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COLUMBIA BASIN FISH & WILDLIFE AUTHORITY

December 10, 2003

Judi Danielson, Chairperson
Northwest Power and Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, OR 97204-1348

Dear Ms Danielson:

The following salmon management agencies and tribes have requested that I deliver to the Northwest Power and Conservation Council, the following Proposed Spill Evaluation. The proposed evaluation plan is designed to address a comprehensive evaluation of spill for fish passage measures included in the Northwest Power and Conservation Council's 2003 Mainstem Amendments to the Columbia River Basin Fish and Wildlife Program, as well as specific 2000 FCRPS Biological Opinion measures for spill and transport evaluations. It is also intended to be responsive to the proposed evaluation of summer spill options 3 and 4 developed by the ad hoc Council-CBFWA spill committee.

The attached spill evaluation proposal represents the agreed upon technical recommendation for the technical evaluation of summer spill, of Washington Department of Fish and Wildlife, Columbia River Inter-Tribal Fish Commission, the Idaho Department of Fish and Game, the Oregon Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, and NOAA Fisheries. This proposal does not address or is not designed to evaluate the effectiveness of non-spill mitigation measures. We expect that, as discussed in the Mainstem Program amendment language, that the Independent Scientific Advisory Board will review the attached study proposal.

Sincerely,

Rod Sando
Executive Director

cc: Doug Marker & Members, NPCC
Science, Full, & Offset Spill Committees
Members, CBFWA
Therese Lamb & Terry Larson, BPA
Dona Watson, FPC

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Proposed Spill Evaluation

Introduction

The National Marine Fisheries Service (NOAA Fisheries) 2000 Biological Opinion (BIOP) for the Federal Columbia River Power System (FCRPS) establishes a suite of measures to provide protection for and ensure recovery of 12 species of listed salmon and steelhead stocks in the Columbia Basin. The Mid-Columbia Habitat Conservation Plan incorporates protection and mitigation measures for all listed and unlisted stocks of anadromous fish in the Mid-Columbia. The Northwest Power and Conservation Council (NPCC) has adopted, in its Columbia Basin Fish and Wildlife Program, a suite of mainstem measures including spill for fish passage. Both the 2000 Biological Opinion and the mainstem program include measures for evaluation of management actions.

The present BIOP and Fish and Wildlife Program measures for summer migrating stocks of anadromous fish include; maximizing collection and transportation of juveniles in the Snake and Columbia rivers; spill for fish passage at Ice Harbor, John Day, The Dalles and Bonneville dams; flow targets in the Snake and Columbia rivers and drafts from federal storage reservoirs; and cool water releases from Dworshak Reservoir. In addition, Mid-Columbia PUD settlement agreements include flow and spill protection measures for listed and unlisted anadromous fish. As stated earlier, each of the plans establish a series of actions to evaluate the benefits of implementing the various protection, mitigation, and recovery measures. The NPCC mainstem program (2003, page 18-19) specifically states:

> *"When making long-term, annual and in-season decisions for when, and to what extent, to spill water for fish passage, priority should be given to 1) minimizing impacts on returning adults and 2) optimizing passage survival benefits for populations that are important to the biological objectives of this program, and that cannot be transported, or are ineffectively transported. This includes spring chinook from the John Day River; wild naturally spawning and key hatchery populations of spring chinook from other tributaries above Bonneville Dam but below the transport projects (or where only a small proportion are collected at McNary), such as from the Deschutes, Hood, Umatilla, Wind, Klickitat and Yakima rivers; listed mid-Columbia steelhead; Hanford Reach fall chinook and Snake River chinook, to the extent that transportation should be determined to be ineffective……………..federal agencies, state fish and wildlife agencies and tribes should determine an optimal passage strategy at each dam and for each passage route. The Council seeks to maximize improvements in life cycle survival. This requires determining the cumulative effects on fish survival of passing multiple dams and taking that information into account."*

The BIOP establishes similar evaluation requirements in Actions 45 and 46 (pages 9-78 through 9-79). These actions require the evaluation of the present transportation of juvenile fall chinook versus in-river and other passage routes. The BIOP action requires the determination of smolt-to-adult survival of listed sub-yearling fall chinook transported at McNary and Lower Granite Dams relative to marked fish traveling in river. The BIOP action requires the provision of spill at Snake River collector projects to reduce turbine mortality, and alternative water management strategies to enhance flow and reduce water temperature. Spill to enhance river conditions is planned annually as a test condition on an alternating basis.

