PRELIMINARY PROPOSAL FOR FY 2005 FUNDING

Title: Movement, Distribution, and Passage Behavior of Radio-Tagged Juvenile Salmonids at Bonneville Dam Associated with Fish Passage Efficiency (FPE) and Survival Tests.

Study Code: SBE-P-00-7

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PROJECT SUMMARY

RESEARCH GOALS

The goal of our study is to monitor the behavior of juvenile salmonids as they approach and pass through Bonneville Dam during Fish Passage Efficiency (FPE), corner collector, and survival tests.

NOTE*: Although the current proposal will address FPE, corner collector efficiency, and survival questions at Bonneville Dam, the nature of radio telemetry technology will also allow us to estimate fish guidance efficiency (FGE) at each powerhouse and effectiveness of the spillway, sluiceway, and corner collector. This is possible because the monitoring equipment needed to determine FPE and survival will also provide the necessary information to calculate FGE and effectiveness.*

STUDY OBJECTIVES

Objective 1: Determine the timing and route of passage for yearling Chinook salmon, steelhead, and subyearling Chinook salmon at Bonneville Dam relative to spill, powerhouse operations, and corner collector tests.

Note*: This study objective meets the research needs identified in SBE-P-00-7 objective 1.*

Objective 2: 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 (yearling Chinook salmon, steelhead and subyearling Chinook salmon).

Note*: This study objective meets the research needs identified in SBE-P-00-7 objective 1.*

Objective 3: Monitor all passage routes at Bonneville Dam to determine route-specific and project survival for yearling Chinook salmon, steelhead, and subyearling Chinook salmon.

Note*: This study objective meets the research needs identified in SBE-P-00-7 objective 1 and SPE-P-02-1 objectives 1-5.*

METHODOLOGY

We propose to use radio telemetry to monitor the behavior, distribution, and passage of juvenile salmonids at Bonneville Dam. A combination of aerial and underwater receiving equipment together with Multiprotocol Integrated Telemetry Acquisition Systems (MITAS) will be positioned strategically along the periphery of the dam and inside all turbine intakes, sluiceways, spillbays, bypass collection channels, and the corner collector at the second powerhouse. This equipment will be used to estimate Fish Passage Efficiency (FPE) for the project and each powerhouse, Fish Guidance Efficiency (FGE) for each powerhouse, efficiency and effectiveness of the spillway, sluiceway, and corner collector, and to estimate project and route-specific survival. All of the radio-tagged fish used to estimate FPE, FGE, efficiency and effectiveness for the spillway, sluiceway, and corner collector, as well as project survival, will be released as part of other COE-funded research upstream of Bonneville Dam. Site-specific releases of radio-tagged fish will be conducted to obtain route-specific survival at Bonneville Dam. Please reference the research proposal for study code SBE-P-00-7, submitted by USGS researcher Tim Counihan titled "Estimating the survival of migrant juvenile salmonids through Bonneville Dam using radio telemetry: 2005 evaluations" for details on numbers of fish and release locations.

RELEVANCE TO THE BIOLOGICAL OPINION

The relevance of this research to the operation of the Federal Columbia River Power System and Juvenile Transportation Program is discussed in the 2000 Biological Opinion, section 9.6.1.4.2, pages 9-66.

