

# SUPPLEMENTATION FISH QUALITY (YAKIMA)

9105500

## SHORT DESCRIPTION:

Define criteria for setting quality of hatchery fish for supplementation. Develop and evaluate fish culture techniques for producing fish with more wild-like characteristics and increased post-release survival to aid recovery of ESA-listed and supplemented stocks.

## SPONSOR/CONTRACTOR: NMFS

National Marine Fisheries Service

Tom Flagg, Supervisory Fisheries Research Biologist

Manchester, WA 98353

206/842-7181

T.Flagg@NOAA.gov

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## GOALS

### GENERAL:

Supports a healthy Columbia basin, Maintains biological diversity, Maintains genetic integrity, Increases run sizes or populations, Adaptive management (research or M&E)

### ANADROMOUS FISH:

O&M, Research, M&E

### NPPC PROGRAM MEASURE:

7.2D.1; 7.2D.3; 7.4K.1

### RELATION TO MEASURE:

The Northwest Power Planning Council's Columbia Basin Fish and Wildlife Program calls for development of strategies, like those being developed in the NATURES program, to increase post-release survival of hatchery fish. In addition, NPPC programs since 1987 have called for the development of hatchery rearing protocols that provide fish with a more natural environment, that train fish to avoid predators after release, and expose fish to natural foods to enhance their post-release foraging ability. These protocols are also being developed to minimize the influence of the hatchery rearing environment on genetic traits that are adaptive in the wild environment. This research need has also been called for in NPPC programs since 1987.

### BIOLOGICAL OPINION ID:

X--Aids recovery of ESA-listed fish populations.

### OTHER PLANNING DOCUMENTS:

Proposed Recovery Plan for Snake River Salmon; 4.4.c and 4.4.d.

### TARGET STOCK

### LIFE STAGE

### MGMT CODE (see below)

Columbia River Basin/Fall Chinook Salmon

Juvenile

S,A,W

Columbia River Basin/Steelhead

Juvenile

S,A,W

Columbia River Basin/Coho

Juvenile

S,A,W

Columbia River Basin/Spring Chinook Salmon

Juvenile

S,A,W

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## BACKGROUND

### Hydro project mitigated:

N/A. Development of NATURES techniques should be applicable basin wide to mitigation, supplementation, and conservation hatcheries in the entire Columbia River Basin.

### Project is an office site only

### Habitat types:

Research fish released into streams and rivers.

## **HISTORY:**

The Coastal Zone and Estuarine Studies Division, National Marine Fisheries Service, in collaboration with the Washington Department of Fish and Wildlife, has been conducting research to develop a natural rearing enhancement system (NATURES) suitable for producing "wild-like" fish from hatcheries. NATURES research is currently directed at providing guidelines for the Yakima Fisheries Project test of supplementation. However, NATURES has application to restoration of many depleted stocks of fish in the Snake River Basin (e.g., those listed under the U.S. Endangered Species Act). Development of natural rearing systems that minimize behavioral changes in hatchery-reared fish is identified as a priority [4.4.c and 4.4.d] in the proposed Recovery Plan for Snake River salmon.

Hatchery practices that induce domestication are considered prime factors in reducing fitness of hatchery fish for subsistence in natural ecosystems. Present hatchery practices are geared toward mass-production under unnatural conditions (e.g., the fish are reared in the open, over uniform concrete substrate; provided no structures behind or under which to seek refuge from water current, predators, or dominant conspecifics; held at high stress-producing densities; surface fed; and conditioned to approach large moving objects at the surface). It is probable that physiological, behavioral, and morphological modifications resulting from this unnatural rearing environment are major factors in the poor post-release survival of many standard hatchery-reared salmon.

NATURES strategies for salmonids include rearing fish in raceways equipped with cover, structure, and natural substrates that promote development of proper body camouflage coloration, feed delivery systems that condition fish to orient to the bottom rather than the surface of the rearing vessel, training fish to avoid predators, exercising fish to enhance their ability to escape from predators, supplementing diets with natural live foods to improve foraging ability, reducing rearing densities, and utilizing oxygen-supplementation technology.

