H. Research Grants

Funded Grants - 2000 Project Descriptions

Category A: Sustainable Fisheries

Development of Field Methods to Determine the Effects of Hatchery Release Methods on Residualism and Interactions Between Hatchery and Wild Juvenile Salmonids in Relation to Stream Carrying Capacity

Project Sponsor: NMFS and WDFW

Principal Investigators: Stephen Riley, NMFS; Howard Fuss, WDFW

HSRG + Sponsor Share = Total Cost: $91,941 + $102,067 = $194,008

Associate Investigators: Todd Pearsons, Geraldine VanderHaegen, WDFW; Barry Berejikian, Walt Dickoff, NMFS

Project Summary: The objective of this project is to develop a cost-effective method to evaluate the effects of hatchery releases on wild juvenile salmonids. We propose to develop field methods designed to determine how hatchery releases affect the abundance, behavior, habitat use, growth, stomach fullness, and condition of wild juvenile salmonids. Field methods will be applied in areas upstream and downstream of hatchery release sites before and after releases, and will involve three levels of effort: a) underwater observation of numbers and behavior of wild and hatchery juveniles; b) estimation of territory size and habitat use of wild juveniles; and c) estimation of the growth, stomach content volume, and physiological status of wild and hatchery juveniles captured by electrofishing or angling. Comparisons between upstream and downstream sites will be used to determine the degree to which wild fish are affected by hatchery releases and the extent of redistribution of hatchery residuals. We will also use these data to estimate the sample size necessary to obtain adequate statistical power of all comparison, and the costs associated with each component of the study will be determined. Similar procedures could be used to evaluate hatchery releases in a variety of streams coast wide. Underwater observations will also be used to assess the level of residualism related to certain hatchery practices such as flush and volitional releases and outplanting. Ultimately, these methods could be routinely applied as part of hatchery evaluations that are likely to be required under the ESA.

Test Commercial Selective Harvest Gears

Project Sponsor: Willapa Alliance

Principal Co-Investigators: Mark Heckert,

HSRG + Sponsor Share = Total Cost:

Willapa Alliance; Geraldine VanderHaegen, WDFW — $49,260 + $53,374 = $102,634

Associate Investigators: WDFW regional staff

Project Summary: On the Naselle River, Willapa Bay, the Willapa Alliance and WDFW propose to test two commercial live capture gears to selectively remove adult hatchery fish from commingled wild stocks. Removing returning adult hatchery salmon will reduce the number of hatchery adults on the spawning grounds, and thereby reduce gene flow and ecological interactions between hatchery and natural spawners. We will also install an adult trap at Naselle Hatchery to collect hatchery broodstock. We will use a series of mark and recapture experiments to estimate long-term survival of released fish, the proportion of hatchery fish that could be removed with these gears and to collect data characterizing the run. If successful, the project will assist Naselle Hatchery in meeting its Chinook egg take goals, will remove hatchery fish from the spawning grounds, and will provide fishing opportunity for commercial fishermen and will evaluate the impacts of selective commercial fishing gear on released fish. This method of removing hatchery adults would be applicable throughout Washington. Our progress and results will be shared at community meetings, by mailings, through annual reports and by publication in a peer-reviewed journal. During the fishing season our progress will be posted daily on the internet.

Impacts of Size Selective Gillnet Fisheries on Puget Sound Coho Salmon Populations

Project Sponsor: WDFW

Principal Investigators: Curtis Knudsen, Craig Busack, WDFW — **HSRG + Sponsor Share = Total Cost:** $11,427 + $3,720 = $15,147

Project Summary: We will document historical trends in size selectivity of terminal Puget Sound and coastal gillnet fisheries by comparing coded-wire tagged recoveries from the fishery to recoveries from the terminal spawning areas (trap or hatchery). Utilizing the coded-wire tag database allows us to focus on specific marked populations of coho caught within terminal area fisheries rather than having to deal with aggregations of mixed populations making estimates of size selectivity much more accurate. Reduced body size impacts a population's productivity and the reproductive fitness of returning adults. We will describe the demographic and genetic impacts to these populations caused by reduced body size selective fisheries. The rates of decline in populations experiencing different intensities of size selection will be compared to determine if they are correlated with the magnitude of size selectivity and fishing intensity and what the background level of size decline may be from other sources such as reduced ocean productivity. Understanding the consequences of size selective fisheries will allow management decisions to be made that take into account the impacts on hatchery and wild population's productivity and reproductive fitness.

Category B: Recover and Conserve Natural Spawning Populations

Genetic Characterization of Lake Ozette Sockeye Salmon

Project Sponsor: Makah Fisheries Management

Principal Investigators: Ken Currens, NWIFC; Jim Shaklee, WDFW; Michael Crewson, Makah Tribe

HSRG + Sponsor Share = Total Cost: $22,000 + $45,920 = $67,920

Associate Investigator: Jeffrey Grimm, WDFW

Project Summary: This project provides baseline genetic and demographic information for testing 1) whether sockeye salmon and be successfully reintroduced into tributaries of Lake Ozette, where they were extinct, and 2) whether distribution and abundance of beach spawning populations can be rebuilt through supplementation. Genetic profiles of Lake Ozette sockeye salmon, which are protected under the ESA, and kokanee salmon, which are not, are necessary to guide brood stock selection and to monitor hybridization and gene flow. Profiles will be developed from 6-8 microsatellite DNA loci. The ability to mark and identify hatchery is also essential to monitor recovery efforts, but most hatchery-produced sockeye salmon will be released before external marking are possible. Consequently, this project tests eolith marking as a tool. The combination of genetic data and otolith marking will allow the co-managers to develop effective strategies to monitor abundance, distribution, and interactions among natural and hatchery populations. Project results will be summarized in a final technical report to the funding agency, co-managers, and National Marine Fisheries Service (NMFS) and will be incorporated into the Hatchery Genetic Management Plan and recovery plan for Lake Ozette sockeye salmon.

White River Acclimation Pond Evaluation

Project Sponsor: WDFW

Principal Investigators: Chuck Baranski, WDFW; Blake Smith, Puyallup Tribe; Richard Johnson, Muckleshoot Tribe

HSRG + Sponsor Share = Total Cost: $40,508 + $154,368 = $194,876

Associate Investigator: Curt Knudsen, WDFW

Project Summary: One strategy employed to increase natural spring Chinook spawning in the upper White River is to release smolts from three upriver acclimation sites (Huckleberry Cr., Cripple Cr., Clearwater R.). Survival from smolt to spawner and the distribution of pond-origin spawners have not been adequately evaluated. If survivals are low or if returning adults are widely distributed in the Puyallup basin (particularly into fall Chinook production areas), alternative strategies will need to be developed. Standard CWT tagging is not a suitable took in this case

because all nose tagged fish are removed from the upriver population. This proposal would utilize "body tagging" as a means of identifying and evaluating these smolt releases. The SSSCTC proposes that WDFW "body tag" (no marks) a total of 400,000 White River Chinook fry at Hupp Springs and White River hatcheries prior to their transfer to the acclimation sites. Tag retention will be estimated at release. Survival and spawning distribution will be quantified by sampling unmarked Chinook returns to White River Hatchery (Muckleshoot Tribe), the Buckley trap and haul facility (Muckleshoot and Puyallup Fisheries staff), Voights Creek Hatchery (WDFW) and Puyallup basin natural spawning grounds (WDFW, Muckleshoot and Puyallup staffs). SSSCTC proposes to tag a complete brood cycle (5 years). Results will be presented annually in the *Northwest Fishery Resource Bulletin's* Project Report Series.