PROJECT DESCRIPTION

BACKGROUND AND JUSTIFICATION

As anadromous juvenile salmonids migrate from freshwater rearing habitats to the ocean, they are vulnerable to a host of factors that affect their survival. Direct effects associated with dam passage (e.g., instantaneous mortality, injury, loss of equilibrium, etc.) and indirect effects (e.g., predation, disease, and physiological stress) contribute to the total mortality of seaward migrating salmonids. Many studies have been conducted to determine the effects of hydroelectric dams on the survival of salmonid migrants (Raymond 1979, Stier and Kynard 1986, Iwamato et al. 1994, Muir et al. 1996, Smith et al. 1998, Hockersmith et al. 2000). Based on this research and other studies examining migrant salmonid behavior at dams in the Columbia River Basin, management actions are currently being implemented to improve dam passage and survival of salmonid migrants. For example, at Bonneville Dam, the Army Corps of Engineers (COE) has recently initiated various programs aimed at improving fish passage efficiency (FPE) and survival. At Bonneville Dam's second powerhouse, a new fish conveyance pipe and outfall was constructed and became operational in 1999 to reduce predation associated with the old juvenile bypass outfall (Holmberg et al. 2001a, 2001b). Also at the second powerhouse, in 2001 and 2002, the COE field-tested a prototype screen system at units 15 and 17 (Monk et al. 2001). In 2004, a new Surface Flow Bypass (SFB) corner collector became operational at the second powerhouse and was tested using radio telemetry and hydroacoustics. At the first powerhouse, a prototype surface collector was tested in 1998-2000 (Hansel et al. 2000, Plumb et al. 2000, Evans et al. 2001, 2001b) and survival tests were conducted in 2002 at a Minimum Gap Runner (MGR) turbine (unit 6), the juvenile collection channel, and the sluiceway (Counihan et al. in review). In 2004, survival tests were conducted at MGR turbine unit 4 and the sluiceway at the first powerhouse. Currently, questions remain on which direction to take improvements (SFB versus extended-length submerged bar screens (ESBS)) at the first powerhouse and are on hold pending additional information on sluiceway efficiency and survival through the first powerhouse. To evaluate the utility of these management actions and others that continue to be implemented, there is a need to estimate passage efficiencies and survival of migrant juvenile salmonids through these and other passage routes at Bonneville Dam.

The first evaluation of species-specific FPE for the entire Bonneville Dam complex, conducted by the USGS-Columbia River Research Laboratory in 2000, estimated FPE at Bonneville Dam to be between 73% and 91%, depending on species (Evans et al. 2001a, 2001b). However, in 2001, when flows were low and spill was limited, FPE at Bonneville Dam was only 56% for yearling Chinook salmon and 40% for subyearling Chinook salmon (Evans et al. 2002a, 2002b). In 2002, FPE ranged from 76% to 84%, depending on species (Evans et al. 2003a, 2002b). No radio telemetry studies were conducted in 2003. During 2004, evaluations of survival and FPE continued. Survival was estimated through MGR turbine unit 4 and the sluiceway at the first powerhouse. FPE and survival were also estimated at the corner collector, spillway, and both powerhouses. The corner collector is located at the south end of the second powerhouse. It was constructed by making significant modifications to the existing Ice and Trash sluice chute. Major modifications at the sluice chute included altering the overflow weir to a more gradual "slide" and extending the outfall from the immediate tailrace of the second powerhouse to the downstream tip of Cascades Island which separates the tailraces of the second powerhouse and the spillway. A radio telemetry evaluation in 1998 indicated that the existing sluice chute was an effective passage alternative for outmigrating juvenile salmonids (Hansel et al. 2000). Results of that study showed that of the 151 radio-tagged fish that passed Powerhouse II, 81 (54%) passed through the sluice chute. Operation of the sluice chute as a passage route was not used in subsequent years because water, and fish, passing over the sluice chute weir would freefall about 20 ft onto concrete. The high potential for injuring fish precluded the use of the sluice chute as a passage alternative until modifications were made to make it more "fish-friendly". With modifications complete in 2004, USGS evaluated the corner collector as a passage alternative. As part of this evaluation we determined passage efficiency metrics relative to the corner collector such as discovery efficiency (DE), entrance efficiency (EE), collection efficiency (CE) and effectiveness (CF). We also determined project FPE, FPE at Powerhouse I, FPE at Powerhouse II, spillway efficiency (SE), spillway effectiveness (SF), and survival.

Although the current proposal will address FPE, corner collector passage efficiency metrics and survival questions at Bonneville Dam, the nature of radio telemetry technology will also allow us to estimate fish guidance efficiency (FGE) at the dam. This is possible because the monitoring equipment needed to determine FPE, corner collector efficiency, and project and route-specific survival will also provide the necessary information to calculate FGE. This will allow us to continue to provide useful information about the Bonneville Dam bypass system; a system that has historically had low FGE.

Lastly, research was conducted at Bonneville Dam in 2004 to test the effects of summer spill on the survival of sub-yearling Chinook salmon. For years spill has been used as a management action during the summer outmigration as a way to help juvenile salmon reach the ocean. Management agencies and the Army Corps of Engineers implemented a test in 2004 which tested the effects of reduced summer spill on the survival of outmigrating juvenile salmon. The study design extended spill through August 31 and compared survival during two treatments. One treatment was 75 kcfs spill during the day and "Biop-spill" at night. "Biop-spill" is when spill occurs in accordance with the criteria outlined in the 2000 Biological Opinion (NMFS). The other treatment was 50 kcfs for 24 h. Further test of summer spill may occur in 2005.

