

PRELIMINARY PROPOSAL FOR FY 2005 FUNDING

Title: Tailrace egress times and routes of travel of juvenile salmonids following spillway passage
at The Dalles Dam.

Study Code: SPE-P-00-8

This proposal addresses the one-page AFEP research summary entitled “Juvenile salmonid survival studies at The Dalles Dam”.

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PROJECT SUMMARY

RESEARCH GOAL

The goal of this study is to provide detailed distribution, movement, and behavior information on juvenile salmonids in The Dalles Dam tailrace. Radio-tagged yearling Chinook salmon or juvenile steelhead (to be determined by regional processes) and subyearling Chinook salmon will be monitored in the tailrace following passage via the spillway. We will use drift buoys to evaluate juvenile salmonid behavior in respect to general flow conditions in the tailrace. This study will be conducted in coordination with the radio telemetry survival estimates being generated by USGS.

STUDY OBJECTIVES

Our study objective is to determine the tailrace egress times and routes of travel through the tailrace for radio-tagged juvenile salmon that pass through The Dalles Dam spillway. This evaluation is part of the post-construction evaluation of the spillway wall installed during the winter of 2003-2004.

METHODOLOGY

We propose to use radio telemetry to monitor the distribution, movements, and behavior of juvenile salmonids in The Dalles Dam tailrace. Study fish will be monitored intensively within approximately 6 km of the dam. Data will be collected by a series of fixed site receiving stations located around the periphery of the dam (see Sheer et al. 1997 and Holmberg et al. 1999), on the islands near the Route 197 Bridge (the bridge islands), on the basin islands, and on both riverbanks. Juvenile salmonids will be collected at either Bonneville Dam or John Day Dam, transported to The Dalles Dam, and implanted with radio transmitters. Radio-tagged juvenile salmonids will be released through three test bays on the spillway. Proposed release sites are bays 4, 6, and 8. Final release sites will be determined after completion of studies conducted to evaluate the effect of the spillway wall in 2004. Spill operations will be constant at 40% spill, and tailrace egress will be compared between the three test bays. Drift buoys will be released from the same study spillbays as radio-tagged fish, and will be used to study the flow conditions encountered by juvenile salmonids.

RELEVANCE TO THE BIOLOGICAL OPINION

This study addresses the 2001 Biological Opinion RPAs 68, 70, and 83.

PROJECT DESCRIPTION

BACKGROUND AND JUSTIFICATION

In response to Action 68 in the 2000 Biological Opinion on operation of the Federal Columbia River Power System (FCRPS; NMFS 2000) the Corps modified the spillway stilling basin and spill pattern at The Dalles Dam during the winter of 2003-04. A training wall was constructed that extends from the pier nose between bays 6 and 7 to the end sill. Spill operations target 40% spill through spillbays 1-6 (Figure 1). The intent of these modifications was to increase the survival of juvenile salmonids that pass through the spillway. Balloon tag studies conducted in 2004 showed higher than anticipated rates of injury and death for fish released through spillbay 6 (M. Langeslay, Portland COE, pers. comm.). Prior to completion of the wall, fish had rapid egress from bay 6, so the wall has influenced egress conditions, at least for some spillbays.



Figure 1. Aerial photo of The Dalles Dam spillway with the new spill pattern based on the wall between spill bays 6 and 7.

In order to assess the post-construction performance of these spillway modifications, the USGS conducted the first of a two-year evaluation in 2004. Objectives for both years are similar, and include estimating survival, and evaluating fish passage distribution and tailrace egress. Based on hydraulic modeling in the 1:80 physical model, the new spillway configuration is expected to influence tailrace egress. Tailrace egress was evaluated via fixed-site receiving stations in 2004, and is proposed to include mobile tracking of spillway-passed fish in 2005.

