RESEARCH PROPOSAL (FY05)

TITLE:	A study to compare SARs of inriver migrating versus transported Snake River anadromous salmonids
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DURATION OF PROJECT:	2005 to 2015
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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 Snake River anadromous salmonids that migrate inriver compared to those transported around dams of the Federal Columbia River Power System (FCRPS). We propose to evaluate transportation of wild yearling chinook salmon (*Oncorhynchus tshawytscha*) and wild steelhead (*O. mykiss*) and hatchery-reared subyearling chinook salmon at Snake River dams.

To achieve this goal, we began a study on yearling chinook salmon at Lower Granite Dam in spring 1995. In 1995, 1996, 1998, and 1999, we PIT tagged transport and inriver-migrating wild and

hatchery yearling chinook salmon smolts. No yearling fish were tagged in 1997 due to very depressed smolt numbers. By 2000, we had sufficient adult returns from fish PIT-tagged in 1995, 1996, and 1998 to suggest some relationship between SARs and detection histories. In general, the more often fish were detected (bypassed), the lower the SARs. Among inriver-migrating Snake River fish, those not detected at a transport collector dam generally had the highest SARs, except for fish bypassed only at Lower Granite Dam. We began the recent studies in 1995 without this knowledge. We adjusted our study design beginning in 2000, tagging and releasing more fish into the Lower Granite Dam tailrace to assure more fish in the non-detected or non-bypassed category. Additionally, in 2000, 2002, and 2003, we only PIT tagged transport and inriver groups of wild yearling chinook salmon and steelhead smolts as sufficient numbers of hatchery fish were tagged above the dam to provide some indices of potential transportation benefits. In 2001, due to extremely low flows, we only tagged transport groups of both species. Based on SARs to Lower Granite Dam, we will calculate a 95% confidence interval (CI) for the overall transport/inriver-adult-return-ratio (T/I). We will compare results from our studies (wild fish marked at the dam) to results from hatchery fish PIT-tagged above the dam. We will also use regression analyses to correlate T/Is with a number of variables related to hydropower system operation, time of release, and ocean-entry timing. Results will also be compared to inriver smolt survival studies being conducted concurrently. We will continue to evaluate transportation of subyearling chinook salmon at Lower Granite Dam, studies we began in 2001. Juveniles will be PIT tagged either at Lyons Ferry Hatchery for subsequent release above the Lower Granite Dam, or at Lower Granite Dam using run-of-river fish. If fish are released above Lower Granite Dam, transport and inriver-migrant study groups will be established as the fish migrate downstream through the FCRPS. If fish are marked at the dam, one

transport group will be formed at Lower Granite Dam and other transport and inriver-migrant groups will be formed as the fish migrate downstream through the FCRPS.

SARs from the 1995-1999 studies showed that early transported fish did not show any benefit from transportation compared to fish allowed to migrate inriver. Concerns have been expressed that the fish may have arrived at the ocean either before they were physiologically ready to transition to saltwater or before ocean productivity reached a level to sustain them. To address these concerns, we also propose to test a barging scheme that would transport fish to below Ice Harbor Dam and compare this group's SARs with SARs of fish transported under present operating conditions which include transport to below Bonneville Dam. This would allow the fish to reach the ocean when they are physiologically ready, while moving the fish past half of the dams and their associated effects.

Research proposed here was called for specifically in Action Items 45, 46, and 47 of Section 9.6.1.3, Action Item 185 of Section 9.6.5.3.5.1, and Action Item 53 of Section 9.6.1.3.4 of the 2000 FCRPS Biological Opinion. 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 inriver-migrating or bypassed anadromous salmonids, to examine potential seasonal effects of transportation, to evaluate the effects of transportation on homing of adults, and to estimate differential delayed mortality ("D") of transported fish. The studies will be conducted using state-of-the-art facilities and technologies and under environmental conditions known to provide as favorable inriver passage conditions as possible through the FCRPS as it is currently configured and operated.

BACKGROUND

Research to evaluate the effects of transporting juvenile salmonids around dams began over 30 years ago. Evaluation of transportation of yearling chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) was conducted from various Snake River dams from 1968 through 1980. In addition, transportation of subyearling chinook salmon and steelhead was evaluated at McNary Dam on the Columbia River from 1978 through 1983.

