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Post-construction evaluation of the new juvenile bypass system and guidance screen modifications at John Day Dam, 1998

*Fish Ecology
Division*

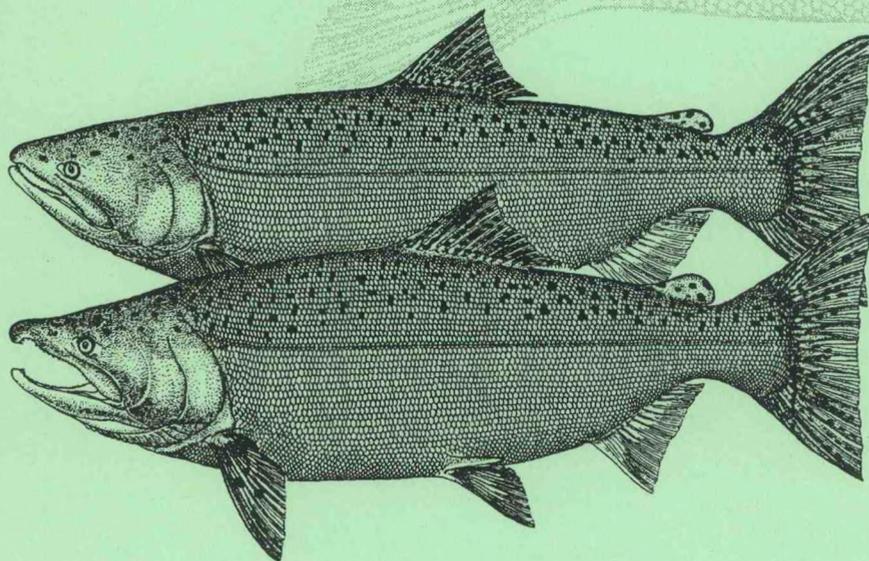
*Northwest Fisheries
Science Center*

*National Marine
Fisheries Service*

Seattle, Washington

by
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Benjamin P. Sandford,
and Douglas B. Dey

September 2000



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**POST-CONSTRUCTION EVALUATION OF THE NEW JUVENILE BYPASS SYSTEM
AND GUIDANCE SCREEN MODIFICATIONS AT JOHN DAY DAM, 1998**

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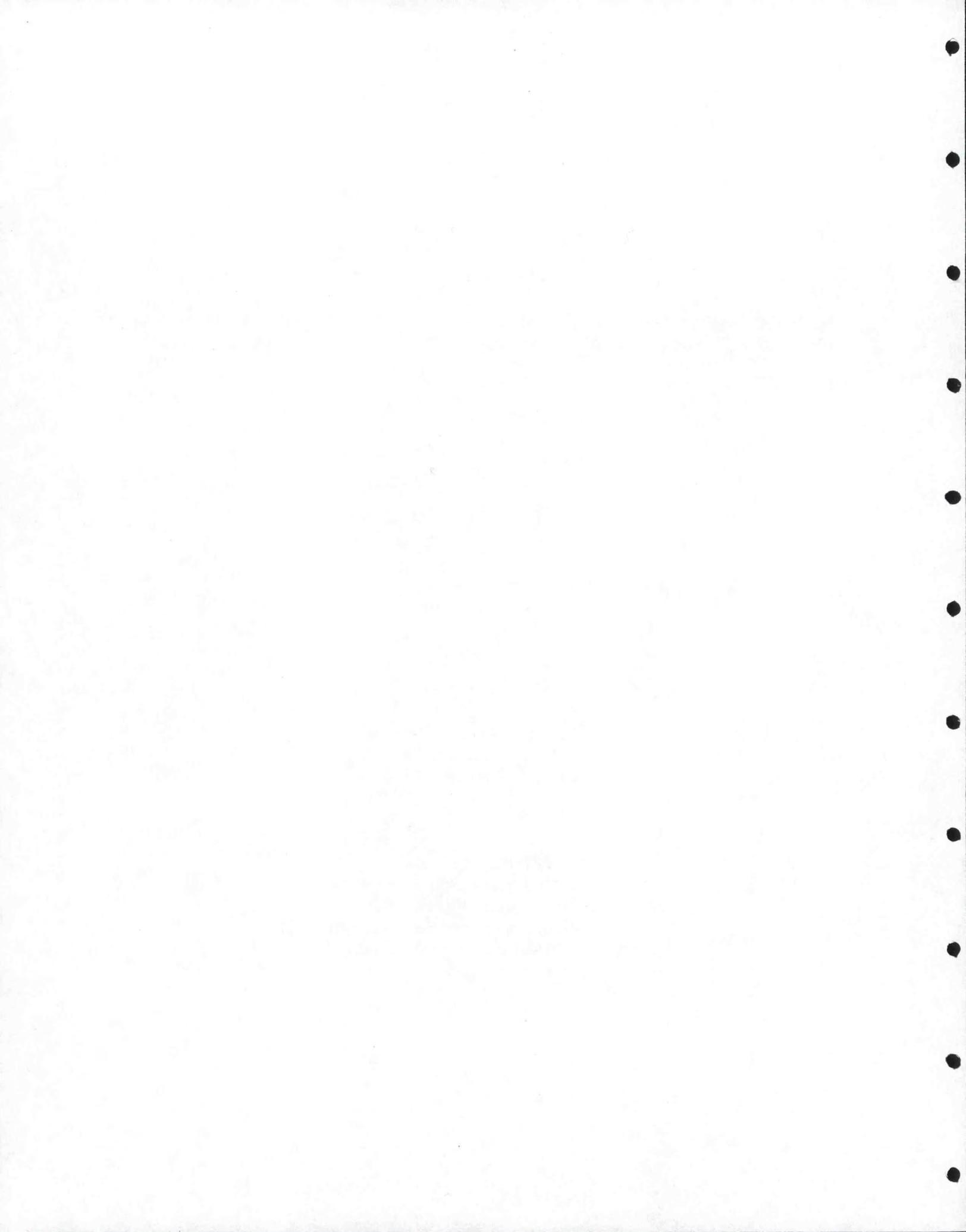
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EXECUTIVE SUMMARY

Modifications to the John Day Dam juvenile salmonid sampling facility and bypass system were completed and the system was 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 which have been constructed during the 1990s at Little Goose, Lower Monumental, Ice Harbor, and McNary Dams. The John Day facility does not have raceways to hold fish for transportation, but does include a hydraulic jump and a wetted separator which are unique to this project. We examined juvenile salmonids for descaling and gross external injuries, analyzed blood samples for evidence of stress build-up, and evaluated the efficiency of the sampling system.

Hatchery yearling chinook salmon and steelhead were released at several locations in the system, including the collection channel adjacent to Turbine Units 1, 9, and 15 on the powerhouse, at the crest gate, and at both the upstream and downstream ends of the primary dewatering structure. These fish were recaptured at the sampling facility and evaluated for signs of injury. Injury levels for both yearling chinook salmon and steelhead were low, and most could be attributed to the release hose used for the collection channel releases.

Blood plasma samples were collected from 180 run-of-river yearling chinook salmon and steelhead and were assayed for levels of cortisol, lactate, and glucose. Fish of both species were collected from the gatewell, the pre-separator, and the pre-sample tank. The levels of all three plasma indicators were similar to those found in other facility evaluations.

