution for 60 minutes to water harden and disinfect. When space is available, only two females are combined in each bucket and then placed in each tray.

- Sooes River water is then turned on to the stacks for the remainder of the incubation period. Water supplied to the incubation stacks has been filtered through sand filters but receives no other treatment.

- Stray rates are unknown but assumed to be low since few marked Makah NFH coho are recovered in other watersheds.

- Smolt-to-adult survival (to hatchery and harvest) ranges from 2.0% to 4.8% with a five-year mean of 3.2% (Zajac 2007).

- Annual hatchery coho returns to the Sooes River have ranged from 892 to 15,841 with an average of 8,567 (return year 1997s – 2007).

- Surplus coho and spawned-out carcasses are provided to the tribes for subsistence as requested.

- Spawned and surplus broodstock carcasses are used occasionally to enhance nutrients in the Sooes watershed.

- The status of the natural Sooes River coho population is largely unknown. The historic and current habitat capacity and productivity is also largely unknown; however, the current habitat capacity was approximated to be about 1,610 adults when deciding how many coho to pass upstream above the weir. [157] Additionally, the number of coho removed from the Sooes River in 1989 may provide some idea of recent natural productivity (see bullet below).

- In 1989, a substantial number of natural-origin juvenile fish were removed from the Sooes River and destroyed in response to the finding of the VHS virus in coho broodstock and in all species of juveniles in the hatchery. A minimum of 15,000 natural-origin coho smolts were removed and destroyed.

Incubation and Rearing

- Incubation takes place in Heath Stacks. Six to eight thousand eggs are loaded in each tray (two to three females). Water flows to each stack at a rate of four to five gallons per minute. The eggs are kept in trays until the eyed stage at which time they are shocked, sorted, and placed back into Heath Tray incubators containing vexar substrate. Water temperatures during incubation generally range from 39^0F to 50^0F with an average of 44^0F although individual years can be much colder than typical.

- Formalin is administered to control fungus at 1,670 parts per million for 15 minutes starting at least 24 hours after fertilization. Formalin is applied every other day then discontinued one week prior to hatching.

- Survival of coho eggs from the green stage to the eyed stage ranges from 60% to 90% with a mean of 80% (1999-2007).

- Eggs are counted at the eyed stage using water displacement (eggs/ounce) with a Von Bayer V-trough.

- When hatched fry have absorbed their yolk sac (~1,100 fish per pound), they are ponded directly to outdoor raceways at an initial loading of 130,000 fish per rearing unit. Fish remain in outdoor raceways until release.

[157] *Zajac, Dave. 2002. An Assessment of Potential Anadromous Fish Habitat Use and Fish Passage above Makah National Fish Hatchery in the Sooes River. U.S. Fish and Wildlife Service, Western Washington Office, Lacey, Washington.*

- The number of fry ponded for brood years 1999-2006 ranged from about 300,000 to almost 900,000. Fry in excess of program needs have been released into the Sooes River at the hatchery.

- Every attempt is made to maintain a density index below 0.20 or flow index below 1.00 in all raceways. Availability of water can be a constraint in this regard. Coho salmon are moved to specific raceways that can be supplied with reuse water if needed during summer rearing. Water temperatures range from 39^0F to 65^0F with an annual mean of 52^0F (1982-1989).

- At a minimum, monthly diagnostic checks by the Service's Olympic Fish Health Center occur in attempt to identify factors that promote disease. Checks are increased to every other week during the summer when conditions increase the chance of disease outbreaks.

- General pond cleaning is done every two to three days using the brush and drain method. Pond brushes are disinfected between raceways. Mortalities are removed daily, and twice a day during disease outbreaks.

- Size and growth rate are estimated at the end of each month. Fish are inventoried with an electronic counter during movements between ponds.

- At final rearing, coho occupy six raceways at about 40,000 fish per raceway (11' X 80' X 3').

- The hatchery operates all of its raceways on first-pass Sooes River water except for a short period during the summer when up to 70% of the water may be reuse water from the abatement channel.

- Furunculosis caused by the bacterium *Aeromonas salmonicida* is successfully treated by oral administration of an antibiotic through medicated feed which conforms to the Food and Drug Administration (FDA) guidelines. Immersion bath vaccination of coho was tested for several years in attempt to prevent Furunculosis. However, the vaccination was only found to delay the onset of the disease and has not been continued.

- Formalin bath treatments to control external protozoan parasites on coho salmon are common. Depending on the parasite and water temperature, this may be a one-time treatment or it may be performed on multiple days either consecutively or alternately. Baths are generally one hour long at 125-167 parts per million and conform to the FDA and EPA guidelines and labels. The parasites which cause the most significant problems in Makah NFH coho are *Ichthyobodo, Trichodina, and Epistylus sp.*

- Predation to gulls, crows, herons, raccoons, and occasional otters is significant throughout rearing.

- Low water flow and high water temperature (up to 72 degrees Fahrenheit) are problematic during summer months, creating increased disease susceptibility.

Release and Outmigration

- Marking of Makah NFH coho for the on-station releases includes 120,000 adipose-fin clip only, 40,000 coded-wire tag and adipose-fin clip, and 40,000 coded-wire tag with no adipose-fin clip. Educket Creek Acclimation Facility releases (40,000) are 100% adipose-fin clip only. Marking occurs when the coho are about 30 fish per pound.

- Release of coho ideally commences when a size of 17-18 fish per pound is achieved (release timing is usually a function of raceway loading, flow, and water temperature). Coho are released as yearlings in May after approximately 18 months on station. These fish are released at a time and size when they appear to be fully smolted. Inspections of the river by canoe trip two to three days post release have shown very few remaining smolts

- Releases coincide with one or more of the following conditions; high tide, high turbidity, and/or nightfall.

- Coho reared on station are force released out of the bottom of each raceway through a six inch diameter pipeline that leads to the Sooes River.

- Coho are volitionally released from Educket Creek Acclimation Facility over a period of two days. The remaining fish are forced out after two days.

Facilities and Operations

- The six raceways used for coho are 11'x 80'and maintained at a depth of three feet.

- Hatchery summer water temperatures can reach 72 degrees Fahrenheit.

- The one-mile long earthen abatement channel is extremely effective at improving water quality to a point where the effluent water can be reused for summer fish rearing of steelhead and coho.

- During summer months when extreme low flows occur, the facility operates on up to 70% reuse water. The reuse system draws water from the tail end of the abatement channel and pumps it back up into the pre-settling intake pond. From here, the water returns to the hatchery. A bypass channel from the tail end of the abatement channel is opened to allow a portion of the water from the end of the abatement channel out into the river **above** the main pump house. The reuse water mixes with what river water there is and is taken up through the usual pump system into the pre-settling intake pond.

See the Makah NFH Fall Chinook section for more information.

Research, Education, and Outreach

- Makah NFH worked with the Aquatic Animal Drug Approval Partnership Program (AADAP) to conduct several on-site pivotal Florfenicol efficacy studies to control Furunculosis at Makah NFH. Makah NFH was the primary contributor to the approval by FDA of florfenicol for use on salmonids.

- Genetic samples (fin tissue from 100 adults) are collected annually and archived for future analysis of genetic trends/changes in the population.

See the Makah NFH Fall Chinook section for more information.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[158] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- Coho released at Makah NFH confer significant sport, tribal, and commercial harvest benefits and provide broodstock for the hatchery program as well as fish for tribal subsistence and ceremonial uses. Based on coded-wire tag data, for broods 1993-2002, on average approximately 4,700 coho are recovered annually. The distribution of those recoveries is: 72% (3,400) recovered at the Makah NFH; 3.6% (170) from US commercial fisheries; 8% (375) from US sport fisheries; 10% (470) from treaty tribal fisheries; 0.5% (25) from Alaska commercial fisheries; 4% (190) from Canada commercial fisheries; 1.5% (70) from Canada sport fisheries; 0.08% (4) from Oregon commercial fisheries; 0.5% (25) from Oregon sport fisheries; and 0.02% (1) recovered from research type activities.[159]

- The program provides significant tribal harvest benefits. Based on catch records for the Sooes and Waatch Rivers, for return years 1997-2007, an average of 4,132 coho were harvested annually in the Sooes River (range 35-10,610), primarily in the tribal gillnet fishery. Coho harvest in the Waatch River has ranged from 31 to 1,718, with an average of 669 (return years 1997 – 2007), primarily captured in the tribal gillnet fishery.

- The program also provides an in-river sport fishery below the hatchery on the Sooes River and a fishery on the Waatch River. Fishing license sales and other associated purchases made by visiting fishermen provide an economic benefit to the Makah Nation.

- The overall total economic net benefit of Makah NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $1.2 million.[160]

Conservation Benefits

- None identified.

Research, Education, Outreach and Cultural Benefits

- Spawned out carcasses and surplus adults trapped at the facility are provided to the Makah Nation for subsistence and ceremonial purposes.

- Unique temperature and flow conditions have been used to explore natural temperature and pathogen challenges in a controlled setting. The infrastructure exists (four small raceways, one of which has been fitted with interior tanks) to provide additional research opportunities.

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[158] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[159] *These data were derived from the Regional Mark Information System (RMIS) database (http://www.rmpc.org/). Some of the tag recoveries were not expanded for sample rate. However, they were few and are not expected to significantly change the proportions reported above.*

[160] *Pers. comm. James Caudill, USFWS, 2008.*

- See the Makah NFH fall Chinook section for additional Research, Education, Outreach and Cultural Benefits.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[161] the Review Team identified the following benefits of this program:

Harvest Benefits

- Substantial harvest of Makah NFH coho occurs in British Columbia (sport and commercial ocean harvest in this region was 1.5 % to sport and 4.0 % to commercial of the returning population for Brood Years 1993-2002), thus conferring a significant harvest and economic benefit to commercial fishers and citizens of British Columbia.

Conservation Benefits

- The adults passed upstream provide a conservation benefit to the Sooes River ecosystem in terms of providing nutrient enhancement and direct forage for scavengers.

Research, Education, Outreach and Cultural Benefits

- Double-index tagging provides harvest exploitation rates on wild stocks in other North Coast Washington rivers assuming similar marine survivals.

- See the Makah NFH fall Chinook section for additional Research, Education, Outreach and Cultural Benefits.

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[162] the Review Team identified the following risks of the hatchery program:

Genetic Risks

- None identified.

Demographic Risks

- Makah NFH is more susceptible to catastrophic loss than other facilities due to the risks of floods and tsunamis, disease, low flows and high water temperatures. Potential mechanical malfunction or failure increases the potential that one or more broodyears of the Makah NFH coho population would be lost.