From these early studies, the apparent benefits of transportation varied by species. For subyearling chinook salmon and steelhead, results consistently showed that more marked/transported fish returned to the point of release than did marked fish released to migrate inriver. However, for yearling chinook salmon, study results were less consistent. Results from the earliest studies, during 1968-73, demonstrated conclusively that significantly more marked fish that were transported returned to the point of marking than did marked fish released to migrate inriver (Ebel et al. 1973, Slatick et al. 1975, Ebel 1980). However, studies conducted between 1976 and 1980 yielded inconclusive results because very low numbers of marked adults returned from either group (Park 1985).

Matthews (1992) postulated that severe physical traumas suffered by many smolts during collection and marking were a primary cause of low returns of marked yearling chinook salmon adults during the 1976-80 studies. From 1981 through 1984, the COE and fisheries agencies addressed this problem by modifying or otherwise improving many features of the smolt collection and bypass systems at dams, particularly at Lower Granite Dam. Moreover, the preanesthetic system of handling and marking smolts (Matthews et al. 1997) was introduced at Lower Granite Dam in 1983. This system eliminated much of the major physical traumas associated with the handling and marking process. All indications suggest that the modifications and improvements increased survival substantially.

A study to re-evaluate smolt transportation of yearling chinook salmon and steelhead migrants from the Snake River, after the substantial modifications to collection and bypass facilities were made, was initiated at Lower Granite Dam in 1986. Yearling chinook salmon and steelhead smolts were marked in 1986 and 1989 at Lower Granite Dam. Approximately one-half of the smolts were placed in barges at Lower Granite Dam and released below Bonneville Dam. The remainder

were trucked to a release site downstream from Little Goose Dam to continue their inriver migration. Although significantly more marked adults of both species returned from those fish barged compared to fish that migrated inriver, concern was raised that the studies were flawed because the inriver migrating fish were transported to below Little Goose Dam (Ward et al. 1997). Further, inriver conditions were not considered optimal for the survival of inriver migrating fish; therefore, potential benefits to inriver fish were not evaluated.

The research detailed in this proposal is designed to address concerns about past transport evaluations. By 2000, we had sufficient adult returns from fish PIT-tagged in 1995, 1996, and 1998 to suggest some relationship between SARs and detection histories. In general, the more often fish were detected (bypassed) the lower the SARs. Among inriver-migrating Snake River fish, those not detected at a transport collector dam generally had the highest SARs, except for fish bypassed only at Lower Granite Dam. We began the recent studies in 1995 without this knowledge. We adjusted our study design beginning in 2000, tagging and releasing more fish into the Lower Granite Dam tailrace to assure more fish in the non-detected or non-bypassed category.

Currently, no data exist on the effects of transporting Snake River subyearling chinook salmon, even though high numbers of these fish are transported annually. In summer 2001, we began research to provide vital information in this area. Unfortunately, exceptionally low river flows resulting from drought conditions prevailed and we PIT tagged sufficient numbers of fish for a transport group only. In 2002, we marked Lyons Ferry Hatchery fish for release above the dam to provide both transport and inriver-migrating test groups. However, due to disease problems at the hatchery, the fish were in poor condition. Thus, we do not expect to obtain much usable information from them. Because of budget concerns in 2003, we again PIT tagged sufficient numbers of fish for a transport group only. In 2004, because of low hatchery returns, we were unable to obtain hatchery

subyearlings and had to tag at Lower Granite Dam using run-of-river subyearlings. For 2005, we propose marking hatchery fish for release above the dam to provide both transport and inriver-migrating test groups. If hatchery fish are not available, we propose marking run-of-river fish at Lower Granite Dam for this study.

These evaluations will provide new data to assess inriver migration and transportation to determine what strategies will provide the highest adult returns of anadromous salmonids to the Snake and Columbia Rivers. Results will also be compared to concurrent, inriver-smolt-survival estimates using the Single-Release Model (Iwamoto et al. 1994). These combinations of studies will provide the basis for estimating "D" values for the various groups of transported fish.

APPROACH

Objective 1

Compare SARs of PIT-tagged wild yearling chinook salmon and wild steelhead smolts barged from Lower Granite, Little Goose, and Lower Monumental Dams to below Bonneville Dam with those released into the Lower Granite Dam tailrace and subsequently not detected at a collector dam downstream from the Lower Granite Dam tailrace.

