POST-CONSTRUCTION EVALUATION OF THE JUVENILE BYPASS SYSTEM AT JOHN DAY DAM, 1999

Randall F. Absolon
Dean A. Brege
and
John W. Ferguson

Annual Report of Research
Funded by

U.S. Army Corps of Engineers
Portland District
Contract W66QKZ80354028

and

Fish Ecology Division
Northwest Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
2725 Montlake Boulevard East
Seattle, Washington 98112-2097

September 2000

EXECUTIVE SUMMARY

The John Day Dam juvenile salmonid sampling facility and bypass system reconstruction was completed and ready for operation in April 1998, at the beginning of the spring outmigration. This bypass system is similar to others on the Snake and Columbia Rivers constructed during the 1990s at Little Goose, Lower Monumental, Ice Harbor, and McNary Dams. The John Day Dam facility does not have raceways to hold fish for transportation, but it does include a hydraulic jump and a wetted separator which are unique to this project.

In 1998, we released hatchery yearling chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) at several locations in the bypass system and recaptured them at the sampling facility where we examined them for descaling and gross external injuries. Blood plasma samples were collected from run-of-river yearling chinook salmon and steelhead for evidence of stress build-up, and the efficiency of the sampling system was evaluated. The evaluation of the adult salmonid sampling system could not be completed in 1998 due to deficiencies in several of its components.

In 1999, we evaluated the facility to ensure the safe passage of fry-sized salmonids. Three groups of 200 marked hatchery subyearling chinook salmon fry were released into the elevated flume in the area of the crest gate and recaptured at the sampling facility. We were able to recapture 599 of the 600 fish released, and none showed any signs of injury or descaling. Based on this test we concluded that the facility passed salmonid fry without delay or injury. The evaluations conducted in 1998 and 1999 indicated that juvenile salmonids pass the facility without injury or undue delay.

The deficiencies in the adult portion of the facility noted in 1998 were corrected during the winter of 1998-99. However, this part of the facility was not evaluated in 1999 because a suitable release location for adult test fish could not be determined. We recommend that run-of-river adult salmonids be monitored each year the facility is used to determine whether there are problems with the adult sampling system. If problems are observed, consideration should be given to conducting an adult evaluation that includes evaluation of the gatewell environment, with initial releases of marked adult salmonids into a gatewell.

CONTENTS

EXECUTIVE SUMMARY . . . iii

INTRODUCTION . . . 1

OBJECTIVE 1: DETERMINE IF MECHANICAL PROBLEMS EXIST WITHIN THE FACILITY THAT MIGHT AFFECT ADULT SALMONIDS DURING PASSAGE . . . 5
- Approach . . . 5
- Results and Discussion . . . 5

OBJECTIVE 2: EVALUATE THE FACILITY FOR THE SAFE PASSAGE OF SALMON FRY . . . 6
- Approach . . . 6
- Results and Discussion . . . 7

CONCLUSIONS AND RECOMMENDATIONS . . . 8

ACKNOWLEDGMENTS . . . 9

REFERENCES . . . 10

INTRODUCTION

Bypass facilities for diverting juvenile salmonids (*Oncorhynchus* spp.) from turbine intakes have been in use at hydroelectric dams on the Snake and Columbia Rivers since the late 1970s. The early facilities did not always receive immediate evaluation for safe fish passage, which at times resulted in needless injury to migrating salmonids (Matthews 1992). To avoid a recurrence of these problems, more recently constructed bypass systems have undergone intense evaluation as soon as possible after completion (Monk et al. 1992; Marsh et al. 1995, 1996a,b; Gessel et al. 1997, Absolon et al. 1999). While no major problems have been found, important modifications have been made to most new bypass systems as a result of these post-construction evaluations.

The first major reconstruction of the John Day Dam bypass system occurred during 1984-86 when gatewell orifices were enlarged to 30.5 cm (12 in) diameter, the collection channel was enlarged, vertical barrier screens and submersible traveling screens were installed, and a transportation channel to carry fish from the bypass gallery to the river was constructed. The second major reconstruction occurred during 1996-98, and was completed in April 1998, at the beginning of the juvenile salmonid outmigration. The National Marine Fisheries Service (NMFS) was asked by the U.S. Army Corps of Engineers (COE) to evaluate the facilities prior to operation and to provide information on the effects of the new bypass and sampling facility on migrating salmonids (Absolon et al. 1999).

The components of the bypass system added during the 1996-98 construction are similar to those in use at other Snake and Columbia River hydroelectric dams, with the exception of a hydraulic jump and a wetted separator which are unique to this project. The components added in the 1984-86 period were retained and remain part of the bypass system (Fig. 1).