NATURES strategies should provide "wild-like" fish from hatcheries that are more suitable for use in supplementation programs than conventionally-reared fish. NATURES strategies also should help minimize potential genetic divergence between wild and hatchery-reared salmonids.

Initial studies have demonstrated that NATURES strategies have the potential to increase post-release survival of hatchery-reared salmonids by 50% or more compared to conventional rearing methods.

## **BIOLOGICAL RESULTS ACHIEVED:**

Research has shown that both the unintended selection and conditioning associated with standard artificial propagation practices generally produces salmonids that are less adept at foraging, less cryptic, more vulnerable to predators, and differ in their level of aggression compared to their wild counterparts. We have evaluated the effectiveness of various NATURES concepts in three post-release survival experiments conducted on chinook salmon (*Oncorhynchus tshawytscha*). The NATURES habitats tested in 1992-1994 increased the instream post-release survival of juvenile chinook salmon by 25-50%.

In the first experiment, fall chinook salmon reared for 4 months from swim-up to smoltification in 400-l raceways with cover, structure, and substrate experienced about 50% better in-stream survival to a collection weir 2.2 km downstream than conventionally-reared controls. In a second experiment, spring chinook salmon reared in similar 400-l raceways for the last 3 months prior to smoltification exhibited about 25% greater post-release survival to a collection weir 225 km downstream than controls in clear water conditions. However, in turbid water conditions there was no significant difference in post-release survival between test and control groups. In the final experiment, fall chinook salmon reared for 4 months from swim-up to smoltification in 5,947-l raceways with cover, structure, substrate, and subsurface feeding systems experienced 27% better post-release survival to a collection weir 21 km downstream than conventionally-reared controls. In 1996, two experiments were conducted that indicated that automatic underwater feeders were not responsible for the increased post-release survival of NATURES reared fish. Future studies will focus on evaluating the efficiency of other NATURES variables.

## **PROJECT REPORTS AND PAPERS:**

Maynard, D. J., T. A. Flagg, and C. V. W. Mahnken. 1995. A review of semi-natural culture strategies for enhancing the post-release survival of anadromous salmonids. *Am. Fish. Soc. Symp.* 15:307-314.

Maynard, D. J., G. C. McDowell, E. P. Tezak, and T. A. Flagg. 1996. The effect of diets supplemented with live-food on the foraging behavior of cultured fall chinook salmon. *Prog. Fish-Cult.*, 58:187-191.

Maynard, D. J., T. A. Flagg, and C. V. W. Mahnken, and S. L. Schroder. 1996. Natural rearing technologies for increasing postrelease survival of hatchery-reared salmon. *Bull Natl. Res. Inst. Aquacult., Suppl.* 2:71-77.

Maynard, D. J., T. A. Flagg, and C. V. W. Mahnken. 1996. Development of a natural rearing system to improve supplemental

fish quality. Report to the Bonneville Power Administration, Contract DE-A179-91BP20651, 216 p. (Available Northwest Fisheries Science Center., 2725 Montlake Blvd. E., Seattle, WA 98112.)

**ADAPTIVE MANAGEMENT IMPLICATIONS:**

The goal of supplementation and conservation programs for threatened and endangered stocks is to develop methods to enhance populations by supplementing wild stocks with hatchery fish. The use of hatchery fish to supplement native populations holds good potential for recovery of natural populations, but existing techniques are controversial. NATURES research is a critical step in determining how live food diets, automated subsurface feeders, and seminatural rearing habitat may increase the post-release survival of hatchery salmonids. Predation experiments will also help to demonstrate whether predation is a significant factor in the differential post-release survival of test fish. These studies will help to define rearing environment factors critical to improving post-release survival of fish released for supplementation. The knowledge gained from our past activities has allowed us to focus on and refine those experimental variables that contribute most to enhancing the post-release survival of hatchery-reared salmonids. Based on our research findings, we recommend that hatchery-reared fish used to supplement, restore, or enhance natural populations be reared in seminatural environments with substrate, instream structure, and overhead cover. Based on these findings, we conclude that future research should focus on: 1) determining the best form of each seminatural habitat component (e.g. pea gravel vs resin encased rock substrate), 2) determining if the increased instream survival benefits of seminatural habitat rearing translate into increased fishery and spawner returns and, 3) developing and evaluating other prerelease conditioning techniques (predator avoidance training, exercise, etc.) for further enhancing hatchery reared salmon post-release survival.