See the Makah NFH fall Chinook section for additional Demographic Risks

[161] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[162] *Ibid.*

Ecological Risks

- High water temperatures and low flows (up to 70% reuse water during the summer) increase the risk of disease to the propagated stock.

Physical Risks

See the Makah NFH fall Chinook section for Physical Risks

Research, Education, Outreach and Cultural Risks

- None identified.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[163] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- The status and viability of the natural population of coho is unknown. Current management practices pose unknown genetic risks to the natural population. However, the establishment and operation of the weir, including past efforts to eradicate the VHS virus in 1989, are believed to have had a significant impact on the existing natural population.

Demographic Risks

- Passing an unknown number hatchery versus natural-origin coho upstream (of the 1,610 passed upstream above the weir) could preclude the maintenance of a self-sustaining natural population.

See the Makah NFH fall Chinook section for Demographic Risks posed to other stocks.

Ecological Risks

- Amplification of diseases such as Furunculosis within the hatchery poses a disease risk to fish populations in the lower three miles of the Sooes River.

- Antibiotics and their metabolites present in hatchery effluent during treatments to control bacterial diseases in coho at Makah NFH pose an increased risk of developing drug-resistant pathogens in the Sooes River that could impact fish, wildlife or humans.

Research, Education, Outreach and Cultural Risks

- None identified.

[163] *Ibid.*

Recommendations for Current Program[164]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

Issue MK20: Present program goals for Makah NFH coho are not expressed in terms of numeric outcomes that quantify intended benefits or goals. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation MK20: Restate program goals to identify the number of harvestable adult coho desired and achievable from this program in the ocean and in nearshore waters, including the Sooes and Waatch Rivers. For example, the current program size and post-release survivals leads to a mean harvest of approximately 4,700 adult coho per year (brood year 1993-2002). This data could be used to develop the program goal.

Issue MK21: There is no clearly defined escapement goal for natural coho production in the Sooes River. *Although there is an attempt to pass a maximum of 805 adult pairs (1,610 total) upstream of the weir, there is no minimum escapement goal for natural production and the number of fish passed upstream is dependent upon first fulfilling hatchery broodstock and harvest needs.*

Recommendation MK21: In consultation with the Makah Nation, develop a natural escapement and hatchery broodstock management plan for the Sooes watershed based on the relative numbers of hatchery-origin and natural-origin coho intercepted at the hatchery. See MK22.

Broodstock Choice and Collection

Issue MK22: Makah NFH coho represent an introduced stock, primarily from the Quinault NFH. *The broodstock goal is to manage the hatchery population as a genetically segregated stock relative to a potentially naturally spawning population. Under this management scenario, wild fish should be excluded from the broodstock and hatchery-origin fish should be excluded*

[164] *The Review Team believes that Makah NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

from spawning upstream of the hatchery weir. However, this management protocol is not followed, and hatchery and wild fish appear to be randomly included in the broodstock and randomly passed upstream independent of origin. This strategy is inconsistent with the broodstock goal for the program. On the other hand, the capacity and productivity of the Sooes River watershed for maintaining a self-sustaining natural population of coho are unknown. Coho are mass marked, but marked and unmarked fish are not distinguished when collecting broodstock for spawning or when fish are passed upstream. The composition of hatchery and natural origin fish used for broodstock is recorded; however, the number of hatchery versus natural origin fish passed upstream is not. The Makah Nation has indicated to the Service that harvest goals currently have a higher priority than conservation goals for coho in the Sooes River, and the capability of the watershed to maintain a natural population under current harvest regimes is unknown.

Recommendation MK22a: Monitor and evaluate the relative composition of hatchery and natural-origin fall coho in the terminal Sooes River fishery and intercepted at the hatchery. After three years (one coho generation), evaluate the ability of the watershed to maintain a self-sustaining natural population under current habitat and harvest conditions.

Recommendation MK22b: During the evaluation and interim, only hatchery-origin fish (marked) should be used for broodstock and all natural-origin fish (unmarked) should be passed upstream.

Recommendation MK22c: After three years of monitoring and evaluating the composition of hatchery and natural origin fish in the terminal harvest and intercepted at the hatchery, establish a minimum escapement goal for the number of natural-origin coho passed upstream of the hatchery, and develop a broodstock management and natural population escapement plan consistent with the principles of managing hatchery and natural fish as two distinct segregated populations, which represents the current management goal, or as an integrated hatchery population, which would represent a change from the present management goal. This plan could consider alternative harvest strategies (e.g., selective fisheries on hatchery fish) that would facilitate attainment of broodstock management and natural population goals for Sooes River coho.

Hatchery and Natural Spawning, Adult Returns

Issue MK23: Currently, adults are collected less frequently throughout the run than what is necessary to maintain the temporal range of the coho population. *To maintain the opportunity for natural populations to be established throughout their historic run-time, spawning protocols must be consistent with a variety of management options outlined in MK22c.*

Recommendation MK23: Spawn coho and pass coho upstream throughout the entire run. Passing only natural-origin coho upstream and spawning only hatchery-origin coho in the hatchery during the interim period will facilitate implementation of this recommendation. Specific spawning protocols should be developed as part of the broodstock management and natural population escapement plan after the evaluation laid out in MK22 is complete.

Incubation and Rearing

Issue MK24: Coho in excess of program needs have been produced in some years in attempt to buffer the effects of disease loss (primarily Furunculosis) during summer month rearing. Excess coho fry were released into the Sooes River if they were not needed. *Rearing fish in excess of production needs increases rearing densities which may be increasing the potential for disease outbreaks. Additionally, rearing excess fish can increase the use of antibiotics during rearing, which end up in the hatchery effluent and may cause the development of drug-resistant pathogens that could impact fish, wildlife or humans. Furthermore, research has shown that coho released as fry have low survival[165] and fry may have negative ecological impacts (competition, predation, disease, etc.). The practice of taking excess coho has rarely occurred in recent years as the disease loss has been greatly reduced through the use of modern antibiotics.*

Recommendation MK24: Discontinue fry outplants. Destroy excess eggs before they hatch. Continue to collect and spawn 225 pairs, but at eye-up, retain approximately equal numbers of eggs from each spawning pair to maximize the genetic effective population size.

Issue MK25: High water temperatures, low flows and the possible use of reuse water during summer months increases the risk of disease to coho and steelhead reared at Makah NFH.

Recommendation MK25: Evaluate opportunities for chilling and/or disinfecting incoming water for use during summer months.

Release and Outmigration

See issue/recommendation MK26.

Facilities/Operations

Issue MK26: Release structure design in the raceways may cause increased mortality during release, especially for coho and steelhead that are released at a large size*. The current design increases the potential that some fish may be injured upon release as the fish are released through a six inch diameter pipe that exits the bottom of the raceway.*

Recommendation MK26: Evaluate the level of injury that may be occurring from this method of release. If it is found to be an issue, consult with engineering to design an alternative release system.

See the Makah NFH fall Chinook section for additional Facilities/Operations issues and recommendations

[165] *Nickelson, T. 2003. The influence of hatchery coho salmon (/Oncorhynchus kisutch/) on the productivity of wild coho salmon populations in Oregon. Canadian Journal of Fisheries and Aquatic Sciences *60:*1050-1056*.*

Research, Monitoring, and Accountability

Issue MK27: Natural production of coho in the Sooes River is not well understood. *Spawning surveys and smolt production information is lacking, making it difficult to determine natural escapement goals and productivity for the Sooes River above the weir. Additionally, genetic information on naturally produced coho to determine their relationship to other populations on the Olympic Peninsula does not exist.*

Recommendation MK27a: Conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Sooes River. Radio-tagging adults could also be used to determine distribution. Use this information to better define the natural escapement goal and habitat protection and restoration measures. Also see MK22 and MK23.

Recommendation MK27b: Collect tissue samples for genetic analyses of 100 marked and 100 unmarked (natural origin) adult coho intercepted at the hatchery for each of three consecutive years to determine the level of genetic similarity between hatchery- and natural-origin fish. Do this in conjunction with MK23.

See the Makah NFH fall Chinook section for additional Research, Monitoring and Accountability issues/recommendations

Education and Outreach

See the Makah NFH fall Chinook section for Education and Outreach issues/recommendations

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing coho program at Makah NFH and developed five alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current program with recommendations

Maintain existing coho program with full implementation of all recommended changes. Continue to rear and release 200,000 and 40,000 coho juveniles to the Sooes and Waatch Rivers respectively**.** This includes evaluating the ability of the watershed to maintain a self sustaining natural population under current habitat and harvest conditions. Based on the results, develop and implement a broodstock management and natural population escapement plan consistent with principles of managing hatchery and natural fish as either an integrated hatchery population or as two distinct populations.

Pros

- Contributes significantly to sport, tribal and commercial fisheries in the Sooes and Waatch Rivers and in marine waters in Washington, Alaska, and British Columbia.
- Provides surplus adults for tribal subsistence and ceremonial purposes.
- Passage of coho adults upstream provides a significant conservation benefit to the Sooes River ecosystem in terms of providing nutrient enhancement and direct forage for scavengers.
- Determining the carrying capacity of the upper watershed and the ability of the watershed to maintain a self-sustaining natural population will help managers determine the number and composition of adults to pass upstream in the future.
- Treatment and/or collection of spawning effluent will reduce the fish health risks to hatchery and natural origin fish downstream and meet NPDES requirements.
- Re-design of the raceway level control and release structures will improve pond cleaning and transferring and releasing fish.

Cons

- Current coho program requires reuse water (up to 70%) that can get up to 65 degrees F during the summer months to stay at or below recommended rearing densities and flow indices. Both exposure to reuse water and the warmer water temperatures impact the health and survival of the coho.
- Risk of amplifying naturally occurring pathogens that may have an adverse affect on free-ranging fish downstream of the hatchery.
- Continued use of antibiotics to control bacterial pathogens will increase the risk of developing antibiotic resistant strains that could impact fish, wildlife, or humans.
- Adult passage above the weir and adult carcass planting for nutrient enhancement purposes increase fish health risks to fish in the hatchery.
- Restricting the number of fish passed upstream may result in logistical problems with disposal of surplus adult broodstock.
- Increased costs associated with facility improvements and monitoring and evaluation studies.

Alternative 2: Terminate the coho program and increase fall Chinook production

Discontinue the production of coho at Makah NFH and increase fall Chinook production to 3.1 million.

Pros

- Reduces on-station fish health issues and the facility's reliance on antibiotics and chemicals to control pathogens during the summer months.
- Reduces the amplification of fish pathogens from the hatchery.
- Increases production of the highest priority species (fall Chinook) for the Makah Nation.
- Increases tribal, sport and commercial harvest opportunity for fall Chinook.
- Increases the amount of fall Chinook available for tribal subsistence and ceremonial purposes.
- Some parties have suggested that increased fall Chinook production may provide some benefit as prey for the ESA-listed southern resident orca population.