In 2000, we marked wild yearling chinook salmon and wild steelhead smolts for a 3-year study to compare the adult returns to Lower Granite Dam between marked smolts transported from Little Goose Dam to below Bonneville Dam and marked smolts allowed to migrate inriver from the tailrace of Lower Granite Dam. Because of the low flows in 2001, we marked wild yearling chinook salmon and wild steelhead smolts for an index group of smolts transported from Lower Granite Dam.

In 2002 and 2003, we continued the study began in 2000 and added a transport group from Lower Granite Dam. Adults from these juvenile marking years will return through 2005.

Task 1.1:

Recover wild adult chinook salmon and steelhead previously marked with PIT tags and analyze adult return data.

Lower Granite Dam will serve as the principal recovery site 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 (survival) estimate (Burnham et al. 1987) and its associated empirical variance. The study will also produce seasonal trends in SARs and T/Is and an overall, statistically-bound T/I estimate for both wild species at Lower Granite Dam. Additionally, we will also use regression analyses to correlate T/Is with a number of variables related to hydropower system operation, time of release, and ocean-entry timing. and also compare them to inriver survival estimates based on the Single-Release Model.

Task 1.2:

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 detection systems are planned for installation in other dams in the future. At these dams, all PIT-tagged fish passing through the fish ladders are susceptible to detection. Similar systems are also in place at certain hatcheries in the Columbia River Basin.

To evaluate if transportation may 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.

Objective 2

Compare SARs of PIT-tagged hatchery-reared subyearling chinook salmon transported from Lower Granite Dam to below Bonneville Dam with the SARs of PIT-tagged inriver-migrating hatchery-reared subyearling chinook salmon arriving in the tailrace of the dam.

Transportation of subyearling chinook salmon has been repeatedly evaluated at McNary Dam on the Columbia River. However, due to logistical constraints, similar evaluations have never been conducted on Snake River stocks even though these stocks are transported to mitigate for losses during downstream passage through the hydropower system.

In 2001, 2002 and 2003, we conducted studies to evaluate the efficacy of transporting subyearling chinook salmon from Lower Granite Dam using fish PIT-tagged at Lyons Ferry Hatchery. In 2004, Lyons Ferry Hatchery subyearlings were not available, so tagging was conducted at Lower Garnite Dam using run-of-river subyearlings. We have 2 options for marking fish in 2005, depending on the availability of subyearling fish at Lyons Ferry Hatchery. In order to answer the question of "now that I have the fish in my 'hand', what should I do with it", we will form both transport and bypass groups at each collector dam. First time detections at each dam will be divided into these two groups. Fish that are detected for the second or more times will be bypassed back to the river to help establish reach survival estimates.

Option 1: We will evaluate the efficacy of transporting subyearling chinook salmon from Lower Granite Dam using fish PIT-tagged at Lyons Ferry Hatchery. We chose these fish because in each of the past 3 years, over 1,500,000 from the hatchery were released above Lower Granite Dam. Releases of this size or larger are expected to continue into the future. We propose PIT tagging a fraction of these fish at the hatchery and transporting them upstream above the confluence of the Clearwater and Snake Rivers where they will be acclimated and released for eventual recapture and sorting into transport and inriver-migrating groups at Lower Granite Dam. We will evaluate transported fish against two inriver migrating groups. The first group will consist of a known number of fish bypassed back to the river at Lower Granite Dam and subsequently not detected downstream. The second will consist of fish not detected at any of the collector dams. We need to evaluate both inriver groups due to the difficulty in determining numbers of juveniles in the "not detected" group, and our lack of understanding of when "not detected" fish migrate. Some likely migrate after the collection facilities close for the winter, and we have observed that subyearling chinook salmon that outmigrate during late fall/early winter have higher SARs. The higher SARs for these fish boost the overall SAR for undetected fish, but we have no comparison to transported fish. Further, recent evidence based on reading scales taken from adult fish at Lower Granite Dam indicates 40-50% of returning adults reached seawater as yearlings (Billy Connor, USFWS, personal communication).

The fisheries agencies and tribes have strongly indicated their desire to have the study conducted under a summer spill program. However, whether or not spill offers the best inriver-migration condition for Snake River subyearling 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 2005. Therefore, we propose to conduct the study under extant inriver conditions in 2005. Testing transportation under a summer spill program would begin in 2007.

Option 2: If insufficient subyearlings are available to allow marking at the hatchery, we propose marking subyearlings collected at Lower Granite Dam. We will transport one group and release a second group into the Lower Granite Dam tailrace to migrate inriver. Marking will begin in early June and continue through July. As in previous year, we will mark a group of transport fish from early September through October.