CURRENT STATUS

We have been conducting radio telemetry studies at Bonneville Dam since 1996. Detailed results from previous studies can be found in the Annual Reports submitted to the Army Corps of Engineers. Detailed results from 2002 are also presented in Annual Reports and a brief summary is provided as follows. In 2002, we radio-tagged and released 2,382 yearling Chinook salmon and 792 steelhead upstream of Bonneville Dam at John Day Dam and The Dalles Dam. At Bonneville Dam, we detected our first radio-tagged fish on 2 May 2002 and we detected our last radio-tagged fish on 9 June 2002. Mean river discharge at Bonneville Dam during the study period was 260.2 kcfs, with 49% of flow discharged at the spillway, 38% at Powerhouse II (B2), and 13% at Powerhouse I (B1). From 2 May to 9 June 2002, fish were exposed to three different spill treatments. A discharge of 75 kcfs during the day (referred to as Day Cap) occurred for a total of 194 h over 14 d. Discharge up to the total dissolved gas (TDG) cap during daytime hours (referred to as TDG Day) occurred for a total of 429 h over 31 d with an average discharge of 137.6 kcfs. Discharge up to the TDG cap during nighttime hours (referred to as TDG Night) occurred for a total of 312 h over 39 d, with an average discharge of 141.0 kcfs. Median travel rates of radio-tagged fish from release to Bonneville Dam were 2.1 - 2.5 km/h, depending on species and release site, resulting in median travel times of 30.7 - 53.5 h. Of the fish released, we detected 83% of the yearling Chinook salmon and 77% of the steelhead at Bonneville Dam. Median forebay residence time was shortest at the spillway for both Chinook salmon and steelhead (0.03 and 0.1 h, respectively) compared to 1.3 and 2.0 h at B2 and 2.5 and 2.4 h at B1.

Passage routes were determined for 98% of Chinook salmon and 97% of steelhead detected at Bonneville Dam. The spillway passed the most fish (57% of Chinook salmon and 55% of steelhead), followed by B2 (35% of Chinook salmon and 39% of steelhead) and B1 (8% of Chinook salmon and 6% of steelhead). Of the fish that passed at B1, 35% passed into the sluiceway, 30% passed through the turbines (unguided), and 30% were diverted into the turbine bypass system by turbine intake screens (guided). All fish that passed at B2 entered the turbine intakes; 63% were unguided and 37% were guided. At all dam areas, a higher proportion of fish passed during the day compared to night, the only exception being at B2 where 52% of steelhead passed at night.

Fish passage efficiency (FPE: the proportion of fish that passed the dam via non-turbine routes) at Bonneville Dam in spring 2002 was 76% (SE 1.0%) for Chinook salmon and 84% (SE 1.5%) for steelhead. During hours of Day Cap spill, FPE was 65% (SE 2.2%) for Chinook salmon and 71% (SE 4.7%) for steelhead. Chinook salmon FPE was 80% during both TDG Day (SE 1.4%) and TDG Night (SE 1.5%), while steelhead FPE was 90% (SE 1.9%) during TDG Day and 82% (SE 2.4%) during TDG Night. At B1, overall FPE was 70% (SE 3.7%) for Chinook salmon and 91% (SE 5.0%) for steelhead. At B2, overall FPE was 37% (SE 1.9) for Chinook salmon and 59% (SE 3.3%) for steelhead. Fish guidance efficiency (FGE: the proportion of powerhouse-entrained fish that are guided by screens into bypass systems) was higher at B1 for both Chinook salmon and steelhead (50% and 75%, respectively) than at B2 (37% and 59%, respectively). Chinook salmon had a spillway efficiency (proportion of fish passing all routes that passed via spill) of 57% (SE 1.1%) overall, 42% (SE 2.3%) during Day Cap, 63% (SE 1.7%) during TDG Day, and 59% (SE 1.9%) during TDG Night. Spillway efficiency for steelhead was 55% (SE 2.0%) overall, 32% (4.7%) during Day Cap, 70% (SE 2.9%) during TDG Day, and 49% (SE 3.1%) during TDG Night. Spillway effectiveness (spillway efficiency divided by the proportion of total discharge through the spillway) for Chinook salmon was 1.2 overall, 1.3 during Day Cap, 1.2 during TDG Day, and 1.1 during TDG Night. Spillway effectiveness for steelhead was 1.1 overall, 1.0 during Day Cap, 1.4 during TDG Day, and 1.0 during TDG Night.