Cons

- Eliminates hatchery contribution of coho to sport, tribal and commercial fisheries in the Sooes and Waatch rivers and to ocean harvest including Washington, British Columbia, and Southeast Alaska.
- Eliminates the availability of surplus Sooes River coho adults for tribal subsistence and ceremonial purposes.
- May lead to the extirpation of naturally spawning coho in the Sooes and Waatch Rivers.
- Eliminates the double-index tagging program which contributes to the evaluation of selective fisheries.
- Eliminates the conservation benefit of coho passed upstream into the Sooes River ecosystem in terms of enhancing nutrients and providing direct forage for scavengers.
- May require a significant change in the broodstock management strategy for fall Chinook in the Sooes River and at the Makah NFH (e.g., development of a two-stage stepping stone program[166] if the conservation goal of the fall Chinook hatchery program is retained).
- Increases marking costs since many more Chinook can be produced in the same raceways.

Alternative 3: Terminate the coho program and increase steelhead production

Discontinue the production of coho at Makah NFH and increase steelhead production to 360,000.

[166] *Stepping-stone program = A hatchery program where two separate broodstocks are maintained. The first broodstock is integrated with the natural population and includes natural-origin fish in the broodstock each year. The second broodstock, intended to support harvest, represents a mixture of returning adults from the first broodstock and returning adults from this second broodstock. This allows a relatively large number of hatchery-origin fish to be available for harvest that are still genetically linked back to the natural population within the watershed where hatchery-origin fish are released. This two-step program can confer both harvest and conservation benefits.*

Pros

- Reduces on-station fish health issues directly related to coho production (specifically Furunculosis) and the facility's reliance on antibiotics to control outbreaks during the summer months. Steelhead are more resistant to Furunculosis than coho.
- Increases tribal and sport harvest opportunity for steelhead in the Sooes and Waatch Rivers.
- Increases the number of steelhead available for tribal subsistence and ceremonial purposes.
- Reduces the cost of marking and tagging since fewer stocks will be reared at the facility.

Cons

- Eliminates hatchery contribution of coho to sport, tribal and commercial fisheries in the Sooes and Waatch rivers and to ocean harvest including Washington, British Columbia, and Southeast Alaska.
- Contributes fish to fewer fisheries.
- Surplus Sooes River coho adults would not be available for tribal subsistence and ceremonial purposes.
- May lead to the extirpation of naturally spawning coho in the Sooes and Waatch Rivers.
- Increases the risk of IHN virus epidemics on-station since steelhead are more susceptible to the IHN virus than are coho.
- Eliminates the coho double-index tagging program which contributes to the evaluation of selective fisheries.
- Eliminates the conservation benefit of coho passed upstream into the Sooes River ecosystem in terms of providing nutrient enhancement and direct forage for scavengers.
- Increases the genetic and ecological risks to the naturally-spawning steelhead population if the weir is compromised (see MK36).

Alternative 4: Increase coho production

See Alternative 3 for Makah NFH steelhead

Alternative 5: Terminate the program (and all other programs at this facility) and decommission the facility

Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

- Same pros and cons as Alternative 3 under the Makah NFH fall Chinook program.

Recommended Alternatives

The Review Team recommends maintaining the existing coho program with full implementation of all recommended changes (Alternative 1). This includes evaluating the ability of the watershed to maintain a self sustaining natural population under current habitat and harvest conditions. Based on the results, develop and implement a broodstock management and natural population escapement plan consistent with principles of managing hatchery and natural fish as either an integrated hatchery population or as two distinct populations.

The Review Team also considered reducing or terminating the coho program in favor of increasing fall Chinook. However, given recent low adult returns of Chinook to the Sooes River, this may not be a viable option due to inconsistent broodstock availability. Additionally, coho adult returns are quite consistent and do provide substantial harvest opportunities for commercial, tribal and sport fisheries.

Makah NFH Winter Steelhead

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: Support commercial and sport fisheries in the Sooes and Waatch Rivers. Based on a desired 2.0% smolt to adult return rate (harvest plus hatchery escapement), the program goal would be to achieve a mean harvest of 2,760 adult steelhead per year in the Sooes River based on the current program size, although a specific harvest goal has not been established. No numeric goal for either survival or harvest has been established for the Waatch River. Rather, this program goal is viewed primarily as a secondary harvest opportunity to the Sooes River program.

- ***Broodstock escapement goal***: Provide an escapement back to the hatchery of 400 hatchery-origin adult steelhead for a segregated broodstock program. Achieve a 0.25% survival from smolt release to adult return at the hatchery to maintain broodstock.

- ***Conservation goal***: The current hatchery program has no direct conservation goals within the Sooes/Waatch watersheds. Although, the hatchery weir and broodstock management program are designed to protect the existing wild Sooes River steelhead population.

- ***Escapement goal for natural-origin adults***: A specific escapement goal for natural-origin adult steelhead returning to the Sooes River does not exist. Although, the hatchery weir is operated to allow upstream passage of all wild stock steelhead, which return later than the hatchery stock. In 1988, the estimated escapement was 717 based on spawning ground surveys performed by the Makah Nation. In 2008 the estimated number of redds identified during spawning ground surveys performed by the Makah Nation was 83 (actual, not expanded for unobserved areas). This is the only information currently available.

- ***Research, education, and outreach goals***: Provide visitation to the general public mostly during the summer tourist season. Support research projects such as the evaluation of INAD medications and feed trials.

Objectives

- Spawn a minimum of 200 females and 200 males to yield 600,000-800,000 green eggs. Discard a portion of the eggs from each female at the eyed egg stage so that all females are still represented in the population as a whole. Approximately 250,000 green eggs are required for the program.

- Release 158,000 smolts at 5.5 fish per pound annually after April 15 into the Sooes River below the hatchery.

- Transfer 22,000 smolts annually at 7.0 fish per pound in early April to the Educket Creek Acclimation Facility (on the Waatch River).

- Protect wild Sooes River steelhead by removing all hatchery steelhead and allowing only natural-origin steelhead to proceed upstream. This is accomplished by operating the weir and ladder until March 1 each year. Hatchery steelhead typically return from late October to late January and natural-origin steelhead from mid-March to June.

Program Description

The steelhead program at Makah NFH was started with eggs from the Quinault NFH. The weir operation during the steelhead return is managed to direct early returning hatchery stock into the hatchery and allow later returning wild stock to continue upstream. The facility initially released just over 30,000 steelhead smolts in 1983. By 1990, smolt releases were exceeding 100,000. The peak release occurred in 2002 with nearly 225,000 steelhead smolts released to the Sooes and Waatch Rivers. In the late 1980's two broods were replaced with Quinault NFH stock after the hatchery had been de-populated when the VHS virus was found in fish reared at Makah NFH.

The hatchery currently produces 158,000 winter steelhead smolts for release into the Sooes River at the hatchery and produces 22,000 smolts for transfer and subsequent release at the Educket Creek Acclimation Facility (Waatch River). Currently no tags or fin marks are applied to either group of smolts. The Sooes River (set-net and sport) steelhead harvest is not managed as a mark-selective fishery.

Broodstock are collected from returns to the hatchery. The goal is to spawn 200 pairs. Annual harvest in the Sooes River has averaged about 2,100 from 1995-1996 to 2005-2006.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- Broodstock are collected from returns to the hatchery. Although, in the late 1980s two broodyears were replaced with Quinault NFH stock after the hatchery had been de-populated when the VHS virus was found in fish reared at Makah NFH. (Natural-origin juvenile fish were also removed from the Sooes River and destroyed in 1989 as part of the measures taken to eradicate VHS.)

- Only hatchery-origin steelhead are used for broodstock.

- Recent DNA profiling of the Makah NFH stock is most similar to the DNA profiling of Quinault NFH steelhead. Wild steelhead from the Sooes River are not included in the hatchery program since run and spawn timing differ significantly between the two populations.

- Neither the current hatchery stock nor the natural stock is listed under the ESA.

- Brood fish enter the hatchery via a fish ladder associated with a suspended-electrode weir that spans the Sooes River. Adults ascend the ladder and enter a holding pond. All five of the adult holding ponds are used for adult collection and holding purposes.

- The hatchery steelhead entry date range is October – February with a mean date of January 8.

- Trapping of adult steelhead begins in late October and spawning of steelhead occurs primarily in December and January.

Hatchery and Natural Spawning, Adult Returns

- All hatchery steelhead are removed at the weir, and all natural-origin steelhead are passed upstream. However, it is possible for adult hatchery steelhead to move upstream past the weir on the infrequent combination of high river flows and high tides. Staff have not observed any significant numbers moving upstream.

- Hatchery steelhead typically return from October to February and natural-origin steelhead from mid-March to June.

- The stated goal of 200 pair results in more eggs taken than needed for production. However, 200 pair is considered the minimum effective population size to maintain the appropriate level of genetic diversity in the hatchery population. Eggs in excess of program needs are discarded after the eyed-egg stage.

- Treatment for disease control has not been needed for adults collected for broodstock.

- Jacks (2 year old males) are included in the broodstock when available; however numbers are highly variable. Between 1998-2007, 0% to 13% of males used were jacks.

- Spawning composition includes primarily age 3 (mean = 70%) steelhead, followed by age 4 (mean = 27%), age 2 (mean = 2%), and age 5 (mean < 1%).

- Broodstock are spawned without selecting for size.

- Spawning ratio is one female to one male. Eggs from one female are deposited into a colander and rinsed with a 1.4% bicarbonate solution, then poured into a dry bucket with sperm from one male added immediately. The sperm and egg mixture is gently stirred with more bicarbonate solution being added. Historically, the eggs from three females were combined into one stainless steel bucket prior to rinsing with Sooes River water. In 2008, the protocol was changed so that only two females are now combined.

- Following rinsing, the eggs are placed in Heath trays containing a 75 parts per million iodine solution for 60 minutes to water harden and disinfect. Sooes River water is then turned on to the stacks for the remainder of the incubation period. Water supplying the incubation stacks is routed through sand filters but otherwise untreated.

- Stray rates are unknown but assumed to be low based on no observed recoveries of coded-wire tags in other watersheds. This is based on a short-term study (2001-03) with limited tag recovery efforts in other Olympic Peninsula watersheds.