At The Dalles Dam, the spillway is considered to be the best available passage route for juvenile salmonids. The Dalles Dam stilling basin is unique in that levels of total dissolved gas are generally kept within approved limits, even under conditions of high volume spill. Concerns have been raised, however, that the shallower stilling basin at The Dalles Dam may cause physical injury to fish passed into the tailrace under conditions of high volume spill. Preliminary results from balloon-tag studies in 2004 support these concerns (M. Langeslay, Portland COE, pers. comm.). In addition, high volume spill may force fish out of the main river channel and into shallow areas where their migration may be delayed and their risk of predation significantly increased.

Tailrace conditions are an important factor to consider in the effort to move juvenile salmonids past hydroelectric facilities. Shoals, eddies, and other physical barriers can have a negative impact on tailrace egress. Even specific routes of passage over the spillway (e.g., north vs. south) may influence how effectively or quickly fish are able to exit the immediate tailrace. Typically, general flow conditions are evaluated through the use of physical model studies. It is often assumed that fish behavior will mimic that of predominant flows in these environments. This assumption, however, has never been addressed specifically under conditions of spill in the tailrace. This study will allow evaluation of this assumption and will aid verification of the flow conditions described by physical models.

We propose to release drift buoys into the tailrace to evaluate the flow conditions encountered by fish (Liedtke et al. 2001). A buoy system attached to a drogue will move through the tailrace according to the predominant flows. By releasing drift buoys at the same sites and under the same conditions as radio-tagged juvenile salmonids, we will be able to determine whether our study fish tend to move with the predominant flows. Drift buoys will be equipped with global positioning systems (GPS), which will allow us to describe the precise position of the buoy during its drift through the tailrace.

PROJECT OVERVIEW

The USGS-BRD has studied juvenile salmonid behavior in dam forebay and tailrace environments since the early 1990's. Our work has primarily focused on assessment of surface bypass/collection concepts at John Day, The Dalles and Bonneville dams. During 1992-1994, the USGS-BRD conducted radio-telemetry studies on northern pikeminnow in the tailraces of John Day and The Dalles dams. Radio-telemetry was used by USGS to assess tailrace egress at The Dalles Dam in 1999, 2000, and 2001.

CURRENT STATUS

The USGS-BRD conducted a radio-telemetry study of tailrace egress through fixed-gear monitoring in 2003, prior to the construction of the spillway wall. No mobile tracking was done, however, drogues were released at several spillways. Egress from the spillway is generally best from the northernmost bays. Fish passing the spillway through the southern bays show lateral

transport to the north, extending their residence time in the stilling basin. Drogues released through northern bays travel immediately downriver, but those released through southern bays tend to move toward the bridge islands, and frequently ground out in shallow water near the islands.

Our most recent effort in mobile tracking fish at The Dalles Dam was in 2001, when we monitored fish that had been released through the sluiceway. The tailrace egress of yearling and subyearling Chinook salmon passing The Dalles Dam through the sluiceway was delayed in two general locations: the series of eddies along the Oregon shoreline, and the bridge islands. Radio-tagged fish entered the eddies, but there were no significant differences in travel times between fish that entered or avoided the eddies. That is, fish entered the eddies, but exited quickly. The bridge island was the more significant cause of delay, likely due to the tailrace elevation associated with a drought year. The delayed fish generally moved laterally (south) along the bridge island and often spent several hours in the area between the main islands. Fish delayed longer in this area during day releases than night releases.

The delay areas we identified for sluiceway fish in 2001 are risk areas for fish passing through the spillway as well. Fish that pass through the spillway to the south of the wall, especially those on the southern edge of a spill pattern, may be directed toward the bridge islands.

OBJECTIVES AND METHODOLOGY

Objective 1. Evaluate tailrace egress at The Dalles Dam using drogues, mobile tracking, and fixed-site monitoring of radio-tagged yearling Chinook salmon or juvenile steelhead, and subyearling Chinook salmon.