The fisheries agencies and tribes have strongly indicated their desire to have the study conducted under a summer spill program. However, whether or not spill offers the best inriver-migration condition for Snake River subyearling 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 2005. Therefore, we propose to conduct the study under extant inriver conditions in 2005. Testing transportation under a summer spill program would begin in 2007.

Task 2.1:

Option 1:

In late spring 2005, PIT tag subyearling chinook salmon at Lyons Ferry Hatchery and transport them for release above Lower Granite Dam to establish transport and inriver-migrating test groups at Lower Granite Dam.

For transport studies conducted at McNary Dam from 1986 through 1989, T/Is for subyearling chinook salmon ranged from 2.8 to 3.5 (Harmon et al. 1996) through three dams and

reservoirs. Since 1989, new bypass systems have been installed, and existing systems have been improved tremendously. Therefore, in summer 2005, we recommend testing a conservative minimum 2.0 T/I for subyearling chinook salmon transported from Lower Granite Dam vs. those that migrate inriver from the tailrace of the dam through 7 additional dams and reservoirs.

In recent years, overall Snake River subyearling chinook salmon SARs were estimated to range between 1.5 and 2.5% back to Lower Granite Dam (Peters et al. 1999). Recent adult returns of PIT-tagged fish support these values. Therefore, we will assume a minimum conservative SAR of 1.0% for subyearling hatchery chinook salmon transported from Lower Granite Dam in 2005.

Sample Size Calculations

Sample size calculations for a transport study using transport SARs relative to inriver 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 and and specified true T/I, the number of fish needed can be determined in the following manner.

T/I is needed such that:

$$LN(T/I) - (t_{/2} + t\ )*SE(LN(T/I)) \quad 0$$

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

$$n \quad 2*(t_{/2} + t\ )^2 / [LN(T/I)]^2.$$

Setting = 0.05, = 0.20 and an expected transport SAR of at least 1.0%, sample sizes needed to detect a 2.0 T/I at Lower Granite Dam are listed below (N denotes the number of juveniles):

T/I	n	N_T	N_I (=N_T*T/I)	N_{total}
2.0	34	3,400	6,800	10,200

Releasing tagged Lyons Ferry Hatchery subyearling chinook salmon above Lower Granite Dam would require increasing the number of fish tagged over that shown above to provide sufficient numbers for each group at Lower Granite Dam. If we assume a 60% survival to Lower Granite Dam and a 50% FGE (both reasonable estimates based on previous PIT-tag detections), then the required number of inriver-migrating fish would need to be multiplied by 3.33 (1.0/0.6*0.5), or 22,644 inriver fish released above the dam. Based upon previous PIT-tag detections, we estimate that 15-30% of the subyearling chinook salmon arriving at Lower Granite Dam and not detected passing through the dam were never subsequently detected at any downstream Snake River collector dam. Therefore, to provide an adequate number of undetected inriver-migrating fish below Lower Granite Dam will require releasing roughly 150,000 (22,644/0.15) PIT-tagged inriver-migrating fish above the dam. This will also provide numbers of transport test fish collected at Lower Granite Dam well in excess of study design requirements. Therefore, we further propose to release 20% of the fish collected at Lower Granite Dam back to the river to measure inriver survival to below John Day Dam. This will allow us to begin the process for calculating post-transport delayed mortality.

Option 2:

In 2005, PIT tag subyearling chinook salmon at Lower Granite Dam to establish transport and inriver-migrating test groups.

For transport studies conducted at McNary Dam from 1986 through 1989, T/Is for subyearling chinook salmon ranged from 2.8 to 3.5 (Harmon et al. 1996) through three dams and reservoirs. Since 1989, new bypass systems have been installed, and existing systems have been improved tremendously. Therefore, in summer 2005, we recommend testing a conservative minimum 2.0 T/I for subyearling chinook salmon transported from Lower Granite Dam vs. those that migrate inriver from the tailrace of the dam through 7 additional dams and reservoirs.

In recent years, overall Snake River subyearling chinook salmon SARs were estimated to range between 1.5 and 2.5% back to Lower Granite Dam (Peters et al. 1999). Recent adult returns of PIT-tagged fish support these values. Therefore, we will assume a minimum conservative SAR of 1.0% for subyearling chinook salmon transported from Lower Granite Dam in 2005.

Sample Size Calculations

Sample size calculations for a transport study using transport SARs relative to inriver 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 and and specified true T/I, the number of fish needed can be determined in the following manner.

