Northwestern Division - US Army Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
FY 2005 RESEARCH SUMMARIES

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2. BPS-00-9
   Evaluate Comparative Survival of In-River Passage to Multiple Bypassed Juvenile Salmon

3. BPS-00-10
   Evaluate Comparative Delayed Mortality of Transported Juvenile Salmon and In-River Migrating Juvenile Salmon

4. BPS-00-9, BPS-00-10
   Identification of Principal In-River Stressors Contributing to Delayed Disease-Induced Mortalities in Outmigrant Juvenile Salmon

5. BPS-00-11
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   Evaluations and Studies of Fish Passage Efficiency at Bonneville Dam

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   Evaluation of Adult Salmon and Steelhead Fallback and Delay at Snake and Columbia River Dams

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   Evaluation of Steelhead Kelt Passage through Lower Columbia River dams and Efficacy of Reconditioning of wild fish from LGR

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   Development of Alternative Means to Pass Adult Pacific Lamprey Around Dams

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   Investigate the Effects of Water Quality on Bull Trout Survival Near Hydro-projects and Fishways

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   Bull Trout Use of Lower Snake River Reservoirs and the Effects of Operations of Hydroelectric Dams on their Movements

Estuary Studies (EST)

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   A Study To Estimate Salmonid Survival Through The Columbia River Estuary Using Acoustic Tags

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   Estuarine Habitat And Juvenile Salmon – Current And Historic Linkages In The Lower Columbia River And Estuary

3. EST-02-03
   Evaluation Of The Relationship Among Time Of Ocean Entry, Physical, And Biological Characteristics Of The Estuary And Plum Environment And Adult Return Rates.

4. EST-02-04
   Evaluating cumulative ecosystem response to restoration projects in the Lower Columbia River and Estuary

Avian Predation Studies (AVS)

1. AVS-W-03
   Evaluate the Impact of Avian Predation on Salmonid Smolts from the Columbia and Snake Rivers

2. AVS-P-05-(NEW)
   Evaluate Caspian Tern Management Measures and Develop Baseline Information on Double-crested Cormorants Directed at Reducing the Impact of Avian Predation on Salmonid Smolts in the Columbia River Estuary

Transport Evaluation Studies (TPE)

1. TPE-W-00-2
   Evaluate Post-Release Losses and Barging Strategies that Minimize Post-Release Mortality

2. TPE-W-00-2004
   Analyze the benefits of transporting Lower Snake River juvenile Fall Chinook salmon

3. TPE-W-04-06
   Determine physiological factors that drive fish survival during the transportation process

4. TPE-W-04-03
   Evaluate the effectiveness of transportation for Fall Chinook Salmon at McNary Dam

5. TPE-W-04-02
   Evaluate the effectiveness of transportation for Spring/Summer Chinook Salmon and Steelhead at McNary Dam

6. TPE-W-04-1
   Determine the Benefits of Early Spring Transport from the Snake River

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-W-00-4

TITLE: Evaluate the Effects of Passage through the Juvenile Bypass Facilities and Reservoirs on Survival of Juvenile Pacific Lamprey.

FISH PROGRAM FEATURE: CRFMP – Bypass

Based on counts of adult lampreys in the fishways and anecdotal observations of abundance of lamprey ammocoetes in juvenile fish facilities, lamprey numbers appear to be in decline. Little is known about the effects of passage through juvenile bypass facilities on juvenile Pacific lamprey. In 2002, PIT tagged juvenile lamprey were released into the juvenile bypass system at McNary Dam. An unexpectedly low percentage of those fish were detected on the PIT detectors at the JBS.

BIOP MEASURE: NA

OBJECTIVES:

1. Determine the location and cause of unaccounted loss of juvenile lamprey in the bypass system at McNary Dam.

SCHEDULE: 2001-2006

POC: Derek Fryer 509-527-7280

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-00-9

TITLE: Evaluate Comparative Survival of In-River Passage to Multiple Bypassed Juvenile Salmon.

FISH PROGRAM FEATURE: CRFMP – System - Bypass

BIOP MEASURE: RPA 189

BACKGROUND: Adult return data from the PIT tagged juvenile chinook released in survival studies conducted throughout the Snake River indicate that fish bypassed multiple times around the dams may be returning at a lower rate than fish that remain in-river. These data sets are burdened with problems; such as small sample sizes, sample set dependent relationships, poor secondary bypass routes, and a lack of sufficient downstream PIT tag detection sites. However, the consistency in the trend of these data sets, including the physiology data, suggests that there may be problems associated with long-term survival of multiple-bypassed fish compared to in-river passage.

Delayed or indirect mortality caused by passage through the bypass systems has been attributed to three possible causes. 1) Fish experience a physiologically changed as they pass through multiple bypass systems resulting in a compromised ability to grow and avoid predation. 2) Fish guidance systems guide some fish better than others. The fish prone to be guided have a pre-existing condition (genetic or physiological) that also results in higher delayed mortality than fish not selected by the guidance system. 3) Bypass systems disrupt the natural, interactive behavior of groups of fish by breaking up large schools into small groups or individuals during the bypass process and release.

OBJECTIVE:

1. Determine the comparative survival of juvenile and adult returns of bypassed and in-river migrating chinook and steelhead. (2001-outyears)
    b. Review historical data to assess survival and adult returns of multiply bypassed fish and in-river migrants. (2004 - data analysis)
2. Monitor and compare differential recovery of multiple bypassed fish downstream of the hydrosystem. (PIT tag and telemetry methodology). PIT tag trawler (1998-outyears) telemetry (2001 – outwears)
3. Compare physiological differences during passage in fish multiple bypassed to fish from a first time bypass. (1999 – 2004)
4. Determine delayed mortality of fish multiple bypassed to in-river migrants.
    a. Investigate the use of rearing studies to document and isolate causes and effects of the physiological differences in mortality (2000 –2004).
    b. Conduct experimental management of the system to address multiple bypass differences. (future years)
5. Investigate and determine a means to more accurately detect (identify) previously undetected groups of fish passing through spillways, turbine and improve detection at the fish bypass facilities.

SCHEDULE: 2004 – Objective 1b only

NOTES: This research summary is pending confirmation of a Multiple Bypass issue from NMFS

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-00-10

TITLE: Evaluate Comparative Delayed Mortality of Transported Juvenile Salmon and In-River Migrating Juvenile Salmon.

FISH PROGRAM FEATURE: CRFMP – System – Delayed Mortality

BIOP MEASURES: RPA 47, 185, 189

BACKGROUND: Much of the post-hydrosystem mortality has been attributed to passage through different routes of passage at the dams (spill, bypass systems, turbines, surface collection and transportation). Although this concept has been assumed based on the return data from the juvenile salmon transportation data and the multiple bypass data compared to in-river migrants. Juvenile chinook transported through the hydrosystem survive at a higher rate compared to in-river migrants. Yet if equal post-system mortality is attributed to both groups of juveniles the transportation release group should be returning at a higher rate. The question concerning differential rates of survival (or delayed mortality) in the ocean environment and how they correlated through time and route of passage has become one of the key unknowns facing future decisions regarding construction of passage systems for fish.

OBJECTIVE:

1. Determine the comparative post-system delayed (differential) mortality of juvenile salmon transported to fish that remain inriver. (see specific objectives under transport)
3. Investigate causes of delayed mortality (by species, stock, and origin).
    a. Isolate physiological causes of delayed mortality. (2000-2005)
        i. Determine differences in short-term (about six months) mortality of transported and inriver fish. Recover PIT tagged fish with different passage histories and rear several months to determine differential mortality rates between the passage groups. (Incremental partitioning of mortality of fish with known passage histories through time.)
        ii. Conduct experimental management to address differential delayed mortality questions. (future years)
    b. Evaluate the behavioral changes in juvenile salmon attributed to route of passage that may be a cause of delayed mortality. (2001-2005)
    a. Determine if fish with different passage histories have a different response to hydraulic stimulus.
    b. Determine if cohort and schooling behavior is altered by the passage route of the fish and determine its contribution to delayed mortality.
    c. Evaluate the logistical and mechanical barging processes that may be contributing to delay mortality (such as release location, season, duration and timing). (See summary on barging strategies)
        i. Determine if there are differences in the use of the estuary and near ocean for fish transported compared to fish that migrate inriver.
        ii. Conduct bioassays of juveniles recovered from bird colonies to determine differential predation rates based on fish condition and route of passage.
3. Isolate areas of post-system loss. (Identified at the SRWG meeting Jun 2000)

SCHEDULE: 2000-2005

NOTES: This work is closely related to the comparative survival studies of multiple bypass, in-river passage and transportation

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-00-9; BPS-00-10

TITLE: Identification of Principal In-River Stressors Contributing to Delayed Disease-Induced Mortalities in Outmigrant Juvenile Salmon

FISH PROGRAM FEATURE: CRFMP-System-bypass

BIOP MEASURE: NOAA Fisheries 2000 Biological Opinion (sections: 11.2; 9.6.1.7.2; 9.6.1.1; 9.6.1.6.2; 9.6.5) Recruitment of salmon, or the health of adult salmonid populations, is strongly influenced by factors acting on their early life-history. In a recently funded COE study[1], fish were PIT -tagged at the Rapid River Hatchery located 40 miles upstream of Lower Granite Dam on the Snake River. These fish were collected at Lower Granite, the first dam encountered during outmigration, and barged around the seven consecutive dams to Bonneville. Concurrently, PIT-tag recorders located at each dam bypass were used to estimate the travel time of in-stream fish within each stream segment. Both in-stream and barged fish were collected at Bonneville dam and challenged with the pathogen *Listonella anguillarum* to provide an aggregate measure of immune status. Fish that traveled through the hydropower network had a substantially higher incidence of disease induced mortality relative to fish barged around the network. Using the disease challenge data in conjunction with a population dynamic model of disease transmission in outmigrant populations, we found that delayed disease-induced mortalities resulting from immune suppression associated with in-stream stressors could approach upwards of 15% of the total outmigrant population, of chinook salmon. This is significant considering that a 9% increase in survival is speculated to be necessary to mitigate declines in, and hence extinction of, evolutionary significant units (ESUs) within the Columbia Basin (Kareiva et al., 2000). Potential in-stream stressors contributing to immunosuppression and subsequent disease- induced mortality are predation, elevated temperatures, chemical exposure, and exposure to general aspects of a hydropower system.

OBJECTIVES: The overall objective of the proposed study is to understand the principal components of in-stream stressors contributing to delayed disease-induced mortality within outmigrant chinook salmon. Specific objectives are to:

1. Develop genetic markers of immune system status to provide a rapid early indication of the incidence of delayed disease-induced mortalities.
    a. Profile immune system function in Fall and Spring Chinook using a DNA microarray
    b. Model dynamics of the immune system to identify specific markers of immune function correlated with delayed disease-induced mortality.
2. Quantify chemical and pathogen body burdens in barged and in-river outmigrant chinook salmon.
    a. Quantitative chemical assays of whole body and stomach contents.
    b. DNA microarray analyses to characterize endemic levels of infection of salmonid pathogens.
    c. DNA microarray analyses of immune system function using markers identified in (1).
3. Utilize genetic markers to assess the impact of passage history on incidents of delayed disease induced mortalities.
    c. Coordinate collection with hatchery releases to sample fish with different life histories. Confirm hatchery of origin with microsatellite analysis.
    d. Measure selective indices of water quality.
4. Incorporate data into an existing model of the population dynamics of disease transmission to identify the relative significance of selected in-stream stressors on delayed disease-induced mortality.

SCHEDULE: 2005-2008

NOTES: The proposed study will synergistically expand the Lower Columbia Estuary Program (recently funded with $lM from BP A) in understanding factors influencing delayed disease-induced mortalities in the Columbia River Basin.