A limitation associated with the present electrical power transmission system precludes the implementation of the full transportation-inriver survival evaluation for fall chinook, including spill as required by the BIOP. This constraint should be resolved by completion of the necessary transmission system upgrades within the next two years. Accordingly, since adoption of the BIOP the region has implemented a "baseline" evaluation of maximum collection and transportation of fall chinook until the transmission system is upgraded to allow the evaluation of a Snake River spill condition.

The following study proposal evaluates the contribution of BIOP spill measures to the achievement of overall life cycle survival goals for both listed and unlisted fish. A requirement of the proposed study is measurement of the baseline effects under existing BIOP spill conditions. The baseline information will inform the final experimental design by determining the needed accuracy of the results and by assessing risks to the survival of listed and unlisted populations by modifying BIOP spill conditions. Conducting this study presents difficult challenges associated with logistics, costs, numbers of marked fish, and changes to operations necessary to carry out the experimental design.

Design Considerations

The proposed study is a multi-year approach designed to meet the stated requirements of the Fish and Wildlife Program's mainstem amendments for evaluation of spill for fish passage and of the BIOP for evaluation of transportation.
The foundation of this approach is:

- It is designed to utilize and build upon the fall chinook studies that are currently in place and generating results.
- It compliments on-going research and monitoring efforts.
- It generates data that has multiple applications to long and short-term management questions.
- It is consistent with the present approach to evaluating the fall chinook transportation program and the baseline benefits of the BIOP spill measures.
- It will, as part of its transportation evaluation, provide the necessary empirical information to help define the long- term transportation strategy to be implemented in the Snake and Columbia Rivers, and thus will help determine the number of fish to be left to migrate in river through the lower Snake and Columbia River.

The proposed study assumes it is commonly understood and agreed that spill provides significantly greater survival of juvenile fish than turbine passage at the projects. Regional acceptance of spill as the safest route of passage by the projects is evident by measures in the NPCC Fish and Wildlife Program and BIOP. Therefore, this study addresses the following management questions

- The efficacy of transportation of fall chinook
- The direct and in-direct benefits of spill passage
- The cumulative effects of passage including multiple bypass
- The life cycle or smolt to adult returns survival improvement with spill.

The study also recognizes the importance of spill mitigation measures in the lower Columbia River FCRPS to non-federal programs such as the Mid-Columbia HCP. Commensurate and consistent with the on-going evaluation of the baseline BIOP condition of maximum transportation, this study begins with an evaluation of the baseline BIOP condition for spill. The study will begin in 2004 so results can be used to determine the experimental design for the comprehensive study that would begin in 2005. As described earlier, the comprehensive study would evaluate the survival benefits of spill for fish passage in the lower Columbia and Snake Rivers and of transportation with enhanced in-river spill and flow conditions.

Background and Rationale

Spill actions should be evaluated in terms of life-cycle survival. However, it is extremely difficult to measure differences in life cycle survival among spill management options or treatment. Therefore, surrogates of over all life-cycle survival, such as smolt-to-adult return rates (SAR), in-river survival, migration rates and delays at projects, will need to be measured to assess different spill actions.

Overall NPCC and regional goals are to protect, recover and rebuild populations. Project evaluations that compare only juvenile survival rates at or between dams are incomplete because they only estimate direct mortality, i.e., they fail to include a measure of indirect effects on survival. These indirect effects need to be incorporated into the evaluation because hydropower system configuration and actions likely result in delayed mortality due to combinations of reduced fish condition (e.g., reduced energy stores, increased stress) and behavioral changes (e.g., altered timing into seawater, reduced predator avoidance). Thus the study needs to measure survival to adults.