Like in previous years, the proportion of discharge allocated at B1, B2, and the spillway affected which dam area fish entered and passed, as well as the time fish spent in the forebay before passing. Overall, greater than half of both species passed through the spillway and of the three spill treatments, TDG Day spill was the most efficient, passing 63% of Chinook salmon and 70% of steelhead relative to all other passage routes. Spillway efficiency varied significantly among spill treatments for both Chinook salmon ($X^2 = 56.96$, df = 2, $P < 0.001$) and steelhead ($X^2 = 47.21$, df = 2, $P < 0.001$). For Chinook salmon, the TDG Day spill treatment was significantly ($q = 10.35$, df = 3, $P < 0.05$) greater than the Day Cap treatment but not the TDG Night treatment ($q = 2.07$, df = 3, $P < 0.05$). For steelhead, the TDG Day treatment was significantly greater than both the Day Cap ($q = 9.25$, $df = 3$, $P < 0.05$) and the TDG Night ($q=6.77$, $df = 3$, $P < 0.05$) treatments.

Passage metrics for yearling Chinook salmon were higher in 2002 than in 2001, with the exception of FPE_{B1} and FGE_{B2} (and therefore FPE_{B2}) and were similar to passage metrics in 2000. Spillway efficiency and FPE were lower in 2001, largely because of low river flows. Very little water was available for spill in 2001 and that resulted in minimal spill and very low spill efficiency and, therefore, low FPE. Fish passage efficiency at B1 in 2001 was 18-22% greater than in 2002 and 2000, respectively. Fish passage efficiency at B1 was higher in 2001 because a large proportion of smolts entered the sluiceway. We believe the cause of high sluiceway passage in 2001 was due to very low turbine operation at B1, which entrained less fish and made them available to the surface-oriented sluiceway. No steelhead were tagged in 2001 so no comparisons could be drawn for this species and year. However, comparison of passage metrics for steelhead between 2002 and 2000 shows that, unlike for Chinook salmon, most efficiencies were greater in 2002. In general, this may be attributable to the natural tendency of steelhead to migrate shallower in the water column than Chinook salmon, enabling steelhead to utilize shallower, non-turbine passage routes to a greater extent than Chinook salmon. Our results indicate that although the current intake screen guidance systems at both B1 and B2 have relatively poor guidance efficiency, the project FPE goal of 80% can be attained if sufficient numbers of fish are passed via a combination of non-turbine routes (spill, sluice, and turbine guidance systems). However, in years that sufficient spill is not available, as was the case in the low water year of 2001, current guidance systems at B1 and B2 likely will not be efficient enough to meet the 80% FPE goal.

PROJECT OVERVIEW

Radio telemetry has been used extensively to evaluate the survival of fish and wildlife populations (White 1983, Bell and Kynard 1985, Giorgi et al. 1985, Pollock et al. 1996, Normandeau Associates, Inc. et al. 1997) and to monitor the behavior and passage routes of yearling and subyearling Chinook salmon *Oncorhynchus tshawytscha* and juvenile steelhead *O. mykiss* through hydroelectric projects in the Columbia River Basin (Sheer et al. 1997, Hansel et al. 1998, Holmberg et al. 1998, Hensleigh et al. 1999). Detection rates of marked fish affect the sample size required for a given level of precision and thus, the reliability of survival estimates (Skalski 1992). Similar to the advantages provided by PIT tags over other marking techniques (Sims and Ossiander 1981, Skalski et al. 1998), the high detection rates observed in radio telemetry studies of migrant salmonids in the lower Columbia River suggest that the numbers of fish necessary to generate survival estimates with similar or greater precision could be reduced using radio-tagged fish. Recent technological advancements in radio telemetry equipment have decreased the size and increased the life of transmitters thereby eliminating many of the past problems associated with using this technique. Further, in areas where PIT tag survival estimates continue to be calculated, the use of radio telemetry would provide a means of cross-validating these estimates using a different technique. Results from studies examining simultaneous releases of PIT tagged and radio tagged fish in the Snake River suggest similar trends in survival between the two groups (Hockersmith et al., 2000). Similarly, results from survival studies conducted from 2000 to 2004 at John Day, The Dalles, and Bonneville dams indicate that radio telemetry techniques can be used to successfully estimate project and route-specific survival (Counihan et al., 2002).