- Stray hatchery steelhead have been captured at the Umbrella Creek weir in the Ozette River basin. In 2005, three adipose-fin clipped steelhead were captured, which coincides with the brief period of time that Makah NFH steelhead were marked. Makah NFH is in close proximity to the Ozette River basin. Additional, unmarked steelhead have been collected at the Umbrella Creek weir. These may or may not have been hatchery origin

- Smolt to adult survival of broods 2001-03 averaged between about 1.0 to 1.5 % (Tipping and Zajac 2009[167]).

- Annual hatchery steelhead catch on the Sooes River ranges from 446 to 3,516 fish (Return Year 1995 – 2006) with an annual mean catch of 1,941 fish. Annual hatchery steelhead catch on the Waatch River ranges from 2 to 166 with an annual mean catch of 65 fish.

- Surplus steelhead and spawned-out carcasses are provided to the tribes for subsistence as desired.

- Carcass outplanting for nutrient enhancement occurs occasionally.

- The status of the natural Sooes River winter steelhead population is largely unknown. The historic and current habitat capacity and productivity is also largely unknown. However, the number of fish removed from the Sooes River in 1989 may provide some idea of recent productivity (see bullet below). Additionally, in 1988, the estimated escapement was 717 based on spawning ground surveys performed by the Makah Nation. Spawning ground surveys conducted by Makah Fisheries staff in the spring of 2008 resulted in the observation of 83 redds. This data was not expanded for unobserved redds or unsurveyed habitat. This is the only information currently available.

- Natural-origin juvenile fish were removed from the Sooes River and destroyed in 1989 as part of the measures taken to eradicate the VHS virus. A minimum of 10,000 smolts were removed and destroyed.

Incubation and Rearing

- Incubation takes place in vertical tray incubation units known as Heath Stacks. Historically, egg loadings were approximately 12,000 green eggs per tray and reloaded at 10,000 eggs per tray at eye up. However, beginning in 2008, initial egg loadings were reduced to only 2 females, or approximately 7,000-8,000 eggs per tray, and reloaded to 7,000 eggs per tray at eye up. Water delivery flows to each stack are set at four gallons per minute during egg and fry development. The eggs are kept in trays until development to the eyed stage (eye-up) at which time the eggs are shocked, sorted, and placed back into Heath Tray incubators along with vexar substrate. Water temperatures during incubation range from 39^0F to 46^0F with an average of 43^0F.

[167] *Tipping, J.M., and D.P. Zajac. 2009. Manipulating Diet in the Last Month of Juvenile Rearing did not Enhance Adult Steelhead Survival at Makah National Fish Hatchery. Submitted to North American Journal of Aquaculture in March 2009.*

- Formalin 1:600 (1667 parts per million) for 15 minutes starting at least 24 hours after fertilization is used to control fungus on the eggs. Formalin is applied 7 days a week and discontinued before hatching.

- Survival of steelhead eggs from the green stage to the eyed stage ranges from 66% to 89% with a mean of 77% (2000-2008). Eggs are enumerated at the eyed stage using water displacement (eggs/ounce) with a Von Bayer V-trough. Eggs in excess to the needs of the program are then discarded.

- After hatched fry have absorbed their yolk sac (buttoned up), they are ponded in 16-foot-long by 3-foot-wide and 2–feet-deep (96 cu.ft.) fiberglass tanks at 20,000 each. Winter steelhead remain in tanks until they attain a size of 400 to 600 fish per pound or larger at which time they are transferred to outdoor raceways. Flows in the tanks are maintained at 30 gallons per minute per rearing unit. Once placed in the outdoor raceways, fish remain there until release. Estimating from the above parameters suggests that density indices approach 0.23 in the fiberglass tanks, while flow indices remain below 0.80. No specific density or flow indices are available since the facility does not measure fish length.

- Every attempt is made to split fish among raceways in advance of the estimated density index reaching 0.20 or flow index of 1.0. Availability of water can be a constraint in this regard. Steelhead, which are held over the summer, are moved to specific raceways that are equipped with a reuse water system for summer rearing. Water temperatures during rearing range from 39^0F to 65^0F with an annual mean of 52^0F (1982-1989). Temperatures have reached the 70's in recent years. However, specific, recent temperature data is not available.[168]

- The total number of fry ponded for brood years 2000-2007 has ranged from about 400,000 to about 600,000.

- Fry in excess to program needs have been planted as fry at the hatchery, in the abatement pond, and below the weir.

- General pond cleaning is done every two to three days using the brush and drain method. Pond brushes are disinfected between raceways. Mortalities are removed daily, and twice a day during disease outbreaks.

- Sample counts are done at the end of each month. Fish are inventoried with an electronic counter during pond movements. At final rearing, steelhead occupy six raceways (11' X 80' X 3').

- There appears to be a great deal of size variance in the steelhead reared at Makah NFH; however no length data is available to quantify the magnitude of the problem. Steelhead are currently not graded and reared by size.

- The hatchery operates all of its raceways on first pass Sooes River water except for a short period during the summer when up to 70% of the water may be reuse water from the abatement channel.

[168] *Pers. comm. Caroline Peterschmidt 2008.*

- Coldwater disease caused by the bacterium *Flavobacter psychrophilum* has been isolated from juvenile steelhead and has been treated by oral administration of oxytetracycline or florfenicol under the Investigational New Animal Drug (INAD) permit.

- Formalin bath treatments to control external protozoan parasites on all species of fish at Makah NFH are common. Depending on the parasite and the water temperature, this may be a one-time treatment or it may be performed on multiple days either consecutively or alternately. Baths are generally one hour long at 1:6000 to 1:4000 (125-167 parts per million) and conform to the FDA and EPA guidelines and labels. The parasites which cause the most significant problems in steelhead at Makah NFH are *Ichthyobodo, Ichthyophthirius,* and *Trichodina sp.*

- Predation is significant throughout rearing. The facility loses approximately 20,000 to 65,000 juvenile fish per year (includes both steelhead and coho mortalities) to gulls, crows, herons, raccoons, and occasional otters.

- All ponds are utilized at the station at some point during rearing of the various species at Makah NFH.

- Water flow and water temperature can be problematic during summer months, creating increased disease incidence.

Release and Outmigration

- Release of steelhead ideally commences when a size of 5.5 fish per pound is achieved (release timing is usually a function of raceway loading, flows, and water temperature). Steelhead are released as yearlings in May after approximately 16 months on station.

- Fish are generally released at a time, size, and physiological condition that provide a low likelihood of residualism, and promote a rapid migration to marine waters.

- Steelhead reared on station are force-released out of the bottom of each raceway through a six inch diameter pipeline that leads to the Sooes River.

- Releases coincide with one or more of the following conditions; high tide, high turbidity, and/or nightfall.

- Steelhead are volitionally released from the Educket Creek Acclimation Facility over a period of two days. The remaining fish are forced out after two days.

Facilities and Operations

See the Makah NFH Fall Chinook section.

Research, Education, and Outreach

- Makah NFH winter steelhead are not currently adipose-fin clipped so returning hatchery adults cannot be visually distinguished from wild steelhead. Mass marking occurred for broodyears 2005 and 2006 but was discontinued with brood year 2006 due to lack of funds and questionable benefits since the mark-selective fishery management strategy is not used for harvest on the Sooes and Waatch Rivers.

- Makah NFH winter steelhead are not coded-wire tagged. Coded-wire tagging occurred between 2001-2003 for a survival study (Tipping and Zajac 2009).[169]

- Research indicates significant run-time separation between the hatchery and wild adult steelhead populations. From 1984-1988, data indicated that very few wild fish were returning before late February (.1%-3%), whereas the hatchery population returns end in early February.[170]

- The WDFW has conducted several feed rationing studies on winter steelhead at Makah NFH to look at various effects on SAR.

- Genetic samples (fin tissue from 100 adults) are collected annually for assessment of long term genetic trends/changes in the population.

See the Makah NFH Fall Chinook section for more information.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[171] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- The program confers significant tribal and sport harvest benefits in the Sooes and Waatch Rivers. Based on catch records for the Sooes and Waatch Rivers, from 1997– 2007, in the Sooes River, the average harvest was 2,563 (range, 1,163-4,362). From 1997– 2007, in the Waatch River, the average harvest was 99 (range, 23-301). The harvest is predominantly tribal.

- The program provides an in-river sport fishery below the hatchery and on Educket Creek. Fishing license sales and other associated expenditures by visiting fishermen provide an economic benefit to the local community.

- The overall total economic net benefit of Makah NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $1.2 million.[172]

Conservation Benefits

- None identified.

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[169] *Tipping, J.M., and D.P. Zajac. 2009. Manipulating Diet in the Last Month of Juvenile Rearing did not Enhance Adult Steelhead Survival at Makah National Fish Hatchery. Submitted to North American Journal of Aquaculture in March 2009.*

[170] *Zajac, D. March 1998. Plan to Minimize the Impact of the Makah NFH Steelhead Program on the Sooes River Wild Steelhead Run. USFWS.*

[171] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[172] *Pers. comm. James Caudill, USFWS, 2008.*

Research, Education, Outreach and Cultural Benefits

- Spawned out carcasses and surplus adults trapped at the facility are provided to the Makah Nation for subsistence and ceremonial purposes.

- Unique temperature and flow conditions have been used to explore natural temperature and pathogen challenges in a controlled setting. The infrastructure exists (four small raceways, one fitted with interior tanks) to provide additional research opportunities.

See the Makah NFH fall Chinook section for additional Research, Education, Outreach and Cultural Benefits.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[173] the Review Team identified the following benefits of this program:

Harvest Benefits

- None identified.

Conservation Benefits

- None identified.

Research, Education, Outreach and Cultural Benefits

See the Makah NFH fall Chinook section for Research, Education, Outreach and Cultural Benefits.

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[174] the Review Team identified the following risks of the hatchery program:

Genetic Risks

- None identified.

Demographic Risks

- Makah NFH is more susceptible to catastrophic loss than other facilities due to the risks of floods and tsunamis, disease, and low flows and high water temperatures, increasing the potential to eliminate one or more broodyears of the Makah NFH steelhead population.

[173] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

[174] *Ibid.*

- Makah NFH is more susceptible to catastrophic loss than other facilities due to the risk of mechanical malfunction, increasing the potential to eliminate one or more broodyears of the Makah NFH steelhead population.

- Hatchery steelhead fry in excess to program needs released into the hatchery abatement pond (which flows into serpentine channel) could pose a fish health risk to steelhead and other fish reared on station when the facility is on reuse water. However, excess fry plants are infrequent.

- Hatchery steelhead vary greatly in size during rearing and at release. Steelhead released below target size could reduce the smolt-to-adult survival rate, and thus the broodstock needs and harvest benefits, of the hatchery population.

