INTRODUCTION

This report was funded by the "Puget Sound and Coastal Washington Hatchery Reform Project." The goals of the hatchery reform project are to "conserve indigenous genetic resources, assist with the recovery of naturally spawning populations, provide for sustainable fisheries, conduct scientific research, and improve the quality and cost-effectiveness of hatchery programs" (Gorton Science Advisory Team 1999).

This report presents options and recommendations regarding anadromous fish use of the habitat above the Quinault National Fish Hatchery (NFH) in Cook Creek. Quinault NFH presently blocks anadromous fish access to at least 8 miles of mainstem creek and to several small tributaries. Restoration of anadromous fish access to this reach of Cook Creek is consistent with the goals of the hatchery reform project.

This work also supports several goals of the U.S. Fish and Wildlife Service (FWS). The FWS adopted an ecosystem approach to resource management several years ago. Teams were established within the North Pacific Coast Ecoregion to discuss and identify ecosystem concerns and possible corrective actions for implementation. Salmon use of stream habitat above human-caused impasses (fish hatchery weirs, for example) surfaced as a priority concern during a North Pacific Coast Ecoregion meeting in August of 1999.

Fish passage improvement has also been identified as a priority effort within the work activity guidance in the FWS Region l Fisheries Program (Diggs 2002). The program guidance specifically states that "Where we have created impediments to fish passage, we must remove them."

In addition to the Region 1 program, a national "Fish Passage Program" is being developed (FWS 2000). The national program goal is to "Restore native fish and other aquatic species to self-sustaining levels by reconnecting historical habitats and re-establishing watershed function through removal of, or passage around manmade barriers."

While the topic of habitat use above our National Fish Hatcheries is currently receiving regional and national attention, it is not a new subject for the Quinault NFH Hatchery Evaluation Team. This team consists of FWS staff from Quinault NFH, the Olympia Fish Health Center, and the Western Washington Fish and Wildlife Office. The team continues to discuss and direct hatchery operations, including use of stream habitat above the hatchery.

We considered salmon restoration in Hatchery Creek, which serves as the nursery's water source. However, disease risk and cost of facility modification prohibit restoring salmon to the Creek at this time. This report assumes no changes to current hatchery production with recommendations discussed herein, because of management constraints described throughout.

OBJECTIVES OF RESTORED SALMON USE

An objective of restoring salmon access to streams that are either void of or under-seeded regarding salmon populations is to optimize fish production from the freshwater environment where humans have created impasses to salmon migration. Historically, this effort was directed primarily towards hatchery programs that were initiated to mitigate for declining wild populations and lost harvest opportunities. Ironically, in many cases this caused a further decline in wild populations since they could not be separated from abundant hatchery stocks in the harvest areas and were subsequently over-harvested. Recently, listings of several populations of salmon under the Endangered Species Act have resulted in closed fisheries or changes in harvest methods. These changes are designed to allow weak populations access to freshwater habitats for spawning. In streams where wild populations are not threatened by hatchery stocks, making additional freshwater habitat available to salmon may result in increased salmon production and subsequent increased contributions to commercial and sport fisheries.

Another objective is to restore some level of “natural selection” pressures if we allow anadromous fish to use the available habitat. In the process of evolution, natural selective forces have chosen the combination of traits that will best enable organisms to survive in their natural environment. These traits may or may not be apparent to us, but we know that unique combinations of genes develop in response to specific environmental influences (Hershberger and Iwamoto 1983). Some scientists believe that hatchery fish have been genetically altered as a result of many years of human selection of matings, stocks, run timing, and other fish cultural practices (Reisenbichler and Rubin 1999). These authors argue that artificial propagation results in significant genetic change which lowers fitness. Fitness in this case refers to the ability to naturally propagate.

A third objective is to enhance stream productivity through nutrient enrichment. As carcasses decompose, they provide a significant amount of the nutrients that are incorporated into the stream food web (Kline *et al.* 1990; Bilby *et al.* 1996). Carcasses are a direct food source for juvenile salmonids. Also, many salmonid carcasses are hauled out of streams for consumption by terrestrial animals and subsequent nutrient cycling through the terrestrial system (Cedarholm *et al.* 2000).

PROGRAM MANAGEMENT

The Quinault NFH is located on Cook Creek 4.5 miles above its confluence with the Quinault River. The Quinault River then flows approximately 16.5 miles before entering the Pacific Ocean (Figure 1). The Quinault NFH was established in 1968 “...to restore and enhance depleted runs of salmon and steelhead on the Quinault Indian Reservation and adjacent Federal lands...”.