We propose to use radio telemetry to collect comprehensive and detailed data on fish movements and passage at Bonneville Dam in 2005. This data will enable us to determine species-specific passage routes through the entire project with enough precision to determine which turbine unit or spillbay a fish passed through. Complete radio telemetry coverage at all passage routes through Bonneville Dam will also allow us to provide the necessary data for route-specific and project survival estimates under a separate proposal (Study Code SPE-P-02-1) submitted by USGS (principal investigator: Tim Counihan). The data we propose to collect will provide the following information:

$$\text{*Fish Passage Efficiency (FPE)} = \frac{\text{\# of fish passing through non-turbine routes}}{\text{Total \# of fish passing}}$$

$$\text{*Fish Guidance Efficiency (FGE)} = \frac{\text{\# of fish guided into the collection system}}{\text{Total \# of fish entering turbine intakes}}$$

$$\text{Spillway Efficiency (SE)} = \frac{\text{\# of fish passing through spill}}{\text{\# of fish passing the project}}$$

$$\text{Spillway Effectiveness (SF)} = \frac{\text{Spillway Efficiency}}{\text{Proportion of project discharge that is spilled}}$$

$$\text{Sluiceway Efficiency} = \frac{\text{\# of fish passing through the sluiceway at Powerhouse I}}{\text{\# of fish passing Powerhouse I}}$$

$$\text{Sluiceway Effectiveness} = \frac{\text{Sluiceway Efficiency}}{\text{Proportion of B1 discharge that passed through sluiceway}}$$

$$\text{Corner Collector (CC) Discovery Efficiency (DE)} = \frac{\text{\# of fish detected within 6 m of CC}}{\text{\# of fish detected at Powerhouse II}}$$

$$\text{Corner Collector (CC) Entrance Efficiency (EE)} = \frac{\text{\# of fish passing through CC}}{\text{\# of fish detected within 6 m of CC}}$$

$$\text{Corner Collector (CC) Collection Efficiency (CE)} = \frac{\text{\# of fish passing through CC}}{\text{\# of fish passing Powerhouse II}}$$

$$\text{Corner Collector (CC) Effectiveness (EF)} = \frac{\text{CC Collection Efficiency}}{\text{Proportion of discharge at B2 that passed through CC}}$$

***Note**: *FPE will be estimated for the project and for each powerhouse and FGE will be estimated for each powerhouse.*

Bonneville Dam is the last hydroelectric project on the Columbia River and therefore provides us the opportunity to take advantage of all radio-tagged fish released upriver. For example, the studies we conducted at Bonneville Dam during the 2004 season utilized over 22,000 fish that were released upstream of Bonneville Dam as part of telemetry studies at The Dalles Dam. By utilizing test fish that are part of other studies, it allows us to economically increase precision of our estimates at Bonneville Dam. Currently, there are radio telemetry studies proposed at John Day and The Dalles dams in 2005. Discussions will be conducted with regional managers to determine the exact numbers and release locations of radio-tagged fish for 2005 studies. We anticipate that the number of tagged fish released upstream of Bonneville Dam will be sufficient to meet the objectives of this study.

STUDY OBJECTIVES

Objective 1: Determine the timing and route of passage for yearling Chinook salmon and steelhead and subyearling Chinook salmon at Bonneville Dam relative to spill, powerhouse operations, and corner collector tests.

Objective 2: 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 (yearling Chinook salmon, steelhead and subyearling Chinook salmon).

Objective 3: Monitor all passage routes at Bonneville Dam to determine route-specific and project survival for yearling Chinook salmon, steelhead, and subyearling Chinook salmon.

METHODOLOGY

Objective 1: Determine the timing and route of passage for yearling Chinook salmon, steelhead, and subyearling Chinook salmon at Bonneville Dam relative to spill, powerhouse operations, and corner collector tests.