Flow in the collection channel runs from north to south (Turbine Unit 16 to Unit 1) and turns 90 degrees (to flow west) just before exiting the powerhouse. At this point, the previous bypass system dropped down a sloping channel and ran under the parking lot for 330 m before emerging at the river bank where the outfall flume extended 28 m into the river. The new bypass system begins at a crest gate, which diverts flow from the sloping channel to an elevated flume. The elevated flume runs 360 m to the primary dewatering structure (Fig. 1). Excess water is removed at the primary dewaterer and returned to the existing underground channel. The flow is reduced from about 600 cubic feet per second (cfs) in the elevated flume to about 30 cfs upon exiting the primary dewaterer.

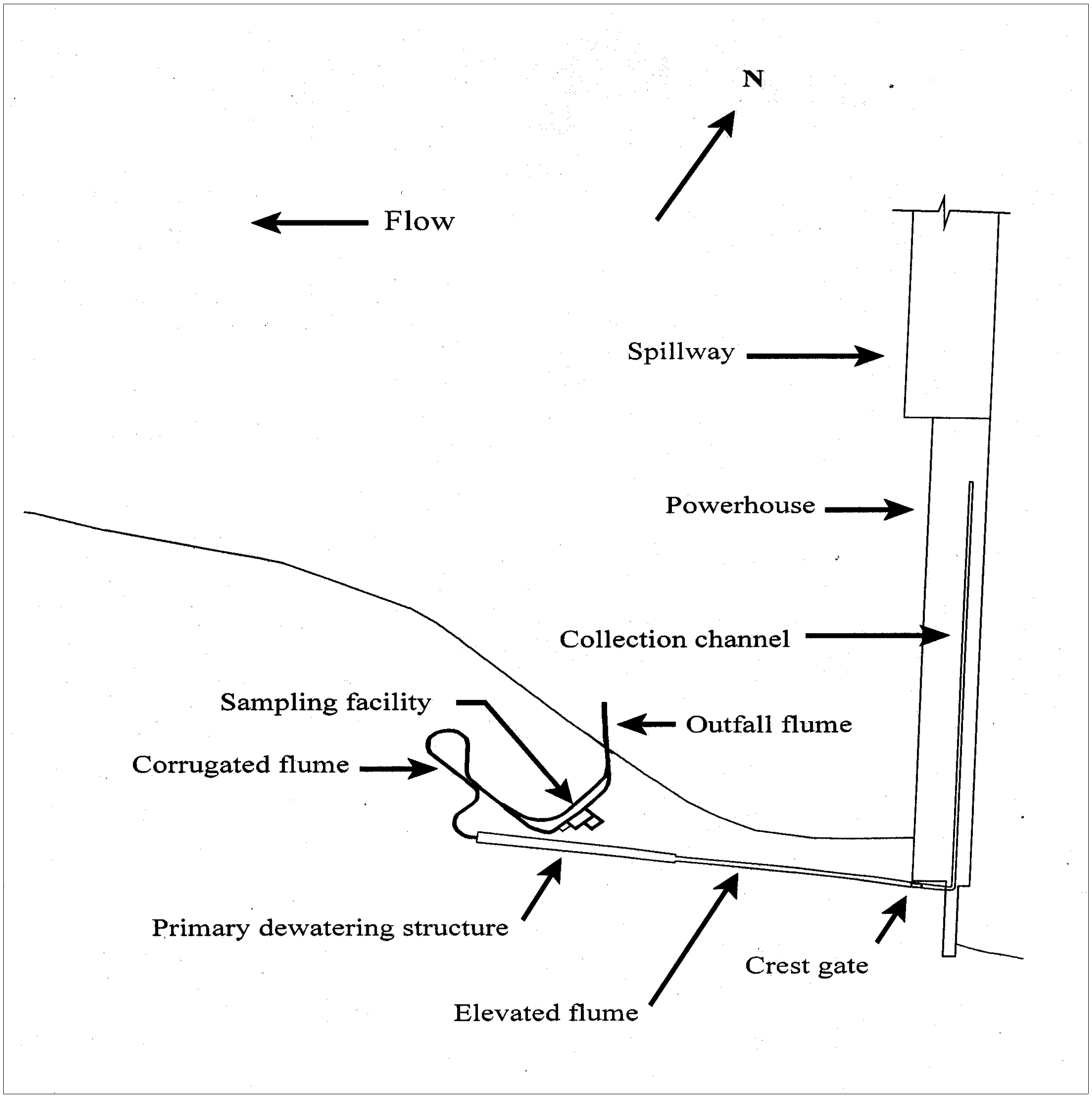

Figure 1. Overhead view of John Day Dam showing major components of the juvenile bypass system.