Differences in Natural Production between Hatchery and Wild Coho Salmon: A Proposal to Measure the Influence of the Degree of Hatchery Ancestry on Natural Production Success

Project Sponsor: WDFW and NMFS

Principal Investigators: Howard Fuss, Patrick Hulett, Cameron Sharpe, WDFW; Ken Currens, NWIFC; Michael Ford, Jeffrey Hard, NMFS

HSRG + Sponsor Share = Total Cost
$146,973 + $96,496 = $243,469

Project Summary: Natural production of coho will be evaluated to measure (and identify causal factors for) differences in reproductive competence between hatchery and wild fish. Analyses of morphological (size/age/fecundity/body shape), behavioral (run-time/spawning/rearing), and genetic (msDNA) data will be used to carry out two phases of work. Phase 1 (from 2000 to 2005) will examine reproductive success of hatchery and wild coho spawning together. Phase 2 (from 2006 to 2011) will examine reproductive success of the adult offspring of the Phase 1 fish. Those fish are wild but individually will have varying degrees of hatchery ancestry. Phase 1 will directly measure the ability of hatchery coho to reproduce in the natural environment relative to wild fish of similar genetic backgrounds n the same basin. Phase 2 will allow a determination of the genetic basis for differences in reproductive success between hatchery and wild fish. To facilitate this research it is essential to modify the existing barrier at Minter creek Hatchery in south Puget Sound to control access of salmonids to Minter Creek spawning grounds. The project will be conducted as a partnership between WDFW, NMFS, and the NWIFC. In addition to annual progress reports, final reports or peer-reviewed publications will be produced at the end of each major research phase. The work will increase understanding of differences in reproductive fitness between hatchery and wild fish and, further, will demonstrate how a large hatchery program can be managed without conflicting with natural production objectives in the same watershed.

Snow Creek Coho Recovery Program

Project Sponsor: WDFW

Principal Investigators: Steve Schroder, Thom Johnson, WDFW

HSRG + Sponsor Share = Total Cost
$10,000 + $46,208 = $56,208

Collaborators: Wild Olympic Salmon, North Olympic Salmon Coalition

Project Summary: In the mid-nineteen seventies, as many as 1,400 adult coho and thousand of coho smolts were observed in Snow Creek, a Discovery Bay stream. However, drastic reductions in adult (often<100 and as few as three) and smolt abundance have occurred since 1991. Beginning in the fall of 1998, WDFW and local volunteer groups began an effort to recover this stock. Every returning adult was captured at a permanent weir located near the mouth of the stream. The fish were artificially spawned and their eggs were incubated at the Hurd Creek Hatchery. Eggs from each female were split into three portions, and each group received a unique thermal otolith mark for later identification. Eggs from two of the groups were placed into remote site incubators that were established in Snow Creek and its main tributary, Andres Creek. The remaining eggs were left in the hatchery and the fish produced form them were cultured for either seven or ten months. The reared fish received CWTs. Those fed for seven months had tags placed in their snouts while those reared for ten months had tags placed in their adipose fins. The fish reared for seven months were released into Crocker Lake in November. The second group of reared fish will be place into Crocker Lake in late February. They are expected to over-winter in the lake and emigrate out of system in the spring of 2000. This approach will be continued annually until 2006 and if abundance increases, coho will be allowed to spawn naturally in the system to produce another type of treatment. The objectives of this study are to assess how many smolts are produced from each type of release, to see if size and out-migration timing differ because of treatment origin, to compare the marine survival of smolts originating from each type of release, to determine how differing rearing treatments may have affected adult attributes (e.g. incidence of precocious maturity, size, fecundity, egg size, reproductive effort) and to examine how annual variation in environmental condition may affect fish from each treatment. Results will be presented in the peer-reviewed literature, and annual reports describing project accomplishment will be produced. Data obtained from this work will be used to refine coho recovery efforts throughout Puget Sound and the Washington coast.

Hamma Hamma River Steelhead Supplementation Evaluation

Project Sponsor: NMFS

Principal Investigators: Barry Berejikian, NMFS; Thom Johnson, WDFW; Rick Endicott, LLTK; Al Adams, HCSEG

HSRG + Sponsor Share = Total Cost
$34,000 + $58,562 = $92,562

Associate Investigators: Chris Weller, PNPTC; Kathy Hopper, LLTK; Steve Schroder, WDFW

Collaborators: Point No-Point Treaty Council

Project Summary: Conservation hatcheries are playing an increasing role in recovery efforts for imperiled salmonid populations in the Pacific Northwest. This research will be carried out through

a cooperative partnership between non-profit organizations (Hood Canal Salmon Enhancement Group and Long Live the Kings), Washington Department of Fish and Wildlife, National Marine Fisheries Service, and the Point No Point Treaty council, established to apply conservation hatchery strategies to salmon recovery in Hood Canal. The project will evaluate the contribution of a steelhead (*Oncorhynchus mykiss*) supplementation program, implementing conservation hatchery protocols, to changes in the abundance of steelhead in the Hamma Hamma River, WA, and will determine the program's impact by comparing changes in steelhead abundance to other Hood Canal Rivers. Recent research suggests that culturing salmonids under more natural conditions, or implementing alternative release strategies may reduce genetic divergence and harmful effects on target wild populations. The project has an excellent opportunity to succeed in empirically testing the merits of using artificial propagation for conservation purposes. Results of the project will be reported annually to the funding agency and published in peer-reviewed scientific literature.

Category C: Improve Quality and Cost-Effectiveness of Hatchery Programs

Development of Engineered Streams for Salmon Production

Project Sponsor: University of Idaho

Principal Investigators: Ernest Brannon, WSU/UI; Bill Kinsel, WSU; Howard Fuss, WDFW

HSRG + Sponsor Share = Total Cost
$48,301 + $20,290 = $68,591

Project Summary: Development of an engineered stream is proposed as a new concept in hatchery supplementation. In collaboration with WDFW development of engineered streams is proposed by UI/WSU as a long-range alternative to hatcheries for supplementation of weak or failing wild salmonids populations. The objectives are to provide natural-type engineered streams for coho salmon production that result in wild smolt quality and to monitor performance as a demonstration project for the new hatchery concept. The approach is to develop artificial streams for use as salmon habitat with engineering specification based on biological criteria of the species targeted, while maintaining genetic specificity, diversity, and natural smolt quality. The artificial stream will substitute for, or be used in conjunction with, standard hatcheries. Natural feed with supplemental artificial feed will be the source of food. The site selected is Hatchery Creek located immediately behind the WDFW hatchery on the Dungeness River. The present upper creek channel will be enhanced with habitat structures, pools and riffles, and cover to mimic natural coho habitat. Coho stock will be introduced from the Dungeness by planting eyed eggs to provide the determined ultimate density of fish/m^2. Performance will be based on monitoring of fish condition at migration, residence time, and biomass sustained. Quality will be based on residence time and fish condition monitored over the residence period. Post-migration monitoring will involve adult return success based on thermal marks compared to hatchery fish. Results will be published and implemented through application at other sites.