[1] A study to compare long-term survival and disease susceptibility of yearling hatchery chinook salmon smolts with different juvenile migration histories.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-00-11

TITLE: Evaluate the Migration Behavior of PIT-Tagged Juvenile Salmonids in the Estuary

FISH PROGRAM FEATURE: CRFMP-System

BIOP MEASURE: RPA 186

BACKGROUND:

Relative abundance, timing, migration behavior and survival of juvenile salmonids passing through the estuary and near shore ocean environments are poorly documented. This knowledge is important to the understanding of the relationship between post release (and in-river migrating) mortality of juvenile salmonids in the estuarine and oceanic environment.

OBJECTIVES:

1. Assess relative abundance and timing, and migration patterns through the estuary and near shore ocean environment of PIT-tagged juvenile Chinook salmon release for the evaluation of transportation and in-river migration from Lower Granite Dam, McNary, and other release groups where applicable. Verification of migration behavior, relative differences in species composition, abundance, depth, and location. (2000 – out years)
    a. Continue recovery of PIT tagged chinook salmon (1998 – 2006)
    b. Recover PIT tagged steelhead and fall chinook (2000 – 2006)
    c. Correlate migration behavior to radio and sonic telemetry of juvenile chinook through the estuary and Columbia River plume.
2. Investigate the potential of incorporating a PIT tag diversion system into the PIT tag trawler for future delayed mortality evaluations. (2001-2006)
3. Recovery of PIT tags from bird colonies in the estuary and river system.
4. Evaluate avian predation and determine if differences in predation can be attributed to origin, passage history or fish condition of juveniles salmon.

SCHEDULE: 2000 plus (Additional years are dependent on the years of transportation, or survival studies using large groups of PIT tagged marked fish.)

NOTES:

A. This work has been identified as a critical element under the comparative survival studies, delayed mortality.
B. This work will be coordinated with future radio tracking work in the estuary and avian predation evaluations.

This work was supported by the Bypass Systems and Transportation sub-groups of the SRWG.

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-P-00-14

TITLE: B2 FGE

FISH PROGRAM FEATURE: CRFMP-Bonneville-Powerhouse 2 FGE

BIOP MEASURE: RPA 67

The current downstream migration system at the Second Powerhouse consists of a submersible traveling screen (STS) system designed to guide juvenile salmonids up into a gatewell slot bypassing the turbines to a release point approximately 2 miles downstream of the project. After initial start up in the early 1980's, the bypass system was tested and found to have low guidance efficiencies (FGE) for all target fish. As part of an extensive multi-year research and development program, turbine intake extensions, streamlined trashracks, and lowered STS' were installed which significantly improved FGE for spring migrants. However, FGE for yearling and subyearling migrants remains unacceptably low, 45-60% and 20-25% respectively. In 1999, we reviewed past work, developed alternatives, and prepared out-year plans and cost estimates. The resulting program used a phased approach to addressing hypotheses presented by the 1999 work. For FY00, we measured vertical distribution upstream and within two intakes, and also estimated FGE across all units. We also initiated a hydraulic modeling program to develop a prototype intake screen system. In both 2001 and 2002, we field-tested a prototype screen system at Powerhouse 2 in units 15 & 17 and found significant FGE improvement for both spring and summer migrants. However, we also evaluated gap loss through top of the screen in modified and unmodified units in 2002 and found significant loss of fish through the gap. In FY03, we continued to investigate gap loss in both a modified and unmodified unit during both spring and summer and found that gap loss was significantly higher in units that were unmodified and without a gap closure devise installed. A new VBS design as well as a gatewell cleaning system has been installed as of April 04. Additional testing is being conducted in FY04 to measure the hydraulic as well as biological performance of the new VBSs.

Pending Issues:

Once full testing is completed in Summer 04, including DIDSON gap loss evaluations, Powerhouse FGE and the FGE effects of the corner collector are better understood; the Corps will decide the following:

- Whether to extend the full intake modifications to other PH2 units (North units VS. Southern and how many).
- Whether to install Gap Closure Devises in some units instead of full intake modifications.
- Do the guidance improvements per unit at B2 equate to the balance of monetary benefits associated with the cost to benefit analysis in association with the Bonneville Decision Document? Is the improved guidance at B2 cost beneficial and is it practical?

OBJECTIVES:

1. Evaluate the effectiveness of additional modified prototype intake screen systems for both spring and summer juvenile salmonid migrants:
    a. Evaluate FGE hydroacousticly in modified units to determine if modified units improve FGE at several differing unit loads.
    b. Quantify gap loss at units both Spring and Summer based on prior DIDSON findings.
2. Evaluate the FGE and improvements at Bonneville 2 with improvements inclusive of the B2 Corner Collector.
    a. Measure FGE in unmodified units closest to B2CC to extrapolate FGE with B2CC influence.

SCHEDULE: 2005- 2006

NOTE: The Corps is currently developing a unit modification decision matrix that includes all past and current research as well as improvements made at B2. This decision matrix will be used to determine if and when other units at B2 will be modified and to what extent practical.

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-P-00-15

TITLE: Evaluation of Modified Extended-Length Submersible Bar Screens at John Day Dam

FISH PROGRAM FEATURE: CRFMP-John Day Dam-Extended Screens

BIOP MEASURE: RPAs 73 and 98.

Fish guidance efficiency (FGE) of subyearling chinook salmon using standard-length traveling screens (STS) at John Day Dam has been estimated to be approximately 26%. In 1996, prototype extended-length submersible bar screens (ESBS) were evaluated for FGE, orifice passage efficiency (OPE), and fish condition. Significant improvements in FGE and OPE were documented during the ESBS evaluation. FGE for subyearling chinook was estimated to be near 60%, OPE was in excess of 97%, and descaling of fish dipped out of the test gatewell was less than 1.5%. However, significant damage to the ESBS' occurred after 30 days of operation, requiring the Corps to modify the structural design of the screens. After modification, the screens were again evaluated in 1999 to verify the 1996 FGE/OPE/fish condition results. PIT-tagged juvenile salmonids released into the test unit gatewell and collected at the John day Dam smolt monitoring facility incurred high mortality (up to 42%) relative to a standard gatewell, presumably due to gatewell hydraulic conditions. As a result, the 1999 summer FGE/OPE evaluation was suspended. For the remainder of 1999 and through 2002, a new vertical barrier screen (VBS) design was developed along with a gatewell flow control device. Additionally, 1/8 inch spaced bar screen on the ESBS (and VBS) was replaced with 1.75 mm spaced bar screen to help reduce impingement of salmonid fry and juvenile lamprey on the screens.

Biological testing of the new system was conducted in 2002. During spring testing, mean FGE was 80.0% for yearling chinook salmon and 72.2% for sockeye salmon; coho salmon and steelhead were not present in large enough numbers during the abbreviated test season for meaningful statistical calculations. Mortality of PIT-tagged yearling chinook released during FGE tests was low, at 0.1, 0.2, and 0.3% for the ESBS slot, STS slot, and the collection channel, respectively. Mean yearling chinook salmon descaling was 4% for the ESBS and 6% for the STS during the FGE tests. During summer testing, mean FGE was 63.8% for subyearling chinook salmon. Mortality of released PIT tagged subyearling chinook salmon was also low, at 0.1, 0, and 0.5% for the ESBS slot, STS slot, and the collection channel, respectively. Mean subyearling chinook salmon descaling was 1% for the ESBS and 2% for the STS. Results from 2002 biological testing were encouraging however, after only a few weeks of operation, small holes developed in the VBS panels. In 2004, the Johnson bar screen VBS material in slot 7C was replaced with heavier-gauge Hendrix bar screen material. Gatewell fish condition and survival will be monitored again in 2004 to ensure that the Hendrix bar screen does negatively impact fish condition. Pending successful run-time tests and gatewell survival/condition testing in slot 7C during 2004, VBS screen material will be replaced in slots 7A and 7B. Further biological testing in 2005 will include gatewell condition/survival tests using salmonid fry in late-March to early-April.

OBJECTIVES: (*Placeholder pending results of 2004 testing)*

1. Determine condition of salmonid fry passing through a prototype gatewell.

SCHEDULE: 2005

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-P-03-NEW

TITLE: Evaluation of full-flow PIT-tag interrogation systems at Bonneville and John Day Dams.

FISH PROGRAM FEATURE: CRFMP - Bonneville and John Day

BIOP MEASURE: RPA 87

Presently, juvenile PIT-tag interrogation at Bonneville and John Day dams occur after bypassed juveniles pass through multiple dewatering systems that reduce collection channel flow down to 2-3 cfs. Normally, these bypass systems initially dewater the collection channel flow down to approximately 30-50 cfs for ease of passing the flow, then dewater further to 2-3 cfs for PIT-tag interrogation and hands-on fish condition sampling. It is thought that this secondary dewatering from 30-50 cfs down to 2-3 cfs may cause additional injury and/or stress to juvenile migrants passing through the bypass system. With the recent implementation of ISO 134.2 kHz technology and improvements in interrogation electronics, PIT-tag detections can now be made over much greater ranges. Developing a PIT-tag interrogation system that precludes the need for secondary dewatering (from 30-50 to 2-3 cfs) is one alternative that may reduce injury and/or stress associated with bypass passage. A 2002 evaluation of "full-flow" PIT-tag detection through a 91.5 cm pipe at McNary Dam indicated that detection was at or above 99%. Similar technology may be applied at the John Day and Bonneville bypasses to improve the condition of bypassed juveniles. Tasks to be completed in 2005 will be limited to conducting site evaluations at John Day and/or Bonneville to determine the feasibility of implementing full-flow technology at these sites. Following a favorable site feasibility evaluation, design and construction could be initiated as funding allows. A post-construction evaluation of the efficiency and performance of the system would follow construction.

OBJECTIVES (2005):

1. Conduct a site evaluation of John Day to determine feasibility, optimal location, and configuration of a full-flow PIT-tag interrogation system.
2. Conduct a site evaluation of Bonneville to determine feasibility, optimal location, and configuration of a full-flow PIT-tag interrogation system.

SCHEDULE: 2005 – 2007

North Pacific Division -- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-02-1

TITLE: Survival of Juvenile Salmonids at Bonneville Dam.

FISH PROGRAM FEATURE: CRFMP - Bonneville

BIOP MEASURE: Per the National Marine Fisheries Service, Biological Opinion RPA's 64 (MGR), 66 (B2 CC), & 82 (spill survival) the Portland District will be evaluating survival through all juvenile salmonid fish passage routes. With the completion of the new SFB Corner Collector at the second powerhouse, a thorough post construction survival program to estimate project survival, and route specific survival is necessary to further evaluate future fish passage programs and operations at the Bonneville project. Further, one route at the first powerhouse will be evaluated (B1 I&T) for survival to assist in future planning efforts.

OBJECTIVES:

1. Conduct a power analysis to determine required sample sizes to meet a range of precision levels (±2%, ±3%, ±4%, ±5% all at $\alpha = 0.05$ and Power of 0.8) for the survival estimates in Objectives 2 - 5.
2. Obtain project and spillway survival for the entire Bonneville project (this will be dependent on releases from upstream projects) for spring (CH1 & Stld) and summer (CH0) migrants.
3. Obtain route specific survival in the spring and summer (CH1, Stld, & CH0) for juveniles passing through the B2 JBS, B2 CC, and spillway, relative to each other and a downstream control (the summer test will occur between the B2 CC and B2 JBS).
4. Obtain route specific survival estimates for spring and summer (CH1, Stld, & Ch0) juvenile salmonids passing through the B1 Ice and Trash Sluiceway.
5. Obtain route specific survival estimates (direct) for juvenile salmonids passing through the 7' versus 14' flow deflectors at the spillway during spring and summer emigration periods.

