RESEARCH PROPOSAL (FY05)

TITLE:	A study to compare SARs of Snake River fall Chinook salmon under alternative transportation and dam operational strategies
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PROJECT SUMMARY

The efficacy of transportation during periods of non-spill and spill is one of the most important, yet unresolved issues facing federal, state, and tribal managers in the Columbia River basin, particularly for ESA-listed juvenile Snake River fall Chinook salmon produced in the wild. Research proposed herein directly addresses the 2004 NOAA Fisheries Biological Opinion's call for information on the efficacy of transportation for this stock.

The goal of this study is to provide statistically valid information on the smolt-to-adult return rates (SAR) of Snake River fall Chinook salmon under two alternative management strategies: transportation around dams of the Federal Columbia River Power System (FCRPS); and in-river migration under prevailing conditions. Migration conditions are likely to change in future study years as the use of removable spillway weirs (RSWs) at Snake River dams, amounts of summer spill, and other structural or operational changes are made. Although the primary aim of this proposal is to evaluate the effects of different management strategies on naturally produced fish, understanding how the different strategies affect the SARs of production fish released from hatcheries and at various offsite acclimation sites is also important.

To achieve the primary research goal outlined here, we will release two groups of PIT-tagged subyearling fall Chinook salmon in the Snake River upstream of Lower Granite Dam. Prior to release, we will designate one group of fish as the "transport group" and the other as the "in-river group". Upon detection at a Snake River Dam, fish from the transport group will move through flumes to raceways for transport to below Bonneville Dam, while slide gates will direct fish from the in-river group to routes leading to the tailrace of the dam to continue in-river migration. In 2005, groups will comprise both hatchery fish raised to a size at release as close as possible to natural subyearling Snake River fall Chinook salmon, and naturally produced fish. The majority of study fish will come from hatcheries because we do not have the ability to capture and tag sufficient naturally produced fish to conduct the studies outlined. In 2006 and future years, the study scope will be expanded to include fall Chinook from Snake River production and acclimation facilities.

For the purposes of the primary evaluation, we will compare the SAR for each group (defined as the number of adults returning to Lower Granite Dam divided by the number of juveniles initially released in each group). We will evaluate the efficacy of transportation relative to in-river migration using the ratio of SARs for the two groups (SAR for transport group divided by SAR for the in-river group). Both the transport and

in-river groups will include fish that were never detected in the hydropower system as juveniles and fish that hold over to migrate as yearlings. That is, unlike past conventional studies of transportation, we will not focus on the SAR of fish after they have been loaded onto the barge. Rather, recognizing that not all fish are transported even under a strategy of maximized transportation, this proposed research is focused on the expected SAR for the entire population from release to adult return. The adult returns are comprised of fish that as juveniles passed through the dams undetected (mostly turbines, spill, or RSW), or if collected and detected were either transported to below Bonneville Dam or bypassed back to the tailrace at dams. Thus, we propose to compare the *strategies*, not the actual modes of travel through the migration corridor.

However, the primary goal of comparing strategies using composite groups of tagged fish released upstream from Lower Granite Dam does not preclude analyses of more conventional groupings. Additionally, we will calculate and compare SARs for fish detected at Lower Granite Dam either transported or returned to the river (responds to the question, " What should we do with fish collected at a dam"), and other groups defined by detection history (never detected, detected once, twice, etc.). The performance of natural and hatchery fish during downstream migration will be compared (timing, survival, detection probability) to determine the adequacy of using hatchery fish as surrogates for natural fish. Scales will be examined from all returning adults to determine whether they migrated as subyearlings or yearlings.

