

Letter of Intent to Conduct Research:

**Studies of the Relation between Chinook Salmon and Steelhead Smolt Condition and System Survival and Adult Returns**

Submitted in response to AFEP Request for Proposals  
STUDY CODE: BPS-W-00-10

Project Leaders

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Multi-year project, 2007-2012

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## Project Summary

### Goal:

To develop non-lethal methodology to assess energetic condition of Chinook salmon and steelhead smolts at multiple points along their seaward migration and relate to system survival and adult return rates for transported and in-river migrants.

*Recognizing that the Corps can not at this time fund the proposed work through normal processes, we submit these potential future study objectives.*

### Objectives:

Here we briefly describe the study objectives that will provide critical information about the relationship between smolt condition and performance during and following transit of the FCRPS, starting upstream from Lower Granite Dam and Reservoir. The following objectives are related in they all deal with investigating the relationship between the health and condition of salmonid smolts and their performance, that is, the direct and delayed mortality they experience that may be associated to passage through the FCRPS.

- 1. Develop a methodology to assess the health status of migrating yearling Chinook and steelhead smolts upstream from Lower Granite Dam and at multiple points along the river to determine whether there is seasonality shift in the health and condition of migrating smolts from multiple origins.**
- 2. Determine whether a difference in latent mortality can be explained by examining the physiological condition and health status of migrating yearling Chinook and steelhead smolts as they pass Lower Granite and Bonneville dams.**
- 3. Determine whether a difference in latent mortality can be explained by examining the condition of migrants originating from upstream and downstream stocks of yearling Chinook salmon smolts**

### Methodology:

Juvenile Chinook and steelhead smolts will be sampled from the juvenile salmon facilities at Lower Granite, McNary, and Bonneville dams. Sampling will include measures of morphometrics (fork length, weight, body depth and widths), lipid meter readings, and tissues will be preserved for proximate analyses to determine percent lipid and protein of muscle and viscera. We will also investigate the potential to coordinate sampling with juvenile migrants held for salt water trials in the Columbia River estuary. This work will be coordinated with studies proposed by Frank Loge investigating the relation between disease loads and stressors on juvenile survival. Measures will also be made from select groups of live fish PIT tagged for transport studies to be related to system survival and SAR measures.

### Relevance:

The proposed work relates to a critical uncertainties regarding the potential relationship between transport and in-river migration histories and delayed mortality for Chinook salmon and steelhead juveniles (Biop Sections 9.1.6, 9.6.5, p.4; RPA's 47, 185, 186, 189, 195) and the reporting thereof (RPA 13)

## Project Description

### **Background:**

Juvenile Pacific salmon descending the Columbia River encounter numerous obstacles before they can reach the Pacific Ocean, most notably the dams and reservoirs of the FCRPS. Transportation has been adopted as a means to reduce loss of juvenile salmonids related to passage through the Columbia River, but there is not universal agreement on the effectiveness of this strategy. Pointedly, the possibility that survival following ocean entry may be influenced by downstream passage history (delayed mortality) may counteract the potential benefits from transportation. However, in-river migrants can experience protracted travel times because of lower than historical flow velocities within the impounded system. Among other effects, long travel times through a system with limited foraging capacity may deplete limited energy reserves in salmon and steelhead smolts. Congleton et al. (2001) showed that juvenile Chinook in the Columbia River are in negative energy balance while migrating to sea. Total lipid and protein reserves (as percentage of total body weight) decreased from upstream to downstream dams and decreased with increasing travel time. This suggests that individuals that initiate migration with less than adequate energy reserves, or that experience excessively stressful and energetically demanding passage conditions will be more vulnerable to mortality from predation, disease, and starvation upon entry to estuarine and marine environments. Studies are ongoing to relate disease loads and stress indices to juvenile performance. We propose a companion study focused on bioenergetics and juvenile performance. We have been conducting studies to evaluate energetic condition of adult salmonid migrants and relate these to migration and reproductive success. Similar techniques as we have developed for adult salmon can be applied to juvenile salmonids to evaluate the potential relationship between fish condition at the start and during their downstream migration and overall system and ocean survival and to compare survival to rearing type (hatchery, wild), transportation, (barge, in-river), and other passage histories.

The proposed research would relate directly to proposed projects to evaluate transport effectiveness (Doug Marsh, NMFS) and to relate disease load and stress levels to delayed mortality and transport effects (Frank Loge, UC Davis, NOAA).

### **Objectives:**

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### **Methodology:**

Generalized methods would be to Detailed methods would be sample juvenile Chinook salmon and steelhead smolts from the juvenile salmon facilities at Lower Granite, McNary, and Bonneville dams. Sampling would include measures of morphometrics (fork length, weight, body depth and widths), lipid meter readings, and tissues will be preserved for proximate analyses to determine percent lipid and protein of muscle and viscera. Fish would need to be sacrificed for these analyses. We would attempt to coordinate sampling with other ongoing research projects whenever possible to reduce the number of fish used for each sample site. We anticipate 100 individuals would be needed from each site weekly in order to capture total temporal and spatial variability in migrant populations. We will also investigate the potential to coordinate sampling with juvenile migrants held for salt water trials in the Columbia River estuary. This work will be coordinated with studies proposed by Frank Loge investigating the relation between disease loads and stressors on juvenile survival. Measures will also be made from select groups of live fish PIT tagged for transport studies to be related to system survival and SAR measures.

Canonical Correlation Analyses (Can Corr) would be used to identify which measures produce the greatest correlation with energy condition. Multiple regression analyses would be used to develop the best model from correlated variables. We would use Akaike's Information Criterion (AIC) to assess the most parsimonious model. Relating condition to SARs by stock of origin, season of passage and transport/migration history would be made using logistic regression techniques in later years following return of adults and their detection at fishway PIT interrogation sites. Details of sampling logistics would be developed after consultaion with Corps biologist and other researchers.

### **Facilities and Equipment**

All equipment required for the proposed work would be provided by the researchers.

### **Impacts.**

Research proposed here would potentially impact research proposed by NOAA Fisheries to investigate disease loads of juvenile salmon, and PIT-tagging efforts to evaluate juvenile transport effects. We have initiated discussion with the related researchers and we would make every effort to coordinate sampling activities to avoid duplication of efforts and interfering with their work. Sampling would need to occur at juvenile facilities at Lower Granite, McNary and Bonneville dams but should not significantly affect planned operations at these sites. No special dam operations are required for this project.

**Biological Effects.** We anticipate the need to sacrifice 900 to 1,000 juvenile yearling Chinook salmon and a similar number of juvenile steelhead during the initial year of the this study. We will make every effort to use fish that have already been collected for other studies to reduce the take of these fish for these analyses.

### **Collaborative Arrangements and /or Sub-Contracts**

We are in the process of developing funding agreements between USACE and University of Idaho. If these efforts are nit successful the proposed work can be conducted under a sub-contract through Normandeau Associates.

**Key Personnel**

Chris Peery, Project Leader; Project development and administration, data analyses, reporting.  
Chris Caudill, Co-Project Leader, Project development, data collection and analysis, reporting.

**Literature Cited**

Congleton, J.L., W.J. La Voie, D. Freyer, J. Evavold, and B. Sun. 2001. Evaluation of the physiological differences in transported, in river migrating and multiple bypassed juvenile salmon (DACW68-00-027), Annual Report, 2000. United States Army Corps of Engineers.