The hydraulic jump is located at the primary dewatering section and functions to slow the water velocity from over 30 feet per second (fps) in the elevated flume to 4 fps at the exit of the primary dewaterer. From the primary dewatering section, the remaining water and all of the fish flow through a round-bottomed (46-cm radius) 300-m-long corrugated flume that leads to a switch gate. The switch gate can divert the flow either 174 m to the outfall flume and into the river, or 85 m to a secondary dewaterer.

The component downstream from the secondary dewaterer is the wetted separator. Unlike wet separators at other dams, which are designed to sort fish for transportation, the wetted separator at John Day Dam has only one size of bar spacing (32 mm). The wetted separator bars have holes to direct streams of water vertically to keep the bars wet and to aid in orienting fish parallel with the bars so they may drop through the bars into the trough below. Adult fish pass over the bars and are returned directly to the river through a 36-cm pipe to the return channel.

Juvenile salmonids and other small fish which have dropped through the separator bars are directed from the trough to a 25-cm pipe and round-bottom (25-cm diameter) flume, which carry them past passive integrated transponder (PIT) tag detector coils to a 3-way rotating gate. This gate is normally open in the center position, which passes fish back to the river. This gate rotates counterclockwise (looking downstream) to collect smolt monitoring samples, and can be programmed to rotate clockwise for PIT-tag separation-by-code collection. There is an additional 2-way rotating gate located in the separation-by-code flume to further separate PIT-tagged fish.

In the fish sampling facility, the two separation-by-code holding tanks and the smolt monitoring sample tank all have anesthetizing chambers built into the tanks from which anesthetized fish flow by gravity to sorting troughs. After handling, 10-cm pipes carry fish to recovery tanks where they are held until recovery (20 minutes minimum) and then returned to the river via a 20-cm pipe which empties into the exit channel and then the existing outfall flume.

In 1998, the juvenile bypass system evaluation included the release and recapture of groups of hatchery yearling chinook salmon (*O. tshawytscha*) and steelhead (*O. mykiss*) for injury/descaling assessment. No injury problems were found in either yearling chinook salmon or steelhead. In addition, 180 blood-plasma samples were collected at three locations in the bypass system from both yearling chinook salmon and steelhead. The samples were analyzed for the stress indicators lactic acid, cortisol, and glucose.

Higher levels of cortisol and glucose were observed in yearling chinook salmon samples collected from the pre-separator and pre-sample tank locations than in those collected from the gatewell site. Juvenile steelhead also showed an increase in cortisol levels in the pre-separator and pre-sample tank locations compared to the gatewell site.

However, the observed levels of cortisol, glucose, and lactic acid were similar to levels seen during evaluations of bypass facilities at Little Goose, Lower Monumental, Ice Harbor, and McNary Dams (Monk et al. 1992; Marsh et al. 1995, 1996a,b; Gessel et al. 1997). This indicated that the hydraulic jump in the John Day Dam bypass facility does not increase the stress levels of juvenile salmonids above levels observed at bypass systems without hydraulic jumps.

The efficiency of the sampling system was evaluated by comparing the number of run-of-river PIT-tagged fish diverted into the smolt monitoring sample to the total number of PIT-tagged fish passing the project at various set sample rates. The system was found to operate effectively (95% confidence interval) at set sample rates of 0.67, 1.33, 2.0, and 3.33%. At a set sample rate of 1.0%, more fish were collected than the set rate, and at set sample rates of 5.0 and 10.0%, fewer fish were collected than the set rate.

The adult fish portion of the facility was rebuilt in the early spring of 1999. Modifications were made to both the collection and release areas of the system. Adult fish pass over the separator bars and now continue in the same direction into a flume/pipe where they either pass back to the river or can be diverted into the sampling facility. This replaced the original exit flume in which the adult fish exited at a right angle to the separator bars after dropping into the flume. In addition, the slope on the exit pipe was reduced by lengthening and re-routing the pipe.

The adult holding and recovery tanks in the sampling facility were also modified. The anesthetizing tank was made an integral part of the holding tank so that adult salmonids can be crowded into the anesthetizing tank without having to be netted and lifted. The existing three- chambered recovery tank was replaced with a single-compartment tank, which fish exit via a new round-bottom flume. This flume was also lengthened to reduce its slope before emptying into the exit channel.

In 1999, the specific study objectives were 1) to determine if mechanical problems exist within the facility that might affect adult salmonids during passage; and 2) to evaluate the facility for the safe passage of salmon fry.