Goal: Assess the benefits of summer spill in achieving recovery targets for ESA-listed fish and protection and rebuilding criteria for non-listed fish and toward maximizing improvements in life-cycle survival, including the determination of cumulative effects of passing multiple dams.

In order to meet the recovery and protection standards of the ESA and Power Act, the following criteria must be met.

1. The interim objective of 2-6% SAR for interior Columbia salmon and steelhead populations established in the mainstem amendment of the NPCC Fish and Wildlife Program.
2. Salmon and steelhead goals established in subbasin plans adopted as amendments to the NPCC Fish and Wildlife Program, as well as reflecting NOAA Fisheries (2002) interim recovery criteria for abundance and productivity for use in NPCC subbasin planning.
3. Delisting criteria defined by NOAA Fisheries Technical Recovery Teams for the listed ESUs (Evolutionarily Significant Units) and independent populations within the ESUs using the Viable Salmonid Population criteria (VSP; McElhany et al. 2000). VSP criteria address abundance, productivity, spatial structure and life history diversity, and may include smolt/spawner and SAR criteria. Criteria will, by definition, require recruits to

spawning ground to equal or exceed spawner levels in parental generation (S/S and lambda $\geq$ 1.0) at adequate abundance levels, for persistence and recovery.

4. Life cycle survival targets for listed and unlisted fish taking into account the cumulative negative effects of multiple bypass.

Objectives:

1) Determine the effects of various levels of spill on in-river survival and migration rates of fall chinook in the lower Columbia and Snake Rivers
2) Determine the effects of various levels of spill on overall life-cycle survival (SAR rates) of fall chinook
3) Compare the life-cycle survival (SAR rates) of lower Columbia and Snake River fall chinook migrating in-river with the provision of various levels of spill to transported fish.

Hypotheses:

1) In-river survival increases with spill volume or the proportion spilled (up to the gas cap) and is lowest under no-spill conditions
2) In-river migration time decreases with spill volume or the proportion spilled and is longest under no-spill conditions
3) SAR rates increase with spill volume or the proportion spilled and are lowest under no-spill conditions.
4) SAR rates of fall chinook migrating in the lower Columbia and Snake River with the provision of spill conditions are greater than SAR rates of transported fish.
5) Forebay distribution and spill passage effectiveness is affected by spillbay and turbine operation.

General Study Approach

There are two approaches for studying changes to the BIOP spill program:

- Fish performance can be evaluated under various spill regimes within season
- Fish performance can be evaluated under various spill regimes among years.

For a valid implementation of either approach, establishment of baseline survival estimates and juvenile migration characteristics is necessary. This baseline information has not been collected for fall chinook to date. This proposed study design collects the baseline information necessary for assessing the benefit of BIOP spill measures for Snake River and Columbia River fall chinook populations. The first step is to mark fish and detect marks at sufficient levels to estimate in-river survival, migration rates and patterns, and overall survival under the implementation of the BIOP spill measures. The results of the 2004-2005-baseline study will also provide the information necessary to determine whether subsequent spill evaluations will utilize an annual experimental approach or if in-season blocked designs can be developed.

There is a risk that ESA-listed populations will not recover even under full implementation of the BIOP spill measures. This risk likely increases should the BIOP spill program be reduced under a scientific study. Non-listed stocks are likely to be impacted to a much greater extent. It is generally accepted that reductions in the BIOP spill program will result in increased mortality of listed and non-listed populations. Evaluations that change the BIOP spill program must be neutral in terms of expected fish survival. Potential mitigation measures could include extending the spill season or increasing flows. This proposal is not designed to address or evaluate the effectiveness of non-spill mitigation or offset measures.

2004-2005 Study Proposal

2004-2005 Objective 1: Estimate reach survival from McNary Dam to below Bonneville Dam for juvenile fall chinook migrants under current BIOP measure implementation. Compare reach survival estimates from the overall reach PIT tag method to overall reach survival estimates calculated by taking the product of individual project survival estimates for the four lower Columbia River dams.

Task 1: PIT tag 1.95 million fall chinook at McNary Dam

Task 2: Estimate survival through the four lower Columbia River projects. Radio tag 10,500 fish for release in telemetry studies for each project (total 42,000 fish).