SCHEDULE: 2004 - 2006

NOTE: This will be the second (and final) year of the B2 CC post construction and project wide survival evaluation. Future studies at BON will be dependent on results from 2004 & 2005. There have been some requests to evaluate multiple spill treatments at BON, at this time the goal is to complete the second year of B2 CC post-construction evaluations. However, additional meetings and discussions on spill treatment tests will occur with regional fishery managers.

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-00-7

TITLE: Juvenile Salmonid Survival Studies at John Day Dam

FISH PROGRAM FEATURE: CRFMP-In-river Passage

BIOP MEASURE: RPAs 71, 73, 82, and 83

From 1999-2003, spill was evaluated at John Day Dam as a way to improve the survival of juvenile salmonids that pass the project. Each year, an alternative spill treatment was compared to a status quo spill operation called for in the Federal Columbia River Power System Biological Opinion (BIOP. Fish passage metrics that were used to compare treatments included survival, fish passage efficiency (FPE), forebay retention time, and tailrace egress. Based on results from this spill passage research, the Action Agencies have implemented a 24-hour spill operation at John Day Dam for summer-migrating subyearling Chinook salmon. In the springtime, the BIOP spill operation remains the status quo. Recent research has shown that survival estimates of fish passing through turbine units and under some operations the juvenile bypass system are some of the lowest observed in the FCRPS and suggest that there is good potential for additional survival improvements at John Day. The Corps has explored a number of alternatives to reduce the proportion of fish passing through turbine units, including extended-length turbine intake screens, surface flow bypass systems, and surface spill options. Under another project, The John Day Configuration Study, these alternatives, along with new alternatives to improve tailrace and turbine passage conditions will be analyzed in the context of the most recent passage research. From this analysis, a plan to fill existing information gaps and proceed with future survival improvements will be developed. Future studies under the John Day Survival and Fish Passage Efficiency Studies program will be geared toward filling biological information gaps needed to make decisions in the Configuration study. Juvenile salmonid tailrace behavior, model observations, and survival study results point to the near-dam tailrace, in particular the area downstream of the skeleton bays, as a potential source of high smolt mortality. In 2005, tailrace egress and survival will be evaluated for powerhouse-passed fish in order to better partition mortality and better focus future survival improvement work. Turbine Unit 4 will be the selected passage route to evaluate in order to build on the existing information base, and because low survival has been previously observed for fish released into this unit. Radio telemetry and balloon-tag techniques will be employed. Future years will be focused on providing information necessary for the plan developed through the Configuration Study. These will likely include prototype evaluations of alternative passage structures designed to reduce turbine entrainment and improve tailrace egress.

OBJECTIVES (2005):

1. Conduct a power analysis to determine required sample sizes to meet a range of precision levels (±2%, ±3%, ±4%, ±5% all at $\alpha = 0.05$ and Power of 0.8) for the survival estimates in Objectives 2-3.
2. Estimate the survival of yearling and subyearling Chinook salmon that pass from the intake of Turbine Unit 4 to the tailrace frontroll.
3. Estimate the survival of yearling and subyearling Chinook salmon that pass from the intake of Turbine Unit 4 to a tailrace site near the public boat launch at French Guiles Park.
4. Evaluate the travel paths and tailrace residence times for yearling and subyearling Chinook salmon that pass through Turbine Unit 4 and for drogues released into the tailrace frontroll of Turbine Unit 4.
5. Estimate the direct effects of turbine passage on yearling and subyearling Chinook salmon survival and injury.

SCHEDULE: 1999 - 2007

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-00-8

TITLE: Juvenile Salmonid Survival Studies at The Dalles Dam

FISH PROGRAM FEATURE: CRFMP-In-river Passage

BIOP MEASURE: RPA 68, 70, and 83
Results from studies conducted in 2001-2003 suggest there is a direct effect on smolt survival and injury for fish passing through the stilling basin and that direct survival and injury appear to be influenced by lateral flow that passes along the stilling basin's length from south to north. A concurrent engineering study developed a solution to eliminate lateral flow in the stilling basin: lateral flow can be blocked by a longitudinal training wall that extends from the downstream spillway pier nose between bays 6 and 7 to the end sill. Balloon-tag studies were conducted in 2003 to determine the amount of spill per bay that can be discharged with minimal fish injury and mortality. Results suggest that for most spring and summer river conditions, 40% of the total river discharge could be safely passed through Bays 1-6 with no measurable increase in fish injury or mortality. Based on results from a 2003 spring balloon tag test, this training wall was constructed in 2003-04 and will be evaluated in 2004 - 05. Primary issues to address in for the post-construction evaluation include the wall's effect on survival and injury rates for spillway passed fish, spillway and fish passage efficiency, and upstream adult fish passage.

OBJECTIVES (FY05):
1. Estimate Total Survival Rates of Yearling Chinook, Steelhead / Sockeye, and Subyearling Chinook Passing the Project, Spillway, and Powerhouse. Project survival estimate 95% CI half-width = ± 4%.
2. Evaluate Tailrace Egress for Juvenile Salmonids that Pass Through the Spillway.
3. Estimate Fish Passage Efficiency (<4%, 95% CI half –width), Spillway Passage Efficiency, and Sluiceway Passage Efficiency.
4. Estimate Forebay Residence Times.

SCHEDULE: 1997 – 2008

NOTE: 2004-05 is a post-construction evaluation of a spillway training wall. Future years' research will focus on additional survival improvements including turbine improvements at Unit 9 (06), and potentially additional improvements at the spillway or other passage routes. A long-term strategy for improving fish passage at The Dalles is currently under development. This strategy will include a multi-year research plan with built-in contingencies based on research results.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE- 04-NEW

TITLE: Summer Spill Evaluation

FISH PROGRAM FEATURE: CRFMP-In-river Passage

PROBLEM STATEMENT: The majority of endangered Snake River fall chinook salmon are transported around FCRPS dams in the summer and few listed fish remain in-river to benefit from a summer spill program. Recently, survival studies on subyearling chinook have occurred at FCRPS dams, but have ended mid to late July because river temperatures were too high to handle fish. A balloon-tag study conducted at The Dalles Dam in August of 2002 suggested that high predation rates on juvenile salmonids might be occurring for spillway-passed fish. Due to the above issues, the need to evaluate the benefit of summer spill for subyearling chinook has been voiced by several regional entities. A regional science group established to develop recommendations on how to study this problem evaluated a range of approaches and concluded that a system-wide evaluation is not feasible. The recommended approach was on a project-specific scale, and would likely require using radio-telemetry to assess survival differences between two spill treatments. There are a number of uncertainties and assumptions that go with this approach: Assumption 1. Spill treatments affect survival rates for fish < 110 mm in the same way they affect rates for fish >110 mm. In other words, the subsampled population of fish > 110 mm is representative of the entire population. This assumption is inherent in the proposed approach because the smallest (total length) subyearling chinook that can be radio-tagged is 110 mm given the current technology; Assumption 2. The effect of spill treatments observed between ~ 20 June – 20 July do not change in late July-August. This assumption is also inherent in the proposed approach because in late July – August, river temperatures are too high to safely handle and tag fish. As in the first assumption, this one assumes that fish tagged between 20 June and 20 July are representative of the entire run; Assumption 3. The approach assumes there are no treatment effects that occur outside the geographic bounds of the study (e.g. upstream release and downstream detection sites); Assumption 4. The approach assumes that project survival rates can be assembled (modeled) to estimate system survival. Without the ability to compare full life cycle or even system wide effects across treatments, assumptions 3 and 4 will likely remain assumptions in 2004. To evaluate assumptions 1 and 2, the following objectives are recommended.

BIOP MEASURE: 82

OBJECTIVES:
1. Determine whether the relationship between spill treatments and subyearling chinook survival rates changes through time (e.g. 20 June - 20 July; retrospective analysis of available spill studies). (04)
2. Determine the feasibility of radio-tagging subyearling chinook in late July and August. (04-05)
3. Determine whether the relationship between spill treatments and subyearling chinook survival rates is affected by fish length (retrospective analysis of available spill studies). (04)
4. Determine whether available smaller tags (i.e. HTI's acoustic tag) will allow a reduction in the size of subyearling chinook that can be tagged. (04-05)

SCHEDULE: 2004 –05

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-W-04-2

TITLE: Fish passage and survival at Little Goose Dam

FISH PROGRAM FEATURE: CRFM – in-river passage and survival

BIOP MEASURES: RPA 82, 83, 88, 89, and 93.

PROJECT INFORMATION: There is currently very little data regarding fish survival at Little Goose Dam. There is a need to collect baseline fish distribution, survival, and forebay behavior information to assist in making decisions regarding future operations. Decisions that will be make in the near future include training wall between powerhouse and spillway, spill operations, spill patterns and RSW implementation.

OBJECTIVES:

1. Estimate fish passage efficiency for steelhead and yearling Chinook for two test treatments, and subyearlings for one treatment. **2005-2006**
2. Estimate project and route specific survival for test operations for steelhead, yearling and subyearling chinook. **2005-2006**
3. Estimate tailrace egress (for all passage routes) for spring and summer test operations. This includes passage time and routing. **2005-2006**
4. Estimate direct injury/survival of fish passing spillway.
5. Estimation of Fish Guidance Efficiency for spring and summer. **2005-2006**

SCHEDULE: FY05 – FY07

POC: Mark Smith 509-527-7275

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-W-04-3

TITLE: Survival of fish at McNary Dam

FISH PROGRAM FEATURE: CRFM - System-Inriver Passage Survival

BIOP MEASURE: RPA 82, 83, 88, 89, and 93.

PROJECT INFORMATION: There is limited fish survival data at McNary dam under existing operating conditions. Fish survival data will be required in the very near future to make operational decisions at MCN and to confirm/estimate fish survival under current operating conditions. The 2004 study underway is under current "BiOP" conditions.

McNary Modernization Project is underway that is working toward replacing the main units with new units with much greater hydraulic capacity. One step in the regionally coordinated plan includes estimating project survival under current BiOp conditions and at current maximum turbine discharge. This will give an indication of the effect of the larger units when installed. In 2005, test operations will entail a block study of two operations: all turbines operating within 1% of peak efficiency and all turbines operating at maximum discharge.

PRIMARY OBJECTIVES:

1. Estimate the route-specific relative survival of juvenile spring and summer Chinook, and steelhead passing through each route (spill, facility and bypass, and turbine) at McNary Dam, for each treatment.
2. Estimate project survival for each treatment.
3. Estimate spill efficiency, fish guidance efficiency, for each treatment.
4. Fish Condition in the gatewells under 2 treatments

SCHEDULE: Initial studies began in 2003. Studies in 2004 were designed to provide an intial look into Project/route specific survival.

NOTES: This summary of research covers both CRFM and McNary Modernization objectives.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-W-04-4

TITLE: Fish passage and survival at Lower Monumental Dam

FISH PROGRAM FEATURE: CRFM – in-river passage and survival

BIOP MEASURES: Action Items 82 and 83.

PROJECT INFORMATION:
Lower Monumental Dam, in recent years, has been implicated as a "bad actor" as pertaining to fish survival in the Lower Snake River. In order to make valuable and proper decisions regarding operations at LMN and the Lower Snake in general, more detailed fish survival information is required. However, there is little data specific to survival at LMN. Spillway survival study in 2003 indicated variable survival depending on operations. Decisions in the near future include, RSW, outfall relocation, project operations, and training wall need/installation. Therefore, it is necessary to conduct a "suite" of studies to begin putting together some basic information at this Project. Results of 2004 study will determine spill patterns and levels tested in 2005.