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**PURPOSE AND METHODS**

**SPECIFIC MEASUREABLE OBJECTIVES:**

Develop and refine NATURES rearing strategies. Compare NATURES-reared fish with conventionally- and naturally-reared fish. Develop and evaluate NATURES rearing strategies that produce more wild-like fish and increase the post-release survival of hatchery reared salmonids. Pre-release conditioning strategies that have or will be developed and evaluated include rearing salmonids in seminatural raceway habitats, rearing hatchery fish on natural live food diets, training cultured fish to avoid predators, and exercising hatchery-reared salmon to enhance their predator evasion ability.

**CRITICAL UNCERTAINTIES:**

Whether NATURES rearing strategies can produce hatchery-reared fish with similar behavior and survival as wild fish.

**BIOLOGICAL NEED:**

In the recent National Research Council (NRC) report "Upstream - salmon and society in the Pacific Northwest," the authors noted that "physical and biological conditions in hatchery facilities have differed greatly from those in natural environments and in general have lacked diversity in habitat structure, cover, and exposure to natural predators." Furthermore, they stated that "the hatchery rearing environment has the potential to alter selection pressures in a single generation, decreasing fitness in the natural environment". The successful use of hatcheries in the recovery process for endangered populations depends on developing new NATURES-like rearing technologies that help hatchery fish retain innate wild attributes. Development of this conservation hatchery strategy is a high priority project identified as critical in the NMFS Proposed Endangered Species Act (ESA) Recovery Plan for Snake River sockeye and chinook salmon (Sections 4.4c and 4.4d). Development of strategies to increase post-release survival of hatchery fish are also called for in the Northwest Power Planning Council's Columbia Basin Fish and Wildlife Program (Section 700e). The development of NATURES fish rearing strategies supports the planned BPA Yakima Fisheries Project test of supplementation as described in the Environmental Impact Statement for the Yakima Fisheries Project (DOE/EIS-0169). The much lower post-release survival of hatchery reared salmon compared to their wild reared counterparts demonstrates new fish culture techniques must be developed for producing hatchery reared fish with a higher post-release survival. The pre-release conditioning strategies being developed by the NATURES program should allow hatcheries to produce salmonids that are less vulnerable to predators due to their wild-like behavior, physiology, and morphology. The higher survival of fish produced by these NATURES hatchery programs can be used to rapidly rebuild endangered and threatened Pacific salmon stocks. The higher post-release survival of these NATURES reared fish will: 1) reduce the number of wild broodstock that must be taken into fish culture programs to produce a given number of recruits in the next generation, 2) reduce the time required for supplementation programs to rebuild self-sustaining runs, and 3) enhance the efficiency of mitigation and fishery enhancement hatchery programs.

**HYPOTHESIS TO BE TESTED:**

The research is examining the hypothesis that rearing salmon in raceways equipped with overhead cover, natural substrate, instream structure, and subsurface feed delivery systems and employing the use of live natural foods, exercise, and predator avoidance training will significantly increase post-release survival compared to conventionally-reared fish. The null hypothesis is that these pre-release conditioning strategies will have no effect on salmonid post-release survival. Alternative hypothesis 1 is that these pre-release conditioning strategies will increase salmonid post-release survival. Alternative hypothesis 2 is that these pre-release conditioning strategies will decrease salmonid post-release survival.

**ALTERNATIVE APPROACHES:**

N/A. All alternative strategies for increasing hatchery-reared salmon post-release survival were considered and are being evaluated as rapidly as available resources permit.