- Rearing densities in the start tanks appear to exceed a density index of 0.20 prior to transfer to outdoor raceways. High rearing density can increase disease incidence, particularly cold-water disease, reducing survival of the propagated stock.

- Low green to eyed-egg survival rate poses a demographic risk to the hatchery population.

See the Makah NFH fall Chinook section for additional Demographic Risks

Ecological Risks

- High water temperatures and low flows increase the risk of disease to the propagated stock.

- The absence of adequate predator controls and excessive predation by birds and mammals on juvenile steelhead reared on station poses an ecological risk to each brood year.

Physical Risks

See the Makah NFH fall Chinook section for Physical Risks.

Research, Education, Outreach and Cultural Risks

- None identified.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[175] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- Wild steelhead incorporated in the hatchery broodstock (since the hatchery brood are unmarked and cannot be distinguished) could pose a risk to the wild population by reducing run-time separation between the hatchery and wild population. Data collected between 1984 and 1998 indicates a significant difference in run-time; therefore, this is assumed to be a low risk.

[175] *Ibid.*

- Hatchery steelhead could pass upstream if they return later than March 1st when the electric weir is turned off, or during extreme flood conditions, posing a genetic risk to the wild population.

- Hatchery steelhead straying into nearby river systems could pose a genetic risk to the steelhead populations in those areas.

Demographic Risks

- Wild steelhead incorporated in the hatchery broodstock (since the hatchery brood are unmarked and cannot be distinguished) could pose a demographic risk to the wild population by reducing the number of naturally-spawning wild steelhead. Data collected between 1984 and 1998 indicates a significant difference in run-time; therefore, this is assumed to be a low risk.

- Hatchery steelhead fry in excess to program needs released into the hatchery abatement pond (which flows into serpentine channel) could pose a fish health risk to steelhead and other fish reared on station when the facility is on reuse water.

- Harvest targeting Makah NFH steelhead poses a demographic and genetic risk to natural-origin steelhead. Given the existing run-time separation between the hatchery- and natural-origin returns, intensive harvest targeting Makah NFH steelhead may have largely reduced the early-timed component of the natural-origin steelhead run and may prevent the reestablishment of this component of the run.

See the Makah NFH fall Chinook section for additional Demographic Risks.

Ecological Risks

- Amplification of disease within the hatchery poses a disease risk to fish populations in the Sooes River.

- Hatchery steelhead vary greatly in size during rearing and at release, increasing the risk of residualism. This may pose a minor predation risk to chum, Chinook and other fish species rearing in the Sooes River downstream of the facility. The risk of impacts to fish populations, including wild steelhead, above the hatchery weir is less since the hatchery juveniles cannot pass upstream of the weir when they are released and since summer water conditions in the river below the weir are not favorable to survival of residualized populations. Additionally, excess fry are periodically released into the Sooes River below the weir posing a similar, albeit minor risk.

Research, Education, Outreach and Cultural Risks

- None identified.

Recommendations for Current Program[176]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

Issue MK28: Present program goals for Makah NFH steelhead are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation MK28: Restate program goals to identify the number of harvestable adult steelhead desired and achievable from this program in the Sooes and Waatch Rivers. For example, the current program size and post-release survivals leads to a mean harvest of approximately 2,563 and 99 adult steelhead per year for the Sooes and Waatch, respectively. This data could be used to develop the program goal.

Broodstock Choice and Collection

No issues identified.

Hatchery and Natural Spawning, Adult Returns

Issue MK29a: In response to a Congressional mandate, mass marking by adipose-fin clip did occur in broodyears 2005-2006, but was discontinued due to reduced funding and a determination that there was no intent to implement a selective fishery which is often an intended benefit to mass marking.

Issue MK29b: Without the mass marking of hatchery steelhead, hatchery and wild steelhead cannot be distinguished during broodstock collection, monitoring and evaluation of genetic and ecological risks to natural populations, and during harvest where mark-selective fisheries are in place. *Although considered a low risk, wild steelhead incorporated in the hatchery broodstock (since the hatchery brood are unmarked and cannot be distinguished) could pose a risk to the wild population by reducing run-time separation between the hatchery and wild population. In addition, releasing unmarked hatchery steelhead may postpone changes in management strategies (e.g. increasing wild harvest, moving to an integrated program if the wild population becomes depressed, initiating a mark-selective fishery, etc).*

[176] *The Review Team believes that Makah NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

Recommendation MK29: Budget to allow mass marking of Makah NFH steelhead to occur on an annual basis, in accordance with Congressional mandates and Service best management practices. Although the Congressional mandate is focused on harvest management and requires a visible mark applied to the fish, the Team's primary concern is broodstock management and monitoring and evaluation. Therefore, the mark does not have to be an adipose-fin clip.

Issue MK30: Current weir operation is based upon data that is 20 years old. *Research from 1984-1988 indicated that there is a significant difference in run-timing between hatchery and wild adults. The weir is currently active from October 1st-March 1st, the assumed return-time for the hatchery origin steelhead.*

Recommendation MK30: Two years after implementing mass marking (MK29), initiate a study to evaluate the current run-time of the hatchery and wild steelhead populations. Operate the weir or perform carcass surveys throughout the return period of both populations to complete this study.

Issue MK31: This also precludes the ability to identify changes in hatchery and wild steelhead run-timing associated with stock composition and environmental changes such as climate change, ocean regime shifts, etc.

Recommendation MK31: Continue to periodically perform run-time studies (MK30).

Issue MK32: Makah NFH steelhead cannot be identified if they stray to river systems other than the Sooes and Waatch.

Recommendation MK32: Consider periodic coded-wire tagging studies to evaluate potential changes in survival and contribution to fisheries, and recoveries at other hatcheries and traps to assess homing and straying. In conjunction with these studies, encourage state and tribal comanagers to conduct periodic monitoring in other North Coast watersheds.

Incubation and Rearing

Issue MK33: Makah NFH steelhead experience poor survival rates from green to eyed-egg stage when compared to other hatchery steelhead programs. *The green to eyed-egg survival rate for Makah NFH steelhead is approximately 77%. Typical green to eyed-egg survival rates for other hatchery steelhead programs is 85-90%. Low survival rates at this stage result in the taking of additional broodstock to meet production goals; increases the risk of fungal infections and consequently, the reliance on formalin treatments; and increases the workload involved in removing dead eggs at the eyed stage and when the fish are transferred from the incubation trays to raceways.*

Recommendation MK33: Investigate and implement methods to increase green to eyed-egg survival. For example, investigate different fertilization methods, egg rinsing solutions, egg loading densities (see MK34), etc.

Issue MK34: Egg loading densities in incubation trays (3 females per tray or approximately 12,000 eggs/tray) exceed loading density protocols for steelhead at other NFH's. *Additionally, Integrated Hatchery Operation Team (IHOT) guidelines developed for steelhead reared in the Columbia River basin are not to exceed 9,000 eggs per tray from the fertilized-to-eyed egg stage and 8,000 eggs per tray from the eyed egg to fry stage. This practice may be contributing to the poor steelhead egg to fry survival rate at Makah NFH.*

Recommendation MK34: Reduce initial loading densities to a maximum of 2 females per tray or approximately 8,000 eggs per tray. This may ultimately increase green to eyed-egg survival (see MK33). Makah NFH staff began to implement this protocol in 2008.

Issue MK35: Rearing densities in the indoor nursery rearing tanks exceed a density index of 0.20 prior to transfer to outdoor raceways. *Tanks are loaded at 20,000 fry per tank, where they remain until transfer to outdoor raceways.*

Recommendation MK35: Reduce initial loading of tanks to 16,000 steelhead fry (2 trays per tank). The 22 tanks in the hatchery building should allow for this loading scenario without reducing production goals.

Issue MK36a: Makah NFH hatchery steelhead vary greatly in size during rearing and at release. The current coefficient of variation (CV) for Makah NFH steelhead is not available. Current Washington Department of Fish and Wildlife standard for size variation in steelhead is a CV of less than 10%. *High size variation results in steelhead released below target size (WDFW standard is a mean of 205mm and less than 5 % smaller than 180 mm)), which could reduce the smolt-to-adult survival rate (and thus the broodstock needs and harvest benefits) of the hatchery population. High size variability may also increase the risk of residualism, which could pose ecological risks to wild fish in the Sooes River basin.*

Issue MK36b: Accurate growth management (feeding strategies) is difficult due to high size variability within each rearing container.

Recommendation MK36: Closely monitor steelhead size by taking length (total length) measurements from a representative sample at least quarterly throughout the rearing cycle. Samples should include a minimum of 100 individuals randomly dipped from a crowded/pooled group of fish in one or two raceways. Use this data to calculate CV in order to track size variation in the steelhead program.

Subsequently, sort (grade) the steelhead among the raceways by size so that they can be reared to meet target size at release with lower CVs. To reduce the need for grading, investigate fish culture practices and implement changes to reduce the CV to less than 10%. For example, combine female egg lots by size, chill eggs during incubation, reduce the number of spawn takes, etc.

Issue MK37a: Fish in excess of program needs have been produced in attempt to buffer the effects of disease loss during summer month rearing. Excess fry are then released into the abatement pond or Sooes River below the hatchery weir if they are not needed. *Rearing additional fish increases rearing densities which may be increasing the potential for disease outbreaks. Additionally, rearing additional fish can increase the use of antibiotics during rearing, which end up in the hatchery effluent and may cause the development of drug-*

resistant pathogens that could impact fish, wildlife or humans. Furthermore, research has shown that salmon released as fry have low survival and salmon and steelhead fry may have negative ecological impacts (competition, predation, disease, etc.) on natural salmon and steelehead populations. [177,178]

Issue MK37b: Excessive predation of juvenile steelhead by birds and mammals occurs annually, further contributing to the need to initially raise more fish than necessary to meet smolt release objectives.

Issue MK37c: Although an infrequent activity, steelhead outplanted in the abatement pond (which flows into serpentine channel) could pose a fish health risk to steelhead and other fish reared on station when the facility is on reuse water.

Recommendation MK37a: Increase predator control measures to reduce fish losses due to bird and mammal predation.

Recommendation MK37b: Reduce the total number of hatched fry retained for rearing to the maximum number necessary to meet smolt release objectives.

Recommendation MK37c: Discontinue fry outplants. Destroy excess eggs before they become fry. Continue to collect and spawn 200 pairs, but at eye-up, retain approximately equal numbers of eggs from each spawning pair to maintain the effective population size.

Issue MK38: High water temperatures, low flows and the use of reuse water during summer months increases the risk of disease to steelhead and coho reared at Makah NFH.

Recommendation MK38: Evaluate opportunities for chilling and/or disinfecting incoming water for use during summer months.