OBJECTIVES:

1. Estimate percent passage efficiency by route for steelhead, yearling and sub-yearling Chinook. Test will be two treatments in spring, and one treatment in summer. **2004-2005**
2. Estimate project and route specific survival for test operations for steelhead, spring and summer Chinook. **2004-2005**
3. Estimate tailrace egress (for all passage routes) for spring and summer test operations. This includes passage time and routing. **2004-2005**
4. Estimate direct injury/survival of fish passing spillway. (dependant on 04 survival estimates)
5. Estimation of Fish Gudance Efficiency for spring and summer. **2004-2005**

SCHEDULE: FY03 – FY07

POC: Mark Smith 509-527-7275

North Pacific Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

Study Code: SBE-P-00-7

TITLE: Evaluations and Studies of Fish Passage Efficiency at Bonneville Dam.

FISH PROGRAM FEATURE: CRFMP - Bonneville.

BIOP MEASURE: Reasonable and Prudent Alternative (RPA) 66 directed the COE to design and construct a permanent corner collector at the second powerhouse. The post construction study will also support the planned post construction survival study, and provide information on fish distribution and passage efficiency necessary for final Bonneville operation. Additionally, this research activity will support planning process in determination of next steps to improve passage at the first powerhouse.

OBJECTIVES:

1. Estimate Fish Passage Efficiency (<4%, 95% CI half – width), Spillway Passage Efficiency, and Sluiceway Passage Efficiency. This will include FPE for spring and summer migrants at large, as well as species specific FPE (CH1, Stld, & CH0).
2. Evaluate fish behavior at the entrance to the B2 CC with Didson technologies.
3. Determine mean densities of juvenile salmon for each depth bin, and horizontal bin, by day/night, season (for hydroacoustic analysis).

SCHEDULE: 2004 – 2006

NOTE: Although this is a post construction evaluation of the B2 CC, the Bonneville Decision Document has dictated the construction of the B2 SFB Corner Collector and prioritization of B2 as the priority powerhouse. Questions concerning which direction to take on improvements to B1 (SFB versus ESBS) are on hold pending additional information on sluiceway efficiency and survival through B1. Future direction at B1 will be dependent on the collection of additional biological information at those routes.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-P-00-17

TITLE: Studies of Surface Flow Bypass at The Dalles Dam.

FISH PROGRAM FEATURE: CRFMP - The Dalles - Surface Flow Bypass (Forebay Studies).

BIOP MEASURE: RPAs 69 and 86

Much of the research completed to date at The Dalles Dam (TDA) has focused on estimating fish passage and survival through various passage routes. In 2003 and 2004, additional studies were initiated to help describe fish distribution and define the approach paths of fish entering the forebay and passing the dam. In 2003, a hydroacoustic study was initiated to collect general, population level information on fish distribution (vertical and horizontal) in the forebay of TDA. In 2004, 3-D acoustic telemetry is being used to obtain information on individual fish behavior in the forebay of TDA. Additionally, in 2004, efforts are underway to optimize sluiceway operations to maximize fish passage through the sluiceway. Results of past research (1999-2003) indicate that between 8 and 50% of the juvenile salmon that pass TDA, pass through turbines. The primary goal of the forebay research program is to gather information on how fish approach and pass TDA and use the information to aid in the design a forebay structure that would effectively reduce turbine passage under current BiOp spill levels (40%) and either maintain or further reduce turbine passage under reduced spill conditions. Recent progress in integrating computational fluid dynamic (CFD) model outputs with individual fish behavior data show promise in forecasting how downstream migrants might respond to hydraulic and structural elements they encounter as they approach the dam during their emigration. Pending further development and validation of the Numerical Fish Surrogate (NFS) model at TDA, the Portland District intends to use the NFS to help determine an optimal design and location of a forebay structure that will help reduce turbine passage and ultimately improve fish survival.

OBJECTIVES (2005):

1. Estimate population level spill passage efficiency, sluice passage efficiency, and fish passage efficiency during spring and summer.
2. Characterize individual 3-dimentional approach paths and determine passage fate of juvenile salmon (yearling chinook, steelhead, sockeye and subyearling chinook).
3. Compare approach paths of turbine vs. sluice vs. spill passed juvenile salmon (yearling chinook, steelhead, sockeye and subyearling chinook).
4. Characterize individual vertical and horizontal fish distribution within the entire forebay up to 2000' upstream of the east end of the powerhouse.
5. Integrate CFD model outputs of representative hydraulic conditions with fish approach path and distribution data.
6. Evaluate alternative sluiceway skimmer gate operations and their effect on sluice passage efficiency during spring and summer.

SCHEDULE: 2003 – 2008

NOTE: Studies in 2003-2005 have been designed to gather baseline information on fish approach paths and passage distribution. The baseline information will be used to further develop and calibrate the NFS model so that the model can be used to aid the design process of a forebay structure to reduce turbine passage. Design and construction of a forebay structure are planned for 2005-2007. Post-construction evaluation of the structure would occur in 2007-2008.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-W-05-1 (NEW)

TITLE: Fish passage and survival at Ice Harbor Dam Removable Spillway Weir

FISH PROGRAM FEATURE: CRFM – Surface Bypass

BIOP MEASURES: Action Items 82 and 83.

PROJECT INFORMATION: Spillway/Project survival studies have been conducted at Ice Harbor in previous years (2000 – 2004), and have indicated variable survival and injury depending on operations and fish release location. A Removable Spillway Weir (RSW) is scheduled for installation at Ice Harbor Dam by spring, 2005.

OBJECTIVES:

1. Estimate percent passage by route (RSW, spill, bypass and turbine) for test operations.
2. Estimate project and route specific survival for test operations for steelhead, spring and summer Chinook.
3. Estimate tailrace egress (for all passage routes) for spring and summer test operations. This includes passage time and routing.
4. Estimate direct injury/survival of fish passing via RSW and conventional spillway.
5. Project Fish Passage Efficiency (FPE) for spring and summer operations. (Includes estimation of FGE with submersible traveling screens – standard length)

SCHEDULE: FY05 – FY07

NOTES: Schedule dependent on RSW installation in FY05. Test operations to be decided in regional forum (FFDRWG/SCT) – likely to include "conventional spill" treatment, based on previous years testing, and RSW treatment.

POC: Tim Wik 509-527-7276

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-W-05-2 (NEW) (Formerly covered in SBE-W-96-01)

TITLE: Evaluation of the modified Behavioral Guidance Structure (BGS) at Lower Granite Dam.

FISH PROGRAM FEATURE: CRFMP – Lower Granite, Surface Bypass Program

PROBLEM STATEMENT: The Lower Granite Removable Spillway Weir (RSW) was installed in spillbay 1 in 2001. Initial biological testing (survival) took place in November 2001, with a full biological test taking place in spring 2002. Testing continued in spring 2003, when the Surface Bypass Collector (SBC) and Behavioral Guidance Structure (BGS) were removed. In 2004, the BGS was moved to a new location between units 5 and 6. The depth of the BGS was also reduced. Unfortunately, low water supply precluded adequate testing of the new BGS configuration in 2004.

BIOP MEASURES: Action 80. "The Corps shall continue the design development, fabrication/deployment and testing of a prototype RSW at Lower Granite, in conjunction with the existing prototype powerhouse occlusion devices, including the forebay BGS and upper turbine intake occlusion devices."

OBJECTIVES:

1. Determine the relative passage rates of juvenile salmonids through the powerhouse, bypass system, spillway and RSW, relative to the position of the BGS.
2. Determine the effectiveness and efficiency of the various passage routes of powerhouse, bypass system, spillway and RSW, relative to the position of the BGS.
3. Determine Fish Guidance Efficiency (FGE) of Extended-Length Submersible Bar Screens (ESBSs) relative to position of the BGS.
4. Establish techniques and protocols for long-term (index) monitoring program for Lower Granite RSW.

SCHEDULE: 2005

NOTES: This evaluation was cancelled in 2004 due to low water forecast and lack of spill at Lower Granite.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-1

TITLE: Evaluation of Adult Salmon and Steelhead Fallback and Delay at Snake and Columbia River Dams

FISH PROGRAM FEATURE: CRFMP - System - Adult Passage

BIOP MEASURE: RPAs 60, 93, 111, 112, 113, 116, 117, and 119

Past and recent studies pointed to fallback, the time to first entrance, and transition pools, as the primary areas of delay at projects. Bonneville dam, the first that fish encounter on the river system had a history of higher fallback rates than other dams, especially for fish leaving the Bradford Island exit. In 2001 and 2002, with a change to powerhouse 2 priority, sp/su chinook fallback rates at Bonneville have dropped dramatically to 2% or less for near-field (still nearly all are Bradford Island exiting fish), 6% or less for all fallbacks.

Project passage times can range from 1 to 1174 hours. Compilation of past telemetry data show median project passage times ranging from 30 to 60 hours for Bonneville, The Dalles, and John Day dams. How migration delay at individual dams and long systemwide passage times affects adult salmon and steelhead escapement and spawning success is being evaluated by evaluating existing data.

Tests of open vs. closed orifice gates at Bonneville PH1 found no differences in passage times. Median passage times at The Dalles, Lower Monumental, and Little Goose were lower during years when orifice gates were closed but differences were not significant. Overall, results since 1997 point to no negative effects from closing orifice gates. In 2003, John Day orifice passage were evaluated and results are pending.

New spillway deflectors and spill patterns have been developed to improve water quality and juvenile passage at many of the dams on the Columbia and Snake Rivers. There are concerns over the effects on adult passage, including fallback, ladder use, and delay, arising from these modifications. In 2002, adult sp/su chinook had very low fallback rates but passage delays of 8-12 hrs were found under gas cap spill levels at Bonneville. As spill patterns and levels are being evaluated to improve juvenile survival, the effects on adults must also be taken into consideration. In 2004, the effects of spillway modifications at The Dalles Dam and the BON corner collector on adult passage and fallback of radio-tagged sp/su Chinook and summer steelhead are being evaluated. If no problems are discovered, no additional RT evaluations should be needed.

Experimental weir modifications in the transition pool of Lower Granite reduced passage times for spring and summer Chinook (2.2 hr reduction in transition pool passage). Once a functional permanent system is installed and tested, similar modifications could be applied and evaluated at other dams where deemed necessary.

The adult PIT detection systems are being installed to monitor adult passage. Developing PIT systems that can be used to estimate river-system passage times and escapement, reascension at dams (a surrogate for fallback), and straying rates are needed to evaluate how well performance standards in the BIOP are being met.

OBJECTIVES:

1. Evaluate existing data (1996-2004) to summarize and model effects of fallback and passage times to successful system passage in relation to environmental conditions and hydro-project operations. 2005-06.
2. Develop alternative methodology, e.g., fallback model and/or use of PIT tag data, that can be used to estimate passage times, reacension rates, at Columbia and Snake River dams for ESU (or best surrogate) in future years without radiotelemetry. 2005-07.

a. Identify index stocks to PIT tag and index streams to monitor to estimate passage parameters. Use PIT-tagged South Fork stock as a test case.

3. Evaluate passage in the LGR ladder with a modified transition pool. 2005.

SCHEDULE: 2005 – 2007.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-4

TITLE: Investigation of Straying in Adult Salmon and Steelhead

FISH PROGRAM FEATURE: O&M - System - Adult Passage

BIOP MEASURE: RPAs 48, 50, 107, 118, 167, and 191

Beginning preliminarily in 2000 and full scale in 2001, fish of known origins (PIT tagged as juveniles) were radio-tagged and followed on their migration routes. From this work we have begun to evaluate the extent and nature of straying in detail. Straying rates in 2001 varied from 1.3% for sp/su Chinook to 7.1% for fall Chinook and 9% for steelhead. Most sp/su Chinook strays from the Snake River entered Deschutes, John Day or Little White Salmon rivers.