BACKGROUND

Staff of NOAA Fisheries began an evaluation of Snake River fall Chinook salmon transportation in 2001. In 2001 through 2003, NOAA Fisheries PIT-tagged Lyons Ferry Hatchery subyearling fall Chinook salmon and released them upstream of Lower Granite Dam. In 2001 and 2002, fish were raised to a smaller size than normal production fish; whereas, in 2003 only production-sized fish were available. In 2004, too few hatchery subyearling Chinook salmon were available to allow tagging at the hatchery. Instead, run-of-river fish were collected at Lower Granite Dam and PIT tagged. One group of fish was placed in a barge, transported to below Bonneville Dam and released. Another group was returned to the Lower Granite Dam tailrace to migrate downstream. Early results from these studies, as well as adult returns from fish marked as part of in-river survival studies that began in the mid-1990's (Muir et al. 1998, 1999; Smith et al.1997, 2002, 2003) show a complex life history for the early freshwater phase of life, and variable rates of return of adult fish (Williams et al. 2005).

Some fall Chinook salmon juveniles exhibit the typical ocean-type life history, characterized by first-year wintering in the ocean, while other juveniles winter in reservoirs and enter the ocean as yearlings (a.k.a., a "reservoir-type" life history; Connor et al., in press). Existing PIT-tag data suggest that reservoir-type fish winter in reservoirs from Lower Granite to Bonneville Dam. The possibility that some Snake River fall Chinook salmon winter in freshwater downstream of Bonneville Dam, but upstream of the estuary has not been investigated but cannot be dismissed.

Migration of reservoir-type juveniles includes periods of residency in all of the reservoirs in the lower Snake and Columbia rivers. Reservoir residency can begin from early spring the year of release and continue through late spring the following year. Because PIT-tag detection systems at the hydroelectric projects along the Snake and Columbia Rivers are not operational from late fall until early spring, knowledge about the movements of juvenile Snake River fall Chinook salmon during this time period is very limited. Detections of (now-yearling) PIT-tagged fish the spring following release give us an indication of the number of fish holding over, but we cannot know exactly where the fish wintered, as they may start moving during winter before the detection systems were activated, as observed at Lower Granite Dam in 2004 (Ken Tiffan, U.S. Geological Survey, unpublished data).

Another potentially confounding issue is that fish that are detected migrating late in the year of release, or as yearlings the following spring, survive to adulthood at much higher rates than fish that are detected during migration during the summer (SAR measured from the time of final detection as juvenile to return as adult). Among spawners (including jacks and mini-jacks) collected at Lower Granite Dam en route to spawning grounds during 1998-2003, an overall average of 41% (N = 384) of the wild and 51% (N = 475) of the hatchery fish had entered the ocean as yearlings (Connor et al. in press). Although SARs measured from time of final detection are much higher for yearling migrants, the mortality rate for these fish between their subyearling and yearling stages remains unknown.

The consequence of the foregoing observations is that a transportation study of Snake River fall Chinook salmon cannot be based on assumptions appropriate for evaluation of transportation of spring migrants (spring/summer Chinook salmon and steelhead). For example, a basic assumption for any model that estimates the total number of fish arriving at Lower Granite Dam (necessary for estimation of the non-detected group) is that all fish have equal probability of detection. Because some Snake River fall Chinook salmon don't migrate past detection sites until after the detection systems are shut down for the winter, this basic assumption is violated. Because we are unable to determine the number of fish that migrate during this time period, appropriate adjustments to models are not obvious. This leads to inability to reliably estimate the number of fish that pass Lower Granite Dam and are never detected within the hydropower system. Lacking a good estimate of non-detected fish that make it to Lower Granite Dam, we cannot calculate or estimate a reliable SAR for the non-detected group, nor compare its SAR to that of a transport group, as is done for transportation evaluations of spring/summer Chinook salmon.

We can compare the SAR of fish returned to the river following detection at Lower Granite Dam to that for transported fish. Fish detected and bypassed are known to have passed the dam during the transportation window and, thus, provide an equal comparison to fish collected and transported from that dam. This comparison answers the important question of "what do I do with this fish now that I've collected it?" However, it does not address all potential effects of transportation or other mitigation strategies (i.e., spill and RSWs) on the entire population of fall Chinook salmon, because it excludes the substantial number of fish that are never detected within the hydropower system.

To overcome this limitation, we will base our comparison on the SARs of two groups of fish released upstream of Lower Granite Reservoir. Fish from the "transport group" will be collected and transported if they are detected at a transport site on the Snake River. Detected fish from the "in-river group" will be directed to the tailrace to continue in-river migration. It is unnecessary to estimate the number of fish arriving at Lower Granite Dam, or the number that migrate through the hydropower system without detection.