Rationale

The tailrace at The Dalles Dam is a challenging environment for juvenile salmonids. They are exposed to risk of physical injury, delay and a high risk of predation by northern pikeminnow or smallmouth bass. Based on hydraulic modeling in the 1:80 physical model, the new spillway configuration is expected to influence tailrace egress. Monitoring tailrace egress of radio-tagged juvenile salmon will enhance management's ability to interpret survival estimates generated for The Dalles Dam and provide a metric that can be compared with previous evaluations, model studies, and dam operating conditions. Regional processes will decide whether the study will use yearling Chinook salmon or juvenile steelhead during the spring outmigration period.

We propose to release 150 yearling Chinook salmon or 150 juvenile steelhead, and 150 subyearling Chinook salmon. All fish will be gastrically tagged using methods in Adams et al. (1998) with a maximum tag-weight-to-body-weight ratio of 6.5%. Radio-tagged juvenile salmonids will be released through three test bays on the spillway. Proposed release sites are bays 4, 6, and 8. Final release sites will be determined following release of the 2004 survival estimates. Spill operations will be constant at 40% spill, and tailrace egress will be compared between the three test bays. We will conduct 10 releases during each outmigration period, timed

to capture the peak of each of the migration periods.

Pulse-coded transmitters operating at frequencies between 162 and 174 MHz will be used to allow each fish to be recognized. Transmitters for yearling Chinook or juvenile steelhead will be no larger than 7.3 mm in diameter x 18.0 mm in length and weigh 1.40 g in air (Lotek Wireless model 3KM). Transmitters for subyearling Chinook will be no larger than 6.3 mm x 4.5 mm x 14.5 mm in length and weigh 0.85 g in air (Lotek Wireless model NTC-3-1). Transmitters will be gastrically implanted using the methods of Adams et al. (1998). Following tagging, fish will be held in tanks for 20 to 28 h to allow fish time to recover from the procedure. After the holding period, the tanks will be checked for mortalities and fish will be transported to the release sites. Any regurgitated tags will be removed from the containers immediately prior to release.

We propose to use drogues released through the spillway to evaluate tailrace egress within the boat-restricted zone (BRZ). Drogues will be released through the same bays that radio-tagged fish are released. Drogues can be used to describe movement paths relative to the new wall and quantify any lateral transport effects that may remain. Drogue egress times will be compared with egress times of radio-tagged fish that pass through the spillway under similar dam operating conditions.

Fixed-site receiving stations will be established on the basin islands and at a site 6 km downriver of the dam to provide tailrace egress times in zones. Egress times will be determined for each spillway release location at The Dalles Dam, and they will be compared at each detection location.

Using the data generated from the tailrace egress evaluation at The Dalles Dam in 2001, we calculated the sample size required to detect 5-7 min differences in tailrace egress time among the three test spillbays. For each release date and species, 5 fish at each spillbay provides good Power (> 0.90) to detect differences in mean egress times among the three release sites. Spillbays 4 and 6 should be open throughout the spill season, but bay 8 will be used intermittently. Using 5 fish at each of two spillbays allows us to detect 5-7 min differences in egress times with good Power (>0.80). For analysis, release dates are compared, and if no differences are found, releases are pooled. If we are able to pool releases we will have sample sizes of 50 fish per spillbay and will therefore have greater power to detect differences among the sites.

In addition to fish released through the spillway via hose release systems, we will monitor forebay receiving equipment and attempt to track egress routes for volitionally passing spillway fish. Fish released by USGS for The Dalles Dam survival estimates in 2005 can be used to supplement our planned releases of fish. During each tracking outing time will be committed to monitoring all possible frequencies of tagged fish in an effort to detect radio-tagged fish as they pass the spillway. These efforts will be aided by monitoring the receiving equipment in the forebay of the dam to alert the tracking crews that fish are in the area and may be passing soon. These data are more difficult to collect, but will add to the interpretive power of the egress data and may allow some data collection at additional spillbays.

Task 1.1 Radio-tag and release groups of juvenile salmonids through spillbays 4, 6, and 8.