OBJECTIVE 1: DETERMINE IF MECHANICAL PROBLEMS EXIST WITHIN THE FACILITY THAT MIGHT AFFECT ADULT SALMONIDS DURING PASSAGE

Approach

To evaluate the facility to ensure the safe passage of adult salmonids, we planned to release 20 fallback adult steelhead. These fish were to be radio tagged, released, and recaptured at the sampling facility. Descaling, other injuries, and the time between release and recapture were to be noted. Numbers and any injuries to adult salmonids captured incidentally during this evaluation were also to be noted.

Results and Discussion

We were unable to complete the adult salmonid evaluation of the facility. The modifications requested by fishery agencies last year (Absolon et al. 1999) were completed prior to the start up of the facility for the spring outmigration. The concerns this year included finding a suitable release location for the adults and evaluating the behavior of radio-tagged adult salmonids for the first several hours after release.

The initial plan of releasing the marked adult fish into a gatewell was abandoned because of the possibility of injury occurring to fish when they exited the orifice. The objective of this study was to evaluate the new part of the bypass system, and if the gatewell release site had been used, then injuries that may have occurred to test fish as they exited the orifice could not have been distinguished from injuries that may have occurred in the new part of the bypass system.

We also considered releasing test fish near the tainter gate at the beginning of the elevated flume. However, because of the velocities present in the flume (30 fps), we believed that test fish would be carried through the elevated flume before they were distributed in the water column as the run-of-river fish were and thus would not be representative of the conditions encountered by run-of-river fish. Another concern was that the behavior of radio-tagged adult salmonids for the first 24 hours after release is not representative of subsequent behavior (Lowell Stuehrenberg, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA, Pers. commun., March 1999).

To evaluate this facility for the safe passage of adult salmonids, we recommend first monitoring the passage of run-of-river fish by diverting them into the sample tank and examining them for recent injury and/or descaling. If no problems are observed it can be assumed the facility passes adult salmonids safely. If injury or descaling problems are observed, a more extensive evaluation should be conducted. A possible approach would be to broaden the scope of the evaluation to include the gatewell environment by releasing fish into the gatewells. Test fish could also be released at the primary dewaterer to help determine if injury was occurring in the upper or middle sections of the facility.

OBJECTIVE 2: EVALUATE THE FACILITY FOR THE SAFE PASSAGE OF SALMON FRY

Approach

To determine whether mechanical or structural problems exist within the system that may adversely affect outmigrating fry-sized salmonids, three groups (n = 200 per group) of hatchery subyearling chinook salmon were released at the upstream end of the elevated flume and recaptured in the sample tank at the monitoring facility. The hatchery subyearling chinook salmon used in this evaluation were obtained from Little White Salmon National Fish Hatchery, Cook, Washington. Fish were transported to John Day Dam on 8 April and held in an unused tank in the sampling facility with flow-through river water. The first replicate was released on 9 April and the second and third replicates were released on 10 April.

The fish available for use in this evaluation were just at the upper limit of what is generally considered fry sized (60 mm). Fish used in the first replicate were measured upon recapture, and average length was found to be 61 mm (range 52-70 mm). To keep the average length of the release groups below 60 mm, fish were measured prior to release, and fish over 63 mm were returned to the holding tank. Average length for the second and third replicates was 59 mm, with a range for the second and third replicates of 46-63 and 51-62 mm, respectively. All fish of or under 63 mm were transferred to the release tank and held for marking.

Release groups of 200 fish were marked by staining them with Bismark Brown Y dye (Krcma et al. 1986). This was accomplished by first adding supplemental oxygen to the release tank via an air stone, and then shutting off the flow-through river water supply. The water level in the release tank was then reduced to an average depth of 20 cm (150 L) and the dye added to the tank. The dye was dissolved in 4 mL of alcohol and added at a concentration of 1 g dye to 70 L water. After 1 hour the flow-through river water was turned back on and the dye flushed from the tank. The supplemental oxygen was shut off, the air stone removed from the tank, and the water level returned to 60 cm (450 L). This technique provided a readily visible means of identifying test fish without the handling necessary to physically mark the fish.

Each release group was transported to the powerhouse intake deck and readied for release. When radio communication was received from smolt monitoring personnel that the facility sample rate had been changed to 100%, the release was made. Releases were made from the intake deck into the elevated flume in the area of the crest gate through a combination of 3-in flexible hose and PVC pipe. Once the fish were released and the tank flushed, personnel returned to the sampling facility to begin collecting the recaptured fish. Recaptured fish were enumerated and examined for injury before being placed in a holding tank. At the conclusion of the evaluation, all test fish were transported and released into Drano Lake, Washington, at the confluence of the Little White Salmon and Columbia Rivers.

