

PRELIMINARY RESEARCH PROPOSAL (FY07)

TITLE: Evaluate the effectiveness of transporting Subyearling Chinook Salmon from McNary Dam

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PROJECT SUMMARY

The goal of this project is to provide statistically valid information on the smolt-to-adult return rates (SAR) of wild and hatchery-reared subyearling Chinook salmon (*Oncorhynchus tshawytscha*) that migrate in-river compared to those transported from McNary Dam around dams of the Federal Columbia River Power System (FCRPS).

Evaluations of transportation from McNary Dam were delayed until adult PIT-tag detectors became operational in the fish ladders at the dam, which occurred in 2002. In summer 2001 and 2002, we PIT-tagged river-run subyearling Chinook salmon at McNary Dam to evaluate transportation from this site. In 2007, we will continue to collect adult returns from the

2002 tagging year, and propose to continue this evaluation by tagging the delayed third year of the study. We also propose to conduct additional studies using hatchery subyearling Chinook salmon PIT-tagged and released from Columbia River hatcheries above McNary Dam

Analyses of data based on this research and research conducted under various other contracts will provide critical information to compare overall SARs of transported and in-river-migrating or bypassed anadromous salmonids, to examine potential seasonal effects of transportation, and to evaluate the effects of transportation on homing of adults.

Relevance

This study addresses needs identified in NOAA's 2004 Biological Opinion (BiOp) "*The Action Agencies will continue to conduct RM&E to provide information on juvenile fish transportation and delayed mortality*", and the 2005-2007 Implementation Plan for the Federal Columbia River Power System Endangered Species Act Updated Proposed Action of the U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration (dated May 2005). Specifically, the Implementation Plan, under the Hydropower Action Effectiveness Research section (page 40), they state "*Advance the understanding of the effectiveness of flow augmentation, spill, **transportation**, and system configuration changes on fish survival for each ESU*".

This study also addresses RPAs identified in NOAA's 2000 BiOp including *Action 48* addressing the effects of prior transport as smolts on the homing of adults, and *Action 185* aimed at defining juvenile migrant survival for both transported and nontransported migrants including a comparison of SARs of both groups to estimate *D*.

BACKGROUND

Research to evaluate the effects of transporting juvenile salmonids around dams began over 30 years ago and the results have been shown to vary depending on the species evaluated and the time of year (Ward et al. 1997, Williams et al. 2005). Transportation of subyearling Chinook salmon was evaluated at McNary Dam on the Columbia River from 1978 through 1983 and showed that more marked/transported fish returned to the point of release than did marked fish released to migrate in-river, while studies conducted from this dam in 1995-1996 were less conclusive (Williams et al. 2005).

In 1994, a new smolt collection and transportation facility became operational at McNary Dam. However, without adult PIT-tag detectors at lower river dams, opportunities for conducting transportation research at this new facility using PIT tags was limited. However, in 2002, the adult fishways at Bonneville and McNary Dams were equipped with PIT-tag interrogation systems. Therefore, we began transport evaluations with PIT-tagged subyearling Chinook salmon migrating through McNary Dam beginning in summer 2001 and continuing in summer 2002. The third year of tagging was dropped in 2003 partly due to a cutback in funding for research activities. For 2007, we will continue monitoring returning adults from the 2002 marking year and propose tagging the third year of the study. In 2002, we proposed a study using subyearling Chinook salmon from Columbia River hatcheries above McNary Dam, but the study was dropped to allow resources to be shifted to more important areas of research. In 2007, we again propose conducting this part of the study.

These evaluations will provide new data to assess the efficacy of transportation from McNary Dam to increase adult returns of anadromous salmonids to the Columbia River.

APPROACH

Objective 1

Compare SARs of subyearling Chinook salmon juveniles PIT tagged at and either transported from McNary Dam to below Bonneville Dam or released into the tailrace to migrate in-river.

For yearling Chinook salmon and steelhead, the great majority of smolts passing McNary Dam originate in hatcheries upstream of the dam. Therefore, a tagging scheme to evaluate transportation that relies on tagging fish in hatcheries above the dam will represent the great majority of the actual population of fish arriving at the dam. The same is not true for subyearling Chinook salmon. The majority of these fish are from natural spawning in the Hanford Reach and further upstream. Additionally, these wild fish have a later timing distribution at the dam than do the hatchery-reared fish. To provide a holistic approach to evaluating transportation of subyearling Chinook salmon from McNary Dam, we believe it would be wise to PIT tag a group that represents the majority of the population arriving at the dam. To this end, we PIT-tagged river-run subyearling Chinook salmon at McNary Dam during summers of 2001 and 2002. Adults from the 2002 marking year will continue returning through 2007.