Radio-tagged fish will be released through hose release systems. Induction systems (supplied with forebay water via pump) will be used to release fish into the hose systems. We plan 10 releases through bays 4 and 6 since they are open during normal 40% spill operation (bays 1-6 are open). Bay 8 will be used for fish releases when possible, since it will be open during atypical spill operations (depending on total discharge and tailwater elevation).

For each release date in the spring, we will release 10-15 fish: 5 yearling Chinook salmon or 5 juvenile steelhead at bay 4, 5 yearling Chinook salmon or 5 juvenile steelhead at bay 6, and, if possible, 5 yearling Chinook salmon or 5 juvenile steelhead at bay 8. For summer release dates, we will release 5 subyearling Chinook salmon at bays 4 and 6, and use bay 8 when possible.

Activity 1.1.1

Conduct 10 releases of radio-tagged fish at spillbays 4 and 6. Schedule releases over each outmigration period, timed to cover the peak numbers of outmigrants.

Schedule: April-July, 2005

Activity 1.1.2

Collect movement and behavioral data on any radio-tagged fish using similar transmitters released upriver of The Dalles Dam. Monitor forebay telemetry equipment to maximize likelihood of detecting volitionally passed spillway fish.

Schedule: April-July, 2005

Task 1.2 Monitor the movements and behavior of radio-tagged juvenile salmonids in The Dalles Dam tailrace using fixed receiving stations located on the face of the dam, along the navigation lock peninsula, on the bridge islands, and on the basin islands. Establish a study site exit station (6 km downriver of the dam) to be used as a final point of contact within the tailrace. Fixed receiving stations will be located and configured as they were in 2001.

Activity 1.2.1

Establish fixed receiving equipment in the tailrace of The Dalles Dam to monitor the movement of radio-tagged fish in the immediate dam tailrace area. The fixed receiving station on the basin islands will serve as the exit station for the immediate tailrace area. In 2001, we monitored fish in the boat-restricted zone (BRZ) with boats, and found that fish were often delayed in the area between the bridge island and the BRZ island. In order to enhance fixed station monitoring in this area, we propose to establish new monitoring stations along the

Route 197 Bridge.

Schedule: January-April, 2005

Activity 1.2.2

Establish fixed receiving equipment on the bridge islands, the basin islands and at one point further downriver to serve as the study site exit station. The primary variable of interest is the travel time from the time of release until contact at the fixed receiving station at the study site exit station.

Schedule: January-April, 2005

Activity 1.2.3

Calculate egress times to each of the exit station monitoring locations (bridge, basin islands, and 6 km exit station). Compare egress times for fish released through the study spillbays. Comparisons will be made using a Kruskal-Wallis test of medians. We plan to test for differences between release dates, and pool where possible to increase our ability to detect differences between release sites.

Schedule: Aug-Dec, 2005

Task 1.3 Monitor radio-tagged juvenile salmonid movements in The Dalles Dam tailrace with boat tracking and manual tracking from the dam or surrounding area.

The goal of these tracking efforts will be to describe the locations where fish may be delayed or movement patterns that may lead to extended residence times. Due to BRZ safety policy, boats cannot be used within the stilling basin. Boats will be positioned under the bridge (and near the bridge islands) during fish releases. When fish approach the bridge or the islands, the boats will begin to monitor and record their movements in order to describe egress paths. No movement data within the BRZ stilling basin will be collected for safety reasons.

Activity 1.3.1

Use boats equipped with radio tracking equipment to intensively monitor the movements of radio-tagged fish following passage through the spillway. The first point of detection by boat tracking will begin near the bridge.

Schedule: April-July, 2005

Activity 1.3.2

Collect detailed movement data on as many fish as possible that were released upriver of The Dalles Dam, and passed through the spillway volitionally. These fish will serve as run-of-the-river surrogates to compare the movements of fish released at the test spillbays with fish that have been migrating in the river for a period of time.

Schedule: April-July, 2005

Task 1.4 Use drogue releases at the spillway to evaluate the tailrace egress times and travel routes in the stilling basin.