2004-2005 Objective 2: Estimate smolt-to-adult return rates for juvenile fall chinook migrating in-river through the McNary to Bonneville reach.

Task 1: PIT tag 166,000 fall chinook at Priest Rapids hatchery

Task 2: Use the 1.95 million fall PIT tagged chinook from Objective 1.

2004-2005 Objective 3: Determine the feasibility of grouping marked fish arriving at McNary to conduct a block study design of differing spill conditions in 2006.

Task 1: Analyze McNary mark group blocks to determine the feasibility of assessing within year spill level modifications.

2004 Ongoing Baseline Evaluation of Transportation: Compare the life-cycle survival (SAR rates) of Snake River and Columbia River fall chinook migrating in-river under existing BIOP conditions to transported fish.

Task 1: Use NOAA Fisheries SAR estimates of transportation and in-river SAR estimates. NOAA Fisheries is currently estimating transportation SAR rates and comparing those to fish that migrate in-river under the current BIOP measures using 150,000 fall chinook PIT tagged at Lyons Ferry Hatchery.

Task 2: Use NOAA Fisheries estimates of late-season transportation SAR rates. NOAA Fisheries is transporting 2500 PIT tagged fish at Lower Granite in September and October to estimate late-season transportation SAR rates.

Task 3: Use NOAA Fisheries marked fish in 2001 and 2002 at McNary for evaluating fall chinook transportation.

Task 4: PIT tag 166,000 fall Chinook at Priest Rapids Hatchery

Discussion

Evaluating survival under the baseline BIOP spill condition will generate a basis for comparing the effects of future perturbations of passage conditions on fish survival. This is consistent with and will support NOAA Fisheries approach to evaluating fall chinook transportation. Fall chinook survival data collected to date indicate that with adequate PIT tag mark groups an annual reach survival estimate is possible. Annual indices of survival will support the evaluation of spill implementation among years. Data from the 2004-2005 study will provide the basis for a determination of whether or not it is feasible to evaluate modifications of the spill program within a year in terms of reach survival and smolt to adult returns. The 2005 study will also identify the limitations associated with in-season spill evaluation and modifications to identify the potential to minimize these limitations in future years' studies.

Calculations can be made to estimate the number of fish needed to generate annual estimates of survival with sufficient precision to detect differences in survival among years. These errors will presumably provide the narrow confidence bounds needed in the decision making process. In calculations developed by NOAA Fisheries they targeted standard errors of 0.015 (providing +/- 3% confidence limits) for expected survival estimates for any particular spill scenario. When comparing two different spill scenarios (treatments), NOAA Fisheries targeted standard errors of 0.015 to provide the ability to detect differences of 3% between the two survival estimates.

PIT-tagged mark groups at McNary Dam

This study will estimate survival between the tailrace of McNary Dam and the tailrace of Bonneville Dam. This requires one PIT-tag detection site downstream of Bonneville Dam. Precision of survival estimates depends on the number of PIT-tagged fish released and the number of fish detected at downstream sites. Since the mid- to late 1990s, NOAA Fisheries has used a trawl to detect fish downstream of Bonneville Dam for spring migrants. Based on numbers of fish released at upstream sites and low detection rates of PIT-tagged fish at the trawl site, the annual survival estimates to the tailrace of Bonneville Dam have had standard errors much larger than those assumed necessary for a summer spill survival study. For example, in 2002, the survival estimate to the tailrace of Bonneville Dam from ca. 78,000 PIT-tagged spring migrants detected passing McNary Dam had a standard error of 0.079. A trawl operated in the summer may not have a higher detection rate than in the spring (and could possibly have a lower detection rate). For planning purposes a similar trawl detection rate for summer migrants as for spring migrants was assumed. Thus, it would take a release of PIT-tagged fish from McNary Dam approximately 25-times greater (or ca. 1.95 M) to provide a survival estimate between the tailraces of McNary and Bonneville Dams with a standard error of 0.015. To capture the variability among years would require a *minimum* of three replicates. It would likely take additional replicates if a large variability in conditions existed between years.