Increase Post-Release Survival by Rearing Coho with NATURES Semi-Natural Raceway Habitat

Project Sponsor: NMFS

Principal Investigators: Desmond Maynard, Thomas Flagg, John Colt, NMFS; Geraldine VanderHaegen, WDFW

HSRG + Sponsor Share = Total Cost
$80,000 + $75,115 = $155,115

Project Summary: It has been repeatedly demonstrated that rearing Chinook salmon in NATURES semi-natural raceway habitat increases their instream survival. Here, WDFW and NMFS are proposing research to determine if NATURES rearing also increases the number of coho salmon recruiting to the fishery and spawning population. The research will be conducted with salmon grown in standard concrete raceways at Puget Sound hatcheries. At each hatchery, there will be control and semi-natural habitat raceways. The experimental habitat will be created by fitting the raceways with: 1) gravel pavers, 2) fir tree instream structure, and 3) camouflage net overhead covers. Salmon will be reared in the raceways for at least 90 days before release. Fish growth, color development, and health will be routinely monitored and compared. Experimental and control fish will be coded-wire-tagged to measure their contribution to the fishery and spawning population. NATURES semi-natural raceway habitat rearing is expected to increase the relative number of fish recruiting to the fishery and spawning population by 25%. Resource managers can use this increased survival to: 1) increase the number of recruits per smolt released, 2) reduce the number of broodstock salmon culture programs must use to produce a given number of recruits to the next generation, and 3) enhance the operational efficiency of mitigation and salmon enhancement programs. We will submit all of our results to peer-reviewed journals for publication.

Using Semi-Natural Rearing Habitat to Improve Smolt-Adult Survival of Chinook Salmon

Project Sponsor: WDFW

Principal Investigators: Geraldine Vander-Haegen, WDFW; John Barr, Bill St. Jean, Nisqually Tribe

HSRG + Sponsor Share = Total Cost
$19,092 + $20,150 = $39,242

Collaborator: Northwest Indian Fisheries Commission

Project Summary: WDFW and the Nisqually Tribe are cooperating to test the hypothesis that the addition of artificial structures to a large rearing pond will increase the smolt-to-adult survival of Chinook salmon. At Clear Creek Hatchery on the Nisqually River (Pierce County), floating and bottom structures will be installed into a large Chinook rearing pond. A second pond identical to the first will be used as a control. Fish in both ponds will be reared identically except for the

addition of the artificial structures. Growth and health of fish form each pond will be compared during rearing. Fish from each pond will be coded-wire-tagged and recoveries of tagged adults in fisheries and at the hatchery will be used to compare survival of each group of fish. If the addition of artificial structures to the Clear Creek rearing ponds increases the smolt-to-adult survival, more hatchery adults will be available for harvest, and the techniques will be directly applicable to the Nisqually Tribe's supplementation plan for recovering Chinook. The increased smolt-to-adult survival may reduce the number of wild broodstock need to produce a given number of recruits in the next generation and reduce the number of fish that must be released to provide the desired number of adults. The study will be repeated over three brood years and the final results will be published in a peer-reviewed journal. Annual report will be made available to all interested parties.

Category D: Protect Genetic Resources

Interactions between Wild and Hatchery Steelhead: Evaluating Key Assumptions

Project Sponsor: University of Washington

Principal Investigators: Thomas Quinn, UW

HSRG + Sponsor Share = Total Cost
$24,000 + $34,428 = $58,428

Associate Investigator: Paul Bentzen, UW
Collaborators: Weyerhaeuser, NMFS, LLTK, Willapa Bay Alliance

Project Summary: Natural resource agencies are challenged to not only maintain the overall abundance of salmon and steelhead but also to maintain their genetic and ecological diversity. Hatchery production, designed to achieve the first objective, sometimes conflicts with the second. To prevent deleterious interactions, steelhead in Washington have been bred to return early in the year with the hope that genetic, ecological and fisheries interactions with wild fish can be minimized. The recent establishment of hatchery steelhead at Forks Creek presents a unique opportunity to examine the assumptions underlying this innovative approach. We request funds to supplement an ongoing study, supported by the Weyerhaeuser Foundation and with cooperation form Long Live the Kings, to sample hatchery and naturally produced steelhead at discrete juvenile and adult life history stages. We will sample all adults spawned at the hatchery, and also naturally-produced fish returning to the river to spawn, as well as naturally produced juveniles in the river, smolts, and hatchery pre-smolts. Analysis of DNA microsatellites form fin-clip samples will reveal the parentage and origin of juveniles and returning adults. From this we will determine the relative production and survival of wild, hatchery, and naturally-spawning hatchery origin steelhead, and the extent of interbreeding between groups. The results will be conveyed to agency management staff, contributing sponsors and regional organization, and the scientific community.

Funded Grants - 2001 Project Descriptions

Category A: Sustainable Fisheries

Development of Field Methods to Determine the Effects of Hatchery Release Methods on Residualism and Interactions between Hatchery and Wild Juvenile Salmonids in Relation to Stream Carrying Capacity

Project Sponsor: WDFW and NMFS

Principal Investigators: Howard Fuss, WDFW; Steve Riley, NMFS

HSRG Share + Sponsor Share = Total Cost: $102,500 + $110,261 = $212,761

Collaborators: University of Washington, Weyerhaeuser Co.

Project Summary: There is currently a great deal of uncertainty regarding the effects of hatchery practices on wild salmonids, and it is important to develop standard methods to estimate the effects of hatchery releases on wild juvenile salmonids, particularly for listed stocks. This study is designed to estimate the effects of hatchery releases on wild juvenile salmonids using underwater observation and sampling for growth and condition. We will evaluate several important fitness parameters, including abundance, behavior, habitats use, growth and physiological condition. We will estimate the sample sizes and effort required to obtain adequate statistical power to determine significant differences between treatment (hatchery fish released) and control (no release) sites, and we will determine the cost effectiveness of all techniques applied. This project will result in the development of a cost-effective method to evaluate the impacts of hatchery releases on wild juvenile salmonids, including estimates of required sample sizes and costs. We will provide estimates of the ecological effects of hatchery releases on selected wild salmonids populations in western Washington, information that is needed to assess risks to ESA-listed wild salmonid stocks that are associated with hatchery operations. Ultimately, if standardized methods are applied widely, the resulting database will be useful in assessing the effects of different hatchery rearing and release practices on wild salmon population.

