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Resource Enhancement & Utilization Technologies Division
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21 August 2002

Northwest Power Planning Council
Attention: Judi Hertz
Response to ISRP
851 SW 6th Avenue, Suite 1100
Portland, OR 97204

Dear Ms. Hertz,

Enclosed are responses to the Independent Scientific Review Panel (ISRP) comments for Project 199105500 (Natural Rearing Enhancement Systems, NATURES) under the Mainstem and Systemwide Province review process. The National Marine Fisheries Service (NMFS), Northwest Fisheries Science Center (NWFSC), Resource Enhancement and Utilization Technologies Division (REUT) has proposed continuation of this project because of the critical need to develop and test conservation hatchery principles to aid restoration of the Region's anadromous salmonid resources. Please contact Tom Flagg of my staff (360-871-8306) if you have any questions.

Sincerely,

Robert N. Iwamoto, Ph.D.
Director

cc: F/NWC2 - Flagg
F/NWC2 - Maynard
F/NWC2 – Berejikian

**Response to the ISRP Preliminary Review of on-going BPA Project 199105500 (Natural Rearing Enhancement Systems (NATURES)**

***Point #1:*** *"The proposal presents results of past studies and suggests that in-stream post-release survival of fish reared in these special habitats is significantly greater than that of their counterparts reared conventionally. These statements, however, are based on relative survival of NATURES reared-fish compared to conventionally reared hatchery fish and have not yet compared survival to adult returns. The studies in 1997-2000 included components to evaluate survival to adult returns.*

*While we acknowledge the efforts in these past studies, the ISRP believes it is important to keep these past results in proper perspective. In the summarized studies, the average improvement in survival (NATURES vs. conventional) is +18% (range +1% to 50%, n = 7 years). Given that smolt-to-adult survival for hatchery fish has frequently been <1%, these improvements (based on short-term smolt survival only to-date) are inadequate to provide the substantial improvement in survival needed for recovery or improved economical value of these hatchery fish. It is essential then that these 1997-2000 studies be reported as the data is available in order that any improved benefits to the adult stage may be accounted for."*

***Sponsor Response to #1:*** NMFS agrees that the ultimate measure of success must be the return rate of adults. As noted above, for the last few years NMFS has been incorporating adult survival evaluations into NATURES studies we have been conducting in partnership with the Washington State Department of Fish and Wildlife (WDFW) at Puget Sound and coastal Washington hatcheries. We anticipate that data from these ongoing studies will be available during 2002-2008. We will make this information available through regional discussions, fisheries conferences, and journal publications. However, the data will only focus on a complete NATURES treatment as applied to rearing of coho and fall chinook salmon.

A major benefit of conducting the proposed NATURES research at the Carson NFH is that the study will focus on a species of major concern in the Columbia River Basin (spring chinook salmon) and that the study will have the experimental power and SARs necessary to statistically evaluate both the full NATURES treatment and the variable components as related to survival to the adult stage.

In regards to concerns that NATURES alone may be "inadequate to provide the substantial improvement in survival needed", we too believe that we must be realistic about our expectations. There is no one "silver bullet" that will by itself restore the Region's anadromous salmonid resources. The most likely scenario is that recovery will be accomplished by threading together many "modest increases" in survival, such as those potentially offered by NATURES.

***Point #2:*** *"The ISRP is also concerned about the publication record of these studies. The authors note a good publication list but upon inspection of those publications there are*

*really 4 papers in recognized primary journals (4 of 32 listed). There does not seem to be any primary paper actually on the NATURES rearing studies?"*

***Sponsor Response to #2:*** NMFS recognizes the need to increase publications on NATURES topics. In the last few years we have been focusing more effort on publication and since 1999 have published three major journal articles on aspects of NATURES research. In addition, we currently have five NATURES-related manuscripts in internal review, including four on NATURES rearing studies.