Fish of hatchery origin will be obtained from the fish collection facility at John Day Dam for all releases upriver of Bonneville Dam (including those fish released at The Dalles Dam). For site-specific releases at Bonneville Dam, fish of hatchery origin will be obtained from Bonneville Dam's second powerhouse juvenile collection facility. As in past years, only radio-tagged fish released from The Dalles Dam (or between The Dalles Dam and Bonneville Dam) and from site-specific release locations at Bonneville Dam will be used for estimating survival at Bonneville Dam. We propose to use pulse-coded radio transmitters supplied by Lotek Engineering. Model MCFT-3KM (7.3 mm in diameter x 18 mm in length; 0.8 g in water; 9 d minimum operational life at 2 s pulse rate) transmitters would be used in yearling Chinook salmon and steelhead. Model NTC-3-1 (6.3 mm W x 4.5 mm H x 14.5 mm L; 0.5 g in water; 8 d minimum operation life at 2 s pulse rate) transmitters would be used in subyearling Chinook salmon. We have used both transmitter models in past year's studies. Coded tags offer several features that make them ideal for studying juvenile fish movements. Because each tag is uniquely coded, as many as 521 tags can broadcast on the same frequency without losing the ability to identify individuals. As a result, the scan cycle of the receiver is relatively short and the probability of not detecting a fish is fairly low. Additionally, Multiprotocol Integrated Telemetry Acquisition Systems (MITAS) can be used to scan multiple frequencies and codes simultaneously. The MITAS system virtually eliminates the scan cycle and allows for nearly instantaneous detection of all fish within range of the antennas. The MITAS system has many advantages over the system used prior to 2000 and has proven to provide more complete data on fish movements at Bonneville Dam. The proposed antenna arrays will be similar to what was deployed in 2004 and can be found in Evans et al. (2003a, 2003b).

Task 1.1: Conduct further tests to optimize methods for use of coded radio-telemetry equipment at Bonneville Dam.

Activity 1.1.1

Conduct laboratory bench tests of coded equipment to determine the best possible configuration to insure that data is collected in an efficient manner.

Schedule:

November 2004.

Activity 1.1.2

Conduct field tests in the lower Columbia River to better determine the range and efficiency at which coded tags can be detected with the newly developed wideband receiver (Orion).

Schedule:

November 2004 through January 2005.

Activity 1.1.3

Electrical engineers will be asked to review the objectives of our study and provide feedback to aid in optimizing the data logging system.

Schedule:

January through February 2005.

Task 1.2: Install fixed monitoring sites on and around Bonneville Dam.

Activity 1.2.1

Install, calibrate, and test the underwater and aerial antenna arrays. The magnitude of the array proposed will require a considerable amount of time and effort to setup and test. We estimate that it will take at least 8 weeks to complete the necessary work.

Schedule:

February through March 2005.

Activity 1.2.2

Install, calibrate, and test fixed monitoring sites downstream of Bonneville Dam.

Schedule:

March through April 2005.

Task 1.3: Tag and release yearling Chinook salmon and steelhead during the spring and subyearling Chinook salmon during the summer of 2005 and monitor their movements. Note: Site-specific releases of radio-tagged fish will be conducted to obtain route-specific survival at Bonneville Dam. Please reference the final proposal submitted by USGS researcher Tim Counihan titled "Estimating the survival of migrant juvenile salmonids through Bonneville Dam using radio telemetry: 2005 evaluations" for details on numbers of fish and release locations. Additionally, radio telemetry studies are currently proposed at John Day and The Dalles dams in 2005. We anticipate that the number of tagged fish released upstream of Bonneville Dam will be sufficient to meet the objectives of this study.

Activity 1.3.1

Determine release sites, number of fish per release, and time interval between releases.

Schedule:

December 2004 through January 2005.

Activity 1.3.2

Complete the necessary Endangered Species Act documentation and obtain the necessary permits and approval to work in the Columbia River.

Schedule:

December 2005.

Activity 1.3.3

Coordinate with appropriate agencies to sequester, gastrically implant tags, and release Chinook salmon, steelhead, and subyearling Chinook salmon smolts during the months of April through July of 2005 (the out-migration period). Juvenile salmonids will be gastrically tagged as described by Adams et al. (1998). Detailed methodology describing fish collection, holding, and release can be found in Evans et al. (2003a, 2003b) and other USGS annual reports of research to the Army Corps of Engineers.

Schedule:

February through July 2005.