Yearling chinook salmon showed a significant increase in mean levels of both cortisol and glucose in the pre-separator and pre-sample tank samples as compared to the gateway samples. No differences were noted in lactate levels from any of the three sites for yearling chinook salmon.

Juvenile steelhead also showed a significant increase in cortisol levels when collected from the pre-separator and pre-sample tank locations compared to the gateway site. No differences were found in lactate or glucose levels between any of the three sample locations.

Evaluation of the efficiency of the sampling system was accomplished using in-river PIT-tagged fish. The percentage of PIT-tagged fish diverted into the smolt monitoring sample was calculated as the number of fish diverted into the sample divided by the total number of fish passing the facility for the time the sample was set at each sample rate. This was compared to the sample rate set at the sampling facility. For sample rates of 0.67, 1.33, 2.0, and 3.33% there was no statistical difference between observed and set rates. The observed rate was statistically higher than the set rate for 1.0%, while the observed rate was statistically much lower for both 5.0 and 10.0%.

Evaluation of the adult portion of the sampling facility could not be accomplished this year because of deficiencies in the release flumes for adult salmonids. Modifications and evaluation of this area are planned before the 1999 migration season.

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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, and at times this 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). 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 new juvenile bypass system at John Day Dam was completed in April 1998, at the beginning of the juvenile salmonid outmigration. The National Marine Fisheries Service (NMFS) was engaged by the U.S. Army Corps of Engineers (COE) to conduct an evaluation of the facilities prior to operation, to provide information on the effects of the new bypass and sampling facility on migrating salmonids.

The first major reconstruction of the John Day Dam bypass system occurred in 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.

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 present bypass system (Fig. 1).

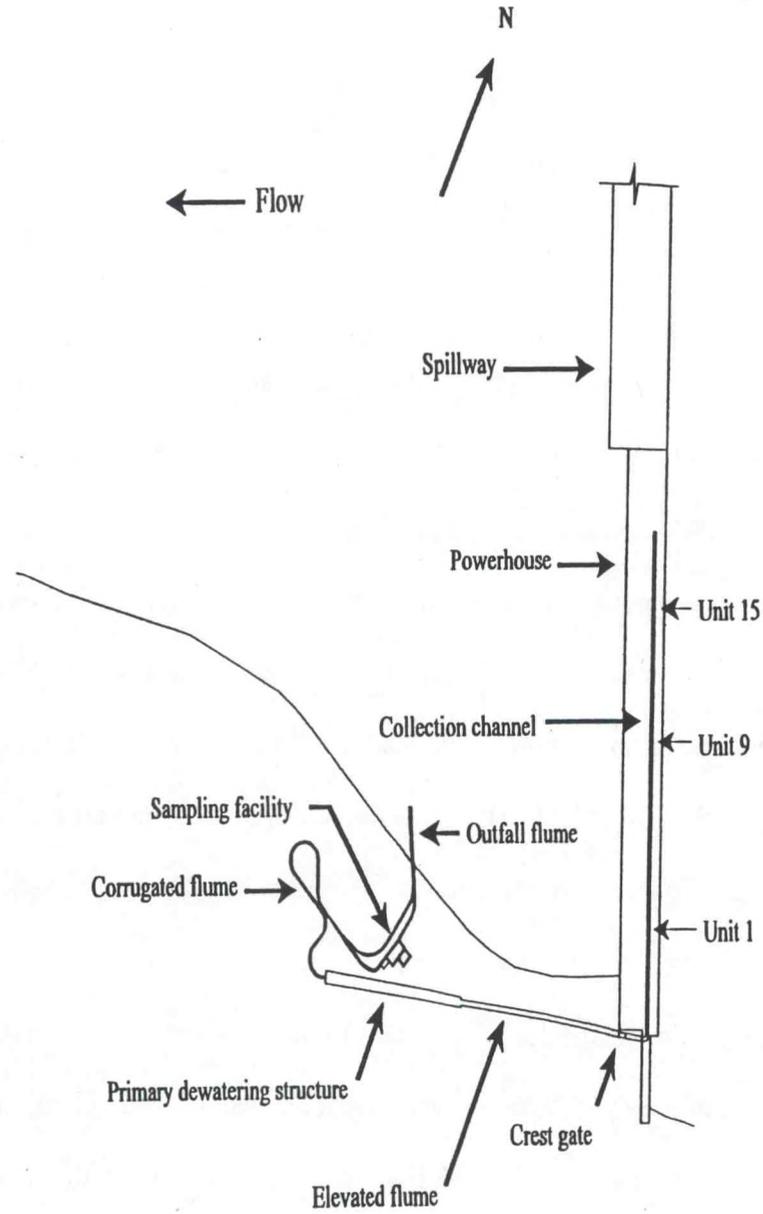


Figure 1. Overhead view of John Day Dam showing major components of the juvenile bypass system.

Flow in the collection channel runs from north to south (Turbine Unit 16 to Unit 1), turning 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 330 m before emerging at the river bank where the outfall flume extends 28 m out into the river.

The new bypass system begins at a crest gate that diverts flow from a sloping channel into an elevated flume, which runs 360 m to the primary dewatering structure (Fig. 1). At this point, excess water is removed and returned to the existing underground channel. The flow is reduced from about 14.16 m³/sec (500 ft³/sec) in the elevated flume to 0.85 m³/sec (30 ft³/sec) exiting the primary dewaterer.

The hydraulic jump is located at the primary dewatering section and functions to slow the velocity from over 9.1 m/s [30 feet per second (fps)] in the elevated flume to 1.2 m/s (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) corrugated flume 300 m 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 the secondary dewaterer.

The next component downstream from the secondary dewaterer is the wetted separator. Unlike other dams, which have wet separators with bars at varying widths to separate fish for transportation, the separator at John Day Dam has only one bar spacing (32 mm). The wetted separator has bars which are not submerged as they are in wet separators, and holes to direct streams of water vertically to keep the bars wet and to aid fish in passing 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 fallen through the separator bars go through a 25-cm pipe and round-bottom (25-cm diameter) flume

fitted with passive integrated transponder (PIT) tag coils and a 3-way rotating gate. This gate is normally in the center position, which bypasses fish to the river. The 3-way 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 separate-by-code flume to further separate samples of PIT-tagged fish.

In the fish sampling facility, there are two separation-by-code holding tanks and a smolt monitoring sample tank, all of which have anesthetizing chambers built into the tanks from which anesthetized fish flow by gravity to handling troughs. After handling, 10-cm pipes carry fish to recovery tanks, where, after recovery, fish are returned to the river via a 20-cm pipe. This pipe empties into the return channel and then into the outfall flume.

At the end of the wetted separator is a tray with a sloping floor which can be lifted out, turned 180 degrees and replaced to sample adult fish. This routes all large fish through a 36-cm pipe into the adult sample tank in the sampling facility. An anesthetizing tank is located near the end of the adult tank, as is a three-chambered recovery tank. Fish from the recovery tank are released via a combination of flumes back to the river.

The specific study objectives were to 1) evaluate the condition and survival of juvenile spring/summer chinook salmon and juvenile and adult steelhead after passage through the John Day bypass and sampling facility, and 2) evaluate the reliability and efficiency of the John Day sampling system.