For the purposes of the primary evaluation, SAR for each group will be defined as the number of adults returning to Lower Granite Dam divided by the number of juveniles initially released in each group. We will evaluate the efficacy of a transportation strategy (the 2004 BiOp prescribes maximizing transportation of all Snake River fall Chinook salmon collected) relative to in-river migration using the ratio of SARs for the two groups (SAR for transport group divided by SAR for the in-river group). The percentage of the population transported will vary with level of spill at collector dams and the use of RSWs that exist in the river each year. Both the transport and in-river groups will include fish that were never detected in the hydropower system as juveniles and fish that hold over to migrate as yearlings (the more spill that occurs, the higher the percentage of fish that we will not detect in the system). Comparison of SARs for the two groups will provide information on the efficacy of a transportation strategy versus a bypass strategy for the entire population of fall Chinook salmon in the Snake River under varying in-river conditions.

Another issue to consider is that migrational behavior differs between juvenile fall Chinook salmon from the Snake and Clearwater rivers. Natural Clearwater River juveniles migrate later in the year and with a higher proportion holding over and migrating as yearlings (Connor et al. 2002; in press). During 1998-2003, an inter-annual mean percentage of 28% of all fall Chinook salmon redds counted upstream of Lower Granite Reservoir were counted in the Clearwater River compared to 57% in the Snake River (Idaho Power Company, Nez Perce Tribe, U. S. Fish and Wildlife Service, unpublished data). Thus, natural fall Chinook salmon juveniles of Clearwater River origin must be represented in an evaluation of transportation.

We will estimate juvenile survival from the release site to Lower Granite Dam, and to points downstream as far as possible (likely McNary Dam, based on results from 2001 through 2004). Empirical estimates of survival downstream of McNary Dam based on release of PIT-tagged fish are likely unfeasible because of poor detection probabilities for fall Chinook salmon at lower Columbia River dams caused by poor guidance into bypass systems, summer spill, and a lack of detection downstream of Bonneville Dam. We will consequently make no effort to estimate D (post-Bonneville survival of transported fish relative to that of in-river fish). Modeling survival in the lower river using per-project or per-kilometer expansions of data from the Snake River, then using this modeled estimate for calculation of D would be fraught with numerous untestable assumptions and of little value.

APPROACH

Objective 1: Compare SARs of PIT-tagged wild and surrogate-sized hatchery-reared subyearling Chinook salmon designated for transportation from Snake River Dams to below Bonneville Dam with the SARs of PIT-tagged wild and hatchery-reared subyearling Chinook salmon designated for in-river passage.

State and tribal fisheries agencies have strongly indicated their desire to have the study conducted under a summer spill program. The implementation of summer spill would greatly increase the information provided by our study because the efficacy of spill relative to Snake River fall Chinook salmon migrating in summer is unknown. The Bonneville Power Administration has indicated that summer spill in the Snake River will require an adjustment to their transmission system hardware and that such an adjustment can not be completed until summer 2007, although a test of the RSWs at Lower Granite and Ice Harbor Dams is likely during 2005. Therefore, we propose to conduct the study under extant in-river conditions in 2005. Testing transportation under a summer spill program would begin in 2007 if spill becomes available.

We will evaluate the efficacy of transporting fall Chinook salmon from Snake River Dams using hatchery and wild subyearlings PIT-tagged and released upstream of Lower Granite Reservoir. The vast majority of subyearlings used in this study will be of hatchery origin because of unavailability of sufficient wild fall Chinook salmon subyearlings (see Objective 2 for information on wild subyearling Chinook salmon collection). Based on previous comparisons of the performance of hatchery and natural fall Chinook salmon subyearlings, hatchery subyearlings should serve as adequate surrogates for natural subyearlings provided they are healthy and similar in size at the time of release to their natural counterparts (Muir et al. 1998, 1999; Smith et al. 1997, 2002, 2003; Connor et al. 2002, 2004). Time of release and hatchery subyearling size should approximate those of natural subyearlings in order to obtain results applicable to ESA listed-natural Snake River fall Chinook salmon.