Straying is a natural characteristic of salmon populations that serves to colonize vacant habitat, and to increase genetic diversity. However, excessive straying can genetically swamp the locally adapted population. The hypothesis has been raised that the COE program of transporting juvenile salmonids downstream may cause increased straying. Salmon PIT tagged as juveniles above Lower Granite and detected at Bonneville in 2000 as adults reached Lower Granite in similar proportions whether or not they were transported. Seventy-three percent (91 of 124) of the adults that were transported as juveniles reached Lower Granite and 76% (54 of 71) that migrated in-river as juveniles reached Lower Granite. 2001 analyses indicate small but not significant differences in rates of straying for steelhead or sp/su Chinook that were transported or river run fish (1.0 vs. 4.2% for sp./su Chinook and 11.1 vs. 9.9% for steelhead). Data from 2002 to 2004 will also be analyzed to evaluate any effects from transport on straying.

Straying rates are an essential adjustment factor to adult PIT based survival estimates used to evaluate if the adult BIOP survival goals are being met. At present, system wide radio-telemetry is the only methodology to obtain straying rates representative of the ESUs. If straying rates cannot be modeled based on data through 2003 and no alternative means of estimating straying rates can be obtained then radiotelemetry will be the only means of obtaining this data.

OBJECTIVES:

1. Evaluate existing data (2001-2004) to summarize and model effects of straying on successful system-wide passage in relation to stock differences, environmental conditions, transport, and hydroproject operations. 2005-06.
2. Evaluate methods other than radiotelemetry to estimate straying rates for ESUs, e.g., modeling or PIT methodology. 2005-06.
    a. Establish methods to estimate straying rates for known source ESU or ESU surrogate fish for BIOP survival goal evaluations. 2005, 2007, 2009.
        i. Identify index stocks to PIT tag and index streams to monitor to estimate straying rates. Use PIT-tagged South Fork Salmon stock as a test case.
            1. Determine feasibility of using PIT technology for monitoring PIT tagged fish at mouths of tributaries.

SCHEDULE: 2005 - 2009

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-P-00-6

TITLE: Evaluation of Steelhead Kelt Passage through Lower Columbia River dams and Efficacy of Reconditioning of wild fish from LGR

FISH PROGRAM FEATURE: O&M - System - Adult Passage

BIOP MEASURE: RPA 109

Unlike chinook, sockeye and coho salmon, steelhead trout may spawn more than once during their lifetime. In the Columbia Basin, post-spawn steelhead (kelts) must first pass up to nine dams on their return to the ocean. Ultrasonic identification and enumeration work estimated 80% to 90% of the steelhead passing through the Lower Granite and Little Goose juvenile fish facilities are kelts. By tagging kelts and monitoring their migration downstream through the FCRPS, we are gaining a better understanding of routes of passage and survival of kelts. This information is needed to develop effective protection measures for these fish. Results in 2001during spill periods (30% spill at The Dalles and 37% at Bonneville) indicate project passage efficiencies of 99% at The Dalles and 84% at Bonneville. Passage efficiency at Bonneville including non-spill periods dropped to 68%. Installation of the corner collector at Bonneville second powerhouse is expected to increase passage efficiency and will be evaluated in 2004. Spilling water significantly reduced the travel and passage times of kelts through the projects and pools in the lower Columbia. Kelt studies continue to indicate that river run Snake River kelts do not survive well (only 1% of in-river kelts return to LGR) but that fair and good condition lower Columbia PIT-tagged Kelts return at rates of nearly 8%. Wild summer steelhead on the Yakima River selected for reconditioning have yielded rematuration rates in excess of 60%, in BPA funded studies. BPA plans to evaluate how reconditioning may work on wild kelts trapped at Lower Granite, but have not yet funded it. Transportation from Lower Granite had a significant benefit, in the first year. Final results are expected in 2006. It is hoped that a system wide strategy for the management of steelhead kelts can be formulated after the 2005 research season.

OBJECTIVE:

1. Evaluate returns of 2004 PIT-tagged Kelts. 2005-06.
2. Evaluate effects of downstream passage routes (guided vs. unguided, turbine, spillway, etc.) on return rates for all years of existing RT data. 2004-05.

SCHEDULE: 2005-2007

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-P-00-8

TITLE: Development of Alternative Means to Pass Adult Pacific Lamprey Around Dams

FISH PROGRAM FEATURE: CRFMP - System - Adult Passage

BIOP MEASURE: Pacific lamprey are petitioned to be listed under the Endangered Species Act.

There is significant regional concern regarding lamprey populations in the Columbia Basin. In 1993, the Oregon Department of Fish and Wildlife designated Pacific lamprey at risk of being listed as threatened or endangered. The U.S. Fish and Wildlife Service designated Pacific lamprey as a Category 2 candidate species in 1994. The Northwest Power Planning Council's (NPPC) 1994 Fish and Wildlife Program acknowledged the apparent decline of Pacific lamprey and requested a status report to identify research needs. Columbia River treaty tribes have repeatedly voiced concern about the decline of Pacific lamprey, a culturally important species.

Radio telemetry data indicate adult lamprey have a low passage success rate at Bonneville Dam (only up to half the fish released below the dam successfully pass). Passage rates at The Dalles Dam are considerably higher (up to 82%) and rates at John Day Dam are intermediate. These data also identify entrances, entrance pools, and serpentine weirs as the primary obstacles to lamprey passage. In 2000 and 2001 we evaluated the effect of rounded entrance corners, floor diffusers, count stations, lighting, and entrance head on lamprey passage. We found that diffuser gratings affected lamprey passage but lighting did not. Reducing ladder entrance flows at night to increase ladder entrance use was evaluated in 2000 and 2001 with no improvements. There were no consistent benefits from plates on diffusers as they were positioned for the tests. We also made some minor modifications to the surfaces around a spillway entrance, and this seemed to improve passage success. Including modifications such as these that aid in lamprey passage to new or retrofitted construction are ongoing.

The goal of this program is to develop upstream migrant facilities at Bonneville that will pass adult pacific lamprey without disrupting adult salmon and steelhead passage. Preliminary tests of the prototype passage structure n the AWS channel in the Bradford Island ladder passed up to several hundred lamprey/night. Evaluations of the AWS prototype systems will continue in 2004 testing a functional exit section.

OBJECTIVES:

1. Evaluate dams for potential modification to adult fishways that would improve passage of Pacific lamprey and initiate as possible. Modifications are ongoing with new or retrofitted construction and Placeholder for additional or new fixes. (2005)
    a. Rounding of right angle corners.
    b. Plates over gratings. Consider moving plate to edge of walls.
    c. Remove raised edges or install ramps (orifices, counting slot lips, etc.)
    d. Smaller opening gratings on fish screens.
2. Evaluate prototype auxiliary passage system at BON and applicability to other locations. (2003-2006).
    a. Develop an auxiliary passage system in the Bradford Island AWS (2003-2005).
    b. Develop an auxiliary passage system prototype at a BON ladder entrance area. (2005-06).
3. Assess the effect of above modifications on adult salmon and steelhead passage. All years.
4. Install and evaluate auxiliary passage system at Bonneville Dam. (2006- 09).
5. Evaluate acceptable grating size and type to avoid stranding adult lamprey during dewatering. (2005-06).
6. Evaluate adult lamprey upstream passage success at McNary and Lower Snake River Dams. (2005-06)
7. Evaluate efficacy of reducing entrance flows at night at ladder entrances to enhance use and reduce passage times, especially in conjunction with objective 9. (2006-07).
8. Evaluate use of Cascade Island exit area for lamprey passage. (2006-07).
9. Improve methodology for more accurate counting of adult lamprey passage at hydro-projects. (2006-07).

10. Use modeling exercises to explore likely age-class bottlenecks to population growth. Is adult passage and survival, juvenile passage/survival, habitat availability, etc. most critical to population? (2005 or 2006).

SCHEDULE: 2005 – 2009.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-13

TITLE: Effects of Dam Passage on Survival and Reproductive Fitness of Adult Salmon and Steelhead

FISH PROGRAM FEATURE: CRFMP – System – Adult Passage

BIOP MEASURE: RPA 118

Adult salmon and steelhead migrating to their natal streams in tributaries of the Columbia River must pass up to eight or nine dams: four dams each in the lower Columbia and Snake rivers, and five in the mid Columbia River. While studies have documented potential effects on sytemwide escapement due to factors such as fallback (reductions of 1-3 %), little is known regarding delayed effects of hydrosystem passage on adult migrant survival to spawning grounds and reproductive success. Fallback has also been linked to Excessive energy expenditure related to difficult or long passage and exposure to adverse water quality are elements of dam and spawning stream passage that may have an effect on adult salmon and steelhead survival and reproductive success.

Understanding the spawning success of specific stocks with known passage histories (using radio telemetry and/or PIT tagged fish) can help determine the effects of dam passage and tributary environmental conditions on salmon escapement and reproductive success. Targeting PIT tagging efforts on specific stocks that can later be evaluated for passage history and spawning success in conjunction with existing carcass surveys would be a way to make such evaluations.

Results from the initial evaluations of spawning success of known source RT and PIT tagged fish on the South Fork and Yakima rivers found unsuccessful fish tended to have longer passage times, that the majority of energy use occurred above hydroprojects in the spawning stream areas, that temperature of spawning streams may greatly influence prespawn mortality, and that a non-lethal method of estimating fat content may be possible. Fish specifically PIT tagged for spawning success evaluations will be available in 2005 and 2007 for the South Fork.

OBJECTIVES:

1. Use known source PIT tagged fish to evaluate potential effects of different upstream migratory passage histories on survival and reproductive success. 2005, 2007.
    a. Identify index stocks to PIT tag and index streams to monitor to estimate reproductive success. Use PIT-tagged South Fork stock as a test case.
    b. Evaluate if reascensions and/or passage time relates to spawning success.
    c. Assess the effect of environmental factors, such as high spawning tributary temperatures, on reproductive success.
2. Implement targeted PIT tagging efforts that will enable future evaluations of spawning success of known history fish. 2005-2009.

SCHEDULE: 2005 – 2009

Note: Objective 1a overlaps with Objective 2 on ADS-00-1

North Pacific Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-04-NEW

TITLE: White Sturgeon Passage at Lower Columbia River Dams.

FISH PROGRAM FEATURE: O&M - CRFMP - System

BIOP MEASURE: This evaluation addresses FWP Measure 10.4A.2 – Determine the impacts of the hydrosystem on sturgeon.

Although the white sturgeon fishery below Bonneville Dam is one of the most productive in the world, populations in the upstream reservoirs are affected by a reduction in swift-water spawning habitats, rearing habitat, and limited upstream and downstream movements of both sturgeon and 2 of their major prey species. Beginning in the 1980s the *White Sturgeon Mitigation and Restoration in the Columbia and Snake Rivers* and *Assessing Genetic Variation Among Columbia River Basin White Sturgeon Populations* projects are working to protect and restore white sturgeon populations and to mitigate for effects of the hydropower system. Among the methods being used are habitat and population studies, harvest management, artificial propagation, and transplant of juvenile fish from below Bonneville to upstream reservoirs. Improving passage for sturgeon at dams is an important part of future actions needed to help restore and maintain white sturgeon populations.

OBJECTIVES:

1. Evaluate upstream and downstream passage of white sturgeon at FCRPS dams in the lower Columbia River.
    a. Evaluate passage/movements of adults in the east ladder at The Dalles Dam. 2004 –2006.
    b. Evaluate fishway designs to facilitate upstream passage of breeding age adults and downstream passage of juvenile fish. 2006-2007.
2. Evaluate how different operations effect survival, passage, and spawning success of sturgeon in vicinity of dams.

SCHEDULE: 2005-2007

NOTE: Areas of interest are the lower Columbia River dams.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BT-W-01-1

TITLE: Effects of Dworshak Dam and Reservoir Operations on Bull Trout Distribution in the Reservoir and North Fork Clearwater River

FISH PROGRAM FEATURE: System - O&M - Dworshak Fish and Wildlife Project

PROBLEM STATEMENT: Construction of the Dworshak Reservoir isolated the sub population of North Fork Clearwater River bull trout from others in the Clearwater Basin. Little information is available on how this isolation and the operations of the Dworshak dam have affected this sub-population. The reservoir may have affected the temperature regime, altered the life cycle of the bull trout prey and changed the migration behavior and seasonal distribution of the bull trout. In addition, Dworshak dam operations have the potential to not only remove bull trout and their prey from the reservoir but also effect the environment downstream through cool water releases and higher dissolve gas levels. The combined affect of Dworshak operation with seasonal high water temperatures, habitat degradation, potential loss of prey, passage barriers, and hybridization on the health of the sub-population population is unknown.