OBJECTIVE 1: EVALUATE THE CONDITION AND SURVIVAL OF JUVENILE SPRING/SUMMER CHINOOK SALMON AND JUVENILE AND ADULT STEELHEAD AFTER PASSAGE THROUGH THE JOHN DAY BYPASS AND SAMPLING FACILITY

Approach

Juvenile Salmonid Descaling, Injury, and Mortality Evaluation

To determine if there were mechanical or structural problems within the system, we released groups of hatchery yearling chinook salmon (*O. tshawytscha*) and steelhead (*O. mykiss*) at different locations throughout the facility. Hatchery steelhead were obtained from Dworshak National Fish Hatchery and yearling chinook salmon from Spring Creek National Fish Hatchery. Fish were transported to John Day Dam in early April and held near the sampling facility in 1.3-m by 1.3-m by 6-m aluminum tanks with river water flow-through systems. Release groups of 200 fish of each species were marked with a partial caudal clip (either upper or lower) and a pectoral fin clip (either left or right) to provide enough clip combinations to minimize duplication of marks. Fish were marked a minimum of several hours before release to allow sufficient time to recover from the effects of anesthesia and to monitor for short-term handling mortality. Only uninjured, non-descaled fish were marked. The facility sample rate was then set at 100% to recapture as many of the marked fish as possible.

Releases of approximately 200 yearling chinook salmon were made into the collection channel through the air vents at Turbine Units 1, 9, and 15, into the elevated flume in the area of the crest gate, and at the downstream end of the primary dewaterer. Releases of steelhead were made through the air vents at Turbine Units 1, 9, and 15 and into the upstream and downstream ends of the primary dewaterer. Releases of fish into the collection channel were accomplished by placing a 10-cm hose through the air vent into the collection channel and connecting this hose

to the tank containing the release group, which had been transported to the powerhouse intake deck by truck. The release of yearling chinook salmon near the crest gate was made by carrying the marked fish in buckets (19-L capacity) from the intake deck to the release site. Fish releases at either end of the primary dewaterer were made by hoisting the fish tank (708-L capacity) from a truck up to the primary dewatering section and to the selected end of the dewaterer. Fish were then released directly from the tank. All fish were recovered at the sampling facility where they were examined for fin clips, descaling, and any other signs of physical injury. Standard descaling criteria were used for this evaluation (Ceballos et al. 1993).

Adult Salmonid Descaling, Injury, and Mortality Evaluation

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 marked, released into a gatewell, and recaptured at the sampling facility. Descaling, other injuries, and the time between release and recapture were to be noted. Numbers and injuries to incidental adult salmonids captured during this evaluation were also to be noted.

Stress Evaluation

Stress and fatigue were measured by analyzing blood serum concentrations of cortisol, glucose, and lactic acid. Samples were collected from run-of-river yearling chinook salmon and steelhead. A total of 180 samples was collected for each species from these three bypass locations: 1) the gatewell, 2) just upstream from the wetted separator, and 3) just upstream from the sample tank. Because juvenile salmonids pass John Day Dam primarily in the evening (Brege et al. 1996), samples were collected at that time to maximize the probability that collected fish had recently entered the facility and had not spent an extended length of time in the facility.

Samples for both yearling chinook salmon and steelhead were collected between 27 May and 3 June.

Gatewell fish were collected from Gatewell Slots 8A and 8B using a dipbasket as described by Swan et al. (1979). Fish needed for blood sampling were immediately placed in a 200-mg/L solution of MS-222. All other fish were released into the bypass channel. Fish sampled from both the separator and sample tank locations were collected using a hand dip-net and immediately placed in the 200-mg/L MS-222 solution. This procedure does not significantly alter any of the blood indices being measured (Black and Conner 1964, Strange and Schreck 1978).

Immediately after gilling activity ceased, the caudal peduncle was severed and blood was collected with a 0.25-mL ammonium-heparinized capillary tube. Blood samples were then centrifuged, and the plasma decanted into numbered vials and frozen. Analysis of blood samples was done at the Oregon Cooperative Fisheries Research Unit, Oregon State University. Thawed plasma was assayed for cortisol using a radioimmunoassay, for glucose using the σ -toluidine method, and for lactate using a fluorimetric enzyme reaction (Barton et al. 1986, Barton and Schreck 1987). Sample means were analyzed by randomized block analysis of variance (RBANOVA) with each replicate considered a block. Significant changes between locations were then examined with Fisher's Protected Least Significant Difference (FPLSD) multiple comparisons technique (Peterson 1985).

Results and Discussion

Juvenile Salmonid Descaling, Injury, and Mortality Evaluation

The initial releases of yearling chinook salmon were made on 8 April, when the facility was re-watered for the spring outmigration. Releases of chinook salmon were also made on 9 and 17 April. We were able to recapture 96% of the released fish. Injuries and mortality rates were low for all release sites (Table 1). Of the mortalities and injuries that were seen, most occurred in the releases made into the collection channel at Turbine Unit 9. We believe these were due to a problem with the release method at this location. The collection channel at John Day Dam is a closed channel which was mined out of the dam during the 1984-86 bypass construction (Krcma et al. 1986). This makes it impossible to control the far end of the release hose when it is lowered into the channel through the air vent. Therefore, the hose end could move in the current, possibly directing the fish toward the channel wall.

Yearling chinook salmon released at Turbine Unit 15 (upstream from Unit 9) had very low injury rates and no mortality, which also supports the conclusion that injuries in the Unit 9 release were due to the release at that location. In addition, the run-of-river juvenile salmonids being examined at the smolt monitoring facility did not exhibit the injuries we were seeing. These injuries were almost exclusively what is commonly called pop-eye, and were most frequently seen on the right side. The only other mortality, and most of the injuries, resulted after the second release into the collection channel at Turbine Unit 1. We also attribute these injuries to the release method. The first release at that location showed no injuries or mortality. The chinook salmon release made in the area of the crest gate had a low injury rate (0.5%) and no mortality, which would indicate that the hydraulic jump was not causing the injuries seen in

Table 1. Fish condition data for marked hatchery yearling chinook salmon released during the evaluation of the bypass system at John Day Dam, April 1998.

Date	Number released	Recaptured (%)	Mortality (%)	Descaling (%)	Eye/Head Injury (%)
<u>Turbine Unit 1 collection channel</u>					
4/8/98	200	99	0.0	0.0	0.0
4/9/98	200	95	0.5	0.0	2.0
<u>Turbine Unit 9 collection channel</u>					
4/8/98	204	100	1.5	0.0	0.0
4/9/98	200	91	1.5	0.0	0.5
<u>Turbine Unit 15 collection channel</u>					
4/9/98	201	91	0.0	0.0	0.5
<u>Elevated flume near crest gate</u>					
4/17/98	198	98	0.0	0.0	0.5
<u>Corrugated flume downstream from primary dewatering structure</u>					
4/17/98	200	100	0.0	0.0	0.0

fish released into the collection channel. The last release of chinook salmon was made at the downstream end of the primary dewaterer, at the upper end of the corrugated flume. There were no injuries or mortality associated with this release.