The current fish production program at Quinault NFH is consistent with existing “operational” (FWS 1995) and “station development” (FWS 1988) plans as well as a cooperative

agreement (FWS and Quinault Indian Nation 1991) and a memorandum of agreement (Bureau of Sport Fisheries and Wildlife and the Indians of the Quinault Indian Reservation of Washington 1965). Modifications to the fish production program are discussed as needed with Quinault Nation representatives. The Washington Department of Fish and Wildlife (WDFW) is not involved with on-reservation fish production. Agreement by the parties is required before a change in production can be implemented, as required by the aforementioned plans and management agreements.

Each year's proposed fish production program is further communicated with the State and Tribal co-managers through the annual Future Brood Document process that includes all Washington hatcheries. This process was originally initiated as a result of the Boldt decision and the court order for the co-managers to communicate fish production activities (Andy Appleby, WDFW, per. comm., 2000). The current production program includes releases of 1.5 million fall chum, 600,000 fall Chinook, 600,000 coho salmon, and 190,000 steelhead trout into Cook Creek. We also release 50,000 steelhead trout yearlings into the Hoh River and 60,000 coho sub-yearlings into a beaver pond adjacent to the Quinault River. The hatchery also transfers 50,000 steelhead trout sub-yearlings to the Chalaat Creek facility operated by the Hoh Tribe. The overall production program, including the species and numbers produced, has remained fairly stable over the last 10 years.

The Quinault Lake Pen program, operated by the Quinault Nation, also produces fish for release into the Quinault system. The program includes releases of about 400,000 fall Chinook salmon and 200,000 winter steelhead trout. A sockeye salmon production effort was renewed in 2000.

While the programs at Quinault NFH and Quinault Lake combined represent a considerable production program, the Quinault system also supports significant populations of naturally produced salmonids. However, the Quinault Nation's fishery is managed primarily for hatchery production with natural production given secondary consideration.

CURRENT PROGRAM

The original electric weir was replaced in 2002. The new design consists of electrodes embedded
in a concrete deck that emits a graduated electrical field that increases with water depth diverting all fish into the hatchery ladder. The weir is also fitted with a bypass section that can be deactivated to allow upstream fish movement. The weir is not a physical block to fish movement if it is not electrified. Usually, the weir is activated year round.

Active passage of adult salmonids into habitat above the hatchery has never occurred. However, some fish are known to move upstream during power outages and high flow events (Tom Kane, FWS, per. comm., 1999).

FISH HEALTH ISSUES

Returning adult fish may harbor large numbers of pathogens that are released into the environment with the eggs and fluids during spawning and subsequent carcass decomposition. This is probably the most significant period of pathogen transmission. A second period of high pathogen release may occur during hatching and emergence of the fry. If these activities occur above the water intake, infectious agents may be showered onto the juvenile fish in the hatchery. Relative risk depends on pathogen density, susceptibility of the hatchery fish to specific pathogens, and stream flow.

With low numbers of pathogens occurring in the water supply, control measures may be used within the hatchery to minimize the impact on the juvenile fish, frequently without the use of drugs and chemicals. Measures could include reduced rearing densities, pond manipulations, or more frequent carcass removal from intake grates. Maintaining a healthy fish population inside the hatchery with minimal use of drugs and chemicals is expected to have the least impact on aquatic populations downstream from the hatchery. If there is a large, highly infected, spawning population above the hatchery intake, juvenile fish losses may result even with the best management practices and with heavy use of approved drugs and chemicals.

The primary pathogens of concern in Cook Creek include *Renibacterium salmoninarum* (causative agent for bacterial kidney disease), *Flavobacter psychrophilum* (causative agent for bacterial coldwater disease), and *Infectious Hematopoietic Necrosis Virus* (IHN). Pathogens that cause bacterial kidney, bacterial coldwater, and enteric redmouth (*Yersinia ruckeri)* diseases have been isolated from juveniles at the hatchery during inspection testing. Pathogens that cause bacterial kidney disease, enteric redmouth, and furunculosis (*Aeromonas salmonicida)* have been isolated from the adults.

Potential disease problems caused by passing infected adults upstream of the hatchery's water supply have been discussed as a concern regarding an adult passage program. While the disease concern still persists, fish health biologists realize that suitable habitat should be used for natural fish production but may recommend modifications to fish hatchery operations to minimize the disease risk if an adult passage program is initiated.

HABITAT and SALMONID FISH USE

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 U.S. Forest Service (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 1). Tribal and Rayonier Timberlands Operating Company lands are managed for timber harvest. The majority of USFS land in the Cook Creek watershed is designated as "Late-Successional Reserve." The goal of this designation is 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).

Cook Creek mainstem length is about 12.8 miles. There are also approximately 25 miles of tributaries entering Cook Creek. There are no known impasses to upstream fish migration except for the hatchery weir itself during operation, the hatchery intake (it is fitted with a bypass ladder), possibly the culvert on the Moclips Highway at RM 10.3 (Figure 1), and seasonally established beaver dams and log jams. It is unlikely that adults could proceed up Cook Creek beyond the Moclips Highway culvert at RM 10.3 if they were allowed access above the hatchery (View 1). However, juvenile outmigrants should have no problem maneuvering through these impediments. Nevertheless, potential juvenile planting locations will not be considered above the Moclips Highway due to safety reasons at the Highway 101 crossings and access reasons on the other tributaries.