Release and Outmigration

See Issue/Recommendation MK39.

Facilities/Operations

Issue MK39: The current management goal is to prevent hatchery steelhead from passing upstream and interacting with the natural-origin steelhead population. Due to its design, the weir is less effective at high water flows and extreme high tide conditions during December-January when hatchery steelhead are returning, allowing some hatchery fish to pass upstream. The weir is a suspended-electrode design and is manually controlled.

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[177] *Nickelson, T. 2003. The influence of hatchery coho salmon (/Oncorhynchus kisutch/) on the productivity of wild coho salmon populations in Oregon. Canadian Journal of Fisheries and Aquatic Sciences *60:*1050-1056*.*

[178] *Kostow, K., A. Marshall, and S.R. Phelps. 2003. Natural Spawning Hatchery Steelhead Contribute to Smolt Production but Experience Low Reproductive Success. Transactions of the American Fisheries Society 132: 780-790.*

Recommendation MK39a: Automate the amperage controller to help restrict fish passage during these events. (There is a SAMMS work order to automate the amperage controller)

Recommendation MK39b: Subsequently, consider an entirely new weir design to improve the structure's effectiveness during high flows and extreme high tide conditions. Perform spawning ground surveys and smolt outmigrant genetic analyses of the similarities and differences of hatchery versus wild steelhead, especially after seasons of high water flows or extreme high tides, to help determine whether a new weir is required (see MK41).

Issue MK40: Release structure design may cause increased mortality during release, especially for coho and steelhead that are released at a large size*. The current design increases the potential that some fish may be injured upon release as the fish are released through a six inch diameter pipe that exits the bottom of the raceway.*

Recommendation MK40: Evaluate the level of injury that may be occurring from this method of release. If it is found to be an issue, consult with engineering to design an alternative release system.

See the Makah NFH fall Chinook section for additional Facilities/Operations issues and recommendations.

Research, Monitoring, and Accountability

Issue MK41: Natural production of steelhead in the Sooes River is not well understood. *Spawning surveys and smolt production information is lacking, making it difficult to determine natural escapement goals and productivity for the Sooes River above the weir. Additionally, genetic information on naturally produced steelhead to determine their relationship to other populations on the Olympic Peninsula does not exist.*

Recommendation MK41a: Conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Sooes River. Radio-tagging adults could also be used to determine distribution. Use this information to better define natural production and habitat protection and restoration measures.

Recommendation MK41b: Collect tissue samples for genetic analyses from 100 hatchery and 100 wild adult steelhead intercepted at the hatchery weir for each of three consecutive years to determine the differences between hatchery- and natural-origin fish. Subsequently, collect genetic samples from juvenile production in the Sooes River either through electro-fishing and seining or smolt trapping. This information will not only help determine the degree of differences between wild and hatchery steelhead, but will also help determine the effectiveness of the existing weir in preventing hatchery fish from going upstream into the natural production area.

Issue MK42: Residualized steelhead can have negative ecological consequence to wild fish in the Sooes River basin. *Steelhead have the potential to residualize in the Sooes River, although the risk is reduced by the limited habitat available downstream of Makah NFH.*

Recommendation MK42: Determine the extent steelhead released from Makah NFH residualize. Depending upon monitoring and evaluation results, determine whether different management actions reduce the risk of residualism.

Issue MK43: Limited effort and opportunity to monitor steelhead in coastal streams makes it difficult to accurately estimate steelhead stray rates. There is very limited information regarding straying of steelhead. For example, hatchery steelhead strays have been collected at the Umbrella Creek Weir in the Ozette River Basin. *The origin cannot be identified due to a lack of marks and/or tags in most years. Coded-wire tag studies have been conducted at Makah NFH that indicated no tags were recovered outside of the Sooes River basin. However, recovery efforts during that time period in all coastal streams were limited.*

Recommendation MK43: The Service should advocate for a coast-wide tagging, and tag recovery program for steelhead.

Issue MK44: IHN virus epidemics have occurred recently in the Gray Harbor, Queets, and Lake Quinault areas. The epidemics have been caused by a strain of IHN virus (IHNV M-D) that has not been observed in the area in the past. Comanagers have agreed on interim guidelines and procedures to help prevent this IHN virus strain from becoming established.

Recommendation MK44a: Work with comanagers and the Olympia Fish Health Center to develop and participate in a Washington coast-wide monitoring and evaluation plan to assess and address the emerging strain of IHN virus.

Recommendation MK44b: Develop an education program to encourage fishermen to disinfect their waders and fishing gear between watersheds.

See the Makah NFH fall Chinook section for additional Research, Monitoring and Accountability issues/recommendations.

Education and Outreach

See the Makah NFH fall Chinook section for Education and Outreach issues/recommendations.

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing steelhead program at Makah NFH and developed five alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current program with recommendations

Maintain existing steelhead program with full implementation of all recommended changes. Continue to rear and release 158,000 and 22,000 steelhead juveniles to the Sooes and Waatch Rivers respectively**.** Develop and implement conservation goals for wild steelhead based on genetic sampling and run timing as data becomes available.

Pros

- Contributes significantly to sport and tribal fisheries in the Sooes and Waatch Rivers.
- Provides surplus adults for tribal subsistence and ceremonial purposes.
- Treatment and/or collection of spawning effluent will reduce the fish health risks to hatchery and natural origin fish downstream and meet NPDES requirements.
- Re-design of the raceways will improve pond cleaning and transferring and releasing fish.
- Provides fishing opportunity on hatchery-origin steelhead at a time when there is little risk to natural-origin steelhead returning to the Sooes and Waatch Rivers

Cons

- To stay at or below recommended rearing densities and flow indices, the current steelhead program requires reuse water (up to 70%). The reuse water can reach temperatures over 65 degrees F during the summer months. Both exposure to reuse water and the warmer water temperatures impact the health and survival of the steelhead.
- Risk of amplifying naturally occurring pathogens that may have an adverse affect on fish downstream of the hatchery.
- Continued use of antibiotics to control bacterial pathogens will increase the risk of developing antibiotic resistant strains that could impact fish, wildlife, or humans.
- Increased costs associated with facility improvements and monitoring and evaluation studies.
- Poses a genetic and ecological risk to the native steelhead population if the program cannot be fully segregated.

Alternative 2: Terminate the steelhead program and increase fall Chinook production

Discontinue the production of steelhead at Makah NFH and increase fall Chinook production to 3.1 million.

Pros

- Reduces on-station fish health issues directly related to steelhead production (bacterial coldwater disease and external parasites) and the facility's reliance on antibiotics and chemicals to control these diseases during the summer months.
- Reduces the amplification of fish pathogens from the hatchery.
- Reduces the risk of IHN virus epidemics. Steelhead are more susceptible to catastrophic loss due to IHN than are Chinook.
- Increases production of the highest priority species (fall Chinook) for the Makah Nation.
- Increases tribal, sport and commercial harvest opportunity for fall Chinook.
- Increases the amount of fall Chinook available for tribal subsistence and ceremonial purposes.
- Eliminates the genetic and ecological risks to the naturally-spawning steelhead population if the weir is compromised.
- Some parties have suggested that increased fall Chinook production may provide some benefit as prey for the ESA-listed southern resident orca population.

Cons

- Eliminates contribution of hatchery steelhead to tribal and sport fisheries in the Sooes and Waatch rivers.
- Eliminates fishing opportunity on hatchery-origin steelhead at a time when there is little risk to natural-origin steelhead returning to the Sooes and Waatch Rivers
- Surplus Sooes River steelhead adults would not be available for tribal subsistence and ceremonial purposes.

Alternative 3: Terminate the steelhead program and increase coho production

Discontinue the production of steelhead at Makah NFH and increase coho production to 480,000.

Pros

- Increases the harvest opportunity for coho to sport, tribal and commercial fisheries in the Sooes and Waatch rivers, and to ocean harvest including Washington, British Columbia, and Southeast Alaska.
- Increases surplus Sooes River coho adults available for tribal subsistence and ceremonial purposes.
- Reduces the risk of IHN virus epidemics. Steelhead are more susceptible to catastrophic loss due to IHN than are coho.

- Eliminates the genetic and ecological risks to the naturally-spawning steelhead population if the weir is compromised.

- Eliminating the production and subsequent harvest targeting Makah NFH steelhead may allow the Sooes River natural-origin steelhead population to restore its historic, natural run time.

Cons

- Increases the incidence of Furunculosis and the facility's reliance on antibiotics to this pathogen during the summer months since coho are more susceptible to Furunculosis than steelhead.

- Eliminates harvest opportunity for hatchery steelhead to tribal and sport fisheries in Sooes and Waatch rivers.

- Eliminates fishing opportunity on hatchery-origin steelhead at a time when there is little risk to natural-origin steelhead returning to the Sooes and Waatch rivers.

- Surplus Sooes River steelhead adults would not be available for tribal subsistence and ceremonial purposes.

- Reduces economic benefit to the tribe from fishing licenses sales and other associated purchases by visiting steelhead fishermen.

Alternative 4: Increase steelhead production

See Alternative 3 for Makah NFH coho

Alternative 5: Terminate the program (and all other programs at this facility) and decommission the facility

Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

- Same pros and cons as Alternative 3 under the Makah NFH fall Chinook program.

Recommended Alternatives

The Review Team recommends maintaining the existing steelhead program with full implementation of all recommended changes (Alternative 1).

The Review Team also considered reducing or terminating the steelhead program in favor of increasing fall Chinook. However, given recent low adult returns of Chinook to the Sooes River, this may not be a viable option due to inconsistent broodstock availability. Additionally, steelhead adult returns are quite consistent and do provide substantial harvest opportunities for tribal sport fisheries.

Makah NFH Ozette Sockeye

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: None.

- ***Broodstock escapement goal***: Approximately 100 females and 100 males (to yield 305,000 "green" eggs)

- ***Conservation goal***: Recover the population and delisting from the U.S. Endangered Species Act. NOAA Fisheries has provided the following delisting criteria as a measure of viability and self-sustainability: *Abundance*: 35,500-121,000 spawners/year over several years; *Productivity* – population growth rate stable or increasing; *Spatial Structure* - multiple spatially distinct and persistent spawning aggregations across the historical range of the population; and *Diversity* - one or more persistent spawning aggregations from each major genetic and life history group historically present within the population (Source: Rawson et al. 2008).

- ***Escapement goal for natural-origin adults***: Minimum of 35,000 natural-origin adults per year.