Test Commercial Selective Harvest Gears

Project Sponsor: WDFW

Principal Investigator: Geraldine Vander-Haegen

HSRG Share + Sponsor Share = Total Cost: $75,000 + $80,870 = $155,870

Co-investigators: Michael Johnson, Pat Verhey

Collaborators: Columbia-Pacific Resource Conservation and Development, Willapa Bay Gillnetters Association, Willapa Bay Regional Fisheries Enhancement Group

Project Summary: On the Willapa River, WDFW and the Pacific Conservation District will evaluate the effectiveness of tangle nets and a floating trap for live capture, selective harvesting of coho. Our objectives are to compare the number and condition of coho caught in the tangle net to the conventional gill net, to enumerate the catch of non-target species in each net, to compare the long-term survival of coho released from each net, to estimate the frequency and short-term survival rate of coho recaptured during the fishery, to compare the fork lengths of fish caught in each net to those spawned at Forks Creek Hatchery, and to evaluate a floating trap for capturing coho. Five fishers will simultaneously fish a net that is half tangle net and half conventional gill net in Sept 2001 and will tag and release coho. Fish recaptured during the test fishery will be held for 24 hours to observe the effects of multiple recaptures. Extensive tag recovery efforts in the sport and commercial fisheries, on the spawning grounds and from area hatcheries will continue through January 2002 to compare the long-term survival of fish released from the tangle net to those released from the gill net. A floating trap will also be deployed to target coho. We expect to collect information that will allow for science based implementation of commercial selective fisheries to provide access to more hatchery fish and to reduce the number of surplus fish returning to the hatcheries.

Salmon Marine Trophic Demand-Distribution

Project Sponsor: University of Washington

Principal Investigator: David Beauchamp, UW

HSRG Share + Sponsor Share = Total Cost: 60,000 + $31,285 = $91,285

Co-investigators: WDFW, Washington Cooperative Fisheries and Wildlife Research Unit, USGS, King County Department of Natural Resources

Collaborators: WDFW, NMFS

Project Summary: WDFW, USGS/BRD and UW will examine temporal distribution, diet and size patterns of juvenile salmon at selected estuarine and nearshore marine areas on northern and southern Puget Sound associated with significant production of wild and hatchery salmon. Chinook, coho and chum salmon will be targeted by this study, but all salmonids and potential predator and competitor species will be examined in a food web context. By combining field data on diet, distribution and growth from beach seining and fine-mesh purse seining with bioenergetics modeling, we will produce first-cut estimates of temporal feeding rates by juvenile salmon on their major prey, thus evaluating whether food limitation, predation or competition reduce survival or growth of juvenile salmon in these areas. This effort will provide a first look at current distribution and feeding conditions for juvenile salmon, establish the foundation for expanded studies, identify key processes that influence interactions among species and size classes of hatchery and wild salmonids and with other marine species. This project will provide the rationale for prioritizing and focusing subsequent research and management activities by identifying and quantifying processes that limit survival and growth of juvenile salmon during their critical early life stages in Puget Sound. We will coordinate with King County's sampling in central Puget Sound to provide the broadest possible spatial coverage using standardized methods.

Category B: Recover and Conserve Natural Spawning Populations

Snow Creek Coho Recovery Program

Project Sponsor: WDFW

Principal Investigator: Steve Schroder, WDFW

HSRG Share + Sponsor Share = Total Cost: $36,000 + $16,290 = $52,290

Collaborators: Wild Olympic Salmon, North Olympic Salmon Coalition, Point-No-Point Treaty Council, Jamestown S'Klallam Tribe

Project Summary: Beginning in 1998, WDFW, Wild Olympic Salmon and the North Olympic Salmon Coalition began an effort to recover a threatened coho population native to Snow Creek, a Northeast Olympic Peninsula stream. Since then, every adult coho returning to Snow Creek has been captured at a permanent weir. The fish are artificially spawned and their eggs are incubated at the nearby Hurd Creek Hatchery. Offspring from each fish are placed into three alternative recovery strategies. One involves placing eyed-eggs into remote site incubators located throughout the Snow Creek Basin. In the other two, fish are reared for either seven- or ten-months before being liberated as pre-smolts into Crocker Lake, a 25-hectare body of water that is used as a rearing and over-wintering location by Snow Creek coho. Fish placed into each treatment group have their otoliths thermally marked and the reared fish are also tagged. The otolith marks and tags are used to determine: 1) how many smolts are produced from each treatment, 2) if treatment origin affects size and out-migration timing of smolts, and 3) whether a recovery strategy affects overall survival, size, age, fecundity, egg size, and reproductive effort at maturation. This approach will be continued annually until 2006 and if abundance allows, coho will be allowed to reproduce naturally to create a fourth treatment type. Results from this study will be used to help refine coho recovery efforts throughout Puget Sound and the Washington Coast.

Differences in Natural Production Between Hatchery and Wild Coho Salmon

Project Sponsor: WDFW and NMFS

Principal Investigator: Howard Fuss, WDFW; Michael Ford, NMFS

HSRG Share + Sponsor Share = Total Cost: $100,500 + $76,058 = $176,608

Co-investigators: Jeff Hard, Barry Berejikian, NMFS

Collaborators: WDFW, NWIFC

Project Summary: A key question facing salmon managers is how successful hatchery propagated fish and their offspring are at surviving and reproducing in the wild. This is critical for assessing both risks and benefits of hatchery supplementation.

In this collaborative federal, state and tribal project, we are using state-of-the-art genetic techniques to evaluate the spawning success and survival in the wild of hatchery propagated and naturally-spawning coho salmon. The results of this project will, for the first time, provide information on the rate at which hatchery fish can readapt to the wild environment.

The project works like this: For three years, starting in the fall of 2000, we will intercept all adult coho salmon returning to spawn in Minter Creek, WA. The run consists of naturally produced and hatchery propagated coho salmon. Before being passed upstream to spawn naturally, we measure, photograph and tag each fish; determine its origin (hatchery or natural); and take a small non-lethal fin clip for later DNA analysis. Over the next 6 years, starting this spring, we will sample the progeny of these fish and use microsatellite DNA fingerprinting to determine their parentage. From these data, we will estimate the relative fitness of naturally spawning hatchery- and natural-origin salmon. In the years 2003-2008, we will measure the relative fitness of natural-origin fish with varying hatchery ancestry, providing data on the rate hatchery coho readapt to the wild.

Hamma Hamma River Steelhead Supplementation Evaluation

Project Sponsor: NMFS

Principal Investigator: Barry Berejikian, NMFS

HSRG Share + Sponsor Share = Total Cost: $62,500 + $70,659 = $133,159

Collaborators: Long Live the Kings, Hood Canal Salmon Enhancement, WDFW, Point-No-Point Treaty Council

Project Summary: This project addresses several aspects of the conservation hatchery paradigm including: natural growth profiles, enriched hatchery rearing habitats, release strategies and experimentation to improving captive broodstock technologies. It also evaluates the impacts of a supplementation program on changes in spawner abundance in the Hamma Hamma River where confounding variables (e.g., habitat degradation, harvest) will have minimal influence. The specific research objectives are as follows:

1. Determine whether the supplementation program affects the abundance of naturally spawning steelhead in the Hamma Hamma River.
2. Determine the relative reproductive success of female steelhead from two different reintroduction strategies (smolt vs. adult release).
3. Estimate the relative abundance of steelhead spawners produced from a) wild smolts, b) smolts reared in 'conservancy' ponds and c) smolts reared in hatchery tanks.

4. Develop rearing protocols to produce steelhead smolts with a two-year freshwater rearing history, such that growth profiles mimic those of wild fish.
5. Compare the reproductive behavior and breeding success of captively reared steelhead grown in high vs. low water velocity environments.