The time it took chinook salmon to travel from release locations to the sampling facility was only a few hours, and the vast majority arrived at the sampling facility within 2 hours of release (Table 2). Because of intermittent examination of recaptured fish at the smolt monitoring facility, precise travel time estimations were not possible. Data from the release made in the area of the crest gate appeared to show that fish remained there for several hours, but this delay was actually due to fish being allowed to collect for several hours in the afternoon without being examined because the smolt monitoring facility was not staffed at that time. To a lesser degree this also occurred with the second release at Turbine Unit 1 (release at 1335 h) and the release at Turbine Unit 15.

Marked hatchery steelhead were initially released on 11 April with additional releases on 13 and 14 April. Due to the number of outmigrating juvenile salmonids in the river, we were able to recapture only 70% of released steelhead. The facility sample rate was set at 100% for as long as possible after a release, but with the holding behavior exhibited by steelhead, it was not possible to recapture all of the released fish without impacting an excessive number of in-river fish.

Similar to results for yearling chinook salmon, injury and mortality rates for steelhead were very low (Table 3). All of the injuries and mortalities occurred in the release made into the collection channel adjacent to Turbine Unit 1. We again attribute this to the release hose, since no injuries were observed in steelhead released upstream from this location, and little or no injury or mortality were seen at the smolt monitoring facility during this time.

Table 2. Number of fish and recapture timing data for hatchery yearling chinook salmon and steelhead released to evaluate the new juvenile bypass system at John Day Dam, April 1998.

Yearling chinook salmon							
Release location	Collection channel adjacent to					Near the crest gate	Corrugated flume
	Unit 1	Unit 1	Unit 9	Unit 9	Unit 15		
Release time	1620	1335	1830	1230	1305	1010	1335
No. of fish released	200	200	204	200	201	198	200
Elapsed time (hrs)	Number of fish recaptured						
	Unit 1	Unit 1	Unit 9	Unit 9	Unit 15	Near the crest gate	Corrugated flume
1	175	147			111	8	195
2			181	155			2
3			18				2
4	23		1				
5						183	
6		40	1			3	
7		1			59		
8			2	11	3		
9			1	8			
≥10		1		7	10		
Steelhead							
Release location	Collection channel adjacent to			Upstream end of the primary dewaterer	Corrugated flume		
	Unit 1	Unit 9	Unit 15				
Release time	0855	1030	0930	134	1145		
No. of fish released	200	200	200	151	200		
Elapsed time (hrs)	Number of fish recaptured						
	Unit 1	Unit 9	Unit 15	Upstream end of the primary dewaterer	Corrugated flume		
2				47	190		
5	96	66	38	27	8		
10	6	20		4			
20			75				
30		2		5			
40	2		14				
50	1	1		1			
60	12	23	4	1			
70							
80				3			
90	6		2				
≥100	2	1	4	1			

Table 3. Fish condition data for marked hatchery steelhead released during the evaluation of the bypass system at John Day Dam, April 1998.

Date	Number released	Recaptured (%)	Mortality (%)	Descaling (%)	Eye/head injury (%)
<u>Turbine Unit 1 collection channel</u>					
4/11/98	200	63	1.5	0.0	1.0
<u>Turbine Unit 9 collection channel</u>					
4/11/98	200	57	0.0	0.0	0.0
<u>Turbine Unit 15 collection channel</u>					
4/13/98	200	69	0.0	0.0	0.0
<u>Elevated flume at upstream end of primary dewatering structure</u>					
4/14/98	151	89	0.0	0.0	0.0
<u>Corrugated flume at downstream end of primary dewatering structure</u>					
4/14/98	200	99	0.0	0.0	0.0

Steelhead tended to hold in the system much longer than chinook salmon. While most of the chinook salmon were recaptured in the first 2 hours after release, less than half of the steelhead were recaptured within 5 hours of release, and several were recaptured more than 100 hours after release (Table 2). Most holding occurred in the area of the primary dewatering structure. Steelhead released below this area passed to the sampling facility within a few hours. Fish released at the upper end of the primary dewatering structure and in the collection channel took much longer to pass through the system.

The water velocity in the area of the primary dewatering structure is slowed by the hydraulic jump from over 9.1 m/s (30 fps) in the elevated flume to 1.2 m/s (4 fps) at the exit of the primary dewaterer. There is an area in the primary dewaterer adjacent to weir gates 19-20 where the water velocity drops to about 0.9 m/s (3 fps). Attempts were made in October 1998 to adjust the weir gates to increase water velocities in this area, but they were only partially successful. The water velocity was increased to 1.2 m/s (4 fps), but to accomplish this the weir gates had to be taken off computer control and adjusted manually. When the weir gates were returned to computer control they compensated for adjustments made to the manually controlled gates, negating improvements in water velocity. Hydraulic modeling work is planned to determine the weir gate settings needed to maintain 1.2 m/s (4 fps) throughout the primary dewaterer, and the computer will be reprogrammed to operate at the new settings (Mike Langeslay, U. S. Army Corps of Engineers, Bonneville Fisheries Field Unit, Cascade Locks, OR, Pers. commun., October 1998). It is hoped that this will reduce the length of time fish hold in this area.

Releases made into the three collection channel locations had similar elapsed times and recovery percentages, indicating little holding in the collection channel.

Fish (mostly steelhead) were observed holding along the inside corner of the elevated flume where it turns before entering the secondary dewaterer/separator structure. It is not known how long individual fish remain in this area before passing onto the separator. Fish were also observed holding under the separator bars. This is a small area, and it is believed that low numbers of fish hold in this area a relatively short time.

Adult Salmonid Descaling, Injury, and Mortality Evaluation

We were unable to complete the adult salmonid evaluation of the facility this year. There were fishery agency concerns with the design of the adult salmonid release flumes. These concerns were that the flumes are flat bottomed, the sides are too low, flumes are uncovered, and the slope of the flume where it leaves the sampling facility is initially too flat. This area is being redesigned to correct these problems.

Another area of the adult system that may be redesigned is at the downstream end of the separator. Adult salmonids (and any other large fish) pass across the separator bars and fall about 25 cm into a trough where they exit at a right angle to the separator into the bypass pipe. Under consideration is whether the large-fish exit can be rerouted to allow adults to exit the separator area in line with the separator instead of at right angles to it. It is hoped that both of these modifications can be made before the 1999 outmigration. NMFS has proposed to evaluate the adult system in 1999.

Stress Evaluation

Means of the replicate group medians for cortisol, lactate, and glucose levels for the three sample locations at John Day Dam are shown in Table 4, and results of the random block analysis of variance are shown in Table 5. Appendix Table A summarizes the individual

Table 4. Mean cortisol, lactate, and glucose levels for yearling chinook salmon and steelhead at sample locations in the juvenile bypass system at John Day Dam, May-June 1998.

	Gatewell	Pre-separator	Pre-sample tank
Yearling chinook salmon			
Cortisol (ng/mL)	103.2	151.6	160.1
Lactate (mg/dL)	91.2	82.6	85.7
Glucose (mg/dL)	63.2	76.2	73.2
Steelhead			
Cortisol (ng/mL)	98.8	192.7	179.0
Lactate (mg/dL)	98.6	81.4	89.3
Glucose (mg/dL)	88.2	105.5	107.5

Table 5. Results of randomized block analysis of variance comparing mean cortisol, lactate, and glucose levels for yearling chinook salmon and steelhead at locations in the juvenile bypass system at John Day Dam, May-June 1998.