Activity 1.3.4

Continue to develop analytical procedures for examining fish tracking data. The regional researchers and managers continue to request the results of these studies almost immediately after the field tests are completed. The data is vital for them to make informed management decisions regarding the operation of the Columbia River hydropower system. We developed an automated proofing program in 2004 that considerably reduced the time needed to process data. We will make efforts to continually improve the data proofing process.

Schedule:

Work will continue through the 2005 field season.

<u>Objective 2</u>: 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 (yearling Chinook salmon, steelhead and subyearling Chinook salmon).

Data collected under objective one will be used to estimate Fish Passage Efficiency (FPE) for the project, as well as for each powerhouse, the spillway, the sluiceway at the first powerhouse, and the corner collector at the second powerhouse. In addition, the data collected under objective one will enable us to estimate Fish Guidance Efficiency (FGE) for both powerhouses, Spillway Effectiveness, Sluiceway Effectiveness, Corner Collector Effectiveness, Corner Collector Discovery Efficiency, and Corner Collector Entrance Efficiency. The methodology described under objective one of this proposal also applies to objective two. The estimates of efficiency and effectiveness will be calculated as follows:

$$\text{*Fish Passage Efficiency (FPE)} = \frac{\text{\# of fish passing through non-turbine routes}}{\text{Total \# of fish passing}}$$

$$\text{*Fish Guidance Efficiency (FGE)} = \frac{\text{\# of fish guided into the collection system}}{\text{Total \# of fish entering turbine intakes}}$$

$$\text{Spillway Efficiency (SE)} = \frac{\text{\# of fish passing through spill}}{\text{\# of fish passing the project}}$$

$$\text{Spillway Effectiveness (SF)} = \frac{\text{Spillway Efficiency}}{\text{Proportion of project discharge that is spilled}}$$

$$\text{Sluiceway Efficiency} = \frac{\text{\# of fish passing through the sluiceway at Powerhouse I}}{\text{\# of fish passing Powerhouse I}}$$

$$\text{Sluiceway Effectiveness} = \frac{\text{Sluiceway Efficiency}}{\text{Proportion of B1 discharge that passed through sluiceway}}$$

Corner Collector (CC) Discovery Efficiency (DE) = <u># of fish detected within 6 m of CC</u>

# of fish detected at Powerhouse II

Corner Collector (CC) Entrance Efficiency (EE) = $\frac{\text{\# of fish passing through CC}}{\text{\# of fish detected within 6 m of CC}}$

Corner Collector (CC) Collection Efficiency (CE) = $\frac{\text{\# of fish passing through CC}}{\text{\# of fish passing Powerhouse II}}$

Corner Collector (CC) Effectiveness (EF) = $\frac{\text{CC Collection Efficiency}}{\text{Proportion of discharge at B2 that passed through CC}}$

***Note**: *FPE will be estimated for the project and for each powerhouse and FGE will be estimated for each powerhouse*.

Objective 3: Monitor all passage routes at Bonneville Dam to determine route-specific and project survival for yearling Chinook salmon, steelhead, and subyearling Chinook salmon.

We propose to use radio telemetry techniques to monitor all passage routes through Bonneville Dam. Complete radio telemetry coverage at all passage routes through Bonneville Dam will enable us to provide the necessary data for route-specific and project survival estimates. The methodology described under objective one of this proposal also applies to objective three. Although we will collect all the necessary data, survival estimates will be generated under a separate proposal (SPE-P-02-1) submitted by USGS (principal investigator: Tim Counihan). A detailed description of the study design for obtaining survival estimates at Bonneville Dam is outlined in a separate research proposal (SPE-P-02-1) submitted by USGS (principal investigator: Tim Counihan).

***NOTE**: Methodology and tasks needed to install and maintain the necessary equipment to collect survival related data on radio-tagged fish are identical to the methodology and tasks described under Objective 1 for the collection of data needed to determine the timing and route of passage of spring and summer migrant juvenile salmonids. At this time, we are proposing to install the necessary equipment to meet survival objectives as identified in a separate proposal (SPE-P-02-1) submitted by USGS (principal investigator: Tim Counihan). A summary of survival objectives is provided below. Please reference the proposal (SPE-P-02-1) submitted by Tim Counihan for a detailed description of the objectives and methodologies.*

1. Conduct a power analysis to determine required sample sizes to meet a range of precision levels ($\pm$2%, $\pm$3%, $\pm$4%, $\pm$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 (using fish released from upstream projects) for spring (CH1 and 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 only).
4. Obtain route-specific survival estimates for spring and summer (CH1, Stld, and 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.