Category C: Improve Quality and Cost-Effectiveness of Hatchery Programs

Development of BKD Vaccine

Project Sponsor: WDFW

Principal Investigator: Jed Varney, WDFW

HSRG Share + Sponsor Share = Total Cost: $40,000 + $81,235 = $121,235

Collaborators: USGS Western Fisheries Research Center, WDFW, NMFS

Project Summary: State, tribal and federal fish health specialists in Washington state believe that bacterial kidney disease (BKD) is a major disease-of-concern for wild and cultured salmonids. Despite significant improvements in fish culture practices and the use of chemotherapeutants such as erythromycin, BKD continues to be a major factor in the propagation of many salmonid stocks in the Pacific Northwest. Because avoidance or treatment is not completely effective, vaccination may represent the most promising control method. This project is a collaborative investigation between the WDFW and researchers at the Western Fisheries Research Center (USGS) in Seattle, WA in which the relative efficacies of one commercial bacteria and five experimental vaccines for BKD, will be compared under laboratory conditions. The final objective of this study is to evaluate the potential for each vaccine to protect juvenile Chinook salmon from infection by the kidney disease bacterium. Groups of vaccinated fish will be exposed under strictly controlled environment conditions to a waterborne BKD challenge specifically designed to resemble what occurs in the natural environment. When complete, this study will provide fish health specialists with an accurate assessment of the feasibility of using any of the six vaccines for the control of BKD in cultured salmonids. If one, or more, vaccines show promise for controlling BKD, they will be evaluated in further laboratory and production-scale trials.

Increase Post Release Survival by Rearing Coho with Natures Semi-Natural Raceway Habitat

Project Sponsor: NMFS and WDFW

Principal Investigator: Desmond Maynard, NMFS

Co-Investigators: Geraldine VanderHaegen, WDFW

HSRG Share + Sponsor Share = Total Cost: $72,380 + $103,885 = $176,265

Project Summary: It has been repeatedly demonstrated that rearing Chinook salmon in NATURES semi-natural raceway habitat increases their instream survival. In the current study, WDFW and NMFS are conducting a 4-year experiment to determine if NATURES rearing also increases the number of coho salmon recruiting to the fishery and spawning population. The research is being conducted with salmon grown in standard concrete raceways at Puget Sound hatcheries. At each hatchery, there are control and semi-natural habitat raceways. The semi-natural habitat was created by fitting the raceways with: (1) gravel pavers (2) fir tree instream structure and (3) camouflage net overhead covers. Fish growth, color development and health are being routinely monitored and compared. Experimental and control fish are coded-wire-tagged to measure their contribution to the fishery and spawning population. NATURES semi-natural raceway habitat rearing is expected to increase the relative number of fish recruiting to the fishery and spawning population by 25%. Managers can use the increased survival offered by NATURES salmon culture practices to restore natural spawning runs, maintain sustainable fisheries, promote economically efficient salmon culture, and reduce ecological interactions with ESA listed wild salmon populations.

Nature vs. Nurture: Do Hatchery Practices Impair Brain Development?

Project Sponsor: NMFS

Principal Investigator: Penny Swanson

HSRG Share + Sponsor Share = Total Cost: $30,000 + $15,800 = $45,800

Project Summary: Fish reared in hatcheries are generally less fit to survive in the wild than naturally-reared fish, but the underlying causes (genetic selection or rearing environment) are not known. Numerous studies have demonstrated behavioral differences between fish reared in conventional hatcheries and wild fish. More recently it has been shown that various regions of the brains of hatchery and wild trout differ considerably in size, but the underlying causes of the brain differences are unknown because fish from this study were from different genetic stocks. The observations on behavior and brain size in salmon and trout are not surprising in view of the recent work in mammals demonstrating that environment can directly impact neural plasticity, development and behavior. In the proposed research, we will determine the effects of rearing environment on brain development in juvenile steelhead reared at the UW, Big Beef Creek Field Station as part of another study funded by Bonneville Power Administration and NMFS. We will compare the size and volume of various brain regions of fish reared in conventional hatchery raceways, raceways enriched with substrate or natural streams. We expect that this technique will be a more direct measure of fitness and could be used as a simple index by which to evaluate wild and hatchery fish, and fish reared in semi-natural rearing systems as proposed for conservation hatcheries.

Development of Engineered Streams for Salmon Production

Project Sponsor: University of Idaho

Principal Investigator: Ernest Brannon, UI

HSRG Share + Sponsor Share = Total Cost: $33,000 + $0 = $33,000

Collaborators: WDFW

Project Summary: This project is a demonstration of a new concept that combines the benefits of hatcheries and natural habitat to improve salmon populations. In collaboration with the WDFW development of engineered streams is proposed by UI/WSU as a long-range alternative to hatcheries for supplementation of weak or failing wild salmonid populations. The objectives are to provide natural-type engineered streams for coho salmon production that result in wild smolt quality and to monitor performance as a demonstration project for the new hatchery concept. The approach is to develop artificial streams for use as salmon habitat with engineering specifications based on the biological criteria of the species targeted, while maintaining genetic specificity, diversity, and natural smolt quality. The artificial stream will substitute for, or be used in conjunction with, standard hatchery raceways. Natural feed with supplemental artificial diets will be the source of food. The site selected is Hatchery Creek located immediately behind the WDFW hatchery on the Dungeness River. A channel was constructed with habitat structures, pools, riffles, and cover to mimic natural coho habitat. Approximately 50,000-eyed eggs will be introduced in the spring of 2001 and fish use of the channel will be quantified through snorkel surveys throughout the summer and fall. Post-migration monitoring will involve adult return success based on thermal marks applied to the eyed eggs.

Category D: Protect Genetic Resources

Residualism in Wild Broodstock Steelhead

Project Sponsor: WDFW

Principal Investigator: Cameron Sharpe, WDFW

HSRG Share + Sponsor Share = Total Cost: $50,000 + $36,893 = $86,893

Co-investigators: Brian Beckman, Pat Hulett, Walt Dickhoff, NMFS

Collaborators: WDFW, NMFS

Project Summary: Some hatchery steelhead and other salmonid smolts become residuals (i.e. fail to out migrate) after release. The problem appears to be particularly acute in hatchery programs that use wild broodstock - a practice that is becoming increasingly popular as a means to limit genetic risk to wild salmonids. Ironically, high rates of residualism increase genetic and ecological risks to wild fish.

Our objectives are to: (1) Develop a method to reduce residualism of hatchery-reared wild-broodstock steelhead, (2) Assess growth, physiological status, and migration/residualism to

determine mechanisms promoting residual behavior and (3) Compare growth, physiological status, migration pattern, and residualism among offspring of wild and domesticated broodstock.

The project is a collaboration between WDFW and NMFS. The work will be conducted in the Kalama River and will coordinate closely with the existing federally funded wild steelhead broodstock project in that basin.

The experimental approach will be to control growth patterns to simultaneously reduce the numbers of (1) small fish that residualize because they fail to reach smolt size and (2) large male fish that residualize because they become precociously mature.

Our goal is to develop a practical and effective method to reduce residualism of cultured salmonids. We expect that the results will be "exportable" to steelhead and other salmonid culture programs region wide.