	F	P	FPLSD ^a
Yearling chinook salmon			
Cortisol	12.10	0.008	25.3 (ng/mL)
Lactate	1.02	0.415	
Glucose	8.22	0.019	13.6 (mg/dL)
Steelhead			
Cortisol	8.78	0.017	52.1 (ng/mL)
Lactate	1.44	0.309	
Glucose	2.93	0.129	

^a Fisher's Protected Least Significant Difference; only shown for significant F-tests.

sample values for all sacrificed fish. Medians of replicate groups were used in the analysis (rather than means) to minimize the influence of samples with values far different from the mean.

Yearling chinook salmon blood plasma analyses showed that cortisol levels were significantly higher in both the pre-separator and pre-sample tank samples than in the gateway samples. No difference was seen between cortisol levels from the pre-separator and pre-sample tank locations. The range of cortisol levels was similar to that noted at Ice Harbor, Lower Monumental, and Little Goose Dams during the facility evaluations of those projects (Monk et al. 1992, Marsh et al. 1995, Gessel et al. 1997). Because cortisol levels at the pre-separator and pre-sample tank were similar to those noted at other projects, we feel the hydraulic jump in the John Day Dam bypass does not increase stress levels more than is seen at bypass facilities without a hydraulic jump.

Lactate levels for yearling chinook salmon were not significantly different among any of the three sample locations. These levels were also similar to results obtained during other bypass facility evaluations.

Glucose levels for yearling chinook salmon were significantly higher at the pre-separator and pre-sample tank locations than at the gateway location, suggesting an increase in stress levels between these locations. There was no difference between the pre-separator and pre-sample tank locations. The glucose levels were lower than those noted at other facility evaluations.

Cortisol levels for steelhead were also significantly higher at the pre-separator and pre-sample tank locations compared to the gateway, and no difference was noted between the pre-separator and pre-sample tank locations. Cortisol levels were higher than those that have been recorded during most other bypass facility evaluations, though the levels we observed were

similar to those seen at Ice Harbor Dam (Gessel et al. 1997). This is not unexpected given the holding that was noted during the release of steelhead in the injury/descaling portion of the study. Steelhead holding was also noted in the evaluation of the Ice Harbor facility (Gessel et al. 1997).

No significant differences were detected among any of the three sites sampled for lactate levels in steelhead. Lactate levels of fish sampled from the John Day gatewells were higher than observed at Ice Harbor (Gessel et al. 1997), Lower Monumental (Marsh et al. 1995), Little Goose (Monk et al. 1992), and McNary Dams (Marsh et al. 1996a). However, lactate levels of fish sampled from the John Day pre-separator and pre-sample tank were similar to those observed at these other facilities.

No significant differences were detected between any of the three sites sampled for glucose levels in steelhead. The glucose levels were lower than those noted in facility evaluations at Ice Harbor, McNary, Lower Monumental, and Little Goose Dams (Gessel et al. 1997; Marsh et al. 1995, 1996a; Monk et al. 1992). While no significant differences among the sample sites at John Day Dam were noted, the trend was for the sampled glucose levels to increase from the gatewell to the pre-separator and again to the pre-sample tank. This trend has only been seen before at Lower Monumental Dam. At Ice Harbor and Little Goose Dams, the trend was for glucose levels to decrease as fish passed through the facilities, while at McNary Dam glucose levels dropped as fish traveled from gatewell to pre-separator, but increased again at the 0-hour raceway sample.

There was a significant difference in cortisol levels between one bypass location and another for both yearling chinook salmon and steelhead, and also in glucose levels between locations for yearling chinook salmon. However, these levels were similar to the levels noted

during other facility evaluations. It must also be recognized that differences in blood plasma indices recorded in different years and at different hydroelectric projects at least in part can be attributed to typical stock and year-to-year variations.

OBJECTIVE 2: EVALUATE THE RELIABILITY AND EFFICIENCY OF THE SAMPLING SYSTEM AT THE BYPASS/SAMPLING FACILITY

Approach

The sampling system at John Day Dam is regulated with a programmable logic controller (PLC) which allows adjustment of the sample rate on an hourly basis if necessary. The evaluation of this system was conducted using in-river PIT-tagged fish. This allowed us to collect a large amount of data without handling any fish or interfering with the operations of the smolt monitoring operation.

The time periods when the PLC was set at various sample rates were obtained from NMFS Smolt Monitoring data. Records of PIT-tagged fish passing through the facility during these time periods were obtained from the Pit Tag Information System (PITAGIS 1998) database. The percentage of fish diverted was calculated as the number of PIT-tagged fish diverted into the sample divided by the number of PIT-tagged fish passing the project at each sample rate. This observed percentage was then compared to the sample rate set at the facility.

Results and Discussion

The comparison between the observed sample rate and the sample rate set by the PLC at the facility is shown in Table 6. The PIT-tag records from 17 April through 13 June were used for this analysis, which assessed sample rates for a total of 22,189 fish. The total time during which each sample rate was set is included in the analysis except for the time for sample rate 0.67%, for which there were much more available data (85 of 666 hours used in the analysis, or 13%), and sample rate 6.67%, which was used only 1 hour during the test period.

Table 6. Results of sample rate efficiency evaluation using in-river PIT-tagged fish passing through the John Day Dam bypass facility, 1998.

Set sample rate (%)	Observed rate (%)	Total no. of fish	Hours at set rate	95% confidence interval	
				lower	upper
0.67	0.56	5,859	85	0.41	0.70
*1.0	1.46	4,596	70	1.10	1.80
1.33	1.38	2,388	66	1.10	1.73
2.0	1.57	3,768	60	1.09	2.03
3.33	2.77	2,965	179	2.18	3.42
*5.0	2.59	2,159	69	1.62	3.71
*10.0	3.52	454	133	1.51	6.40

* Indicates that the pre-set sample rate was outside the 95% confidence interval.

At sample rates 0.67, 1.33, 2.0, and 3.33% the pre-set sample rate fell within the 95% confidence intervals of the observed rate. At the rate of 1.0%, the observed sample rate was significantly higher than the set sample rate, while at rates of 5.0 and 10.0%, the observed sample rate was significantly lower than the set sample rate.

We believe the much lower observed rates at the 5.0 and 10.0% sampling rates were due to the clumping behavior exhibited by migrating juvenile salmonids at low densities. There are two areas where we observed fish holding below the primary dewaterer which would allow fish to accumulate in groups before passing through the system. These areas are the curve in the corrugated flume just upstream from the secondary dewaterer/separator structure and below the separator bars. This holding behavior was also noticed during the evaluation of the large-fish flume at a sample rate of 4.0% at McNary Dam (Marsh et al. 1996a).