T/I is needed such that:

$$LN(T/I) - (t_{/2} + t\ )*SE(LN(T/I)) \quad 0$$

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

$$n \quad 2*(t_{/2} + t)^2 / [LN(T/I)]^2.$$

Setting = 0.05, = 0.20 and an expected transport SAR of at least 1.0%, sample sizes needed to detect a 2.0 T/I at Lower Granite Dam are listed below (N denotes the number of juveniles):

T/I	n	N_T	N_I (=N_T*T/I)	N_{total}
2.0	34	3,400	6,800	10,200

Based upon previous PIT-tag detections, we estimate that 15-30% of the subyearling chinook salmon released at Lower Granite Dam were never subsequently detected at any downstream Snake River collector dam. Therefore, to ensure an adequate number of undetected inriver-migrating fish, we will release 45,333 (6,800/0.15) PIT-tagged inriver-migrating fish into the Lower Granite Dam tailrace.

Task 2.2:

<u>In fall 2005, PIT tag subyearling chinook salmon collected at Lower Granite Dam and transport them for release below Bonneville Dam to provide a fall transport index SAR.</u>

For Snake River subyearling chinook salmon PIT tagged upstream from Lower Granite Dam from 1995 through 1999, adult returns indicate that SARs of inriver-migrating fish are roughly 4 times higher for fish detected and returned to the river at Snake River dams in September and October than for those detected and returned to the river during the summer months. During the same period, data on SARs of transported fish are meager because few juveniles were transported.

To provide a more precise supplemental fall transport index group, we propose to PIT tag 2,500 subyearlings at Lower Granite Dam in September and October. Assuming a 1.0% SAR, the 2,500 marked fish would provide a 95% CI of 0.4% around the transport SAR point estimate.

Task 2.3:

Recover adult fall chinook salmon previously marked with PIT-tags and analyze adult return data.

Because returning adults could volitionally enter Lyons Ferry Hatchery, Ice Harbor Dam will serve as the principal recovery site 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 (survival) estimate (Burnham et al. 1987) and its associated empirical variance. The study will produce SARs for transport and inriver-migrating fish and an overall, statistically-bound T/I estimate for subyearling chinook salmon at Lower Granite Dam.

Task 2.4:

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 detection systems are planned for installation in other dams in the future. At these dams, all PIT-tagged fish passing through the fish ladders are susceptible to detection. 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 the appropriate PIT-tag detection systems within the Basin.

Task 2.5:

Take scale samples from returning PIT-tagged adults at Lower Granite Dam.

Based on some data indicating large percentages of fish returning that did not migrate until they were yearlings, taking scale samples of fish from known passage histories will provide the basis for determining which fish have yearling migrations to the ocean and how transportation influences this percentage.

Objective 3

Compare SARs of PIT-tagged wild yearling chinook salmon smolts that are transported under current guidelines with the SARs of those transported below Ice Harbor Dam.

Adult returns from spring/summer chinook salmon PIT tagged for the 1995, 1996, 1998, and 1999 for Lower Granite Dam transport studies indicated that fish transported early in the outmigration did not receive any benefit over the fish allowed to migrate inriver. Two possible explanations for this are either the fish are arriving at the estuary before they are physiologically ready to transition to saltwater, or they are arriving before ocean carrying capacity is high enough to sustain them. One possible indicator that fish are arriving below Bonneville Dam too early is a trend showing that for fish tagged at the Salmon River trap, those arriving at Lower Granite Dam early in the outmigration (the faster migrating fish) slow their migration beyond Lower Granite Dam, while fish arriving later in the outmigration (the slower migrating fish), increase their migration speed below the dam. One possible method of overcoming the problem of getting the fish to the estuary too early, while still drawing the benefit of not having to migrate through the entire river and dams, is to transport the fish only part way down the river. Historical data indicates that prior to the construction of dams, travel times from Lewiston to Bonneville were between 7 and 12 days for flows over 70 kcfs, and were approximately 20 days below 70 kcfs. We propose transporting fish

past half the dams, then allowing them to migrate the rest of the way to the ocean. Since no previous data exist on which to base expected results, we will consider the initial study year as exploratory.

Task 3.1:

During spring 2005, PIT tag a group of wild yearling chinook salmon smolts at Lower Granite Dam and transport them below Ice Harbor Dam.