When these conditions are not met, hatchery fish perform differently than natural fish. For example, the subyearlings we marked in 2003 at Lyons Ferry Hatchery were significantly larger than the natural subyearlings that year and the larger hatchery fish had higher survival and detection probabilities. Hatchery fish also traveled to Lower Granite Dam in about half the time as natural fish. Therefore, it is critical that surrogate hatchery subyearlings be released to approximate the timing of seaward movement and size of natural subyearlings. Based on previous research we have conducted, marking only hatchery production fish will not adequately address the issues related to the ESA-listed naturally produced fish in the basin.

Subyearlings for the hatchery surrogate releases will be cultured, acclimated, and released in coordination with NPT and WDFW. The exact procedure followed each year might vary from year to year, because of the complex nature of allocating fish for research and the needs of managers. An annual request for research fish will be presented at the spring and autumn fall Chinook salmon coordination meetings. For 2005 releases of surrogate-sized fish, subyearlings will be requested from the 400,000 subyearlings designated for the Direct Release comparison (Production Plan, Table B4, Production Priority 8) at the NPT acclimation facility located at Captain John's Rapids. In early April, 176,000 hatchery subyearlings will be transferred to Dworshak National Fish Hatchery (DNFH) for 5 to 8 weeks of rearing to a target size of 65-75 mm (the cooler water at DNFH will retard growth). The fish will be PIT-tagged at DNFH, then transported by truck to Captain John's Rapids for direct release to the Snake River at dusk (after short term tempering to ambient Snake River water temperature). The date of release will depend on timing and size of natural fall Chinook salmon collected by beach seining, likely ranging from mid-May to early June based on past data collected during beach seining (e.g., Connor et al. 2002).

The small size at release we propose might concern some managers because size at release of Lyons Ferry Hatchery fall Chinook salmon subyearlings is directly proportional to survival in freshwater (Connor et al. 2004). Survival in freshwater, however, is not necessarily directly proportional to SAR. Lyons Ferry Hatchery subyearlings averaging 70-75 mm fork length released at Pittsburg Landing in June 1997 had a SAR of 0.42% compared to a SAR of 0.14% for Lyons Ferry subyearlings of production size (84-mm fork length) (unpublished data from Connor et al. 2004). Thus, releasing fish at smaller fork lengths than the typical production size might help managers increase hatchery returns.

After tagging, we will randomly assign all PIT-tag codes into two groups, one group for transport and one for in-river passage. We will then set separation-by-code detection systems at Lower Granite, Little Goose, Lower Monumental, and McNary dams so that on detection, fish from each group get routed to their designated destination; either to transportation raceways or return-to-the-river lines.

During 2005, we will tag hatchery surrogate fish only in the Snake River for transportation evaluation because fish small enough to behave like natural fish from the Clearwater River are unavailable. A small group of fish will be reared at DNFH to approximate the timing of seaward movement and size of Clearwater River fall Chinook salmon. These fish will be PIT tagged and released and their performance compared to natural Clearwater fish to determine if rearing a hatchery surrogate is feasible from this drainage in future years.

As stated earlier, both subyearlings that migrate in-river and those transported for release downstream of Bonneville Dam could cease their migration, winter in freshwater, and then resume active seaward movement the following spring as yearlings. Also, some portion of fish in both the transported and in-river groups will pass through the system undetected. Thus, in a companion proposal we discuss reading scales on PIT-tagged adult returns to determine juvenile migration histories of successful survivors for both transported and in-river groups, detected and undetected fish. This will include a comparison of gender, size, and age of returning adults between the two life history types.

Task 1.1: *In late spring 2005, PIT tag subyearling Chinook salmon and release upstream of Lower Granite Dam*

Sample size for primary evaluation

We will release PIT-tagged subyearling fall Chinook salmon in the Snake River upstream of Lower Granite Dam. Prior to release, we will randomly assign fish to one of two groups – a "transport group" or an "in-river group". Upon detection at a Snake River Dam, flumes will direct fish from the transport group to raceways for transport to below Bonneville Dam and slide gates will direct fish from the in-river group to the tailrace of the dam to continue in-river migration.