CONCLUSIONS

- 1) No evidence of a descaling problem was observed at the John Day Dam juvenile salmonid sampling facility for either hatchery yearling chinook salmon or steelhead.
- 2) For yearling chinook salmon, blood-plasma cortisol and glucose levels were significantly higher in fish collected from the pre-separator and pre-sample tank locations than in fish collected from the gateway sampling site.
- 3) For yearling chinook salmon, there was no significant difference in lactate levels in fish collected from any of the three sample sites.
- 4) For juvenile steelhead, cortisol levels were significantly higher in fish collected from the pre-separator and pre-sample tank locations than in fish collected from the gateway site.
- 5) For juvenile steelhead there was no significant difference in the lactate or glucose levels in fish collected from any of the three sample sites.
- 6) The John Day Dam juvenile salmonid sampling system sample rates of 0.67, 1.33, 2.0, and 3.33% provided samples that were relatively accurate. Sample rates of 1.0, 5.0, and 10.0% were significantly higher or lower than the observed rates.
- 7) The adult salmonid sampling system was not operational in 1998. This system should be evaluated when it becomes operational.

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APPENDIX A

Data Tables

Appendix Table A. Plasma cortisol, lactate, and glucose levels for migrating yearling chinook salmon and steelhead collected at the new juvenile salmonid bypass system at John Day Dam, 27 May - 3 June 1998.

Sample site	Yearling chinook			Steelhead			
	Cortisol (ng/mL)	Lactate (mg/dL)	Glucose (mg/dL)	Cortisol (ng/mL)	Lactate (mg/dL)	Glucose (mg/dL)	
First Replicate							
Gatewell	84.2	82.5	56.2	114.4	98.4	116.1	
	188.4	66.6	95.7	210.4	28.0	81.6	
	116.6	108.1	314.0	60.3	70.6	24.2	
	122.2	38.6	73.7	171.0	84.8	82.3	
	131.3	77.4	13.8	94.1	105.7	119.2	
	121.7	68.9	57.5	114.1	50.6	32.6	
	136.3	47.2	54.0	48.1	109.1	58.3	
	142.6	101.8	83.6	82.9	82.1	110.4	
	77.5	68.5	34.7	18.0	149.3	27.9	
	53.1	86.0	82.2	140.8	85.7	120.3	
	33.9	93.4	87.6	108.9	120.7	69.5	
	53.0	70.3	71.2	111.4	113.9	97.1	
	50.4	70.3	77.2	63.5	123.5	53.2	
	78.1	108.2	49.9	202.3	180.0	90.5	
	54.4	90.0	70.0	106.8	123.6	31.2	
	Pre-separator	131.3	64.0	82.5	211.4	78.5	97.3
		139.2	69.3	69.8	145.9	32.8	121.7
164.1		69.3	74.7	275.0	81.7	48.9	
191.1		86.9	64.3	168.9	76.9	82.3	
226.8		78.8	94.2	227.7	62.6	67.6	
202.5		123.3	97.1	130.8	59.7	43.7	
99.3		68.8	71.3	275.9	90.9	75.9	
86.9		45.7	77.6	123.1	101.7	57.1	
120.4		62.7	78.0	180.5	91.1	103.7	
126.9		95.8	74.7	139.0	51.6	89.6	
139.6		87.2	69.3	221.3	79.0	98.2	
145.1		110.3	46.3	135.9	148.0	73.2	
122.1		100.9	37.7	161.4	109.8	182.1	
48.6		69.8	95.2	138.9	68.9	64.8	
156.1		99.1	83.2	147.4	99.6	129.0	
Pre-sample tank	305.5	102.5	90.5	64.1	64.5	89.6	
	134.5	67.7	67.6	180.6	69.1	93.5	
	186.0	68.6	84.4	175.5	63.0	70.6	
	176.4	85.8	88.8	188.4	64.1	84.5	
	153.9	51.9	75.9	263.9	119.6	93.6	
	198.9	76.1	108.9	223.4	204.9	333.6	
	143.5	97.8	110.5	167.8	29.8	104.2	
	172.9	89.7	79.7	276.3	65.7	102.0	
	169.0	72.6	96.9	154.4	71.1	75.0	
	197.7	96.3	82.7	142.5	59.7	99.5	
	239.2	61.8	76.0	282.7	56.3	112.9	
	182.4	118.4	77.6	192.7	77.2	85.5	
	153.3	123.3	38.3	183.2	48.7	98.8	
	125.8	87.8	47.2	201.6	58.0	115.3	
	289.5	139.0	23.2	233.7	63.8	97.3	

Appendix Table A. Continued.

Sample Site	Yearling chinook			Steelhead			
	Cortisol (ng/mL)	Lactate (mg/dL)	Glucose (mg/dL)	Cortisol (ng/mL)	Lactate (mg/dL)	Glucose (mg/dL)	
Second Replicate							
Gatewell	86.8	80.5	24.6	135.8	183.4	48.7	
	163.4	115.9	106.7	73.8	122.6	143.4	
	146.1	86.9	38.6	91.8	160.9	91.7	
	81.5	94.3	29.8	132.7	148.5	106.9	
	123.8	91.1	52.7	125.4	130.4	51.5	
	93.0	82.9	33.0	181.1	107.0	101.3	
	91.4	111.1	64.8	172.4	125.7	44.7	
	96.3	134.9	55.4	67.6	155.3	67.7	
	99.1	90.3	31.9	71.1	68.5	39.5	
	219.3	105.3	19.8	84.2	134.6	47.5	
	76.3	99.0	43.9	87.9	125.8	34.1	
	132.4	68.1	80.2	163.3	124.3	99.7	
	124.0	74.4	27.1	138.7	162.9	48.2	
	78.2	68.3	38.7	161.7	44.9	129.4	
	105.6	61.0	85.1	210.6	39.1	90.5	
	Pre-separator	167.9	61.5	83.4	327.4	57.9	331.8
		182.5	63.9	96.5	218.4	39.3	80.9
		238.8	85.0	90.4	316.6	89.0	258.5
		171.0	89.9	71.8	199.1	53.6	128.3
		204.9	55.1	73.2	206.4	62.5	97.9
213.5		86.0	63.8	231.7	45.1	53.2	
149.0		80.0	92.1	216.4	44.6	164.3	
319.7		146.0	228.6	174.4	139.3	106.7	
135.5		63.0	72.7	199.3	79.8	128.2	
159.4		82.9	78.8	250.4	47.9	99.7	
173.7		52.8	87.6	211.7	109.3	107.6	
147.4		70.8	69.8	211.3	77.3	69.2	
124.4		41.8	82.2	63.5	125.9	79.3	
133.1		69.3	92.6	243.1	105.8	62.4	
128.1		119.7	69.0	210.9	70.0	53.1	
Pre-sample tank		12.7	61.7	77.6	151.5	74.3	116.1
		300.4	47.2	96.0	109.6	94.3	61.3
	155.5	57.3	57.3	175.5	215.1	386.2	
	188.2	65.4	90.1	169.3	124.6	76.0	
	166.3	94.5	65.7	209.7	124.9	84.4	
	116.0	91.7	50.7	82.9	133.7	117.8	
	196.7	50.9	113.8	144.8	84.4	88.1	
	155.4	88.8	80.2	135.6	105.6	75.0	
	143.1	105.9	62.9	85.1	144.3	92.2	
	112.0	119.3	47.0	153.6	155.0	73.5	
	163.9	76.9	84.4	137.5	186.2	35.6	
	169.9	57.1	79.3	99.2	101.9	115.7	
	169.0	110.5	68.5	135.3	105.6	95.6	
	120.7	105.0	47.5	132.2	106.2	152.2	
	92.2	96.9	73.5	119.4	110.3	74.6	

Appendix Table A. Continued.