In 2005, we will PIT tag wild yearling chinook salmon smolts at Lower Granite Dam and transport them under current guidelines. These smolts will serve as the control group for this study. To transport the other test group, we will place PIT-tagged wild yearling chinook salmon smolts into another barge at Lower Granite Dam, but release them below Ice Harbor Dam. These fish will have the benefit of avoiding any mortality and delay associated with passage past three dams, but will be able to continue at their own pace, reaching the estuary when they are ready. This will result in a 7-10 day delay in the time the fish arrive below Bonneville Dam. The study will begin the day before barge transport begins (approximately 7 April). We will mark 4 replicates, with 6 days between each replicate. Because the number of fish collected at the dam varies as the season progresses, the number of fish in each replicate will depend on the number of fish available on the day of tagging.

In spring 2005, we will PIT tag sufficient numbers of wild yearling chinook salmon smolts at Lower Granite Dam to test a 1.3 transport-below-Ice-Harbor-Dam-to-transport-normally ratio (T_t / T_n) for adults returning to the dam from the above two groups of fish.

Sample Size Calculations

The method used to calulate sample sizes is the same as described in Objective 2. Set = 0.05, = 0.20, and an expected transport SAR of at least 2.0% for T_t. Sample sizes needed at Lower Granite Dam are listed as follows (N denotes the number of juveniles):

T_t/T_n	n	N_{Tih}	N_{Tn} (=N_{Tih}*T_t/T_n)	N_{Total}
1.3	228	11,400	14,820	26,220

This study will require marking 11,400 fish for the test transport condition (over a time period of twelve days), and 14,820 fish for the control condition, fish transported under existing transportation guidelines. All handling/marking will be done using pre-anesthesia techniques (Matthews et al. 1997).

Task 3.2:

Recover study adults utilizing the PIT-tag detection system in the fish ladder at Lower Granite Dam and analyze adult return data.

Lower Granite Dam will serve as the principal recovery site 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. The CIs for the T_t/T_n will be calculated using the ratio (survival) estimate (Burnham et al. 1987) and its associated empirical variance. The study will produce an overall, statistically-bound T_t/T_n estimate at Lower Granite Dam.

FISH REQUIREMENTS FOR FY 2005

Lower Granite Dam

We will PIT tag 26,220 wild yearling chinook salmon smolts to evaluate a transportation study of fish transported to below Ice Harbor Dam compared to fish transported under existing guidelines. Under Objective 2, Option 2, from June through July, we will PIT tag a total of 48,733 subyearling chinook salmon at the dam to evaluate transportation. From September through October, we will PIT tag a total of 2,000 subyearling chinook salmon at the dam to provide a fall transport index group.

Lyons Ferry Hatchery

Under Objective 2, Option 1, we will PIT tag 150,000 subyearling chinook salmon at Lyons Ferry Hatchery in year 2005.

SCHEDULES

Activity	Time FY04	Outyears
Task 1.1		
Adult recovery	Mar-Dec	Same
Task 2.1		
Fish marking and release	June-July	Same
Task 2.2		
Fish marking and release	Sept-Oct	Same
Task 2.3		
Adult recovery	Aug-Dec	Same
Task 3.1		
Fish marking and release	April	Same
Task 3.2		
Adult recovery	Mar-Dec	Same

PROJECT IMPACTS, FACILITIES, AND EQUIPMENT

1. Coordination with operations for smolt marking will be required at McNary and Lower Granite Dams during years when smolts are marked.
2. We will require exclusive use of at least three (possibly four) of the upstream raceways at Lower Granite Dam to collect and hold study fish.
3. 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 all field duties involved with Objectives 1-3.
2. Douglas M. Marsh--biologist and co-principal investigator working on Objectives 1-3.
3. Neil Paasch--biological technician working on Objectives 1-3.
4. Kenneth McIntyre--biological technician working on Objectives 1-3.
5. Kenneth Thomas--biological technician working on Objectives 1-3.

TECHNOLOGY TRANSFER

Technology transfer will be in the form of written and oral research reports as required. A draft report for spring/summer chinook salmon will be provided to the COE by 15 November each year, with a final report provided by 15 March the following spring. A draft report for fall chinook salmon and steelhead 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.

CITATIONS

Ebel, W. J. 1980. Transportation of chinook salmon, *Oncorhynchus tshawytscha*, and steelhead, *Salmo gairdneri*, smolts in the Columbia River and effects on adult returns. Fish. Bull. 78:491-505.

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