Fish from the "in-river group" will have juvenile migration histories of the following types (not necessarily mutually exclusive): 1) mortality between release and arrival at Lower Granite Dam; 2) hold over in fresh water; 3) mortality in reservoirs downstream of Lower Granite Dam; 4) complete in-river migration as subyearling and never detected as juveniles; 5) complete in-river migration as subyearling and detected one or more times at dams with PIT-tag detectors. Our transport group will also include fish with the first four histories. Instead of the 5^{th} history category above, the transport group will include history 6): collected as subyearling and transported from collector dams.

For the purposes of the primary evaluation, we define SAR for each group as the number of adults returning to Lower Granite Dam from all above categories divided by the number of juveniles initially released in each group. We will evaluate the efficacy of a transportation strategy relative to in-river migration strategy using the ratio of SARs for the two groups (SAR for transport group divided by SAR for the in-river group). That is, unlike past conventional studies of transportation, we will not focus on the SAR of transported fish after they are loaded onto the barge. Rather, recognizing that not all fish are transported even under a strategy of maximized transportation, this proposed research is focused on the expected SAR for the entire population given the transportation strategy used. At this time, the 2004 BiOp designates a maximum transportation strategy, i.e., transportation of all fish collected at dams where transportation is feasible.

Below, we refer to the ratio of SARs as the "T/I ratio" or simply "T/I", reflecting the comparison of a transport ("T") group with an in-river ("I") group. We note that in the context of our primary evaluation, the quantity T/I has a slightly different meaning than in conventional transport studies. Conventionally, for example, groups were defined at Lower Granite Dam, and "T" referred to the SAR for fish from the time of barge loading until return as adult and "I" was the SAR from release into the tailrace at Lower

Granite Dam until return. Our groups will include the conventional “T” and “I” groups, but also additional categories of fish, as described above.

The consequence of including additional categories that are common between the two groups is that the ratio of SARs for our groups will be closer to 1.0 than the ratio of SARs between the conventional in-barge and in-tailrace groups. This will occur because the transport group will include a non-negligible number of fish not collected and transported at each dam, but instead pass through turbines or spillways, or migrate after detection systems are shut down for the winter (in common with the in-river group). Thus, detecting differences in SAR for the two groups is more difficult. If the SAR for fish loaded into barges at Lower Granite Dam is 1.5 that for fish remaining in the river, then the likely value for the ratio for our groups as a whole is approximately 1.3.

Accordingly, we have planned sample sizes to detect a minimum ratio of 1.3 for fall Chinook salmon in our transport group vs. those in our in-river group. In recent years, overall SAR for Snake River fall Chinook salmon (Lower Granite Dam as juveniles to Lower Granite Dam as adults) were estimated between 1.5 and 2.5% (Peters et al. 1999). Recent adult returns of PIT-tagged fish support these values. For planning purposes and to have a conservative estimate for fish needed if SAR is lower, we assumed a Lower Granite-to-Lower Granite SAR of 1.0% for our transport group. Taking into account all categories of history that will occur for fish in our transport group, we assumed that the SAR for our transport group from initial juvenile release site to return as adult to Lower Granite Dam will be approximately 30% that of fish transported from Lower Granite Dam (the lower SAR for fish from the release groups results from mortality between release and arrival at Lower Granite Dam).

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 significance level (α) and statistical power ($1-\beta$) and desired detectable T/I, the number of fish needed can be determined in the following manner.

Sufficient sample size is need so that:

$$LN(T/I) - (t_{\alpha}/2 + t_{\beta})*SE(LN(T/I)) \geq 0$$

where SE(LN(T/I)) is the estimated standard error of the sample ratio.