BIOP MEASURE: USFWS BiOp 2000, Reasonable and Prudent Measure 10.A.3., Terms and Conditions 11.A.3

OBJECTIVES:
1. Determine bull trout temporal and spatial distributions within Dworshak Reservoir Project Area by use of non-intrusive methods, survey all Dworshak reservoir tributaries. **2001-2004**
2. Determine timing and extent of migration into the North Fork and Little North Fork Clearwater Rivers and tributaries including the establishment of monitoring areas for annual redd counts to establish trends in spawning success and production. **2001 - 2006**
3. Evaluate the effects of project operation on the distribution of bull trout and their prey. **2002-2006**
4. Determine the origin, distribution, and numbers of bull trout entrained by Dworshak Dam in the North Fork Clearwater river and the main stem of the Clearwater River down to its' confluence with the Snake River.**2004-2006**
5. Determine the effect of entrainment on bull trout spawning success. **2004-2006**

SCHEDULE: 2001-2006NOTES: This study was initiated and funded by the Walla Walla District in 2002. The intent is to fund the research through completion in 2006. It was funded in 2001 by the BPA.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BT-W-03-1

TITLE: Investigate the Effects of Water Quality on Bull Trout Survival Near Hydro-projects and Fishways

FISH PROGRAM FEATURE: System

PROBLEM STATEMENT: Hydro management for anadromous salmon and steelhead has changed thermal regimes and TDG saturation production and distribution in the Columbia and Snake River basin. An altered thermal regime in the main- stem Snake River and Clearwater River could change the movements and survival of bull trout. As a result bull trout could cue to move to refuge conditions later in the summer at a time when flows are low and water temperatures become lethal. Indirect temperature effects related to timing and duration of cool water releases from Dworshak reservoir may cause extra and delayed mortality to bull trout juveniles and subadults passing through the Clearwater River and lower Snake River dams and reservoirs. It may also affect year-round habitat downstream from Dworshak. Adult bull trout may encounter high river temperatures or supersaturated dissolved gasses en route to entrance into tributaries. High temperatures may reduce reproductive success, increase susceptibility to disease, accelerate loss of energy reserves, extend passage delay and elevate stress of adult bull trout. Not enough scientific evidence is available to accept a generalized assumption that %TDGS exposure above 110% to bull trout would be similar enough to salmon (USFWS BiOp, 2000). There are documented differences in response between salmon and steelhead (i.e., salmon and trout), therefore likely differences between salmon and char, especially considering differences in their body composition and habits of distribution. It is not known whether adult bull trout are able to avoid areas of high temperatures or supersaturated gasses or how these variables affect their reproductive success.

BIOP MEASURE: USFWS BiOp 2000, Reasonable and Prudent Measure 10.A.3.
Terms and Conditions11.A.3

OBJECTIVES:
1. Evaluate the effects of critical water quality parameters on distribution of bull trout between McNary and Dworshak Dams.
2. Evaluate the effect of specific project operations on the fallback routes, percentages and rates between low spill with high SE and spill to 120% TDG at lower Snake River and McNary dams.

SCHEDULE: PLACEHOLDER for future work (2006-2009). This study would be dependent on the findings of study BT-W-05-01 NEW, “Bull Trout Use of Lower Snake River Reservoirs and the Effects of Operations of Hydroelectric Dams on their Movements.”

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BT-W-05-1 (NEW)

TITLE: Bull Trout Use of Lower Snake River Reservoirs and the Effects of Operations of Hydroelectric Dams on their Movements.

FISH PROGRAM FEATURE: System

PROBLEM STATEMENT: There is significant regional concern regarding the effects of lower Snake River and McNary reservoir hydro operations centric to salmon and steelhead upon bull trout populations in the Columbia Basin. Little is known of bull trout numbers, distribution, occurrence, timing, behavior, or their survival through the Federal Columbia River Power System (FCRPS).

Based on historical passage information and a summary of research that was compiled in early 2004, it appears that the highest occurrence of bull trout passage at a lower Snake River hydroelectric project takes place at Little Goose Dam. The largest number of bull trout passing Little Goose in one year has been 24 in 2001. These fish passed Little Goose through the juvenile fish facility and the adult ladder. Hence, they could originate from several streams including the Tucannon, Grand Ronde, Imnaha, or Salmon Rivers, or Asotin Creek. If all of these fish were tagged and released it would be virtually impossible to obtain statistically valid information from a sample size this small. The need for further studies involving bull trout passage routes, water quality and seasonal use should be reevaluated pending discussions with the Region and the U.S. Fish and Wildlife Service.

BIOP MEASURES: USFWS BiOp 2000
Reasonable and Prudent Measures: 10.A.2 and 10.A.3.
Terms and Conditions**:** 11.A.2 and 11.A.3.

RESEARCH OBJECTIVES:
1. Determine the origin, distribution and enumerate the abundance of bull trout entering and using the Lower Monumental and Little Goose and Lower Granite reservoirs. 2005 -2007
2. Evaluate the passage route(s) of bull trout that move through the lower Snake River hydro-projects, particularly Little Goose and Lower Granite dams. 2005-2007.
3. Analyze potential operational or structural changes that could improve passage and survival at Little Goose and Lower Granite.

SCHEDULE: PLACEHOLDER

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: EST-02-01

TITLE: A Study To Estimate Salmonid Survival Through The Columbia River Estuary Using Acoustic Tags
FISH PROGRAM FEATURE: CRFMP – Estuary Program

BIOP MEASURE: Reasonable and Prudent Alternative (RPA) 195 requires the Corps to evaluate survival of fish passing through the FCRPS below Bonneville dam, which will include the estuary. The Columbia River estuary is an important transition habitat to out migrating juvenile salmon. Recent evidence suggests that improvement in survival of the estuarine and early ocean life history phase of Columbia River salmon may be critical to the recovery of endangered stocks. Survival success of Columbia River salmon hinges on the complex interaction of smolt quality and the abiotic and biotic ocean conditions at the time of entry and during their first year of ocean residence. Factors that potentially affect age-class recruitment during the first months of ocean residency include fish size and health status at the time of entry, entry timing, and ocean conditions during the first months. These factors are influenced or controlled by several aspects of the Columbia River estuary: differences in life history strategies, river flow (hydropower system management), and estuarine habitat availability and quality. Therefore, it is important to understand how salmonids use the estuary, both spatially and temporally, and how different ESU's, life history types, and various rearing, passage, and condition histories use and benefit from the estuary, and how these conditions affect ocean entry and survival. Development of micro-acoustic transmitters would enable their use in the estuary environment for both ocean- and stream-type salmon. This would allow the following hypotheses to be evaluated a) interannual, life history (ocean- and stream-type), and biological (size/age) differences impact estuarine habitat selection and residence time, b) residence may vary within season, and c) estuarine habitat use is patchy, not uniform, and salmonids key on specific habitat features. Spatial and temporal observations of fish utilization of the estuary habitat are needed that link back to the variables described above, to develop hydropower management scenarios that benefit survival, growth, and health of juvenile salmon in the Columbia River estuary and their entry into and survival in the nearshore ocean environment.

OBJECTIVES:

1. Continue development an acoustic tag that is small enough to use in ocean-type juvenile salmonids. Research and development needs to continue in the following area(s):
   a. Continue investigation of new battery and transducer technologies to support the continued downsizing engineering effort.
2. Analyze the acoustic environment at the mouth of the Columbia River and develop appropriate detection arrays to monitor juvenile timing and behavior through the estuary. Prototype test and deploy the detection array and monitoring software in preparation for full deployment in 2005.
3. Using the single-release statistical model estimate survival from Bonneville Dam to the mouth of the Columbia River for target groups of various ESU's, and rearing, transportation, hydropower system passage histories (2004-2008). Compare survival through the estuary for various target groups evaluated. Data collected in 2004 will assist in plans for 2005 objectives, and additional meetings to discuss details are planned with regional fishery managers.
4. Continue development of mobile tracking techniques to identify preferred estuary habitat types and monitor and estimate small-scale behaviors relative to these habitats to support estuary habitat restoration activities. Integrate findings with results from other COE and BPA funded estuarine habitat studies to link habitat use behaviors to growth, benefits, and survival into the nearshore marine environment.

SCHEDULE: 2001 - 2008

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: EST-02-02

TITLE: Estuarine Habitat And Juvenile Salmon – Current And Historic Linkages In The Lower Columbia River And Estuary

FISH PROGRAM FEATURE: CRFMP - Estuary

BIOP MEASURE: RPA's 160, 161, 196

GOAL: Understanding how juvenile salmon use of the Columbia River estuary in regards to rearing is vital to understanding the factors that effect their survival. Little information is available on which habitats are important, why they are important, and how they are used and for how long. The goal of this research will be to provide information that can be used to answer these questions, and assist in future estuary restoration activities.

OBJECTIVES:

1. Continue monitoring on use of estuarine habitat by juvenile salmon. This effort needs to be re-evaluated from past years efforts to insure additional mark/re-capture of juveniles to better determine habitat use and benefits gained from the different habitats.
2. Continue developing linkages between juvenile salmon and habitat attributes that determine juvenile salmon use and performance in estuarine habitats. The first year's focus has been on tidal and forested wetlands, however, it is necessary to evaluate all potential habitat types for use and ESU fitness.
3. Continue developing monitoring stations to continuously measure the physical oceanographic environment in support of the biological studies in the Columbia River estuary
4. Initiate studies to characterize the role of sediment input into the estuary as a factor affecting habitat creation and use and performance (growth) of juvenile salmon of estuarine habitat in the lower Columbia River and estuary

SCHEDULE: 2000-2008

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: EST-02-03

TITLE: Evaluation Of The Relationship Among Time Of Ocean Entry, Physical, And Biological Characteristics Of The Estuary And Plum Environment And Adult Return Rates.

FISH PROGRAM FEATURE: CRFMP-Estuary

BIOP MEASURE: RPA's 161, 196

GOAL: The goal of this study will be to examine the relationship among time of salmonid ocean entry, physical and biological characteristics of the Columbia River estuary and nearshore plume environment, and smolt-to adult return rates (SARs) for yearling chinook and/or coho salmon.

OBJECTIVES:

1. Estimate smolt-to-adult-returns of serially released yearling chinook and/or coho salmon through the spring migration period.
2. Characterize variations in the physical and biological conditions in the Columbia River estuary and nearshore ocean environment during this time period.
3. Determine the level of physiological development and disease status of smolts at release.
4. Correlate SARs with environmental conditions.
5. Identify potential indicators (biotic, abiotic, or a combination of both) of salmonid marine survival that could be used to improve management actions.

SCHEDULE: 2000-2010

NOTE: This will be the last year of juvenile releases as part of the Estuary Program, additional work in out years will continue on analysis of adult return data.