Task 1.1:

Recover adult subyearling Chinook salmon previously PIT tagged at McNary Dam and analyze adult return data.

Adult PIT-tag detection systems located in the fish ladders of Bonneville and/or McNary Dams will serve as the principal detection sites for adults. Data acquired from other areas will be considered ancillary. To analyze results, statistical tests will be applied when adult returns for the study are complete. Confidence intervals for the T/I will be calculated using the ratio of SAR estimates (Burnham et al. 1987) and their associated empirical variance. The study will produce statistically-bound T/I estimates for PIT-tagged fish returning to the Columbia River.

Task 1.2:

Examine PIT-tag detection histories of adults as they migrate upstream through the hydropower system.

To evaluate the potential for transportation of subyearling fall Chinook salmon as juveniles to influence the homing characteristics of returning adults, we will compare the PIT-tag detection histories of transported and non-transported adult study fish as they pass upstream through the appropriate PIT-tag detection systems within the Basin.

Task 1.3:

PIT tag two groups of subyearling Chinook salmon at McNary Dam in summer 2007. Transport one group for release below Bonneville Dam and release the other group into the McNary Dam tailrace to continue its in-river migration through the remaining three dams and reservoirs.

In summer 2001 and 2002, we began a study to evaluate transportation of subyearling Chinook salmon from McNary Dam. The original study design called for three years of tagging; however, the third year of tagging was canceled due in part to cutbacks in research funding. In summer 2007, propose to conduct the third year of the original study design.

We recommend testing a minimum 1.3 T/I for subyearling Chinook salmon transported from McNary Dam vs. those that migrate in-river from the tailrace of the dam through 3 additional dams and reservoirs. Currently, the transport SARs from the 2001 and 2002 subyearling Chinook salmon studies are 0.3% and 1.0%, respectively. Given that 2001 was a record low flow year, we will discount that year's SAR and assume a SAR of 1.0% for subyearlings transported from McNary Dam in 2007.

Sample Size Calculations

Sample size calculations for a transport study using transport SARs relative to in-river SARs can be based on determining precision around the estimated T/I such that the ½ width of a confidence interval on the true T/I will not contain the value 1, or the confidence interval on the true natural-log-transformed T/I, LN(T/I), will not contain 0. Therefore, for a desired α and β and specified true T/I, the number of fish needed can be determined in the following manner.

T/I is needed such that:

$$\text{LN}(T/I) - (t\alpha/2 + t\beta) * \text{SE}(\text{LN}(T/I)) \approx 0$$

and $\text{SE}(\text{LN}(T/I)) \approx \text{SQRT}(1/n_T + 1/n_I) = \text{SQRT}(2/n)$, where $n_T = n_I = n$ is the number of adult returns per treatment (n for transport and in-river groups set equal for simplicity). The previous two statements imply that the sample of adults needed is:

$$n \approx 2 * (t\alpha/2 + t\beta)^2 / [\text{LN}(T/I)]^2.$$

Set $\alpha = 0.05$, $\beta = 0.20$, and an expected transport SAR of at least 1.0% for each species. Sample sizes needed at McNary Dam are listed as follows (N denotes the number of juveniles):

T/I	n	NT	NI (=NT*T/I)	NTotal
1.3	228	22,800	29,640	52,440

Therefore, we will tag a total of 52,440 river-run subyearling Chinook salmon at McNary Dam in 2007.

We will attempt to sample the population collected at McNary Dam at levels that will permit marking a constant rate of fish throughout the outmigration. The percentage of the daily collection we handle will depend upon the number of fish collected. Marked study fish will be held an average of 12 hours before transport or release into the McNary Dam tailrace.

As in the past, all handling/marking will be done using preanesthesia techniques (Matthews et al. 1997). After the fish are anesthetized, they will be gravity-transferred in water into the sorting building. Fish to be marked will be sorted out and sent to one of several marking stations to receive a PIT tag.

This basic study design can be executed under any hydropower system operation scenario. The proportion sampled daily for marking will be established when river operation scenarios are known. Once established, we will attempt to hold the proportion sampled constant throughout the season. Any deviations will be recorded. This will provide a total adult-return estimate for marked/transported fish that represents the number of fish collected and transported.

Objective 2

Compare SARs of subyearling Chinook salmon PIT tagged and released from hatcheries in the Columbia River upstream of and subsequently transported from McNary Dam to below Bonneville Dam with the SARs of groups of the same fish estimated to have arrived in the tailrace of the dam and to have migrated in-river through the remaining three dams and reservoirs.