Now SE(LN(T/I) ≅ SQRT($1/n_T + 1/n_I$) = SQRT(2/n), where $n_T = n_I = n$ is the number of adult returns per treatment group (n set equal for transport and in-river groups for simplicity). Because the expression for the standard error of the sample T/I ratio strongly depends on the number of returning adults in each group, the required sample size (number of juveniles to release) is determined by the number of adults required for the desired precision:

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

Setting $\alpha = 0.05$, $\beta = 0.20$ and an expected SAR for the transport group of 0.3% (see above regarding the 30% survival from release to Lower Granite Dam), the required number of juveniles to detect a 1.3 T/I are listed below (N denotes the number of juveniles):

T/I	n	NT	NI(=NT*T/I)	Ntotal
1.3	229	76,334	99,234	175,568

Sample size for secondary evaluations

Our study plan for the primary evaluation provides the opportunity to address the secondary, but still important, question of whether it is better to transport a fish guided into the bypass system at a dam or to return it to the river ("what do I do with this fish now that I've collected it?"). For an evaluation of this question for Lower Granite Dam, we set the desired detectable ratio of transported to in-river SAR (a more traditional use of "T/I") of 1.5, and use the same significance level and power as above for the primary evaluation. For this minimum detectable T/I, 96 adults are needed in each group. Assuming a 1.0% SAR for fish transported from Lower Granite Dam, 9,600 transported and 14,400 bypassed juveniles are required.

Releasing PIT-tagged hatchery subyearling Chinook salmon above Lower Granite Dam requires increasing the number of fish tagged over that shown above to provide sufficient numbers for each group at Lower Granite Dam. If we assume 40% survival to Lower Granite Dam and 50% FGE (both reasonable estimates based on previous PIT-tag data), then the required number of fish to release to form the transported and bypassed groups would be the required collected number multiplied by 5.0 (1/(0.4*0.5)), or 120,000 (48,000 for transport and 72,000 for bypass) fish released upstream of the dam.

Thus, the sample size for the primary evaluation will provide sufficient fish in the categories appropriate for the secondary evaluation as well.

Task 1.2: *Collect scales and lengths from subyearling Chinook salmon at Lower Granite and Bonneville Dams for growth analysis and comparisons with adult scale samples*.

In a separate proposal ("A study to understand the early life history of Snake River fall Chinook salmon"), we propose collecting scales from returning adults PIT tagged for previous transportation studies. An analysis of the subyearling scales will provide a reference number of circuli and scale size against which we would compare the adult scales taken in the other study. We will use the sort-by-code systems at Lower Granite and Bonneville Dams to collect a sample of the PIT-tagged fish and determine growth patterns. In addition, we will measure the fork length of migrants at Lower Granite and Bonneville Dams for comparison to determine growth for in-river migrants. We will also take scales from a random sample of unmarked fish collected at Lower Granite Dam to determine growth patterns and the percentages that are of hatchery and wild origin. By including Bonneville Dam as a collection site, we will get growth patterns as close to ocean-entry as possible, giving more strength to the adult scale analysis (see Connor et al. in press for details on scale pattern analyses).

Task 1.3: *Recover adult fall Chinook salmon previously marked with PIT tags and analyze adult return data*.

We will collect adult return information from all adult detection sites in the Columbia and Snake Rivers. 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 (survival) estimate (Burnham et al. 1987) and its associated empirical variance. The study will produce SARs for the group of fish designated for transport and for those designated for in-river migration. Both groups will include some fish that were never detected and some that migrated as yearlings. In addition, SARs for fish detected at Lower Granite Dam and transported will be compared to those detected at Lower Granite Dam and returned to the river providing a T/I estimate for subyearling Chinook salmon at Lower Granite Dam. Similar comparisons will be possible for fish transported and bypassed at other sites. We will also analyze SARs for groups of fish with different detection histories.

Task 1.4: *Examine PIT-tag detection histories of adults as they migrate upstream through the hydropower system*.

Currently, Bonneville, McNary, Priest Rapids, Ice Harbor, and Lower Granite Dams are equipped with adult PIT-tag detection systems, and systems are planned for installation in other dams in the future. At these dams, all PIT-tagged fish passing through the fish ladders will likely be detected. Similar systems are also in place at certain hatcheries in the Columbia River Basin.