North Pacific Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: EST-02-4

TITLE: Evaluating cumulative ecosystem response to restoration projects in the Lower Columbia River and Estuary

FISH PROGRAM FEATURE: CRFMP -- Estuary

BIOP MEASURE: In Action 160 of the Reasonable and Prudent Alternative of the Biological Opinion on operation of the Federal Columbia River Power System (December 2000), the National Marine Fisheries Service stated, "*The Corps and BPA, working with LCREP, shall develop and implement an estuary restoration program with a goal of protecting and enhancing 10,000 acres of tidal wetlands and other key habitats…Action Agencies shall provide planning and engineering expertise to implement the non-Federal share of on-the-ground habitat improvement efforts...*" The types of restoration activities under consideration in the long-term plan for estuarine restoration might include the following: reconnect backwater channels, sloughs and oxbows through dike removal and/or tide gate replacement; recovering estuarine wetlands through removal of dikes and floodgates and filling of ditches; reconnecting upland drainages and freshwater inflow through removal of armored channels, culverts, diversions, and other channelizing structures; removing intertidal fills and piling fields; allowing natural accumulation of large woody debris; placement of dredged material; and, removing armor from shorelines. The vision for the lower Columbia River and estuary is to restore ecosystem functions. However, based on present information, there is little basis to evaluate whether the proposed actions will have a net cumulative benefit to ecosystem health and functionality. True ecosystem restoration requires that these changes be reversed to a *measurable degree*. Although it is relatively straightforward to measure area of habitat restored, we do not have any formal method for quantifying whether restoration of habitats will have a measurable cumulative effect on the health and functionality of the ecosystem. ***Restoration actions in the Lower Columbia River represent a unique opportunity to develop and employ science-based, defensible methods to evaluate the potential cumulative gains in restored ecosystem function provided by a suite of restoration projects in the system.*** The proposed work will quantify the cumulative improvements associated with restoration projects and to lay the foundation for the evaluation of the effectiveness of the restoration activities undertaken.

GOAL: The goal of this study is to develop standardized techniques and protocols that will facilitate evaluation of the performance of salmon habitat restoration actions and support the decision-making process for said actions in the lower Columbia River and estuary aimed at increasing population levels of listed Columbia Basin salmon. The management implications of the research are two fold. It will provide techniques (1) to obtain data to compare project results in order to support decisions regarding what projects to pursue for restoration of the ecosystem, and (2) to evaluate the ecological performance of the collective habitat restoration effort in the lower Columbia River and estuary (LCR&E).

OBJECTIVES:

1. Finalize standard monitoring protocols developed in 2004 that can be applied to LCR&E habitat restoration activities for listed salmonids.
2. Using 2004 results, further develop the empirical basis for a cumulative assessment methodology, together with a set of metrics and a model depicting the cumulative effects of LCR&E restoration projects on key major ecosystem functions and supporting listed salmon.
3. Design and implement field evaluations of the cumulative effects of restoration projects using standard methods, and sensors or remotely operated technologies, to measure the effects on listed salmon through ecosystem response.
4. Develop an adaptive management system; including data management and dissemination, to support decisions by the Corps of Engineers and others regarding LCR&E habitat restoration activities intended to increase population levels of listed salmon.

SCHEDULE: 2004-2010

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: AVS-W-03 (NEW)

TITLE: Evaluate the Impact of Avian Predation on Salmonid Smolts from the Columbia and Snake Rivers

FISH PROGRAM FEATURE: CRFMP – Estuary Program

BIOP MEASURE: RPA 49, 101,102, 103, 104, 186 and 195

DECISION QUESTION: What is the level of avian predation on salmonid stocks from the Snake and Columbia rivers that pass through the McNary Pool?

BACKGROUND: Caspian terns nesting on Crescent Island in 2000 and 2001 consumed an estimated 465,000 and 679,000 juvenile salmonids, respectively (Antolos 2003; Antolos et al. in prep). Non-transported steelhead are particularly vulnerable to tern predation at Crescent Island especially during low flow years. A minimum of 12.4% of PIT-tagged smolts from the threatened Snake River Steelhead ESU fell prey to Caspian terns nesting on Crescent Island in 2001 (Antolos et al., in prep.). Tern predation rates on the Mid-Columbia River Steelhead ESU (threatened) and the Upper Columbia River Steelhead ESU (endangered) are apparently similar. Increasing numbers of double-crested cormorants, California gulls, and American white pelicans are nesting on islands in the mid-Columbia River and little is known concerning the impacts of these colonies on survival of juvenile salmonids. Studies are needed to determine the magnitude and dynamics of predation on juvenile salmonids by piscivorous birds nesting in McNary Pool. These bird populations may pose an increasing threat to salmonid recovery because (1) the distribution, number, and size of bird colonies have been increasing throughout Eastern Washington and Oregon, and (2) current and future management of piscivorous water birds in the Columbia River estuary, and the Columbia Basin generally, may result in large numbers of these birds relocating to colonies along the mid-Columbia River.

OBJECTIVES:

1. Research, monitor and evaluate Caspian tern predation on salmonid smolts in the Columbia River above The Dalles Dam.
2. Research, monitor and evaluate double-crested cormorant predation on salmonid smolts in the Columbia River above The Dalles Dam.
3. Research, monitor and evaluate American white pelican predation on salmonid smolts in the Columbia River above The Dalles Dam.

SCHEDULE: 2004-2007

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: AVS-P-05 (NEW)

TITLE: Evaluate Caspian Tern Management Measures and Develop Baseline Information on Double-crested Cormorants Directed at Reducing the Impact of Avian Predation on Salmonid Smolts in the Columbia River Estuary

FISH PROGRAM FEATURE: CRFMP – Estuary Program

BIOP MEASURE: RPA

DECISION QUESTIONS: What is the effectiveness of Caspian tern management measures implemented to reduce the level of avian predation on salmonid stocks in the Columbia River estuary? What methods are available to manage double-crested cormorants and thereby reduce their level of predation on salmonid stocks in the Columbia River estuary?

BACKGROUND: Caspian terns (*Sterna caspia*) were first recorded nesting in the Columbia River estuary in 1984. Since then, their numbers have increased from approximately 1,000 breeding pairs to nearly 10,000 pairs in 2002, the largest known breeding colony for the species in the world (Shuford and Craig 2002, Collis et al. 2002a, Suryan et al. In press). From 2000 to 2003, Caspian terns nesting on East Sand Island consumed an average of 5.9 million juvenile salmonids annually (the yearly average ranged from 4.2 to 8.2 million), including ESA-listed salmonids (Collis et al. 2002a, 2002b, 2003a, and 2003b). Although the Caspian tern breeding population in the Columbia River estuary has remained fairly stable since 1998, the colony on East Sand Island is expected to increase in size in the near future due to the high production of fledglings in 2001, 2002, and 2003 (Collis et al. 2002a, 2003a, 2003b). These cohorts are likely to recruit into the East Sand Island breeding colony starting in the 2005 breeding season, because the average age of first reproduction is thought to be 4 years (Suryan et al. In press). Thus, predation on juvenile salmonids by Caspian terns in the Columbia River estuary may increase in the future as the tern colony on East Sand Island grows.

The double-crested cormorant (*Phalacrocorax auritus*) colony on East Sand Island consisted of nearly 11,000 nesting pairs in 2003, the largest nesting colony for the species on the Pacific coast of North America. This colony was first noticed in 1989, when a total of 91 double-crested cormorant nests were counted on East Sand Island. Unlike the breeding population of Caspian terns in the Columbia River estuary, the breeding population of double-crested cormorants has roughly doubled since 1998. In 2003 alone, the size of the East Sand Island cormorant colony increased by 23% over 2002, and another large increase in colony size is expected this year.

Estimates of the number of out-migrating juvenile salmonids consumed by double-crested cormorants in the Columbia River estuary during 2003 (ca. 4.8 million) were similar to or greater than estimates of the number of smolts consumed by Caspian terns nesting on East Sand Island in 2003 (ca. 4.2 million). Together, the two species consumed approximately 9 million juvenile salmonids that reached the estuary in 2003.

The Environmental Impact Statement for Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (EIS) presents habitat management measures to address redistribution of the Caspian tern population. Measures presented would result in the reduction of available nesting habitat on East Sand Island, coupled with development of alternative habitat elsewhere in the region. No comparable effort to address double-crested cormorants nesting in the estuary has been initiated, although current information indicates their take of juvenile salmonids may exceed that of Caspian terns.

OBJECTIVES:

1. Research, monitor, and evaluate Caspian tern predation on salmonid smolts in the Columbia River estuary.

2. Research, monitor, and evaluate response of Caspian terns to management measures implemented to reduce the size of the breeding colony on East Sand Island to the preferred objective stated in the Environmental Impact Statement for Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary (EIS).
3. Research, monitor, and evaluate alternative sites developed with implementation of the EIS to determine success of any effort to redistribute Caspian terns to colonies outside the Columbia River estuary.
4. Research, monitor, and evaluate the response of the regional Caspian tern population to implementation of the EIS.
5. Research, monitor, and evaluate double-crested cormorant predation on salmonid smolts in the Columbia River estuary.
6. Research, monitor, and evaluate potential management methods to limit the size of the double-crested cormorant colony on East Sand Island, including manipulation of nesting habitat, social attraction, and redistribution of a portion of the colony to alternative colony sites outside the Columbia River estuary.
7. Research, monitor, and evaluate the regional double-crested cormorant population to determine sub-species status, population trends (current and historical), geographic boundaries, colony locations (present and historical), productivity, and habitat characteristics of colonies to gather baseline information for preparation of an EIS to potentially redistribute part of the East Sand Island colony to sites outside the Columbia River estuary, and thereby reduce predation on juvenile salmonids from the Columbia River basin.

SCHEDULE: 2004-2008

POC: Geoff Dorsey (503) 808-4769

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE-W-00-2

TITLE: Evaluate Post-Release Losses and Barging Strategies that Minimize Post-Release Mortality.

FISH PROGRAM FEATURE: O&M-System-Transportation

BIOP MEASURE: RPA 49, 186, 187, 195

Survival downstream of Bonneville and through the estuary for in-river migrants and transported fish have been studied for spring/summer, fall Chinook and steelhead. Results from these evaluations, although preliminary, suggest that there are several factors contributing to losses in the estuarine environment. These relate to exposure to avian and piscivorous predators, be it through poor barge release locations, timing to the tidal cycle, flows, or season of arrival to the estuary. Understanding the estuarine losses will help guide future barging strategies that may increase survival through this area.

Avian predation continues to be a problem in the estuary. Up to 30% of the smolts are estimated to be taken by terns colonizing dredge spoil islands. This predation rate coupled with new information on estuary migration behavior (i.e., passage routes through shallow grass flats, and holding in the fresh water lens, and ocean entry tied to tidal timing) suggests increased smolt exposure to predation and suggests that mortality though the estuary may be reduced by providing transportation through this environment.

Survival of transported fish from the comparative survival study from Lower Granite show a dramatic increase in the rate of adult returns of fish transported later in the season (~mid May) to those transported earlier. The factors contributing to this difference are unknown but understanding the factors (cyclic patterns of oceanic predators versus estuarine losses) contributing to the early season losses may have potential to reduce post-release losses.

OBJECTIVES:

1. **(Complete in 2004)** Evaluate post-release survival, behavior, migration characteristics and habitat use of juvenile salmon through the estuary, plume and near shore environment. Identify potential trouble areas (delays and losses) and correlate to route of passage, stocks, seasons, and species. Recommend improvements in barge release locations.
2. Evaluate barging strategies to reduce mortality. (Pending the result of the steelhead and fall chinook post-release objectives) (2005-2007)
    a. Determine adult returns of smolts transported and released downstream from the current release point, possibly near the saltwater interface.
    b. Develop and compare transportation strategies to increase early season survival.
    c. Evaluate post-release migration behavior, ocean entry timing, and timing to the tidal cycle.

SCHEDULE: 2000-2007

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE-W-00-2004

TITLE: Analyze the benefits of transporting Lower Snake River juvenile Fall Chinook salmon

FISH PROGRAM FEATURE: O&M-System-Transportation
CG-CRFMP-Delayed Mortality (Objective C.iv)

BIOP MEASURE: RPA 46 and supports 190

DECISION QUESTION: How should the Snake River collector projects be operated to provide the highest level of Snake River fall chinook inriver survival and system (adult returns)?