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

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 (Views 2 and 3). Riparian vegetation consists of stands of alder and conifers, as well as areas of smaller plants such as vine maple and salmon berry (Views 3 and 4). 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% 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 to about 10 cubic feet per second at the hatchery (Glenn Green, FWS, 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 1) (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.

However, during a site visit by FWS staff to the same reach (RM 5.0 to 8.5) in September 2000, observations of gravel bar abundance, morphology, and sediment structure appear to indicate substantial bedload sediment movement with concomitant tendencies for scour and bar instability (Paul Bakke, FWS, 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 cutbanks in glacial outwash terraces provides ample gravel supply and, currently, much recruitment potential for moderately large wood (mostly red alder). Active cutbank 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 FWS staff in the reach between RM 8.5 to 9.3.

Currently, coho, fall Chinook, fall chum salmon, steelhead, and cutthroat trout use Cook Creek below the Quinault NFH. The creek above the hatchery is used by cutthroat and steelhead trout and a few coho and chum salmon that infrequently escape past the hatchery electrical weir during power outages and high water caused by storm events. One observation of three bull/Dolly Varden trout was made just below the hatchery weir during a bull/Dolly Varden trout survey training session in June 2000 (Brian Missildine, FWS, per. comm., 2000). A fin tissue sample was removed from an individual fish during salmon spawning operations in 2001. The sample was identified by the University of montana as a bull trout. However, Cook Creek does not provide optimum bull trout spawning and incubation temperatures. The observed bull/Dolly Varden trout were probably taking advantage of the abundant food source provided by hatchery juvenile releases, escapees, and discarded mortalities. Also, the Olympic Mudminnow, a Washington State identified sensitive species, is reported to inhabit the watershed.

Limited sampling suggests that there is production potential in the section of creek above the hatchery. Juvenile coho salmon were captured above the hatchery in 1997 during FWS National Wild Fish Health surveys, indicating that adults that moved upstream during high flow events spawned successfully. Juvenile coho salmon and trout were seen during a snorkel survey from the hatchery weir to the intake (Jason Dunham, USFS, per. comm., 2000). Also, adult coho salmon mark-return ratios may indicate that some production is being realized from naturally spawning adults above the hatchery (Kane 1996).

OPTIONS

Following are three options that could be considered, either individually or in combinations, regarding salmonid use of the habitat above Quinault NFH: 1) adult passage, 2) juvenile planting, or, 3) adult carcass distribution for stream/nutrient enhancement purposes. All three options are directed towards the section of creek between the hatchery at RM 4.5 and the suspected impassible culvert at the Moclips Highway crossing at RM 10.3 (View 1). The creek downstream of the hatchery is already being used by coho, chum, and Chinook salmon, and steelhead and cutthroat trout, as well as the occasional bull/Dolly Varden trout.

Option 1: <u>Adult Passage.</u> The advantage of initiating an adult passage program is that all project objectives could be accomplished. Additional freshwater salmon production could contribute to all fisheries. Mate selection and subsequent juvenile survival would experience "natural selection pressures." Spent carcasses would contribute to the ecology of the stream by providing flesh for aquatic and terrestrial organisms and nutrients to the system during decomposition.

A new weir was constructed in 2002 that is fitted with a bypass channel that can be operated separately from the main weir electrical field. Under this option the channel could be de-activated and adults counted as they pass through.

There is some risk associated with infected adults shedding pathogens into the hatchery water supply. Since part of our current production program includes a release and a transfer of juvenile steelhead trout to the Hoh River, the hatchery water supply must remain regulated pathogen-free, or if it is not, an exemption from the co-managers' salmon disease control policy must be obtained (Northwest Indian Fish Commission and WDFW 1998). An exemption has been in place for several years since the water supply is not pathogen free. Returns from these juvenile plants support the main Hoh Tribal fishery (Jim Jorgensen, Hoh Tribe, per. comm., 2000). An adult passage program would negate the exemption.

The agencies are currently exploring alternatives to the Hoh program with respect to stock and rearing location. The current exemption to the fish health policy is conditional and stipulates that the last transfer will occur with brood 2001. If no other exemptions are approved, the Hoh program at Quinault NFH will end with brood 2001 juveniles that would be transferred in late 2001or early 2002. If the Hoh program is terminated or moved, coho salmon and steelhead trout would be the preferred species in an adult passage program at Quinault NFH. All of the chum and Chinook salmon that enter the hatchery are needed for production purposes. Also, cutthroat and bull/Dolly Varden trout would be passed as well.