**METHODS:**

Research in FY 1998 will focus on evaluating and refining NATURES variables and examining ecological interactions between conventionally-, NATURES-, and wild-reared fish. This includes:

1. Rearing fish in replicated groups using conventional fish culture methods and using NATURES methods. NATURES methods may include rearing fish with overhead cover, natural substrate, instream structure, subsurface feed delivery systems, exercise systems, and involve antipredator conditioning. Fish will be reared in freshwater to smolting and released. A number of different studies will be conducted. Depending on the exact study, rearing vessel size may range from 400-l to 40,000-l.
2. Appropriate bioassays and statistical analysis will be used to compare behavioral differences, predator susceptibility, and ecological interactions of NATURES- and conventionally-reared fish at pre- and post- release stages.
3. A number of different NATURES rearing habitat studies will be conducted. Most studies will be conducted using chinook and coho salmon. Depending on the exact study, number of fish per study may range from 1,000 to 60,000. Replicate size will be similar or greater than that which has previously allowed us to detect 25-50% increases in post-release survival.

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**PLANNED ACTIVITIES**

**SCHEDULE:**

<b>Planning Phase</b>	<b>Start</b> March, 1997	<b>End</b> On-going	<b>Subcontractor</b> None
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**Task** 1997 Conduct experiments to refine NATURES variables. Release juveniles and assess survival. Examine interactions between conventionally-, NATURES-, and wild-reared fish. Including: 1. Fall 1997-summer 1998 - establish conventional and NATURES rearing units. Rear fish and conduct prerelease bioassays including predator susceptibility, foraging efficiency, and social interactions. 2. Spring-summer 1997 - Release replicated groups of conventionally- and NATURES-reared fish. Conduct instream bioassays including predator susceptibility, foraging efficiency, and social interactions. Evaluate ecological interactions between NATURES-, conventionally-, and wild-reared fish. Recapture juveniles at stream weirs and compare instream survival.3. Write reports and scientific papers. Similar project activities are expected in 1998-2001, except that beginning in 1998, work elements may also include quantifying adult survival of test and control fish.

**CONSTRAINTS OR FACTORS THAT MAY CAUSE SCHEDULE OR BUDGET CHANGES:**

No known critical risks are associated with studies to develop conservation hatchery strategies for producing wild-like fish for use in supplementation projects.

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**OUTCOMES, MONITORING AND EVALUATION**

**SUMMARY OF EXPECTED OUTCOMES**

**Expected performance of target population or quality change in land area affected:**

The goal of supplementation and conservation programs for threatened and endangered stocks is to develop methods to enhance populations by supplementing wild stocks with hatchery fish. The use of hatchery fish to supplement native populations holds

good potential for recovery of natural populations, but existing techniques are controversial. NATURES research is a critical step in determining how live food diets, automated subsurface feeders, and seminatural rearing habitat may increase the post-release survival of hatchery salmonids. Predation experiments will also help to demonstrate whether predation is a significant factor in the differential post-release survival of test fish. These studies will help to define rearing environment factors critical to improving post-release survival of fish released for supplementation. NATURES studies will provide precision for fish rearing strategies to be used in the planned BPA Yakima Fisheries Project test of supplementation as described in the Environmental Impact Statement for the Yakima Fisheries Project (DOE/EIS-0169). The results of this research should significantly increase the performance of target populations by greatly enhancing post-release survival.

**Present utilization and conservation potential of target population or area:**

The present utilization of Columbia River Basin salmon stocks is low. The need for conservation of these stocks is high.

**Assumed historic status of utilization and conservation potential:**

The historic utilization of Columbia River Basin stocks was high, and the need for conservation of these stocks was low until recent times.

**Long term expected utilization and conservation potential for target population or habitat:**

Columbia River Basin stocks of salmon will be rebuilt to levels where there is low need for conservation, and utilization can again be high.