Nevertheless, we feel that our past publication record should not be totally discounted. Several of the other articles listed, while perhaps not "primary", did receive peer review (i.e., Berejikian and Mahnken in press; Maynard et al. 1995, 1996). This includes two (Maynard et al. 1995, 1996) that provide primary information regarding NATURES rearing components. Additionally, the articles published in conference and workshop proceedings have been critical for the transfer of technology and information throughout the region..

***Point #3:*** ***"****In their response the proposers should provide any available information about smolt to adult survival of NATURES-reared fish."*

***Sponsor Response to #3:*** The only data currently available regarding smolt to adult survival of NATURES-reared fish is for the first year's release of fall chinook salmon in a NMFS-WDFW study at the WDFW Forks Creek Hatchery. However, even this data set is not complete since recovery data for 5-year-old 1996 broodyear fish returning to the hatchery will not be available until December 2002. Nonetheless, the preliminary results are encouraging, with a 15.75 % smolt-to-adult relative survival advantage (NATURES = 0.0595% vs Conventional = 0.0514%) for fall chinook salmon grown full term in NATURES seminatural habitat raceways. This survival difference is more remarkable in light of the observation that the instream survival of NATURES and conventional fish differed by less than 5% in the first release year. Data for other broodyears released in the Forks Creek study will be made available as they are collected during 2003-2006.

***Point #4:*** *"Concerning the sampling design for Objective 1 though, the proposed design includes monthly sampling of 100 animals per replicate/treatment group. In large raceways with various levels of structure (NATURES treatments) we question that this is adequate to estimate the variance or size distribution in each treatment (likely is for mean size). The authors might re-consider their design by initially evaluating how variance decreases with increasing sample sizes."*

***Sponsor Response to #4:*** We agree that using an appropriate sampling technique to obtain a valid estimate of the variance or size distribution in each treatment is crucial. We also concur the presence of structure in the raceway during sampling reduces data quality. In the past NATURES research, we have produced valid variance and mean estimates with 100 fish samples/raceway (replicate) when: 1) the trees were removed from the raceway; 2) the fish were crowded to the upstream end of the raceway with a seine; 3) the crowded fish were selected from 20 dipnet samples containing a minimum

of 100 fish each; and 4) five random handgrabs were made in each dipnet to obtain sampled fish. This same procedure will be used in the Carson study.

***Point #5:*** *"Further, in Objectives 1 and 2, all fish will be coded-wire tagged, but will they be mass-marked to indicate presence of the tag. Given that mass-mark selective fisheries for spring Chinook are commencing, the mark identification could influence the return of these tags."*

***Sponsor Response to #5:*** Yes, all fish released from Carson National Fish Hatchery will be mass marked with an adipose fin clip. When these mass-marked fish return to Carson NFH, all adipose fin-clipped fish will be scanned with coded-wire-tag detection equipment to ensure no coded-wire-tag data is lost at the rack. Regional fisheries management agencies have implemented similar coded-wire-tag scanning protocols in creel census, stream surveys, and landing facilities to reduce coded-wire-tag data loss due to mass marking. Any fisheries data loss caused by mass marking will be unbiased and is being compensated for by ensuring enough tagged fish are released from each replicate raceway to ensure sufficient adult recoveries for successful smolt-to-adult survival data analysis.

***Point #6:*** *"However, a major question related to Objectives 1 and 2 is not really technical in nature. It is whether the Council's FWP can support an additional 5-10 years of research into the NATURES components. Modified elements of NATURES are already being incorporated into facilities. Data collected so far on juvenile survival immediately post-release show small increments of greater survival by NATURES reared juveniles (above); but when translated into adult returns, the likely benefits could be small."*

***Sponsor Response to #6:*** As noted above, modified elements of NATURES are currently being incorporated at state, federal, and tribal fish culture facilities in the Columbia River Basin. Given this fact, it seems critically important to conduct the necessary scientific research to resolve issues of effects of various NATURES enriched habitat components (cover, structure, and substrate) on fitness and post release survival to adulthood.