FACILITIES AND EQUIPMENT

Our final cost estimate assumes that the COE will directly purchase all radio transmitters for the spring and summer studies and engineering services related to the Multiprotocol Integrated Telemetry Acquisition Systems (MITASs).

The USGS operates the Columbia River Research Laboratory, which includes research boats, vehicles, office space, and laboratory facilities for the conduct of this study. Boats will be operated at cost with no additional lease cost to the project. Boats will be operated by Department of Interior certified boat operators trained in CPR and First Aid. Boats will be inspected by a third party to meet U.S. Coast Guard standards. USGS will provide a quality control system consistent with the Good Laboratory Practices Act.

Other resources include:

-A selection of 25 boats up to 30 feet in length for work on the river.

-Two 2,700 square foot storage facilities with a shop.

-4,000 square foot wet lab facility.

-A local computer network integrating state-of-the-art GIS capabilities.

-A technical staff of 60-100 fishery biologists, technicians, ecologists, and GIS specialists.

-An office and analytical laboratory in a 15,000 square foot facility.

IMPACTS

<u>Impacts to other researchers</u>

Because radio telemetry is being widely used throughout the basin in a variety of fish behavior studies some potential impacts on other ongoing research activities is possible. Specifically, we will need to coordinate radio frequencies used with other researchers to minimize conflicts with other projects. Research efforts will be coordinated with personnel from Battelle, Oregon Department of Fish and Wildlife, U.S. Geological Survey, Bio analysts, Idaho

Fish and Wildlife Cooperative Unit, the University of Idaho, and Oregon Cooperative Fishery Research Unit.

Impacts to the Bonneville Project

Preseason installation of equipment will start in February 2005 and continue through April 2005. The equipment will be in use through the summer evaluation, which should be completed by the end of July. We are capable of installing most of the necessary equipment for the aerial arrays, and the impact to the Bonneville project should be minimal. However, we may require assistance for periodic maintenance of underwater antennas at the spillway and traveling screens at both powerhouses.

COLLABORATIVE ARRANGEMENTS AND SUB-CONTRACTS

As part of this study, we will be coordinating the collection of radio telemetry data on adult "kelts" released as part of a passage study submitted by the Army Corps of Engineers (Bob Werthheimer, Evaluation of kelt passage through Columbia and Snake river dams). We will also be coordinating radio telemetry data collection on adult salmon and steelhead released as part of a passage study submitted by the University of Idaho (Chris Peery, Evaluation of Adult Salmon and Steelhead through the Columbia and Snake River Dams). The radio telemetry monitoring system that we propose to install at Bonneville Dam will be used to collect passage information for these other proposals.

LIST OF KEY PERSONNEL AND PROJECT DUTIES

Personnel	Organization	Project Duties
Noah Adams	USGS	Principal Investigator
Dennis Rondorf	USGS	Project Leader
Rachel Wardell	USGS	Data Analysis Coordinator and Logistics
Scott Evans	USGS	Technical Lead, implementation/coordination

TECHNOLOGY TRANSFER

The data we propose to collect during the 2005 season will provide detailed information on the movements and passage routes of juvenile salmonids at Bonneville Dam. The data will provide useful information on species-specific FPE, FGE, spill efficiency, corner collector passage efficiencies, and survival. We plan to transfer information obtained from our analysis in the manners listed below. Once this information is transferred, it will be used in making decisions relative to operation of the Federal Columbia River Power System and Juvenile Transportation Program. In addition, the information will be used by other federal and state agencies, Indian tribes, and the public to make management decisions to aid in the recovery of threatened and endangered salmon populations in the Columbia Basin.

1. Preliminary reports to the Army Corps of Engineers. A preliminary report of our findings from the spring analysis will be submitted on September 1, 2005. A similar report summarizing the summer analysis will be submitted on October 1, 2005.

2. Presentation to fisheries agencies, tribes, and the public at the Anadromous Fish Evaluation Program (AFEP) Annual Research Review, 2005.

3. Expected draft report for 2005 by December 31, 2005 and final report by March 31, 2006.

4. Presentations to the Army Corps of Engineers staff and study review groups as requested.

5. Presentations at professional meetings (i.e., Transactions of the American Fisheries Society) and publication of information in peer reviewed journals.

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