**Contribution toward long-term goal:**

The NATURES project will provide culture techniques that will enable conservation and enhancement hatcheries to produce wild-like salmon with high post-release survival that will permit the rapid rebuilding of runs. This will return a productive fishery to the river and conserve the salmonid resources in the Columbia River Basin. The guidelines developed by the project will also enable the Cle Elum Hatchery to optimize the production of anadromous fish in the Yakima River Basin.

**Indirect biological or environmental changes:**

Population could recover to self sustaining and harvestable levels. NATURES rearing strategies could result in genetics of hatchery reared fish being similar to the wild populations from which they were obtained.

**Physical products:**

In the last several years the fish culture research program generally produces 30,000-300,000 salmon for release. The majority or all of these fish are tagged so that the effect of different culture strategies on postrelease survival can be evaluated.

**Environmental attributes affected by the project:**

N/ A.

**Changes assumed or expected for affected environmental attributes:**

N/ A.

**Measure of attribute changes:**

N/ A.

**Assessment of effects on project outcomes of critical uncertainty:**

Statistical analysis of empirical data will be used to determine which of the experimental hypotheses solves the critical uncertainties being tested in NATURES experimentation.

**Information products:**

Scientific journal articles, annual reports to BPA, presentations at national and regional science meeting, regional science workshops, agency program annual reviews, Federal and State agencies staff meetings, and regional fisheries enhancement groups.

### **Coordination outcomes:**

The NATURES Program scientists have developed the New Innovative, Limited New Innovative, and Optimal Conventional Treatments as well as the experimental variables to be measured in the Yakima Fisheries Project test of supplementation. The results of past and continuing experimentation are being coordinated with YFP to ensure the experimental variables incorporated into the New Innovative Treatment have the greatest possibility for increasing smolt-adult survival. In addition, NATURES staff scientists frequently advise Federal, tribal, state, Public Utility District, and regional fisheries enhancement groups on how NATURES fish culture techniques can best be incorporated into their fish culture programs. As a result of these coordination efforts, NATURES fish rearing protocols are beginning to be adopted at various fish culture facilities to increase salmon post-release survival.

The program's laboratory research has evaluated the effectiveness of various components of the NATURES concept in three post-release survival experiments conducted on chinook salmon (*Oncorhynchus tshawytscha*). 1) In 1991-1992, fall chinook salmon were reared from swim-up to smoltification in 400-L raceways outfitted with cover, structure, and substrate. These fish experienced a 50% increase in-stream survival to a collection weir 2.2 km downstream compared to conventionally-reared salmon. 2) In 1994, spring chinook salmon were reared for 3 months in 400-L raceways outfitted with cover, structure, and substrate. These fish exhibited 24% greater post-release survival to a collection weir 225 km downstream than controls when the fish were released in a clear-water situation. However, when fish were released in turbid water conditions, there was no significant difference in post-release survival. 3) In 1994, fall chinook salmon were reared from swim-up to smoltification in 5,947-L raceways outfitted with cover, structure, substrate, and an underwater feed delivery system. These fish averaged 27% higher post-release survival to a collection weir 21 km downstream than their conventionally-reared counterparts.

The use of live-food supplementation to increase the post-release foraging ability of hatchery-reared fall chinook salmon has also been investigated. Replicate groups of fry were reared in six 2.4-m-diameter circular tanks and fed on two different diets. Fish in three tanks received a standard, commercially available, pelletized diet, while those in the other tanks were given the opportunity to forage on natural live prey (mysids, mosquito larvae, chironomid larvae, and daphnia) prior to their daily ration of pellets. When foraging ability of individual fish was examined in 200-L observation tanks, the trained salmon were found to feed on twice the number of familiar prey (chironomids) and novel prey (mayfly larvae) as untrained fish. This suggests that live-food supplementation can be used to increase the post-release foraging ability of hatchery-reared salmon.

In 1997-1998, NATURES research is focusing on determining the efficacy of live food supplementation and in evaluating benefits of exercise and pre-release predator exposure on the post-release survival of salmonids.