Data collected from the drift buoy releases will be useful in evaluating the assumption that fish behavior is similar to dye patterns in a physical model. Drift buoys will use a global positioning system (GPS) unit that will record the position of the drift buoy each second. These data can be used to describe the precise path of the buoy/drogue as it moves through the tailrace. Drogues will be released at the same study spillbays, and under the same dam operating conditions as radio-tagged fish. Alternate releases of fish and drogues will allow comparisons of fish and drogue movements under the same test conditions, aiding in the interpretation of fish movements within the tailrace.

Drogues were released at spillbays 1-8 during the 2004 post-construction evaluation of the spillway wall. Drogues incurred significant damage during these deployments, and illustrated movement paths toward the bridge and BRZ islands. Alternately releasing radio-tagged fish and drogues through the same spillbay will allow comparisons with 2004 data, and comparisons between the movements of fish and drogues in 2005.

Activity 1.4.1

Release drogues (equipped with GPS units) through the spillway to evaluate egress times and routes within the BRZ. Drogues will be released through the same spillbays as the radio-tagged fish. We propose to release 20 drogues through each study spillbay during the spring out-migration, and 20 drogues through each study spillbay during the summer out-migration. On each release date, radio-tagged fish and drogues will be released alternately through each study spillbay so that they experience the same tailrace conditions.

Schedule: April-July, 2005.

Activity 1.4.2

Equip some drogues with a basic accelerometer package to describe the forces the drogue encounters as it passes through the stilling basin. Video monitoring of the drogue, combined with GPS positioning will show where the drogue was located when it encountered high acceleration events.

Schedule: April-July, 2005.

Activity 1.4.3

Calculate drogue egress times to each study site exit station (bridge, basin islands and 6 km exit station). Comparisons of egress times for each release location will be made using a Kruskal-Wallis test of medians. We plan to test for differences between release dates, and pool releases where possible to increase our ability to detect differences between study spillbays.

The egress times of drogues will be compared to the egress times of radio-

tagged fish released on the same dates, from the same locations. Comparisons will be made using the Kruskal-Wallis test of medians. This product will be useful in evaluating the assumption that fish tend to behave similar to the predominant flows in the tailrace.

Schedule: July-December, 2005

Activity 1.4.4

Use a Geographic Information System (GIS) to display GPS positions of drift buoys. Graphic displays will be generated for each release site and dam operation represented.

Schedule: July-December, 2005

FACILITIES AND EQUIPMENT

No specific facilities or equipment will be required to complete the fixed monitoring component of this study as we have previously established methods and protocols for these activities. The degree to which we may effectively boat track fish will depend on the boating policy within the boat restricted zone. Depending on what spillway sites are selected for release of radio-tagged fish, we may require project support to establish release mechanisms.

IMPACTS

Since radio-telemetry is being widely used throughout the basin in a variety of fish behavior studies, some potential impact 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.

COLLABORATIVE ARRANGEMENTS AND SUBCONTRACTS

We currently have several other research studies proposed under this and other AFEP project codes, including survival and FPE estimates at The Dalles Dam. Fish entering the forebay of The Dalles Dam can be used to describe tailrace egress. The tailrace egress objective at The Dalles Dam will not impact the other studies, but will benefit from fish released for their purposes. Radio telemetry studies at Bonneville Dam will also benefit from fish used in this study, through increases in their sample sizes without cost to their projects.

LIST OF KEY PERSONNEL AND PROJECT DUTIES

Alec Maule	Project Leader
Theresa Liedtke	Principle Investigator
John Beeman	Principle Investigator
Hal Hansel	Data Analysis Coordinator

TECHNOLOGY TRANSFER

Results from this study will be disseminated in the form of preliminary reports, annual reports of research, oral presentations and briefings, and peer-reviewed journal publications. Preliminary reports for the spring and summer outmigration periods will be available September 1 and October 1, 2005 (respectively). The draft annual report of research will be submitted to the COE by December 31, 2005. Comments from the COE will be accepted for 45 d from receipt of the draft final reports, after which the USGS will provide a final report to the COE or any interested parties within 60 d.

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