Even though several, multi-species transportation studies were conducted from the dam from the late 1970s through the late 1980s, the tests were conducted under conditions that no longer exist. New transportation studies are needed to ensure that correct decisions are being made on behalf of listed and unlisted anadromous salmonids of the Columbia River. We, therefore, propose to initiate new studies of smolt transportation from McNary Dam using modern technologies and conducted under contemporary conditions.

Evaluations of transportation from McNary Dam are complicated because the populations of fish arriving at the dam originate from two major river systems--the Snake River and the Columbia River upstream of the dam. Objective 1 addresses an evaluation of transportation for the composite populations of anadromous fish arriving at McNary Dam. Objective 2 addresses an evaluation of transport from McNary Dam for fish originating only in the Columbia River.

Task 2.1:

PIT tag and release subyearling Chinook salmon in Columbia River hatcheries upstream of McNary Dam to establish transport and in-river-migrating test groups at the dam in 2007.

To provide a holistic approach to evaluations of SARs and T/Is for fish originating only in the Columbia River upstream of McNary Dam, we propose to tag and release three groups of fish that originate in hatcheries in this area. Transport and in-river-migrating groups will be established when the fish pass through McNary Dam. The numbers of fish transported will be a known value, while the numbers of fish arriving in the dam's tailrace will be estimated (Sandford and Smith 2002).

Sample Size Calculations

The method used to calculate sample sizes for a transport study at McNary Dam is the same as described under Objective 1. Setting $\alpha = 0.05$, $\beta = 0.20$ and an expected transport SAR of at least 1.0% for each hatchery, sample sizes needed to detect a 1.2 T/I at McNary Dam are listed below (N denotes the number of juveniles):

T/I	n	NT	NI (=NT*T/I)	Ntotal
1.2	473	47,300	56,760	104,060

The above numbers are required at McNary Dam. Releasing tagged fish from hatcheries upstream of the dam will require increasing the numbers of fish tagged to provide sufficient numbers collected for transport at the dam. To determine the numbers required for tagging at the hatcheries, we examined the estimated survivals to the dam and detection probabilities for fish released previously in the Columbia River above the dam.

For subyearling fish released from Wells Hatchery, survival to McNary Dam has averaged about 0.300 (pers. commun., Larry Basham, Fish passage Center, 2001). Using this value, about 270,000 (47,300/0.300/0.585) PIT-tagged subyearling hatchery fish would be required for release in the Columbia River upstream of McNary Dam.

We propose to tag fish at three hatcheries upstream of McNary Dam and in numbers roughly proportional to each hatchery's contribution to the total number of fish released. The following table provides numbers of fish proposed for tagging at each hatchery:

Population	Hatchery	Number tagged
Subyearling Chinook salmon		
	Priest Rapids	160,000
	Ringold	80,000
	Eastbank complex	<u>30,000</u>
		270,000

FISH REQUIREMENTS FOR FY 2007

1. We will need to coordinate with WDFW, COE, and other researchers at McNary Dam to obtain 52,440 subyearling Chinook salmon and the facilities for marking.
2. We will coordinate with the proposed Columbia River hatcheries as to the best time for tagging fish at each location. We will work with the COE and whoever is chosen for the actual tagging of these fish.

SCHEDULE

Activity	FY07	Outyears
Task 1.1		
Adult recovery	April-Aug	Same
Task 1.3		
Fish marking and release	Jun-Aug	Same
Task 2.1		
Fish marking and release	Oct-April	Same

PROJECT IMPACTS, FACILITIES, AND EQUIPMENT

We will need use of a part of the Smolt Monitoring Laboratory at McNary Dam for our marking stations. If no space is available, we will need a location close to the lab where we can set up a tagging trailer for our use.

PROJECT PERSONNEL AND DUTIES

Douglas M. Marsh--biologist and principal investigator working on Objectives 1-2.
Steven Smith--statistician working on Objectives 1-2.
Benjamin Sandford--statistician working on Objectives 1-2.

TECHNOLOGY TRANSFER

Technology transfer will be in the form of written and oral research reports as required. A draft report for fall Chinook salmon will be provided to the COE by 15 August each year, with a final report provided by 15 December. In this way, complete returns for each age class of adults can be included in the final report for each study year. Results will also be published in appropriate scientific journals.

REFERENCES

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- Ward, D. L., R. R. Boyce, F. R. Young, and F. E. Olney. 1997. A review and assessment of transportation studies for juvenile chinook salmon in the Snake River. *North American Journal of Fisheries Management* 17:652-662.
- Williams, J. G., S. G. Smith, R. W. Zabel, W. D. Muir, M. D. Scheuerell, B. P. Sandford, D. M. Marsh, R. McNatt, and S. Achord. 2005. Effects of the federal Columbia River power system on salmon populations. NOAA Technical Memorandum, NMFS-NWFSC-63.