Olfactory Imprinting in Hatchery Salmon

Project Sponsor: National Marine Fisheries Service

Principal Investigator: Andrew Dittman, NMFS

HSRG Share + Sponsor Share = Total Cost: $32,000 + $78,100 = $110,100

Project Summary: Exposure to home-stream water during appropriate juvenile stages is critical for olfactory imprinting in salmon and ultimately for successful completion of the adult homing migration. Inappropriate hatchery rearing conditions and juvenile release practices that interfere with the imprinting process can dramatically increase straying. Straying hatchery fish may in turn have negative ecological and genetic effects on endangered and/or wild populations. The overall goal of this project is to identify the critical developmental periods and environmental conditions required for olfactory imprinting in hatchery-reared Pacific salmon. Experimentally assessing successful imprinting is difficult and currently the only effective measures of imprinting involve expensive large-scale tag-recapture studies or behavioral assessments of captively-reared mature adults. This project has two major components: 1) develop and validate new molecular and electrophysiological tools for assessing imprinting that will not require large-scale adult rearing experiments; 2) determine the critical periods for imprinting for Puget Sound coho salmon by exposing juvenile salmon to imprinting odorants during key developmental periods under different environmental conditions. Ultimately, the imprinting assays developed for this project should be useful for studying homing in all salmonids and the findings of this study will be used to improve hatchery rearing and release strategies to minimize straying.

Interactions between Wild and Hatchery Steelhead: Evaluating Key Assumptions

Project Sponsor: University of Washington

Principal Investigator: Thomas Quinn, UW

HSRG Share + Sponsor Share = Total Cost: $23,700 + $11,156 = $34,856

Collaborators: Weyerhaeuser Company, NMFS, WDFW

Project Summary: Natural resource agencies are challenged to maintain both the abundance of salmonids and their genetic and ecological diversity. Hatchery production, designed to achieve the first objective, sometimes conflicts with the second. In Washington, steelhead have been bred to return early in the year. This selection was initially done to help produce yearling smolts but it now permits selective fisheries on hatchery and wild fish, and provides a measure of genetic separation between the stocks. The extent to which timing differences minimize genetic and ecological interactions between hatchery and wild fish depends on the heritability of spawning date, the reproductive success of the stocks, and the extent of interbreeding. The recently established hatchery steelhead program at Forks Creek Hatchery presents a unique opportunity to examine the assumptions underlying this approach. We request renewal of funds to sample hatchery and naturally produced adults returning to spawn, naturally produced juveniles in the river and smolts, and hatchery pre- smolts. Analysis of DNA microsatellites from fin-clip samples will reveal the parentage and origin of juveniles and returning adults. This will allow us to determine the relative production and survival of wild, hatchery and naturally spawning hatchery origin steelhead, and the extent of interbreeding. The results will be conveyed to agency staff, contributing sponsors and regional organizations and the scientific community.

Funded Grants - 2002 Project Descriptions

Category A: Sustainable Fisheries

Salmon Marine Trophic Demand-Distribution

Project Sponsor: University of Washington

Principal Investigator: David Beauchamp, UW

HSRG Share + Sponsor Share = Total Cost: $69,445 + $33,672 = $103,117

Associate Investigator: Raymond Buckley,

Collaborators: WDFW, UW-Wetland WDFW, Ecosystem Team, USGS, King County Department of Natural Resources, NOAA, NMFS

Project Summary: UW, WDFW, and USGS/BRD will examine temporal distribution, diet and size patterns of juvenile salmon at selected estuarine and nearshore marine areas on northern and southern Puget Sound containing significant numbers of wild and hatchery salmon in a year with high juvenile pink salmon densities. Chinook, coho and chum salmon will be targeted by this

study, but all potential predator and competitor species will be examined in a food web context. Diet, growth, and timing of nearshore use will be compared among species, between hatchery and wild salmon, between northern and southern sites, and to historic data. By combining field data on diet, distribution and growth from beach seining and tow netting with bioenergetics modeling, we will estimate temporal feeding rates by juvenile salmon to evaluate whether food limitation, diet, environmental conditions, predation or competition reduce survival or growth of juvenile salmon in these areas. Changes in body size and growth conditions will be related to timing of declines of salmon in nearshore and the offshore transition. This project will provide the foundation for prioritizing and focusing subsequent research and management activities by identifying and quantifying processes that potentially limit survival and growth of juvenile salmon during critical early life in Puget Sound. Activity will be coordinated with King County, Seattle, NMFS, Army Corps to broaden spatial and topical coverage using standardized methods.

Category B: Recover and Conserve Natural Spawning Populations

Differences in Natural Production between Hatchery and Wild Coho Salmon

Project Sponsor: WDFW and NMFS

Principal Investigator: Howard Fuss, WDFW and Michael Ford, NMFS

HSRG Share + Sponsor Share = Total Cost: $107,567 + $74,637 = $182,204

Collaborators: NWIFC

Project Summary: A key question facing salmon managers is how successful hatchery propagated fish and their offspring are at surviving and reproducing in the wild. This is critical for assessing both risks and benefits of hatchery supplementation. In this collaborative federal, state, and tribal project, we are using state of the art genetic techniques to evaluate the spawning success and survival in the wild of hatchery propagated and naturally produced coho salmon. The results of this project will, for the first time, provide information on the rate at which hatchery fish can readapt to the wild environment. The project works like this: For three years, starting in the fall of 2000, we will intercept all adult coho salmon returning to spawn in Minter Creek, WA. The run consists of naturally produced and hatchery propagated coho salmon. Before being passed upstream to spawn naturally, we measure, photograph, and tag each fish; determine its origin (hatchery or natural); and take a small non-lethal fin clip for later DNA analysis. Over the next six years, we will sample the progeny of these fish as fry and as smolt and use microsatellite DNA fingerprinting to determine their parentage. From these data, we will estimate the relative fitness of naturally spawning hatchery and natural-origin salmon. In the years 2003-2008, we will measure the relative fitness of natural-origin fish with varying hatchery ancestry, providing data on the rate hatchery coho readapt to the wild.

Snow Creek Coho Recovery Program

Project Sponsor: WDFW

Principal Investigator: Steve Schroder, WDFW

HSRG Share + Sponsor Share = Total Cost: $28,130 + $10,000 = $38,130

Collaborators: Wild Olympic Salmon, North Olympic Salmon Coalition, Point-No-Point Treaty Council, Jamestown S'Klallam Tribe

Project Summary: Beginning in 1998, WDFW, Wild Olympic Salmon and the North Olympic Salmon Coalition began an effort to recover a threatened coho population native to Snow Creek, a Northeast Olympic Peninsula stream. Since then, every adult coho returning to Snow Creek has been captured at a permanent weir. The fish are artificially spawned and their eggs are incubated at the nearby Hurd Creek Hatchery. Offspring from each fish are placed into three alternative recovery strategies. One involves placing eyed-eggs into remote site incubators located throughout the Snow Creek Basin. In the other two, fish are reared for either seven or ten months before being liberated a pre-smolts into Crocker Lake, a 25-hectare body of water that is used as a rearing and over-wintering location by Snow Creek coho. Fish placed into each treatment group have their otolith thermally marked and the reared fish are also tagged. The otolith marks and tags are used to determine: 1) how many smolt are produced from each treatment, 2) if treatment origin affects size and out-migration timing of smolt, and 3) whether a recovery strategy affects overall survival, size and age at maturation. This approach will be continued annually until 2006 and if abundance allows, such as in 2001, coho will be allowed to reproduce naturally to create a fourth treatment type. Results from this study will be used to help refine coho recovery efforts throughout Puget Sound and the Washington Coast.