Information on components of NATURES strategies have been accepted for publication as:

Maynard, D. J., G. C. McDowell, E. P. Tezak, and T. A. Flagg. 1996. The effect of diets supplemented with live-food on the foraging behavior of cultured fall chinook salmon. *Prog. Fish-Cult.*, 58:187-191.

Maynard, D. J., T. A. Flagg, and C. V. W. Mahnken, and S. L. Schroder. 1996. Natural rearing technologies for increasing postrelease survival of hatchery-reared salmon. *Bull Natl. Res. Inst. Aquacult., Suppl. 2:71-77.*

Maynard, D. J., T. A. Flagg, and C. V. W. Mahnken. 1996. Development of a natural rearing system to improve supplemental fish quality. Report to the Bonneville Power Administration, Contract DE-A179-91BP20651, 216 p. (Available Northwest Fisheries Science Center., 2725 Montlake Blvd. E., Seattle, WA 98112.)

Maynard, D. J., T. A. Flagg, and C. V. W. Mahnken. 1995. A review of seminatural culture strategies for enhancing the post-release survival of anadromous salmonids. *Am. Fish. Soc. Symp.* 15:307-314.

### **MONITORING APPROACH**

The region should measure the project's biological outcome by the ability of NATURES scientists to successfully develop, refine, and evaluate the effectiveness of pre-release conditioning strategies that increase the post-release survival of hatchery-reared salmonids. At the end of each experimental series, the effect of a rearing treatment variable ( positive, negative, or no effect) on salmonid behavior, morphology, physiology, or post-release survival should be determined. When the variable has a consistent positive effect on post-release survival, as seminatural raceway habitat has, the new methods should either be incorporated into fish culture programs or further evaluated to refine the variable. If the fish culture strategy has either a neutral or negative effect on behavior, morphology, physiology, or post-release survival, either alternative forms of the variable should be suggested for evaluation or the variable should not be incorporated into fish culture programs. Research in 1997-1998 will focus on evaluating new NATURES variables, refining the shape of positive NATURES variables, and examining ecological interactions between conventionally-, NATURES-, and wild-reared fish. This includes:

1. Rearing fish in replicated groups using conventional fish culture methods and using various NATURES methods. In some experiments fish will be reared in semi-natural habitat vessels equipped with overhead cover, natural substrate, and instream

structure. In other experiments NATURES fish will be exercised or exposed to predators to determine how these factors effect the post-release survival of hatchery reared salmon. Fish will be reared in freshwater to smolting and released. A number of different studies will be conducted. Depending on the exact study, rearing vessel size may range from 400-l to 40,000-l.

2. Appropriate bioassays and statistical analysis will be conducted to compare behavioral differences, predator susceptibility, post-release survival, and ecological interactions of wild-, NATURES- and conventionally-reared fish at pre- and post-release stages.

3. A number of different NATURES rearing studies will be conducted. Most studies will be conducted using chinook and coho salmon. Depending on the exact study, number of fish per study may range from 1,000 to 60,000.

**Provisions to monitor population status or habitat quality:**

N/A. The effectiveness of NATURES techniques on the status of target populations cannot be fully measured until the techniques move from the research to the region- wide implementation stage.

**Data analysis and evaluation:**

NATURES scientists utilize an array of parametric and nonparametric statistics to analyze data. Chi-square analysis is usually applied to survival data, t-tests or analysis of variance to growth data, migration rate data, coloration data, depth preference, and predator vulnerability data. Mann Whitney U or Kruskal Wallis tests are utilized to analyze most of the foraging behavior data.

**Information feed back to management decisions:**

Information feedback to management decisions will be through annual reports, scientific journal articles, presentations before professional society meetings, presentations at workshops, and frequent discussions with Federal, Tribal, State, PUD, and local fisheries enhancement group fish culture staffs.

**Critical uncertainties affecting project's outcomes:**

The only way to resolve critical uncertainties is to conduct the research. It would be very valuable to increase the size of the project to full hatchery scale to determine if the instream survival advantages demonstrated in NATURES experiments translate into increased smolt-adult return. Although the NATURES project explicitly cover this type of research, resources have not been made available to project personnel to conduct this level of experimentation.