***Point #7:*** *"In Objective 3 and 4, the authors refer to density in the treatment, but the reviewers' reading is that this is the density at release into the artificial channels. How are the numbers of animals released determined and at what density are the animals reared? Reviewers suggest that the initial rearing density may be influential on the behavior of these fish even before they are released."*

***Sponsor Response to #7:*** The reviewers are correct. The study is designed to vary release density into the stream channel. Release density is determined based on Grant and Kramer's (1990) allometric regression model of territory size and represents 100%, 200% and 400% of habitat saturation. As described in the proposal, varying density will allow us to separate the effects of two factors that go along with releases of hatchery fish:

1) hatchery rearing environment effects on behavior, and 2) effects of stocking density. Both may influence interactions with natural fish in streams.

The reviewers are also correct in that hatchery rearing density may affect social behavior. Surprisingly few studies have evaluated the effects of hatchery rearing density on social behavior of salmonids after they have been released into a natural or laboratory stream (see Berejikian et al. 1996). Pennel and McLean (1996) noted that rearing density varies widely and may be determined by species reared, fish size, rearing container type, water quality and culture methods. Based on the recommendations of Flagg and Nash (1999) for chinook salmon reared in conservation hatcheries, we have chosen to rear steelhead at densities not to exceed 0.15 $lb/ft^3$, which is similar to densities in our previous work.

***Point #8:*** *"Unfortunately there is essential no information in the budget description about how these values were estimated, what labor is involved and what charge-out rates were used. For example, Section 8 includes costs for Indirect but also includes costs for utilities, rents, communications, printing under Other. What is the basis of these Other items that seem to be costs appropriate for Indirect cost accounting?"*

***Sponsor Response to #8:*** Unfortunately, the FY2003 proposal form did not provide space for detailed budget information for each objective. Labor for the project includes 1.5 NMFS FTEs and 3.5 contract FTEs. NMFS FTE labor charge-out contains an indirect overhead (currently about 52%), but contract labor does not. The utilities, rents, communications, and printing category consists of $1.9K for telecommunications, $15.0K for the electrical costs associated with the operation of fish culture pumps, chillers, UV sterilizers, and miscellaneous electrical equipment, $9.1K for equipment rental to install experimental habitats at Carson National Fish Hatchery, and $20.0K to lease research space at the University of Washington facility at Seabeck, Washington.

***Point #9:*** *"At present, the ISRP is inclined to recommend completion of the project after 3 brood years of the factorial study of NATURES components now underway at Carson NFH (the reduction from 5 brood years would probably not entail an important loss of experimental power), and then a shift to evaluation studies at production facilities in the basin that are employing NATURES techniques.*

***Sponsor Response to #9:*** The statistical power analysis for the Carson study was set to ensure the experimental design could detect at least a 20% difference between the rearing treatments with $\alpha = 0.05$ and $1 - \beta = 0.80$. The key controllable factor determining statistical power is the number of replicates/treatment. The project design utilizes all raceways possible at the hatchery. Thus, the option is not available to increase the number of replicates/year. The calculated power $(1 - \beta)$ for the smolt to adult survival evaluation under objective 1 equals 0.65 with three release years, 0.77 with four release years, and 0.87 with five release years. Consequently, any reduction in the number of release years (e.g. from 5 to 3) will appreciably reduce experimental power below the 0.80 standard.

***Point #10:*** *Oversight by the proposers could standardize experimental rearing approaches among the various facilities and coordinate data collection and analysis (as proposed in Objective 5). Adaptive development of NATURES techniques could proceed at the various production facilities.*

*The ISRP is open to the proponent's response to this suggestion in their reply."*

***Sponsor Response to #10:***

Coordination of NATURES activities could provide a useful mechanism for determining benefit of approaches being advanced throughout the region. The NWFSC would be open to participation.

## References


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Pennell, W. and W.E. McLean. 1996. *In* Principles of salmonid aquaculture. *Edited by* Pennell, W. and B.A. Barton. Developments in Aquaculture and Fisheries Science 29: 365-465.

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