Various transport to in-river SAR ratios have been proposed for evaluation. The number of marked fish necessary to detect differences at a specified level of significance and power is dependent upon these SAR ratios. The following tables (Tables 1 and 2) presents the preliminary number of marked fish required to detect different transport to in-river SAR ratios.

Radio-tagged mark groups

This technique would require releasing radio-tagged fish into the tailrace of each dam and detection of fish as they pass two detection arrays in the tailrace of the next downstream dam. The product of survival probabilities derived from survival estimates through each reach would provide an estimate of survival under one spill scenario through the hydropower system. To detect differences between survival estimates obtained under two different spill scenarios would take approximately 5,250 radio-tagged fish per treatment released in each reach. Thus, to detect differences of 3% survival between two treatments in a reach would require 10,500 fish. To estimate the differences through the four lower Columbia River projects would require 42,000 fish. Again, the feasibility of handling and radio-tagging this many subyearling fall chinook in the summer under periods with warm water temperatures may make it difficult to conduct a study of this magnitude.

PIT Tag groups at Priest Rapids Hatchery

This study will compare transported fall Chinook to in-river migrating fall Chinook under BIOP conditions in 2004. Smolt-to-adult return estimates will be computed for the transported smolts at McNary Dam and the smolts that passed McNary Dam undetected. This latter group Co, represents the fate of the untagged population not collected at McNary Dam. A sample size of 166,000 PIT tagged fish released at Priest Rapids Hatchery is chosen to provide a power of 80% and error of 5% detecting a significant T/I ration greater than 1.4 if the SAR of transported fall Chinook is "truly" 40% higher than that of the in-river migrants. A range of sample sizes for detecting differences from 10% to 100% are presented in Table 1.

Table 1. PIT tag sample size for evaluating transport versus best in-river conditions in the Lower Columbia River with transportation at McNary Dam. PIT tag sample sizes are based on a Power of 80% and error of 5% with smallest SAR of 1%. Determination uses a one-tail test of T>I, where I is 1% and T ranges from 1.1% to 2.0%. Release number assumes release to McNary survival of 0.717, McNary collection efficiency of 0.155, and 50% of collected fish transported. The smallest group size belongs to Category T_{MCN} since the best in-river conditions require 75% spill at McNary Dam.

T/I Ratio	Smallest group # Category T_0	In-river group # Category C_0	Release Number at Priest Rapids Hatchery
1.10	128,917	1,405,607	2,320,000
1.15	58,624	639,188	1,055,000
1.20	33,730	367,760	607,000
1.25	22,227	242,346	400,000
1.30	15,670	170,854	282,000
1.35	11,781	128,443	212,000
1.40	9,224	100,574	166,000
1.50	6,113	66,645	110,000
1.75	3,001	32,717	54,000
2.00	1,834	19,994	33,000

Evaluating feasibility of successfully handling and marking representative samples of fish

There are some immediate concerns that could be addressed in 2004-2005 by evaluating the results generated during the conduct of the baseline and pilot study. One relates to fish handling. The above scenarios for both PIT-tagged and radio-tagged studies presume the ability to handle and tag fish throughout the summer migration season, independent of flows and water temperatures. They also presume tagged fish represent the untagged population. Clearly, the size of migrant fish is sufficient to PIT tag nearly 100% of them, but this probably does not hold true for the ability to radio tag nearly all fish, as radio-tagged fish need to be >110 mm. We also do not know if the region has sufficient personnel with the expertise to set up the equipment and tag fish in the short period of time necessary to conduct these types of studies. All of these issues will be tested. In addition, information will be generated relative to the size of the block that would be appropriate for incorporation into a block design to yield the least overlap of test design for study groups.