**EVALUATION**

Element 1: The project's overall performance can be assessed by its ability to develop fish culture strategies that increase the post-release survival of hatchery-reared fish. Element 2: The project's overall performance can be assessed by its ability to evaluate the effect of these and other fish culture strategies on post-release survival.

**Incorporating new information regarding uncertainties:**

NATURES scientists will incorporate new information into the decision process as it becomes available. This information will be used to decide if a NATURES fish culture strategy should be further researched to conclusively demonstrate its effectiveness or modify it to a more effective form. If the information consistently indicates no or a negative effect on post-release or inculture survival, then scientists will not incorporate that fish rearing strategy in NATURES protocols.

**Increasing public awareness of F&W activities:**

The project will cooperate with regional enhancement groups, user groups, and the public media to publicize the Region's efforts to develop fish culture strategies that enhance fish and wildlife.

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**RELATIONSHIPS**

**RELATED BPA PROJECT**

**RELATIONSHIP**

8335000

NATURES strategies are being considered for use in the proposed Nez Perce hatchery. The Supplemental Fish Quality Project is developing and refining fish rearing strategies to be tested in the planned BPA Yakima Fisheries Project test of supplementation.

5507700 Monitoring of Supplementation Response Variables for YKFP

NATURES project is cooperatively refining response variables for use in the proposed YKFP test of supplementation

**RELATED NON-BPA PROJECT**

**RELATIONSHIP**

Natural Rearing Protocols/National Marine Fisheries Service

In kind funding

**OPPORTUNITIES FOR COOPERATION:**

NMFS is cooperating with the Washington Department of Fish and Wildlife (WDFW) in conducting NATURES research. Continued NMFS/WDFW cooperative research is critical to the success of refining NATURES rearing variables and conducting juvenile and adult survival evaluations.

**COSTS AND FTE**

**1997 Planned:** \$400,000

**FUTURE FUNDING NEEDS:**

**PAST OBLIGATIONS (incl. 1997 if done):**

<u>FY</u>	<u>\$ NEED</u>	<u>% PLAN</u>	<u>% IMPLEMENT</u>	<u>% O AND M</u>
1998	\$400,000	2%	98%	
1999	\$500,000	2%	98%	
2000	\$500,000	2%	98%	
2001	\$400,000	2%	98%	
2002	\$400,000	2%	98%	

<u>FY</u>	<u>OBLIGATED</u>
1991	\$149,100
1992	\$117,600
1993	\$472,000
1995	\$400,000
1996	\$372,900

TOTAL: \$1,511,600

Note: Data are past obligations, or amounts committed by year, not amounts billed. Does not include data for related projects.

<u>FY</u>	<u>OTHER FUNDING SOURCE</u>	<u>AMOUNT</u>	<u>IN-KIND VALUE</u>
1998	NMFS, Weyerhauser, Long Live the Kings, National F&W Foundation	\$50,000	\$75,000
1999	NMFS, Weyerhauser, Long Live the Kings, National F&W Foundation	\$50,000	\$75,000
2000	NMFS, Weyerhauser, Long Live the Kings, National F&W Foundation	\$50,000	\$75,000
2001	NMFS, Weyerhauser, Long Live the Kings, National F&W Foundation	\$50,000	\$75,000
2002	NMFS, Weyerhauser, Long Live the Kings, National F&W Foundation	\$50,000	\$75,000

**OTHER NON-FINANCIAL SUPPORTERS:**

Washington State Department of Fish and Wildlife, Northwest Indian Fisheries Commission, Long Live the Kings

**LONGER TERM COSTS:**

\$200,000 continued annual costs for implementation of NMFS NATURES research to aid recovery of Columbia River Basin salmon stocks.

**1997 OVERHEAD PERCENT:** 45.6% of total direct labor costs

**HOW DOES PERCENTAGE APPLY TO DIRECT COSTS:**

Applies to total direct labor charges.

**SUBCONTRACTOR FTE:** 2.3

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