Hamma Hamma River Steelhead Supplementation Evaluation

Project Sponsor: NMFS

Principal Investigator: Barry Berejikian, NMFS

HSRG Share + Sponsor Share = Total Cost: $68,554 +$124,440 = $192,994

Collaborators: Long Live the Kings, Hood Canal Salmon Enhancement, WDFW, Point-No-Point Treaty Council

Project Summary: This project addresses several aspects of the conservation hatchery paradigm including: natural growth profiles, enriched hatchery rearing habitats, release strategies, and experimentation to improving captive broodstock technologies. It also evaluates the impacts of a supplementation program on changes in spawner abundance in the Hamma Hamma River where

confounding variables (e.g., habitat degradation, harvest) will have minimal influence. The specific research objectives are as follows:

1. Determine whether the supplementation program affects the abundance of naturally spawning steelhead in the Hamma Hamma River.

2. Determine the relative reproductive success of female steelhead from two different reintroduction strategies (smolt vs. adult release).

3. Estimate the relative abundance of steelhead spawners produced from i) wild smolt, ii) smolt reared in 'conservancy' ponds, and iii) smolt reared in hatchery tanks.

4. Develop rearing protocols to produce steelhead smolt with a two-year freshwater rearing history, such that growth profiles mimic those of wild fish.

5. Compare the reproductive behavior and breeding success of captively reared steelhead grown in high vs. low water velocity environments.

Category C: Improve Quality and Cost-Effectiveness of Hatchery Programs

Increase Post-Release Survival by Rearing Coho with NATURES Semi-Natural Raceway Habitat

Project Sponsor: NMFS

Principal Investigator: Des Maynard, NMFS

HSRG Share + Sponsor Share = Total Cost: $84,962 + $84,209 = $169,171

Associate Investigator: Geraldine Vander-Haegen, WDFW

Collaborators: WDFW, Tribes

Project Summary: It has been repeatedly demonstrated that rearing Chinook salmon in NATURES semi-natural raceway habitat increases their instream survival. In the current study, WDFW and NMFS are conducting a 4 (four) year experiment to determine if NATURES rearing also increases the number of coho salmon recruiting to the fishery and spawning population. The research is being conducted with salmon grown in standard concrete raceways at Puget Sound hatcheries. At each hatchery, there are control and semi-natural habitat raceways. The semi-natural habitat was created by fitting the raceways with: 1) gravel pavers, 2) fir tree instream structure, 3) camouflage net overhead covers. Fish growth, color development, and health are being routinely monitored and compared. Experimental and control fish are coded-wire-tagged to measure their contribution to the fishery and spawning population. NATURES semi-natural raceway habitat rearing is expected to increase the relative number of fish recruiting to the fishery and spawning population by 25%. Managers can use the increased survival offered by NATURES salmon culture practices to restore natural spawning runs, maintain sustainable fisheries, promote

economically efficient salmon culture, and reduce ecological interactions with ESA listed wild salmon populations.

Development of Engineered Streams for Salmon Production

Project Sponsor: University of Idaho

Principal Investigator: Ernest Brannon, UI

HSRG Share + Sponsor Share = Total Cost: $18,819 + $0 = $18,819

Collaborators: WDFW, NMFS

Project Summary: The project is a demonstration of a new concept that combines the benefits of hatcheries and natural habitat to improve salmon populations. In collaboration with the WDFW development of engineered streams is proposed by UI/WSU as long-range alternative to hatcheries for supplementation of weak or failing wild salmonid populations. The objectives are to provide natural-type engineered streams for coho salmon production that result in wild smolt quality and to monitor performance as a demonstration project for the new hatchery concept. The approach is to develop artificial streams for use as salmon habitat with engineering specifications based on the biological criteria of the species targeted, while maintaining genetic specificity, diversity, and natural smolt quality. The artificial stream will substitute for, or be used in conjunction with, standard hatchery raceways. Natural feed with supplemental artificial diets with be the source of food. The site selected is Hatchery Creek located immediately behind the WDFW hatchery on the Dungeness River. A channel was constructed with habitat structures, pools, riffles, and cover to mimic natural coho habitat. Approximately 25,000-eyed eggs will be introduced in the spring of 2002 and fish use of the channel will be quantified through snorkel survey throughout the summer and fall. Post-migration monitoring will involve adult return success based on the thermal marks applied to the eyed eggs.

Funded Grants - 2003 Project Descriptions

Category A: Sustainable Fisheries

Salmon Marine Trophic Demand-Distribution

Project Sponsor: University of Washington

Principal Investigator: David Beauchamp, UW

HSRG Share + Sponsor Share = Total Cost: $60,871 + $0 = $60,871

Associate Investigator: Raymond Buckley, WDFW

Collaborators: WDFW, UW-Wetland Ecosystem Team, USGS, King County Department of Natural Resources, NOAA Fisheries

Project Summary: Predation rates will be estimated on nearshore-offshore distribution of juvenile hatchery and wild salmon during their early life history in northern and southern Puget Sound. Previous results revealed significant predation by small sea-run cutthroat trout. Larger sea-run cutthroat trout and other salmonids also forage in these habitats, but are not captured effectively with the standard beach seining methods. It is hypothesized that these larger predators represent a larger and prolonged source of mortality for juvenile salmon in Puget Sound, because the per capita consumption rates are higher, they can consume larger prey, and can forage more effectively for juvenile in both nearshore and offshore habitats. Larger seines will be used, tow netting, angling, gillnetting, and hydroacoustics to determine the distribution of predators and juvenile salmon, and to provide samples for diet analysis of predators. Differential predation rates between hatchery and wild origin salmon will be recorded. The transition from nearshore to offshore habitats and offshore distribution of juvenile salmon will determine both their growth potential and exposure to predators. This information will help managers identify the timing and location of critical factors limiting survival of juvenile salmon during residence and migration in Puget Sound. This will be a joint project between University of Washington, United States Geological Service, and WDFW and will coordinate with complementary efforts of Army Corps, NOAA Fisheries, tribes, and city and county agencies.

Category B: Recover and Conserve Natural Spawning Populations

Differences in Natural Production between Hatchery and Wild Coho Salmon: A Proposal to Measure the Influence of the Degree of Hatchery Ancestry on Natural Reproductive Success

Project Sponsor: WDFW and NOAA Fisheries

Principal Investigator: Howard Fuss, WDFW and Michael Ford, NOAA Fisheries

HSRG Share + Sponsor Share = Total Cost: $106,627 + $57,872 = $164,499

Collaborators: NWIFC

Project Summary: A key question facing salmon managers is how successful hatchery propagated fish and their offspring are at surviving and reproducing in the wild. This is critical for assessing both risks and benefits of hatchery supplementation. In this collaborative project National Marine Fisheries Service (NMFS) and Washington Department of Fish and Wildlife (WDFW), are using state-of-the art genetic techniques to evaluate the spawning success and survival in the wild of hatchery propagated and naturally produced coho salmon. The results of this project will, will for the first time, provide information on the rate at which hatchery fish readapt to the wild environment.