Block Design Evaluation

The 2004-2005 study will assess the feasibility of evaluating the effect on fish survival of in-season spill modifications using a block design study. It will identify limitations and evaluate the likelihood of resolving them. The study will examine whether juvenile survival estimates can be collected over sufficiently long reaches to address the concern that site-specific studies are not sufficient to capture the full benefits of spill. It will contrast the results from site-specific survival estimates from radio tags with PIT tag estimates collected over long reaches. It will also examine whether sufficiently large samples can be collected to provide survival to the adult life stage. Although it may be feasible to mark sufficiently large numbers of fish and hold them for release through the implementation of the block design, this approach introduces a myriad of issues related to the potential impact of the holding on the survivability of the fish. Trying to solve the holding problem by releasing fish at one time and stratifying into subsamples as they pass a downstream detection site may compromise the ability to mark sufficient numbers of fish throughout the entire season to implement a block design. Marking fish in-river is a possibility, but fish availability as well as the conditions late in the summer season with the warmest water temperatures may preclude the ability to safely collect, handle, and/or tag the needed numbers of subyearling fall chinook. Presently, facilities at McNary Dam may not handle the large number of PIT-tagged fish necessary for such a study.

Another challenge to implementing the block study design is that as fish pass by a downstream project they spread out over time, introducing the concern regarding overlapping test conditions among blocks. The study design in the Lower Columbia would primarily rely on fish originating in the Mid Columbia. These Mid Columbia origin subyearling fall chinook take considerable time to migrate through the Lower Columbia River, exacerbating the potential for overlapping test conditions if the block length is not pre-determined based on information collected during a base line study.

2005-2006 and Beyond Study Proposal

Objective 1: Estimate reach survival from McNary Dam to below Bonneville Dam for juvenile fall chinook migrants under current BIOP measure implementation.

Task 1: Estimate survival through the four lower Columbia River projects. Radio tag 10,500 fish for release in telemetry studies for each project (total 42,000 fish)..

Task 2: PIT tag 1.95 million-fall chinook at McNary Dam.

Objective 2: Estimate SAR rates for juvenile fall chinook migrating in-river through the McNary to Bonneville reach for the BIOP spill condition and alternative spill regime.

Task 1: PIT tag 166,000 fall chinook at Priest Rapids.

Task 2: PIT tag 1.95 million-fall chinook at McNary Dam from Objective 1.

Objective 3: Determine the feasibility to conduct a block study design of differing spill conditions in the lower Columbia.

Task 1: Analyze McNary mark group blocks to determine the feasibility of assessing within year spill level modifications.

Objective 4. Conduct study comparing the life-cycle survival (SAR rates) of Snake River and Columbia River fall chinook migrating in-river with the provision of BIOP spill and an alternative spill regime to transported fish as described below.

Task 1: PIT tag 45,500 juvenile hatchery fall chinook for release at each acclimation pond with major production.

Task 2: Use PIT tags from objective 2 to estimate the Columbia River SARs.

2005 Transportation Considerations

The following proposed evaluation of Snake River fall chinook has been developed assuming the present system configuration and current BIOP operations of the hydropower system. Determining the "best" migration mode for subyearling chinook originating above Lower Granite Dam to below Bonneville Dam requires comparing the current transportation mode to optimum in-river conditions, which should provide improved passage conditions over current levels. This may require that spill be provided at collector dams to enhance the survivability of in-river migrants over what is possible under current BIOP operations, where collector dams do not have spill provided during the summer migration season. In order to make a fairer comparison of survival benefits of fish migrating in-river versus fish transported through the hydropower system, spill may need to be provided at the collector dams.

The following criteria were used to determine adequate PIT tag smolt numbers.

- Summer minimum flows are 50 kcfs in the Snake River and 200 kcfs in the lower Columbia River from the start of the summer migration season through the end of August.
- Spill levels at collector dams, which presently is zero under the BIOP, will be increased to the maximum permitted by the state water quality agencies if one turbine unit is operational at the Snake River dams and a minimum powerhouse flow of 50 kcfs is maintained at McNary Dam. This translates to a 75% spill level at Lower Granite, Little Goose, Lower Monumental, and McNary dams, and an 80% spill level at Ice Harbor Dam.
- Spill levels at the non-collector dams would be set at BIOP levels (approximately 60% at John Day and Bonneville dams, and 40% at The Dalles Dam).
- The bypass FGE assumed is taken from Table D-2 of the 2000 FCRPS BIOP and is 53% at Lower Granite and Little Goose dams, 49% at Lower Monumental Dam, 54% at Ice Harbor Dam, 62% at McNary Dam, 32% at John Day Dam, and 28% at Bonneville Dam Powerhouse 2.
- The collection efficiency of the bypass system is simply the (1- spill proportion) times FGE, under the assumption of a 1:1 spill effectiveness. As spill effectiveness increases, more smolts will pass through spill than used for planning purposes, making the determination of numbers of smolts in the in-river study category conservative.
- From PIT tagged releases in regular production at the four fall chinook acclimation ponds over the 5-year period from 1999 – 2003, we have estimates of reach survivals. The