- ***Research, education, and outreach goals***: (a) Determine whether artificial propagation and supplementation of natural spawning by hatchery-origin sockeye can rebuild the tributary spawning aggregations, and (b) whether sockeye can be successfully reintroduced to the point where there are established self-sustaining tributary spawning populations without impacting the natural beach spawning populations. Specific research objectives associated with the program include the following:

    - Assess the proportion of the naturally-spawning population composed of hatchery-origin fish.
    - Assess ecological interactions between hatchery and natural-origin fish in Lake Ozette and tributaries.
    - Control diseases in the hatchery and potential effects on the natural population.
    - Assess behavior of program fish during spawning migration (radio telemetry studies).
    - Assess homing and straying rates for program fish.
    - Assess gene flow of program fish into the natural population.

Objectives

- Transfer in 305,000 unfertilized green eggs and sperm from the Makah Nation Neah Bay staging building. Makah Nation fertilizes the eggs in a 4x4 factorial cross on site at Makah NFH.

- Incubate up to 305,000 sockeye eggs from green egg to the eyed stage.

- Otolith mark the eggs at Makah NFH.

- Transfer 122,000 eyed eggs to Umbrella Creek and 183,000 eyed eggs to Stony Creek remote site incubation and rearing tribal facilities for rearing and release. The release goal for Umbrella Creek is 122,000 at 450 fish per pound (fpp) and the release goal for Stony Creek is 91,500 at 900 fpp and 91,500 at 450 fpp.

Program Description

The Lake Ozette sockeye were listed as threatened under the ESA in 1999. A Proposed Recovery Plan (PRP) was published in April 2008 and is currently out for public comment. Implementation of the final recovery plan will occur in 2009. The recovery goal in the proposed plan is for the Lake Ozette sockeye population to reach the point that it no longer needs the protection of the Act and can be delisted. Based on currently available information, the Technical Review Team (TRT) recommended that a viable sockeye population in Lake Ozette should range in abundance between 35,500 and 121,000 adult spawners, over a number of years. A viable sockeye population in Lake Ozette would include multiple, spatially distinct and persistent spawning aggregations throughout the historical range of the population. A viable sockeye population would therefore have multiple spawning aggregations along the lake beaches, which are the known historical spawning areas. The certainty that the population achieves a viable condition would be further increased if spawning aggregations in one or more tributaries to the lake were also established.

The current supplementation program was initiated in 2000. An evaluation of the program is scheduled to occur in 2012, 12 years or three full generations post implementation. The evaluation will determine if it is necessary to continue or to terminate the tributary supplementation project. The approach to recovering beach spawning sockeye will focus on habitat improvements in the short term, however if research and monitoring reveal the need for supplementation of the beach spawning population, propagation of these fish may occur in the long term.

Eggs were imported from Lake Quinault in 1982, the first year that Lake Ozette sockeye were supplemented. This program had limited, if any, success and was quickly discontinued. From 1983 to 1999, eggs were collected from beach spawners in Lake Ozette. Beginning in 2000, eggs were collected from returns to tributaries of Lake Ozette, primarily Umbrella Creek. At the request of the Makah Nation, Makah NFH became involved in the Lake Ozette sockeye program in 2003. The Makah NFH Isolation/Quarantine facility was modified at that time to be used for initial incubation to reduce the risk of egg loss that could occur at the Umbrella and Stony Creek remote sites and to provide the capability to apply a thermal otolith mark to all hatchery progeny.

This is a native stock with no evidence of interbreeding with introduced stocks. Artificial production has occurred to some extent, but has involved small egg takes and limited broodstock collection (an average of 98 fish per year). This is the only stock within the Ozette Sockeye GDU. Adults are captured in a trap located at river mile one on Umbrella Creek. They are transported to Umbrella Creek Hatchery at river mile 4.6 and held there until ripe. Ripe adults are taken to the Makah Nation's "staging building" in Neah Bay to be spawned. Unfertilized gametes are taken to Makah NFH. The egg take goal is 305,000. Incubation and otolith marking occur at Makah NFH. Eyed eggs are taken to Umbrella Creek (122,000) and to Stony Creek Hatchery (183,000 in remote site incubators, or RSI, plus fiberglass troughs). Planting goals are 122,000 at 450 fish per pound into Umbrella Creek (Elk Lake RSI), 91,500 at 900 fish per pound and 91,500 at 450 fish per pound into Stony Creek.

Twenty-two percent of Lake Ozette is within the boundaries of the Olympic National Park. The National Park Service is a land manager for the lake, which includes managing fisheries that occur within park boundaries. There is no fishery for sockeye within park boundaries due to its Endangered Species Act status as a threatened population. National Park Service regulations generally promote selective harvest of hatchery fish and catch-and-release of wild salmon and steelhead.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

The Service does not take part in broodstock collection. Broodstock are collected by the Makah Nation.

- Adults are captured in a trap located at river mile one on Umbrella Creek. They are transported to Umbrella Creek Hatchery at river mile 4.6 and held there until ripe.
- Hatchery origin fish are selected for broodstock in approximately the same proportion as is present on the spawning grounds.
- Adults are held on regulated pathogen-free water while at Umbrella Creek Hatchery.
- Ripe adults are taken to the Makah Nation's "staging building" in Neah Bay to be spawned. Unfertilized gametes are taken to Makah NFH.
- The broodstock originated from a beach spawning population, but the Lake Ozette sockeye population has developed into a primarily creek spawning population as a result of trapping and release strategies. The current recovery policy discourages hatchery involvement in supplementation of the beach spawning populations until a pilot study is complete.
- Lake Ozette sockeye are a native stock with no evidence of interbreeding with introduced stocks.
- The Lake Ozette sockeye population is listed as *threatened* under the Endangered Species Act (ESA).

Hatchery and Natural Spawning, Adult Returns

The Service does not take part in spawning the adults. The Makah Nation spawns the adults and fertilizes the eggs.

- Genetics studies indicate no evidence of interbreeding of native stocks with any planted stocks.

- Recent run-sizes of Lake Ozette sockeye have ranged from 1,000 to over 2,200 adults from the period of 1997-2000[179].

- The egg-take goal for the program is 305,000 from approximately 100 adult females.

- There has been no harvest of Lake Ozette sockeye since 1984. From 1974 - 1984, harvest was limited to tribal ceremonial harvest of 0-86 sockeye. From 1964-1974, harvest was approximately 500. Prior to 1964, harvest was greater than 4,000. Due to the earlier run-timing, well in advance of Canadian and US sockeye commercial fisheries, it assumed that minimal harvest occurs in the ocean.

- Makah Nation transfers in unfertilized gametes from the Neah Bay staging area to Makah NFH.

- Makah Nation fertilizes the eggs in a 4x4 factorial cross on site at Makah NFH.

- Newly fertilized eggs from each female are rinsed once and then placed in a 100 parts per million iodine solution for one hour in individual isolation buckets in the Makah NFH Isolation/Quarantine facility. After one hour the water is turned on and the iodine is diluted out.

- 100% of the adults spawned are tested for viruses. The Makah Nation and Service are currently developing a risk assessment matrix to address management actions to take for all of the possible situations if the broodstock test positive for the IHN virus.

Incubation and Rearing

- Eggs are incubated in the isolation incubation building at Makah NFH. Eggs are incubated at one female, approximately 3,000 eggs, per incubation bucket. Green to eyed egg survival rates range from 80-90%.[180]

- Eggs are incubated using Sooes River water. Temperatures during the incubation period range from 40^0F to 49^0F with a mean of 44^0F.

- At the eyed stage and after clearing virology screening, eggs are shocked, picked, enumerated, and transferred from isolation buckets to Heath trays for thermal marking. Eyed eggs are thermally otolith marked (by State and Makah Tribal personnel) by increasing the water temperature with a heating unit.

- Distinctive otolith marking during incubation requires a full 8-10 degree (F) increase in temperature which often puts eggs at risk due to elevated Sooes River water temperatures.

- Makah Nation transfers eyed eggs back to the Umbrella Creek and Stony Creek facilities for final development and hatching. Eyed eggs are not disinfected with iodine prior to transfer because they are too close to hatch after thermal marking.

[179] *Ozette Sockeye HGMP.*

[180] *pers. comm. Joe Hinton. 2008.*

- Fungus has not been a problem; however, a prophylactic formalin treatment (15 minute flow through at 167 parts per million) is administered once or twice a week to "clean" the eggs when they are moved out of the "warm" stack during the thermal marking process.

Release and Outmigration

The Service does not take part in final rearing and release. Makah Nation rears and releases the sockeye from Umbrella Creek and Stony Creek.

Facilities and Operations

- The isolation facility receives water from the Sooes River via a series of sand filters located in the hatchery building. Water is then pumped through a series of three, 5 to 10 micron canister bag filters. Next the water passes through an industrial UV sterilizer. Both the UV sterilizer and the bag filtration system are maintained and checked by Makah NFH staff.

- All effluent water is treated with chlorine utilizing a chlorine contact chamber to prevent pathogens from entering the Sooes River watershed. Operation and maintenance of the chlorine contact chamber are performed by MNFH staff.

- The facility does not have chillers. Instead, it uses heater units for thermal marking.

- The facility has adequate backup equipment including pumps, heater units, filters, and UV bulbs.

- The facility is equipped with low water and security alarms.

Research, Education, and Outreach

See the Makah NFH Fall Chinook section for Research, Outreach, and Education benefits.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[181] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- None identified or intended. This is a recovery program.

Conservation Benefits

- The program reduces the demographic risk of extinction of the Lake Ozette sockeye population.

Research, Education, Outreach and Cultural Benefits

[181] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

- This program will provide information as to whether supplementation can rebuild the tributary spawning aggregations and to test whether sockeye can be successfully reintroduced to the point where there are established self-sustaining tributary spawning populations without impacting the natural beach spawning populations. In addition, a pilot study is proposed to investigate the feasibility of restoring beach habitat near the mouth of Umbrella Creek, an historical use area where no beach spawners occur at present, and introducing program eggs into artificial redds along the beach to determine if this type of supplementation could potentially aid in recovery efforts.

- The program will provide significant cultural and educational benefits to the Makah Nation. Ozette Village, located at the mouth of the Ozette River, was historically a large tribal settlement where sockeye returning to Lake Ozette was an important food source.

- The program's associated research will answer many of the questions outlined in the research portion of the program summary. This research should provide substantial benefits to the scientific community as well as the Makah Nation in recovering sockeye to Lake Ozette and potentially other sockeye ESU's.