Since the fall of 2000, all adult coho salmon returning to spawn in Minter Creek, Washington have been intercepted. The run consists of naturally produced and hatchery propagated coho salmon.

Before being passed upstream to spawn naturally, each adult is measured, photographed, and tagged, its' origin (hatchery or natural) determined, and a small non-lethal fin clip taken for later DNA analysis. Over the subsequent six years, the progeny of these fish are being sampled as fry and as yearling smolts and microsatellite DNA fingerprinting used to determine their parentage. From these data, the relative fitness of naturally spawning hatchery and natural-origin salmon will be estimated. In the years 2003-2008, the relative fitness of natural-origin fish with varying hatchery ancestry will be estimated, providing data on the rate hatchery coho readapt to the wild.

Snow Creek Coho Salmon Recovery Program

Project Sponsor: WDFW

Principal Investigator: Steve Schroder, WDFW

HSRG Share + Sponsor Share = Total Cost: $32,972 + $10,000 = $42,972

Collaborators: Wild Olympic Salmon, North Olympic Salmon Coalition, Point-No-Point Treaty Council, Jamestown S'Klallam Tribe

Project Summary: Beginning in 1998, WDFW, North Olympic Salmon Coalition, and Wild Olympic Salmon began an effort to recover a threatened coho salmon population native to Snow Creek, a Northeast Olympic Peninsula stream. Since then, every adult coho salmon returning to Snow Creek has been captured at a permanent weir. The fish are artificially spawned and their eggs are incubated at nearby Hurd Creek Hatchery. Offspring from each fish are placed into three alternative recovery strategies. One involves placing eyed-eggs into Remote Site Incubators located throughout the Snow Creek Basin. In the other two, fish are reared for either seven or ten months before being liberated as pre-smolts into Crocker Lake, a 25 hectare body of water that is used as a rearing and over-wintering location by Snow Creek coho salmon. Fish placed into each treatment group have their otoliths thermally marked and the reared fish are also tagged. The otolith marks and tags are used to determine: 1) how many smolts are produced from each treatment, 2) if treatment origin affects size and out-migration timing of smolts, and 3) whether a recovery strategy affects overall survival, size, age, fecundity, egg size, and reproductive effort at maturation. This approach will be continued annually until 2006. In 2001 and 2002 adult coho were allowed to reproduce naturally in Snow Creek to create a fourth treatment type. Results from this study will be used to help refine coho recovery throughout Puget Sound and the Washington Coast.

Hamma Hamma River Steelhead Supplementation Evaluation

Project Sponsor: NOAA Fisheries

Principal Investigator: Barry Berejikian, NOAA Fisheries

HSRG Share + Sponsor Share = Total Cost: $68,226 + $105,660 = $173,886

Collaborators: Long Live the Kings,
Hood Canal Salmon Enhancement,
WDFW, Point-No-Point Treaty Council

Project Summary: This project evaluates the impacts of a steelhead supplementation program on changes in spawner abundance in the Hamma Hamma River, where confounding variables (e.g., habitat degradation, harvest) will have minimal influence. Collaborators include Long Live the Kings, Hood Canal Salmon Enhancement Group, NOAA Fisheries. WDFW, and Point No Point Treaty Council The project addresses several aspects of the conservation hatchery paradigm including: natural growth profiles, enriched hatchery rearing habitats, alternative release strategies, and experimentation to improving captive broodstock technologies. The specific research objectives are as follows:

1) Determine whether the supplementation program affects the abundance of naturally spawning steelhead in the Hamma Hamma River; 2) Determine the relative reproductive success of female steelhead from two different reintroduction strategies (smolt vs. adult release); 3) Estimate the relative abundance of steelhead spawners produced from i) wild smolts, ii) smolts reared in 'conservancy' ponds, and iii) smolts reared in hatchery tanks; 4) Develop rearing protocols to produce steelhead smolts with a two-year freshwater rearing history, such that growth profiles mimic those of wild fish; and 5) Compare the reproductive behavior and breeding success of captively reared steelhead grown in high versus low water velocity environments.

Category C: Improve Quality and Cost-Effectiveness of Hatchery Programs

Increase Post-Release Survival by Rearing Coho with NATURES Semi-Natural Raceway Habitat

Project Sponsor: NOAA Fisheries

Principal Investigator: Des Maynard, NOAA Fisheries

HSRG Share + Sponsor Share = Total Cost: $82,172 + $126,580 = $208,752

Associate Investigator: Geraldine Vander-Haegen, WDFW

Collaborators: WDFW, Tribes

Project Summary: It has been repeatedly demonstrated that rearing Chinook salmon in NATURES semi-natural raceway habitat increases their instream survival. In the current study, WDFW and NMFS are conducting a 4 year evaluation to determine if NATURES rearing in a production environment increases the number of coho salmon recruiting to the fishery and spawning population. The research is being conducted with salmon grown in standard concrete raceways at Puget Sound hatcheries. At each hatchery, there are control and semi-natural habitat raceways. The semi-natural habitat was created by fitting the raceways with: 1) gravel pavers, 2)

fir tree instream structure, and 3) camouflage net overhead covers. Fish growth, color development, and health are being routinely monitored and compared. Experimental and control fish are coded-wire-tagged to measure their contribution to the fishery and spawning population. NATURES semi-natural raceway habitat rearing is expected to increase the relative number of fish recruiting to the fishery and spawning population by 25%. Managers can use the increased survival offered by NATURES salmon culture practices to restore natural spawning runs, maintain sustainable fisheries, promote economically efficient salmon culture, and reduce ecological interactions with ESA listed wild salmon populations.

Development of Engineered Streams for Salmon Production

Project Sponsor: University of Idaho

Principal Investigator: Ernest Brannon, UI

HSRG Share + Sponsor Share = Total Cost: $30,464 + $0 = $30,464

Collaborators: WDFW, NOAA Fisheries

Project Summary: This project is a demonstration of a new concept that combines the benefits of hatcheries and natural habitat to improve salmon populations. In collaboration with the WDFW development of engineered streams is being investigated by the University of Idaho as a long-range alternative to hatcheries for supplementation of weak or failing wild salmonid populations. The objectives are to provide natural-type engineered streams for coho salmon production that result in wild smolt quality and to monitor performance as a demonstration project for this new hatchery concept. The approach is to develop artificial streams for use as salmon habitat with engineering specifications based on the biological criteria of the species targeted, while maintaining genetic specificity, diversity, and natural smolt quality. The artificial stream will substitute for, or be used in conjunction with, standard hatchery raceways. Natural feed with supplemental artificial diets will be the source of food. The site selected is Hatchery Creek located immediately behind the WDFW hatchery on the Dungeness River. A channel was constructed with habitat structures, pools, riffles, and cover to mimic natural coho habitat. Production levels were comparable to natural habitat at 1.5 smolt/m^2. Based on the previous two years of data, the channel will be modified to increase volitional rearing densities and increase smolt production to levels above natural production while still maintaining wild fish characteristics.