average 5-year survival estimates used for planning purposes are 0.41 from release to Lower Granite Dam tailrace, 0.75 from Lower Granite to Little Goose tailrace, 0.78 from Little Goose to Lower Monumental tailrace, and 0.74 from Lower Monumental to McNary tailrace (estimates for below McNary Dam are not needed for determining numbers of smolts in the various study categories.

- The study categories include those smolts transported (Category T_0 in Lower Granite Dam equivalents), those smolts migrating in-river without a prior detection at a collector dam (Category C_0 in Lower Granite Dam equivalents), and those smolts migrating in-river with at least one detection at a collector dam (Category C_1 in Lower Granite Dam equivalents).

There are two alternative approaches to evaluating transportation vs in-river migration survival. The first method is patterned after the Fishery Agencies and Tribes' Comparative Survival Study, and the second method is patterned after the Nez Perce Tribes' Sub-basin Survival Studies. For details of survival methods and sample size calculations see appendix A.

Table 2. PIT tag sample size for evaluating transport versus best in-river conditions in the Snake River with transportation at four dams. PIT tag sample sizes are based on a Power of 80% and error of 5% with smallest SAR of 0.45%. Determination uses a one-tail test of T>I, where I is 0.45% and T ranges from 0.5% to 0.9%. Release number assumes survivals of 41% release to LGR, 75% LGR-LGS, 78% LGS-LMN, and 75% LMN-MCN, collection efficiencies of 0.133 at LGR and LGS, 0.123 at LMN, and 0.155 at MCN, and 50% of first-time collected fish transported at each collector dam. The smallest group size belongs to Category T_0 (aggregate transportation group) since the best in-river conditions require 75% spill at each of the four transportation collector dams.

T/I Ratio	Smallest group # Category T_0	In-river group # Category C_0	Release Number at Acclimation Pond
1.10	288,043	727,306	3,179,000
1.15	131,111	331,051	1,447,000
1.20	75,480	190,577	833,000
1.25	49,384	124,688	545,000
1.30	35,068	88,538	387,000
1.35	26,278	66,347	290,000
1.40	20,569	51,935	227,000
1.50	13,774	34,777	152,000
1.75	6,705	16,931	74,000
2.00	4,124	10,409	45,500

Discussion

The results of the 2004-2005 baseline study will provide the information necessary to determine whether subsequent spill evaluations will utilize an annual experimental approach or if in-season blocked designs can be developed. Examples of the information generated include reach survivals from PIT tags versus radio tags, travel times for determining appropriate blocks of time for experimental treatment, and temporal changes in survival associated with environmental factors and stock composition.

There is a risk that ESA-listed populations may not recover even under full implementation of the BIOP spill measures. Long–term decisions about future spill management will depend upon the efficacy of transportation. Therefore, evaluations of transportation need to consider improved passage conditions, which includes the provision of summer spill at collector projects and meeting BIOP flow targets. Consistent with BIOP Actions 45 and 46, the proposal includes an evaluation of fall chinook transportation with improved inriver migration conditions. There is additional risk to recovering ESA-listed species should the BIOP spill program be reduced under a scientific study. Similarly, non-listed stocks will also be impacted. It is accepted that reductions in the BIOP spill program will result in increased mortality of listed and non-listed populations. Therefore any evaluations that change the BIOP spill program must be neutral in terms of expected fish survival. Potential mitigation measures could include extending the spill season or increasing flows.

The information generated on survival and migration characteristics will be used to guide discussions on whether block designs or annual designs are appropriate for evaluating spill. Additionally, the risks imposed upon the ESA-listed and non-listed fish in the Columbia and Snake Rivers must be a major factor in considering experimental designs.