Option 2: <u>Juvenile Planting.</u> The advantages in considering this option are the ability to plant specific pathogen-inspected fingerlings, minimizing fish health concerns that arise in an adult passage program, and allowing continuation of the Hoh River program via Quinault NFH if future exemptions are approved. It would satisfy the objectives of increasing production from the additional freshwater environment and imposing natural selection pressures on a part of the population.

The objective of enhancing stream productivity through nutrient enhancement would not be accomplished. And, in theory the lack of carcass derived nutrients may limit survival of juvenile stocking. However, adult salmon are recorded to move upstream past the hatchery during storm events and power outages. Consequently, some nutrient enhancement is occurring annually. Access points are limited to a culvert crossing on the Moclips Highway at RM 10.3 and a bridge crossing at RM 8.5 on Rayonier Timberlands (Figure 1). However, planted fry should distribute mostly downstream (Roger Peters, FWS, per. comm., 2000).

The low stream gradient and lack of same-species competition should facilitate dispersion. The bridge crossing at RM 8.5 has a gated access road that is owned by Rayonier Timberlands Operating Company. Access to the bridge crossing via the gated access road should be no problem (Rayonier Timberlands Operating Company, per. comm., 2000).

Coho salmon and steelhead trout are the preferred species. Juveniles are expected to inhabit the stream for 1 or 2 years before emigration. The juveniles would experience natural selection pressures during their residence. A production parameter of 1.12 coho salmon smolts produced per linear meter of stream (Baranski 1989), a 7.3% coho salmon fry-to-smolt survival factor for May outplants (Scott Chitwood, Quinault Nation, per. comm., 1989), and approximately 5.8 miles of stream length may be used to calculate the appropriate number of juvenile coho salmon to plant. For steelhead trout, production parameters of 16.85 parr produced per 100 square meters of stream (Johnson *et al.* 1988), a fry-to-parr survival rate of 35% (Thom Johnson, WDFW, per. comm., 2001) and an estimate of 42,676 square meters of stream may be used to calculate the appropriate number of juvenile steelhead trout to plant. Again, chum and Chinook salmon are needed for hatchery production purposes, while additional coho salmon and steelhead trout could be spawned for fry planting purposes.

Option 3: <u>Carcass Distribution.</u> Carcass distribution would meet the objective of enhancing stream productivity and providing another food source to the ecosystem. It would not, however, actually be using the habitat for fish production. Also, all of the carcasses would require specific pathogen inspection and frozen storage until the inspection results were known. Only specific pathogen-free carcasses could be used so that the Hoh River program would not be impacted. This option is not advantageous when compared to Option 2.

DISCUSSION and RECOMMENDATION

We recommend pursuing Option 2, juvenile planting, until a long term solution can be found regarding the Hoh River steelhead trout program. We recommend planting up to 143,000 specific pathogen-inspected coho salmon fry and up to 20,500 specific pathogen-inspected steelhead trout fry. The fry should represent the parent entry timing and be distributed proportionally with about two thirds of each species released at the access point at RM 8.5 and the remainder at the RM 10.3 crossing.

This recommendation would be changed to an adult passage program if, in the future, an alternative to the current Hoh River steelhead program can be found or if the program is otherwise terminated. This would likely require the transfer of the Hoh program from the Quinault NFH to another facility within the Hoh River fish health zone to comply with the restrictions in the co-managers' salmonid disease control policy.

Neither program will be exercised at the expense of hatchery production needs, commercial and sport harvest opportunities, nor the carcass distribution program to the Quinault Nation. Carcasses not needed for scientific purposes are property of the Quinault Nation by cooperative agreement. Typically, more coho salmon and steelhead trout return than are needed for hatchery production purposes, can be effectively harvested, or are distributed for human consumption.

Co-manager Contact

The subject of using the habitat above the hatchery for salmonid production has been briefly discussed with Quinault Nation fisheries staff. Generally, the discussions have been positive and in one instance, Cook Creek was described as having the potential of being a "fish producing machine" (Scott Chitwood, Quinault Nation, per. comm., 2000). We also anticipate an internal "no effect" determination regarding impacts to bull trout with Option 2. These preliminary discussions were held to ensure that our internal recommendation was attainable and that the Quinault Nation would likely support the program. The discussion was not framed as a final proposal. Rather, it was approached as a theoretical possibility pending completion of this report and final concurrence from the Quinault Nation.

Program Evaluation

No specific program evaluation is proposed in the short-term. However, as time and funding permit, we should evaluate the resulting smolt production and subsequent adult return from juvenile coho salmon and steelhead trout plants above the Quinault NFH.

An indication of program success may be realized through our coded-wire tagging and mass marking of hatchery production. Returning ratios of marked-to-unmarked fish may provide information on natural production associated with a juvenile plant program.

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