BACKGROUND: Currently, all Snake River fall Chinook salmon collected are transported around FCRPS dams in the summer. The benefits associated to fall chinook transport are based on historic data, little baseline information exists for fall chinook with regards to transport returns, migration characteristics and inriver survival under current river operations. The BiOp states that summer transport should be reassessed and as soon as the BPA transmission modifications have been completed a comparative spill vs. transport study should be conducted from the Snake River. While a comparative transport study provides part of the information necessary for future decision on how to best operate the hydrosystem for Snake River fall chinook survival, it also requires a series of baseline studies ranging from general transport survival, inriver system survival under various project operations including RSWs and non-spill bypass to route specific project survival. In addition, the future comparative transport vs. inriver spill passage study will also require summer spill at all projects (collector and non collector). Recently the summer spill survival benefits at non-collector projects have been questioned. Before a summer transport/spill study begins the optimal summer spill operations needs to be established.

These two major baseline actions must be completed before a summer transport/spill evaluation may be conducted to ensure efficiency in study design and resources (fish, time and money).

OBJECTIVES:

1. Provide baseline information required for the future comparative transport and spill in-river survival study, started 2004-2005. (Marking at LGR due to inconsistence quality and availability of Lyons Ferry Fish)
    a. Develop a statistically sound tagging and sampling regime for the future Snake River fall chinook transport evaluations. (Complete pending review of 2004 marking activity).
    b. Determine baseline migration characteristics.
        i. Estimate project/reach survival,
        ii. Estimate proportion of the fall chinook out migration that over winter,
        iii. Develop study design that partition adult returns of current year and over wintering fall chinook transport and for those that remain inriver.
        iv. Determine the post-release behavior of Snake River Fall chinook (estuary rearing)
    c. Estimate adult return rates for fall chinook
        i. Transported under current operating conditions.
        ii. Bypassed (and passed through turbines) under current operating conditions.
        iii. Estimate system survival.
        iv. Estimate “D” for fall chinook under current operations.
        v. Partition adult returns and (T/I) rations incrementaly through the summer.
2. Initiate summer fall chinook comparative evaluation of transported and spill-passed inriver migrants. (2006-2008) (Adult returns – 2011)
    a. Spill operations must be previously established for all projects (including RSW operations, see note).
3. Analysis of variables that lead to management decisions including but not limited to the seasonality of transport benefits, effect of river environment, project operations, ocean environment, etc…(yearly)

4. Conduct late season tagging of fish transported from Lower Granite Dam to determine the contribution to Fall Chinook adults of late season transport. Research results should include analysis of variables meant to lead to management decisions on late season transport of fall chinook salmon.

SCHEDULE: 2004-2005: Objectives, all under 1 and 3
2006-2008: Objectives, all under 2 and 3
Through 2011: Adult Returns and Objective 3

NOTES: Decisions to change project operations for summer migrant survival requires input from the transport studies identified in this research summary and from research on summer spill survival. Objectives related to Inriver Survival Configuration of the projects and hydrosystem (spill and bypass structures) fall under the CRFM program.

2003 SRWG Sub-group Findings

1. Summer transport evaluation from LGR would be sufficient to make a determination for LGO and LMO.
2. Spill would be required at all downstream projects for the spill portion of the test.
3. Spill at the collector projects would likely be developed from the WES models.
4. Baseline transport index releases are a high priority.
5. Inriver survival under current operation is a critical baseline for the future inriver spill comparisons.
6. Due to the variability in the quality of the Lyons Ferry fish, a pre-marking physiological monitoring must be conducted.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE-W-04-06

TITLE: Determine physiological factors that drive fish survival during the transportation process.

FISH PROGRAM FEATURE: O&M-System-Transportation
CG-CRFMP- Delayed Mortlaity

BIOP MEASURE: RPA 49, 51, 52, 189, and 195

DECISION QUESTION: Are there barging processes that are physiologically detrimental to fish?

BACKGROUND: Physiological factors including disease profiles and smoltification levels are known to have substantial roles in the downstream survival of juvenile salmon. Studies for this summary are meant to determine if there is a physiological impact to fish encountering the transportation system and/or process that may be causing barged fish to survive at lower levels after release from the barge, as compared to inriver migrating fish that arrive at the Bonneville tailrace.

OBJECTIVES:

1. Determine the physiological disposition of fish during the early part of the juvenile fish migration season at transportation projects (Possibly Lower Granite and McNary Dams), to determine the relationship to the lower than expected early season transportation returns.
    a. Studies include impact of immunology, levels of BKD infection, smoltification levels, and/or relationships to the aquatic environment.
2. Barge Environment and Experience
    a. Barge Environment – Determine if there are detrimental impacts of the barge environment that may be contributing to reduced fitness of transported fish.
        i. A potential impacts that has been proposed include vibrations from onboard engines that may damage nerve hair cells, thus impairing fishes sensory ability. Studies may include a wide array of scopes.
    b. Barge Experience – Determine if there are detrimental impacts of the barge experience itself that may be contributing to reduced fitness of transported fish.
        i. Effects of temperature differentials passing through various river reaches,
        ii. barges passing through mill effluent, speed of the transportation process, etc…
        iii. The range of studies may include examining physical properties of the river, temperature and effluent plumes, to modification of barging scenarios.
3. Determine the impacts of mixed species transport on the fitness of transported fish. Determine if enhanced separation of juvenile chinook, steelhead, lamprey, and/or shad for both the raceway holding and transporting processes has the potential to increase the survivability of listed stocks of fish.
    a. Short term rearing study coupled to Transport SAR (see transport density research summary).

SCHEDULE: 2005-2007 plus adult returns

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE–W–04–03

TITLE: Evaluate the effectiveness of transportation for Fall Chinook Salmon at McNary Dam

FISH PROGRAM FEATURE: O&M-System-Transportation
CG-CRFMP – Delayed Mort (Objective 4)

BIOP MEASURE: RPA 46

DECISION QUESTION: Should juvenile fish be transported from McNary Dam or returned to migrate inriver via primary bypass?

BACKGROUND: Construction of the newer McNary Juvenile Bypass System and additional improvements to that system, warrants a study at that facility to determine if migrating Fall Chinook Salmon should be migrating inriver or transported. Adult detectors at numerous ladders throughout the system, makes PIT tag studies more feasible and is also needed to provide information to make management decisions on whether or not to transport Fall Chinook from McNary Dam. The major operational alternatives to transport include primary bypass and facility bypass.

OBJECTIVES:

1. Compare the effectiveness of transported, primary bypassed and non-detected passage routes at McNary Dam for Hatchery Fall Chinook (2005-07). Research results should include analysis of variables meant to lead to management decisions including but not limited to; the seasonality of transport benefits, effect of river environment, project operations, ocean environment, etc.. Tagging would be expected to occur at Mid-Columbia Hatcheries in representative proportions.
2. Compare the effectiveness of transport and bypass passage routes at McNary Dam for the run at large including a composite Hatchery Fall Chinook (2005-07). Tagging would be expected to occur at McNary Dam.
3. Tag sufficient numbers of Fall Chinook Salmon at McNary Dam from October through December to determine the effectiveness of transporting late migrating Fall Chinook Salmon.
4. As part of transportation evaluations, determine the differential delayed Mortality “D” of transported Fall Chinook compared to non-detected fish passing McNary Dam.

SCHEDULE: 2005-2008 plus adult returns

NOTE: At a Walla Walla FFDRWG meeting, April 2003, the management agencies concurred that if transport of mid-Columbia stocks shows a benefit, it would be acceptable to transport Snake River stocks from this location as well without further evaluation.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE–W–04–02

TITLE: Evaluate the effectiveness of transportation for Spring/Summer Chinook Salmon and Steelhead at McNary Dam

FISH PROGRAM FEATURE: O&M-System-Transportation
CG-CRFMP- Delayed Mort (Objective 3)

BIOP MEASURE: RPA 45, 46, 47

DECISION QUESTION: Should juvenile fish be transported from McNary Dam or returned to migrate inriver via primary bypass?

BACKGROUND: Transport of spring migrants from McNary was suspended in the 1995 FCRPS Biological Opinion because a review of the data indicated the benefit from transport was uncertain. However, with the newer McNary Juvenile Bypass System, additional improvements to that system, and adult detectors at numerous ladders throughout the system, evaluation of transportation from McNary Dam is more feasible. It is also needed to provide information to make management decisions on whether or not to transport spring migrants from McNary Dam. The major operational alternatives to transport include primary bypass and facility bypass.

OBJECTIVES:

1. Compare the effectiveness of transported, primary bypassed and non-detected passage routes at McNary Dam for Upper Columbia Hatchery Spring Chinook (2004 – 2005 ? per NMFS Seattle) and Hatchery Steelhead (2004-05). Research results should include analysis of variables meant to lead to management decisions including but not limited to the seasonality of transport benefits, effect of river environment, project operations, ocean environment, etc… Tagging would be expected to occur at Mid-Columbia Hatcheries in representative proportions.
2. Compare the effectiveness of transport and bypass passage routes at McNary Dam for the run at large including composites of Spring Chinook (2004, 2005?) and Hatchery Steelhead (2004-05). Tagging would be expected to occur at McNary Dam.
3. As part of transportation evaluations, determine the differential delayed Mortality “D” of transported Chinook and Steelhead compared to non-detected fish passing McNary Dam.

SCHEDULE: 2004-2005

NOTE: At a Walla Walla FFDRWG meeting, April 2003, the management agencies concurred that if transport of mid-Columbia stocks shows a benefit, it would be acceptable to transport Snake River stocks from this location as well without further evaluation.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: TPE-W-04-1-*NEW*

TITLE: Determine the Benefits of Early Spring Transport from the Snake River

FISH PROGRAM FEATURE: O&M – System - Transportation

BIOP MEASURE: RPA 46, 51

DECISION QUESTION: Should spring migrants of juvenile spring chinook and steelhead from the Snake River be transported or remain in river during their early spring (April) outmigration? When should spring transport start on the Snake River?

BACKGROUND: Trends in the data comparing the adult returns of spill-bypass versus transported fish for the very early out migration indicate that these two groups of fish return at similar rates. There appears to be a turning point in late April and early May when there is a marked change in the rate of returns with a dramatic increase of transport benefits for both, wild chinook and steelhead. While the data sets are small for these groups this trend has been observed in the returns from several years of release; 1995, 1998 and 1999. However, a recent change in this pattern of returns was observed in data starting with the 2000 release that makes the continuation of the previous pattern uncertain. The new pattern of returns exhibit, high early season return rates for both groups, with sustained high returns for transport fish (especially wild steelhead) into May followed by a sharp decline in returns for both groups. Other than attributing these returns patterns to offshore productivity cycles, it is not clear if this pattern will continue or if this is an anomaly. It has been suggested that these dramatic changes in the return patterns is tied to ocean conditions (such as temperature, productivity and upwelling cycles), thus, linking it in time to the pivotal point of change in the adult return data.

OBJECTIVES: (New data correlates river temperature as measure for start of transport)

1. Determine absolute return rates and comparison ratios for early spring (April and first week of May for bypassed and transported juvenile wild spring chinook and wild steelhead smolts.
    a. Mark early migrating juvenile wild spring chinook and steelhead at Lower Granite with PIT tags in weekly or bi-weekly intervals to prepare a return rate for the season and within the season. Two release groups are proposed, a transport and bypassed group. The transport group would include barged fish only. The bypass groups would be through primary bypass where possible. (Releases for 2004, 2005, and 2006, Adult returns thru 2009)
    b. Monitor juvenile system survival, post-release survival, migration behavior, ocean entry timing of transported and bypassed migrants in the upper estuary with the PIT tag trawler. (2004-2006)
    c. Monitor returning adults using adult PIT tag detection system. (2005-2009)

SCHEDULE: 2004-2009