APPENDIX A
Details of Survival Methods and Sample Size Calculations

In the CSS approach, an initial group of smolts are PIT tagged from production fish in acclimation ponds above Lower Granite Dam and released directly with the production. As the PIT tagged smolts pass the four collector dams, a fixed percentage of first-time detected fish are routed to the raceways (Category T_0) and the remainder returned to the river for in-river survival estimation purposes (Category C_1). Smolts that pass the four collector dams undetected become the group (Category C_0) that closest represents the in-river migrating un-tagged smolts.

In the NPT approach, the initial population of PIT tagged smolts is divided into two categories prior to release. The first NPT group is used for in-river survival estimation and contains the in-river fish that are detected at a collector dam and routed back to the river (Category C_1), plus the in-river fish that are not detected at a collector dam (Category C_0). The second NPT group is used to mimic the untagged population passing the collector dams. Every collected PIT tagged smolts in this group has the same migration fate as the collected untagged smolts. Nearly all collected PIT tagged smolts will be transported (Category T_0), with the only exception occurring when the dam must dump raceways because of unforeseen events. Those PIT tagged smolts that are not detected at a collector dam will become part of Category C_0 fish. Combining the number of smolts in Category C_0 from the first NPT group with those from the second NPT group will provide the total number of smolts in Category C_0.

The NPT approach has the advantage of giving more direct control to how many PIT tagged smolts will be in the in-river Categories C_0 and C_1, and after summing across the four collector dams, the number of PIT tagged smolts in Category T_0 is directly related to the total number of untagged transport smolts. In the event of lower than expected adult returns across all study categories, such as when poor ocean survival occurs, the NPT approach has the capability to be analyzed as a simple comparison of two study groups, the group of PIT tagged fish released for in-river survival estimation (Category C_1 and partial C_0 combined) versus the group of PIT tagged fish released to mimic the untagged population (Category T_0 and partial C_0 combined). In this latter situation, there would be no estimation of smolts in Category C_0. Instead, the first study group would represent the untagged population of smolts that would occur if transportation did not exist, and the second study groups would represent the overall untagged population in which a small proportion of fish remain in-river in spite of full transportation at each collector dam.

The CSS approach relies on diverting adequate numbers of smolts back to the river at each collector dam, and if differential proportions are diverted back to the river at each dam, then the need for an adjustment to the transportation PIT tag numbers at each dam to reflect the "true" proportion of untagged smolts transported there. In general, this is not a problem, but there is less flexibility in how to conduct the estimation in the event of poor overall adult returns. However, from the planning aspect, it is preferable to use the CSS approach for PIT tag sample size determination since under the spill levels proposed to produce "best" in-river conditions, the number of PIT tagged smolts in Category T_0 will generally be the limiting factor in this analysis.

The PIT tag sample size requirements for the CSS approach is based on the set of criteria presented in paragraph two for in-river reach survivals, dam FGE's and spill proportions. A fixed 50% of first-time detected PIT tagged smolts would be transported from each collector dam. In addition, the goal was to have a 80% power of detecting a differences ranging 10% to

100% with an error of 5% when the lowest SAR for a study category was 0.45% for Snake River fall chinook. For Priest Rapids hatchery fall chinook, a lowest SAR of 1% was used. So the goal is to determine the minimum number of fish to PIT tag such that we would be able to show that a minimum difference was greater than could occur simply based on random chance with minimal error. The sample size for comparing two independent binomial proportions is:

$N = (Z_a + Z_ß)^2 \bullet (p_1q_1 + p_2q_2)/(p_2 - p_1)^2$

where $(Z_{0.05} + Z_{0.10})^2 = 6.2$ and $p_1 = 0.0045$ and p_2 ranges from 0.005 to 0.009 for Snake River fall chinook. For Priest Rapids hatchery $p_1 = 0.010$ and p_2 ranges from 0.011 to 0.020.

The minimum sample size required in any key study category is shown in Table 2 for Snake River fall chinook. Minimum sample size information for Priest Rapids fall chinook was presented earlier in Table 1.