To evaluate the potential for transportation 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 PIT-tag detection systems within the Basin. This will include interrogation of adults that might return to Lyons Ferry Hatchery.

Objective 2: Compare post-release performance of natural fall Chinook salmon subyearlings from the Snake and Clearwater rivers to hatchery fall Chinook salmon subyearlings released in these rivers as surrogates for natural fish in transportation studies.

Task 2.1

We will increase the number of natural fall Chinook salmon subyearlings presently collected and implanted with PIT tags in the Snake and Clearwater rivers (e.g., Connor et al. 2002) by supplemental sampling the week before, during and after the release of hatchery fall Chinook salmon subyearlings. A total of 100 natural fish captured in each river will be fin-clipped to determine genetic lineage (i.e., spring or fall run; Rasmussen et al. 2003). Primary sampling is presently funded by the Bonneville Power Administration. Sampling and all subsequent analyses in the Snake and Clearwater rivers will be coordinated between the FWS (lead Snake) and NPT (lead Clearwater).

Using the separation-by-code systems at collector dams, we will direct natural fall Chinook salmon subyearlings designated for the transportation group to the raceways, and fish designated for the in-river group back to the river. This will provide data for calculating smolt-to-adult return rates for natural fish for comparison to their hatchery counterparts, acknowledging the likely large 95% confidence intervals on the estimates. Smolt-to-adult return rates for natural fish collected and tagged during primary sampling that are not detected during their outmigration will be compared to the smolt-to-adult return rates observed for non-detected hatchery fish. Results of genetic analyses (Task 1) will be used to adjust the starting numbers used to calculate smolt-to-adult return rates.

Task 2:2

We will use data collected during primary and supplemental sampling to calculate six indicators of natural and hatchery fish performance for each treatment group (i.e., Snake River natural, Clearwater River natural, Snake River hatchery, Clearwater River hatchery). The indicators are passage date, travel time, condition factor, growth rate in fork length (mm/d), survival (e.g., Connor et al. 2004) and the percentage of the fish that were last detected passing dams the year after release (i.e., reservoir-types; Connor et al.

2002, in press). We will record passage dates and travel times to Lower Granite Dam and downstream dams as sample sizes of natural fish permit. The separation-by-code system at Lower Granite Dam (e.g., Downing et al. 2001) will be used to recapture at least 30 fish/treatment group to calculate condition factor and growth. Survival will be calculated from release to the tailrace of Lower Granite Dam and farther downstream as sample sizes of natural fish permit.

We will conduct statistical analyses to test for differences among treatment groups in passage date, travel time, condition factor, growth rate, survival, or the percentage of the reservoir-type fish. Analysis of variance will be used to compare travel time, condition factor, growth rate and the percentage of fish that were last detected passing the dams the year after release. Passage date will be compared among treatment groups by use of a Kolmogorov-Smirnov test. Survival will be compared among treatment groups by calculating 95% confidence intervals for the point estimates and examining plots for overlap between these intervals and the point estimates.

Objective 3: Compare SARs of PIT-tagged production-sized hatchery-reared subyearling Chinook salmon designated for transportation from Snake River Dams to below Bonneville Dam with the SARs of PIT-tagged hatchery-reared subyearling Chinook salmon designated for in-river passage.

The stock of fall Chinook salmon cultured at Lyons Ferry Hatchery by the WDFW is genetically similar to fish produced in the wild (Marshall et al. 2002) and the release of Lyons Ferry Hatchery subyearlings at acclimation facilities and hatcheries upstream of Lower Granite Reservoir may lead to subsequent natural spawners that can successfully produce a viable F_2 generation of fish. These fish would then become part of the designated ESU of natural fish. Further, production fish have value in their own right to mitigate for past losses and to provide harvest opportunities. Therefore, beginning in 2006, the scope of the study will be expanded to include releases of production-sized hatchery fall Chinook salmon from acclimation facilities operated by the NPT, the newly constructed NPT Hatchery, and Oxbow Hatchery operated jointly by IDFG and the Idaho Power Company.