Results and Discussion

All three release groups of subyearling chinook salmon passed quickly through the bypass system. The first fish from each release arrived in the sample tank about 5 minutes after being released. This is the approximate water particle travel time through this section of the bypass system.

All of the fish from the first two releases were recaptured in the first hour after release: fish arrived in the sample tank from about 5 minutes after release until nearly the end of the first hour after release. In the third release, 192 of the 200 fish were recaptured in the first hour, and 7 of the remaining 8 fish were recaptured in the second hour after release: the last fish was not recaptured. After the first hour of the third replicate, a visual inspection was made of the sanctuary area under the bars of the wetted separator. The approximate number of remaining test fish were observed holding in this area. Since this evaluation was conducted early in the spring outmigration, and few juvenile salmonids were present, the test fish may not have been pushed out of the sanctuary area by the arrival of additional fish into this area. None of the recaptured fish from any of the three releases showed descaling, nor were injuries noted in any recaptured fish.

CONCLUSIONS AND RECOMMENDATIONS

1. Juvenile salmon fry pass through the juvenile bypass system quickly and with no signs of injury or descaling.

2. Based on the fry evaluations conducted this year and the evaluations conducted in 1998 with yearling chinook salmon and steelhead, we conclude that the John Day Dam juvenile bypass system safely passes juvenile salmonids of all sizes.

3. If the facility is evaluated for the safe passage of adult salmonids, we recommend first monitoring the condition of run-of-river fallback fish. If a problem appears to exist with fallback fish, the scope of the evaluation could then be expanded to include the gatewells so they may be used as an upstream release point for test fish.

ACKNOWLEDGMENTS

We express our appreciation to our seasonal personnel for their interest and efforts during this study. We extend thanks to the Portland District COE personnel at John Day Dam, particularly Miroslaw Zyndol, fisheries research coordinator, and Robert Cordie, project biologist.

Thanks are also extended to Greg Kovalchuk, (Pacific States Marine Fisheries Commission) Smolt Monitoring Program project biologist. Special acknowledgment of William Myers, PSMFC Smolt Monitoring Program laboratory research mechanic, must also be made; his capable assistance, which began with set-up and continued throughout the study period, was greatly appreciated.

The assistance of William Ryan of our maintenance staff at the Pasco Research Station must also be recognized for his contribution toward the completion of this study.

REFERENCES

Absolon, R. F., D. A. Brege, B. P. Sandford, and D. B. Dey. 1999. Post-construction evaluation of the juvenile bypass system at John Day Dam, 1998. Report to U.S. Army Corps of Engineers, Contract W66QKZ80354028, 26 p. + Appendices. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Gessel, M. H., B. P. Sandford, and D. B. Dey. 1997. Post-construction evaluation of the juvenile salmonid bypass system at Ice Harbor Dam, 1996. Report to U.S. Army Corps of Engineers, Delivery Order E86960098, 14 p. + Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Krcma, R. F., D. A. Brege, and R. D. Ledgerwood. 1986. Evaluation of the rehabilitated juvenile salmonid collection and passage system at John Day Dam - 1985. Report to U.S. Army Corps of Engineers, Contract DACW57-H-0001, 25 p. + Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Marsh, D. M., B. H. Monk, B. P. Sandford, and G. M. Matthews. 1996a. Preliminary evaluation of the new juvenile collection, bypass, and sampling facilities at McNary Dam, 1994. Report to U.S. Army Corps of Engineers, Contract DACW68-84-H-0034, 39 p. + Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Marsh, D. M., B. P. Sandford, and G. M. Matthews. 1995. Preliminary evaluation of the new juvenile collection, bypass, and sampling facilities at Lower Monumental Dam, 1993. Report to U.S. Army Corps of Engineers, Contract DACW68-84-H-0034, 48 p. + Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Marsh, D. M., L. K. Timme, B. P. Sandford, S. Achord, and G. M. Matthews. 1996b. Preliminary evaluation of the new juvenile collection, bypass, and sampling facilities at Lower Monumental Dam, 1994. Report to U.S. Army Corps of Engineers, Contract DACW68-84-H-0034, 54 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Matthews, G. M. 1992. Potential of short-haul barging as a bypass release. Unpublished issue paper. 56 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Monk, B. H., B. P. Sandford, and J. G. Williams. 1992. Evaluation of the juvenile fish collection, transportation, and bypass facility at Little Goose Dam, 1990. Report to U.S. Army Corps of Engineers, Contract E86900057, 131 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)