Sample Site	Yearling chinook			Steelhead			
	Cortisol (ng/mL)	Lactate (mg/dL)	Glucose (mg/dL)	Cortisol (ng/mL)	Lactate (mg/dL)	Glucose (mg/dL)	
Third Replicate							
Gatewell	179.7	62.7	73.1	59.9	52.9	97.3	
	111.6	81.6	86.3	65.3	39.9	107.3	
	146.5	133.0	49.7	85.1	52.9	92.6	
	114.3	66.0	59.4	93.7	47.9	72.0	
	82.5	77.2	47.4	84.3	48.9	110.2	
	121.1	65.5	54.8	138.6	97.7	233.9	
	42.2	120.0	64.0	56.6	51.6	85.8	
	124.3	75.8	51.9	44.6	56.9	117.7	
	70.7	96.4	55.7	21.1	90.7	105.9	
	95.6	65.8	35.4	69.6	60.7	100.7	
	149.5	93.6	57.7	19.8	91.9	82.5	
	110.8	115.2	31.6	90.1	76.7	118.0	
	141.0	89.6	34.1	22.0	85.2	143.7	
	101.2	94.4	66.4	94.5	99.1	54.9	
	107.6	78.3	54.0	142.2	66.3	89.2	
	Pre-separator	180.4	43.2	88.0	204.2	41.7	108.2
		123.6	42.7	80.1	174.5	82.9	112.9
144.9		89.3	110.6	218.8	61.4	116.1	
171.0		125.4	119.7	166.2	54.1	111.2	
153.8		48.4	80.2	198.5	81.0	114.9	
155.3		137.5	51.9	228.8	65.0	110.9	
155.9		91.5	58.2	236.5	67.5	102.5	
105.2		67.4	96.7	58.1	44.4	78.0	
121.7		82.9	36.3	243.7	67.0	110.6	
127.3		105.8	49.9	196.1	45.5	90.5	
136.5		147.4	62.2	215.9	74.5	139.0	
107.6		82.3	64.4	269.7	114.9	86.4	
125.8		136.8	75.1	215.3	60.8	96.5	
98.9		169.6	88.0	148.5	85.9	89.6	
60.9		63.5	61.5	145.9	144.4	164.7	
Pre-sample tank	181.6	135.5	13.8	265.2	71.3	135.8	
	323.8	60.6	131.1	267.7	63.5	92.8	
	154.2	68.6	88.0	156.6	71.6	120.5	
	123.9	70.6	51.5	242.1	69.8	114.7	
	186.6	69.0	77.2	151.5	96.2	69.0	
	189.6	70.6	78.3	223.2	54.9	143.4	
	190.5	93.5	67.1	241.6	98.5	93.3	
	144.5	62.2	71.4	273.2	110.7	65.6	
	132.4	72.2	92.4	193.4	69.7	86.0	
	136.9	142.7	39.9	153.7	54.1	92.1	
	106.5	78.8	115.8	128.6	27.9	86.2	
	154.3	89.2	53.6	113.5	40.5	110.9	
	164.6	75.2	54.5	266.8	116.8	88.6	
	153.4	96.4	50.7	205.0	147.4	107.6	
	170.4	94.4	73.5	269.1	64.2	96.1	

Appendix Table A. Continued.

Sample Site	Yearling chinook			Steelhead		
	Cortisol (ng/mL)	Lactate (mg/dL)	Glucose (mg/dL)	Cortisol (ng/mL)	Lactate (mg/dL)	Glucose (mg/dL)
Fourth Replicate						
Gatewell	73.6	98.6	41.2	167.9	91.1	116.9
	116.5	80.5	45.5	69.2	78.7	54.5
	56.7	124.8	78.8	41.3	117.2	123.5
	129.6	86.9	26.0	51.5	86.6	51.5
	96.6	81.9	36.3	29.2	129.1	72.5
	112.8	96.5	20.9	30.0	79.7	23.7
	70.9	77.3	33.5	46.0	92.5	106.5
	98.1	101.7	37.4	27.9	86.3	116.1
	86.3	79.3	31.2	60.3	76.0	34.5
	103.3	157.5	414.5	269.6	129.7	281.1
	100.7	82.5	47.5	119.4	213.7	252.9
	31.9	110.5	20.4	59.3	121.7	39.1
	50.0	142.3	114.1	261.7	62.5	45.5
	149.4	130.4	32.3	22.5	109.5	49.5
	58.5	166.1	35.2	42.0	61.0	55.1
	Pre-separator	148.4	60.8	53.1	141.9	47.2
158.5		59.1	84.4	160.5	59.6	116.1
147.8		69.1	103.3	77.6	45.4	87.6
130.4		67.1	75.1	175.6	128.8	110.2
146.1		85.0	54.5	198.1	86.8	123.5
115.7		54.1	62.3	199.8	92.0	105.8
235.9		106.4	61.2	171.7	58.8	97.9
157.0		78.3	55.0	119.8	85.0	93.8
161.6		40.7	85.7	217.8	159.3	108.9
100.8		62.6	76.4	194.9	124.6	147.5
227.4		68.8	67.6	231.5	148.0	110.6
154.2		93.9	92.8	315.5	91.5	89.2
109.4		63.7	49.8	130.9	88.0	49.5
204.3		72.8	48.0	135.5	114.8	98.5
183.7		140.8	11.6	206.8	85.0	97.9
Pre-sample tank		170.9	48.3	51.9	186.4	106.8
	130.2	109.9	51.0	187.7	79.8	106.7
	177.2	70.4	56.5	189.2	80.1	86.2
	85.7	68.9	61.1	180.5	70.0	97.5
	135.2	62.3	57.5	241.1	96.4	92.3
	85.7	84.5	76.0	93.2	66.9	84.8
	60.3	112.9	72.0	141.8	66.9	90.9
	142.8	61.9	82.4	178.9	74.5	147.9
	246.0	106.4	119.3	93.4	122.6	154.3
	136.4	83.6	49.9	151.8	61.9	129.4
	217.8	105.9	83.4	215.1	88.0	115.8
	53.7	83.0	74.1	167.5	121.1	126.4
	137.9	84.7	87.2	169.0	72.1	153.9
	114.6	99.2	79.2	189.3	64.5	73.2
	107.4	114.5	88.0	229.0	46.6	80.0

APPENDIX B

Fish Condition Evaluation of Modified Extended-length Submersible Bar Screen

INTRODUCTION

In the latter part of April 1998, the U.S. Army Corps of Engineers (COE) placed extended-length submersible bar screens (ESBS) in Turbine Unit 7 at John Day Dam. Soon after this unit was placed in service, an increase in descaling and mortality was noted at the smolt monitoring facility. Several dead juvenile salmonids were seen from the intake deck in Gatewell Slot 7C. A camera inspection of the orifice was made by COE project staff and no problems were seen, although several dead juvenile salmonids were observed. Turbine Unit 7 was taken out of service until the problem could be identified. The National Marine Fisheries Service (NMFS) was asked to evaluate the condition of juvenile salmonids in Turbine Unit 7.