PIT tagging, release group formation, and analysis will mirror that used in objective 1 for surrogate-sized hatchery fish. The PIT-tagged fish will be apportioned among the various production facilities based on their contribution to total production. The number of fish required will be dependent on the size and time of release from each facility and their expected survival to Lower Granite Dam, but the total number should be similar to, or less than needed for the surrogate-sized releases described in Objective 1.

FISH REQUIREMENTS FOR FY 2005

Under Objective 1, we will PIT tag 175,568 surrogate-sized subyearling fall Chinook salmon at DNFH (transferred to DNFH from Lyons Ferry Hatchery) for direct release at Captain John Rapids acclimation facility in 2005. We will PIT tag and release only a small number of fish (n=3,000) in the Clearwater River during 2005 (also transferred to DNFH from Lyons Ferry Hatchery), to determine their adequacy as surrogates for natural Clearwater River fish.

FISH REQUIREMENTS FOR FY 2006 AND BEYOND

In 2006 and beyond, we will again PIT tag 175,568 surrogate-sized subyearling fall Chinook salmon at DNFH (transferred to DNFH from Lyons Ferry Hatchery) for direct release at Captain John's acclimation facility in the Snake River and into the Clearwater River (provided successful results are obtained from our pilot scale effort to rear surrogate fish for the Clearwater River in 2005) under Objective 1. The number apportioned between the Snake and Clearwater River releases will be based on their recent adult returns (about 2/3 to the Snake River and 1/3 to the Clearwater River).

Under Objective 3, we will PIT tag and release production-sized hatchery subyearling Chinook salmon at all of the production and acclimation facilities above Lower Granite Dam in 2006 and beyond. The number of fish required will be dependent on the size and time of release from each facility and their expected survival to Lower Granite Dam, but the total number should be similar to or lower than that needed for the surrogate-sized releases in objective 1.

COLLABORATION

The study design, locating and securing fish for the study, and its implementation are a result of a collaborative effort among the FWS, NPT, NOAA Fisheries Service, and WDFW. We will coordinate the attainment of hatchery fish through the annual meetings on Snake River fall Chinook salmon production under the guidelines of the fall Chinook salmon management plan developed under U.S. v Oregon.

We will contact the State, Federal and Tribal fishery agencies' joint technical staff to request their assistance in appointing a group of researchers to provide an annual peer review of the study results and analyses. We will conduct an annual coordination meeting (s) where we will discuss the input from reviewers. One month prior to the meeting, we will provide raw data, analytical methods, and draft analyses of the results and discussion sections to this group. At the annual peer-review meeting we will discuss with the collaboration group any input they have regarding possible further analyses or suggestions about our draft results and discussions.

SCHEDULES

	Activity	FY05	Outyears
Task 1.1	Fish marking and release	May-Aug	Same
Task 1.2	Scale collection	June-Oct	Same
Task 1.3	Adult recovery	Aug-Dec	Same
Task 1.4	Adult recovery	Aug-Dec	Same
Task 2.1	Fish marking and release	May-Aug	Same
Task 2.2	Analysis	Nov-Jan	Same

PROJECT IMPACTS, FACILITIES, AND EQUIPMENT

1. COE shall provide maintenance and repair of the adult collection facility at Lower Granite Dam.

PROJECT PERSONNEL AND DUTIES

1. Jerrel Harmon—biologist in charge of Lower Granite Dam field duties involved with Objective 1.
2. Douglas M. Marsh—biologist and co-principal investigator working on Objective 1.
3. Ben Sandford—mathematical statistician working on Objectives 1 and 2.
4. Steve Smith—mathematical statistician working on Objectives 1 and 2.
5. William Connor—biologist and co-principal investigator working on Objectives 1 and 2.
6. Neil Paasch—biological technician working on Objectives 1.
7. Kenneth McIntyre—biological technician working on Objectives 1.
8. Kenneth Thomas—biological technician working on Objectives 1.
9. John Sneva—biologist responsible for scale pattern analyses.

TECHNOLOGY TRANSFER

Technology transfer will be in the form of written and oral research reports as required. A draft report will be provided to the COE by 15 February each year, with a final report provided by 15 June. 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.

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