- The Proposed Recovery Plan (PRP) outlines numerous educational and outreach benefits relating to the recovery of Lake Ozette sockeye. Some highlights include; the implementation of an outreach plan to inform fishers and general public regarding the negative impacts of non-native fish and plants on native species, habitat, and the Lake Ozette ecosystem; produce a three to five page summary brochure or handout describing the key parts of the Lake Ozette Sockeye Recovery Plan and highlighting the recovery actions that can be carried out by the public and landowners; develop a clearinghouse of information about recovery plan implementation to keep partners and the public informed about progress on recovery actions; produce educational materials that can be used in the local schools, community colleges, and community centers to educate children about needed recovery actions; work with Olympic National Park staff to develop materials, posters, and display boards to educate the public visiting Lake Ozette about the need to recover sockeye salmon and the recovery actions being carried out within the Park; develop public education information that can be posted on the NOAA Fisheries, Olympic National Park, Olympic Coast National Marine Sanctuary, and Clallam County's NOPLE web sites. Identify other opportunities for web postings of recovery information; lead seasonal tours of the watershed so the public can observe spawning sockeye salmon and visit recovery project restoration sites.

- If successful, the program may contribute to the delisting of Lake Ozette Sockeye and restoration of Makah subsistence and ceremonial harvest of sockeye salmon.

See the Makah NFH fall Chinook section for additional Research, Education, Outreach and Cultural Benefits.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[182] the Review Team identified the following benefits of this program:

[182] *Ibid.*

Harvest Benefits

- None identified or intended.

Conservation Benefits

- None identified.

Research, Education, Outreach and Cultural Benefits

- This program could provide information useful for the recovery of other depressed northwest sockeye populations.

See the Makah NFH fall Chinook section for additional Research, Education, Outreach and Cultural Benefits.

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[183] the Review Team identified the following risks of the hatchery program:

Genetic Risks

- The hatchery program poses a genetic risk to the population's spatial structure by potentially preventing distinct shoreline and tributary spawning populations to develop and evolve naturally.

- There is an inherent risk of domestication associated with the program. The program attempts to minimize the effect of domestication by: randomly collecting adults throughout the run, ensuring that the proportion of clipped hatchery-origin to natural-origin fish used for broodstock is similar to what is occurring on the natural spawning grounds, minimizing the time the sockeye are in the hatchery, and limiting production to three sockeye generations or 12 years.

Demographic Risks

- There is a spatial structure risk associated with the transition of the Ozette sockeye population from a beach spawning to primarily a creek spawning population as a result of supplementation. However, beaches have been degraded as a result of deforestation allowing fine sediments to be flushed into the lake and imbed in the rocky substrate. Therefore, there may be some demographic benefit as well.

- Potential for catastrophic loss in the isolation incubation building, the staging facility, remote rearing sites, or during transport.

- The heating unit used for thermal marking poses a risk to the sockeye reared in the isolation incubation building.

[183] *Ibid.*

Ecological Risks

- Hatchery-reared sockeye may have greater vulnerability to predation than naturally-produced smolts.

- A high level of predation and competition from indigenous species including cutthroat and rainbow trout, northern pikeminnow, and non-indigenous, introduced species including yellow perch and large-mouth bass pose an increased ecological risk given the small sockeye population size, and small individual fish size at release associated with the hatchery component of the population. Marine mammal predation also poses an ecological risk.

Physical Risks

See the Makah NFH fall Chinook section for Physical Risks

Research, Education, Outreach and Cultural Risks

- If this program does not succeed at recovering the Lake Ozette sockeye population, there is an increased likelihood that the Makah Nation could lose a culturally relevant population of salmon.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[184] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- The sockeye program poses a risk of hybridization with the native kokanee population.

Demographic Risks

- The operation of an adult collection weir can result in incidental take of other species in the watershed.

Ecological Risks

- None identified

Research, Education, Outreach and Cultural Risks

- None identified.

[184] *Ibid.*

Recommendations for Current Program[185]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current program. Preceding each numbered recommendation is a brief summary of the issue.

Program goals and objectives

None identified.

Broodstock Choice and Collection

None identified. The Service does not take part in broodstock collection. Broodstock are collected by the Makah Nation.

Hatchery and Natural Spawning, Adult Returns

None identified. The Service does not take part in spawning the adults. The Makah Nation spawns the adults and fertilizes the eggs.

Incubation and Rearing

No issues identified.

Release and Outmigration

None identified. The Service does not take part in final rearing and release. Makah Nation rears and releases the sockeye from Umbrella Creek and Stony Creek.

Facilities/Operations

Issue MK45: Elevated Sooes River water temperatures in the incubation building water supply make it difficult to safely heat the water to a full 10 degree increase in order to apply a distinct, consistent otolith mark. *The Lake Ozette sockeye incubated in the Makah NFH isolation building are marked using Sooes River water and a water heating unit.*

[185] *The Review Team believes that the Makah NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

Recommendation MK45: Acquire a chilling unit to bring the incubation water temperature down to a safe range for thermal otolith marking.

Research, Monitoring, and Accountability

No issues identified.

Education and Outreach

See the Makah NFH fall Chinook section for Education and Outreach issues/recommendations

Alternatives to Current Program

The Review Team considered the benefits and risks of the existing Lake Ozette Sockeye program at Makah NFH and developed four alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

Alternative 1: Current program with recommendations

Maintain the existing Ozette sockeye program with full implementation of all recommended changes. Continue to incubate 305,000 Ozette sockeye eggs to the eyed stage for transfer to Umbrella (122,000) and Stony (183,000) Creeks remote tribal sites for incubation, rearing and release. .

Pros

- Contributes to recovery efforts for *threatened* Lake Ozette sockeye.
- Maintains and improves the quarantine facility for present and future use.
- Provides continuous pathogen-free water supply for incubation of Ozette stock embryos.

Cons

- Disease risk associated with the handling and inter-basin transfer of fish.

Alternative 2: Use the isolation quarantine facility to support hatchery production for the restoration of other naturally spawning populations in the region (could be combined with other alternatives)

Makah NFH is located in an area with a large number of conservation needs and priorities. The isolation facility could be used to aid in the recovery of other species where life stages do not overlap with the Lake Ozette sockeye. Additional rearing space could be utilized for conservation programs initiated at Makah NFH. However, utilizing additional rearing space would likely require reductions to current on-station production.

Pros

- Provides the opportunity for Makah NFH to contribute to conservation programs for other populations of salmon and steelhead.
- Contributes to the long-term conservation and recovery goals for listed or otherwise depleted salmon and steelhead populations on the Olympic Peninsula.

Cons

- May require additional investments in infrastructure depending on program choice.
- If the nursery building and outdoor raceways are utilized for conservation programs, this may reduce the amount of rearing space available for the current production of fish for harvest, including valuable tribal fisheries.

Alternative 3: Discontinue rearing of Ozette sockeye

Pros

- Reduces costs associated with maintaining and operating capital infrastructure.
- Reduces disease risks associated with bringing fish in from other watersheds.

Cons

- Makah Nation may lose a culturally relevant population of salmon.
- The ESA recovery plan for Ozette Lake sockeye may fail or be significantly delayed.

Alternative 4: Terminate the program (and all other programs at this facility) and decommission the facility

Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

- Same pros and cons as Alternative 3 under the Makah NFH fall Chinook program.

Recommended Alternatives

The Review Team recommends Alternatives 1 and 2. The Team agrees with the proposed term of the existing sockeye supplementation program, which is to discontinue in 2012 with a follow-up assessment of whether supplementation was successful as well as determination of future management needs, if any, associated with artificial propagation of Ozette Lake sockeye.

The Service commends the project managers on this well designed and operated program. The program should continue as described in the Ozette Lake Sockeye Recovery Plan. This is also consistent with the Puget Sound and Coastal Washington HSRG recommendation for the program.

The Review Team believes that the isolation capability at Makah NFH may also be an important tool in other restoration and recovery programs in the Olympic Peninsula area (Alternative 2). The Team urges the Service to work with state and tribal managers to identify other priority uses for this facility.

VI. Conclusions

The Team concluded that Quilcene, Quinault, and Makah National Fish Hatcheries are effectively performing their original intended functions of providing fishing opportunities to partially replace those lost due to habitat alteration in the Olympic Peninsula region. Each of the three facilities works closely with Indian Tribes in their local area and provides important economic, social, and cultural benefits to tribal members. This is a very significant role for these facilities and should remain a Service priority. While the Team identified some ways in which the individual facilities can improve their success in providing fish for harvest opportunities, many of the Team's recommendations address means to better protect naturally spawning populations from possible adverse effects of production hatchery releases and opportunities to utilize available facilities to assist in restoration of depleted or ESA listed populations.

Quilcene NFH is balancing its coho rearing capacity against the effects of harmful algal blooms in North Hood Canal which place limitations on the use of net pens. The Team recommends downsizing the coho program to reduce the risk of fish losses. Quilcene NFH is located in an area facing numerous fish restoration challenges. The facility previously contributed to Big Quilcene River summer chum recovery and is making a major contribution to steelhead recovery efforts. Opportunities exist to assist Chinook recovery in central Hood Canal and steelhead restoration in the Big Quilcene River. The facility is approaching one hundred years old and future renovation plans should take into account ways to better equip Quilcene NFH for future conservation missions.

Quinault NFH deals with significant disease risks and summer low flow issues which limit its rearing capabilities. The facility operates five programs which are closely integrated with the management strategies of the Quinault Indian Nation and Hoh Tribe. The Team concluded that an opportunity exists to shift species with the Lake Quinault Pen Rearing program to increase the effectiveness of programs at both facilities. The small steelhead program in the Hoh River is in need of modification in consultation with tribal and state comanagers. It may be possible to transition this program to a wild fish only management strategy in the future.

Makah NFH also deals with significant summer low flow and elevated temperature issues. This facility maintains a close working relationship with the Makah Nation. Information collection, data analysis, and coordination needs to move forward in order to gain a better understanding of future management strategies for natural production in the Sooes and Waatch Rivers. Hatchery programs here need to evolve as new management strategies are put in place. The Makah Nation and the staff of Makah NFH are to be commended for their efforts toward restoration of Lake Ozette sockeye.

Each of these National Fish Hatcheries has isolation and early rearing capability for small conservation programs. The Service should actively seek opportunities to partner with comanagers in developing and implementing new conservation/recovery programs where needed.

Appendices

Appendix A: Olympic Peninsula NFHs Briefing Document

Available from the Pacific Region Hatchery Review website, www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/

Appendix B: Comments on Draft Report and Review Team Responses

Available from the Pacific Region Hatchery Review website, www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/

Appendix C: Complete Text of Comment Letters Received from Stakeholders

Available from the Pacific Region Hatchery Review website, www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/

Appendix D: Olympic Peninsula NFHs Operations and Maintenance Costs Summary

Available from the Pacific Region Hatchery Review website, www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/

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The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people.

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