The ESBSs evaluated by NMFS in 1996 were found to have descaling rates similar to those found with the existing standard-length submersible traveling screens (STSs) (Brege et al. 1997). However, these screens were prone to developing structural failures in the perforated plate panels due to harmonic vibration after being in service for relatively short times at the high turbine capacity 595 m³/sec flows at John Day Dam [about 21,000 cubic feet per second (cfs) at 150 megawatts (MW)]. In the winter of 1997-98, the COE modified one of the ESBSs with several different perforated plate configurations to test the harmonics developed by each. Another ESBS was modified to the configuration which showed the most promise of those tested on the multiple configuration ESBS. This modified screen, which was located in Slot 7C, was the one which was believed to be causing the injury/mortality problem (Robert L. Dach, Fisheries Biologist, COE Portland District, Portland, OR, Pers. commun., May 2, 1998). During the April 1998 tests, the 1996 prototype ESBS was located in Slot 7A and the multiple configuration ESBS was in Slot 7B.

Approach

To evaluate the fish condition in Turbine Unit 7, gatewell dipnetting was done on 1-3 May. Fish dipnetted from the gatewell slots of Turbine Unit 7 were compared to fish dipnetted from Slot 8C which contained an STS. The turbines at John Day Dam are normally run at about 150 megawatts (MW). For this evaluation, Turbine Unit 7 was brought on line at 100 MW and the orifices in all three gatewell slots were closed, as was the orifice in Slot 8C. All four gatewells were dipnetted to remove any residual fish. Gatewell 7C was dipnetted periodically to monitor fish condition and recruitment. This continued until a target number of 200 fish had been collected. At that time, the other selected gatewells were dipnetted until 200 fish were recruited in each of them. If the descaling rate with the modified ESBS did not exceed that in the control slot (STS) by 10% and did not exceed the mortality rate in the control slot by 5%, the load was increased and the test repeated using standard Fish Transportation Oversight Team descaling criteria (Ceballos et al. 1993). This procedure was repeated with the load at 130 MW and then at 150 MW.

Additional dipnetting was done on 5, 6, 9, 15, and 18 June to monitor the condition of migrating subyearling chinook salmon in Turbine Unit 7. The load on Turbine Unit 7 was maintained at 150 MW until just before dipnetting began, when the load was reduced to 100 MW.

Results and Discussion

Descaling and injury rates were low in all gateway slots. The detailed results are shown in Appendix Table B. The 1-3 May dipnetting effort resulted in descaling rates for yearling chinook salmon ranging from 0.0 to 4.1% for the gateways containing an ESBS. The rate for the 1996 prototype ESBS ranged from 0.0 to 4.1% and for the modified configuration screen from 1.1 to 2.3%. The descaling rate in the control slot was 1.0% on 2 May. The control slot was not dipnetted on 1 or 3 May: since descaling rates in the ESBS-equipped slots were so low, it was apparent that a descaling problem was not present, and it was not necessary to confirm this by dipnetting the control slot and thus handling more fish than necessary.

Results of the dipnetting conducted in June to monitor the condition of subyearling chinook salmon also showed no descaling problem in the gateway slots of Turbine Unit 7. Descaling rates ranged from 0.0 to 9.2% for the ESBS-equipped slots. The rate for the 1996 prototype screen was 0.0% for all 3 days this slot was dipnetted. The multiple configuration ESBS descaling rate ranged from 0.0 to 0.4% and the rate for the modified configuration ESBS ranged from 0.0 to 9.2% and averaged 3.0%. The 9.2% descaling rate occurred on 5 June which was the day with the lowest sample size ($n = 87$). There were 120 yearling chinook salmon collected from that gate slot on that day with a descaling rate of 0.8%. Numbers of other salmon species collected are presented in Appendix Table B, but are too low for meaningful evaluation.

Since no problem was found in the dipnetting efforts of 1-3 May, Turbine Unit 7 was returned to service. Smolt monitoring personnel were asked to note any subsequent increases in descaling or mortality, but no increase in injury or mortality was seen.

CONCLUSIONS

The dipnetting effort conducted periodically for over a month did not show any problem with any of the ESBS configurations tested. The cause of the injury and mortality observed at the smolt monitoring facility and in Gatewell 7C during the latter part of April 1998 was not determined.

REFERENCES

- Brege, D. A., R. F. Absolon, B. P. Sandford, and D. B. Dey. 1997. Studies to evaluate the effectiveness of extended-length screens at John Day Dam, 1996. Report to U.S. Army Corps of Engineers, Delivery Order E96960028, 22 p. + Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)
- Ceballos, J. R., S. W. Pettit, J. L. McKern, R. L. Boyce, and D. F. Hurson. 1993. Fish Transportation Oversight Team. Annual Report-FY 1992. Transportation operations on the Columbia and Snake Rivers. NOAA Tech. Memo. NMFS F/NWR-32. 75 p. + Appendices.

Appendix Table B. Results from descaling evaluation of modified extended-length submersible bar screen (ESBS) at John Day Dam, 1998 (Desc. = descals fish; STS = standard-length submersible traveling screen).

Unit 7, Slot A: ESBS (1996 prototype)

Test date	Load (MW)	Subyearling chinook		Yearling chinook		Steelhead		Coho		Sockeye		
		Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	
1 May	100	0	151	0	62	1	1.6	0	8	0	2	0.0
2 May	130	4	146	4	44	0	0.0	0	2	0	2	0.0
3 May	150	2	136	2	122	0	0.0	0	8	0	8	12.5
9 June	150	0	217	0	1	0	0.0	0	3	0	3	0.0
15 June	150	0	335	0	1	0	0.0	0	4	0	4	0.0
18 June	150	0	197	0	3	0	0.0	0	1	0	1	0.0

Unit 7, Slot B: ESBS (multiple configuration screen)

Test date	Load (MW)	Subyearling chinook		Yearling chinook		Steelhead		Coho		Sockeye		
		Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	
9 June	150	0	193	0	12	0	0.0	0	15	0	4	0.0
15 June	150	1	267	0	12	0	0.0	0	3	0	5	0.0

Unit 7, Slot C: ESBS (modified configuration screen)

Test date	Load (MW)	Subyearling chinook		Yearling chinook		Steelhead		Coho		Sockeye		
		Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	
1 May	100	0	1	1	94	1	1.1	0	85	0	1	100.0
2 May	130	3	128	3	128	0	2.3	0	70	0	3	0.0
3 May	150	1	96	1	96	3	1.0	2.9	103	1	2	50.0
5 June	150	8	87	1	120	0	0.8	0.0	44	4	31	2.6
6 June	150	5	273	0	18	0	0.0	0.0	7	0	3	0.0
9 June	150	0	91	0	9	0	0.0	0.0	10	1	4	0.0
15 June	150	6	183	0	8	0	0.0	0.0	3	0	5	0.0

Appendix Table B. Continued.

Unit 8, Slot C: STS															
Test date	Load (MW)	Subyearling chinook		Yearling chinook		Steelhead		Coho		Sockeye					
		Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	Desc.	Catch %	Desc.	Catch %				
2 May	120			2	195	1.0	0	47	0.0	0	7	0.0	0	9	0.0
5 June	150	0	38	0	44	0.0	0	2	0.0	0	16	0.0	0	15	0.0
6 June	150	2	195	1	43	2.3	0	6	0.0	0	13	0.0	0	15	0.0