Evaluation of extended-length bypass screens at John Day Dam, 1999

Fish Ecology Division

Northwest Fisheries Science Center

National Marine Fisheries Service

Seattle, Washington

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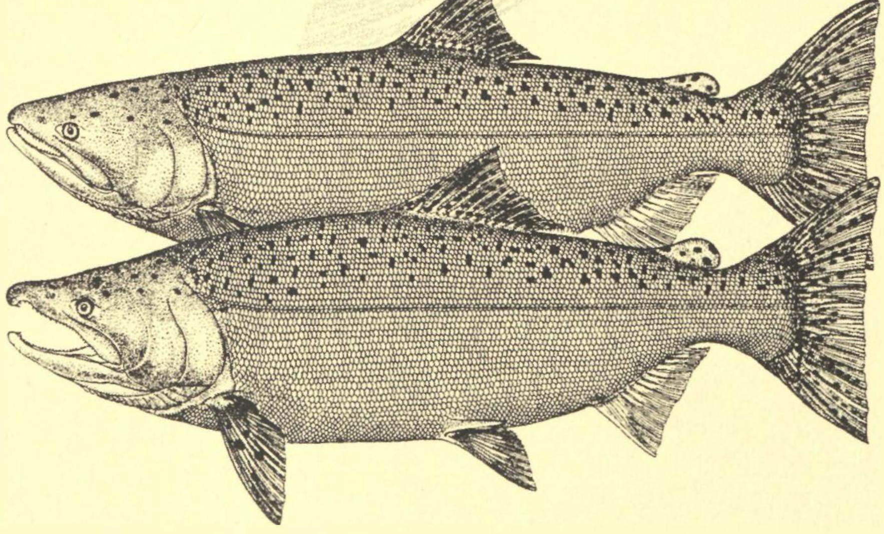
August 2001



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Report of research by

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EXECUTIVE SUMMARY

During the 1999 spring juvenile salmonid outmigration, we conducted fish guidance efficiency (FGE) tests, descaling evaluations, and orifice passage efficiency (OPE) tests at John Day Dam. FGE, descaling, and OPE tests were conducted in Turbine Unit 7 (Slot B) which was equipped with an extended-length submersible bar screen (ESBS) with modified perforated-plate panels and inlet flow vane. Descaling and OPE tests were also conducted in Turbine Unit 6 (Slot B) which was equipped with a standard-length submersible traveling screen (STS). In addition, a dip-basket efficiency/gatewell mortality test was conducted.

Mean FGEs (with 95% confidence intervals) for spring fish were as follows: yearling chinook salmon 80.3% (± 4.4%), steelhead 94.0% (± 3.8%), coho salmon 99.5% (± 1.2%), and sockeye salmon 75.4% (± 4.1%). Descaling during FGE tests was low throughout the spring season. Yearling chinook salmon descaling was 4.0 and 7.0% for the ESBS and STS, respectively.

Mean OPEs for yearling chinook salmon with the ESBS and the STS were 97.1 and 39.8%, respectively, with a statistically significant difference of 57.3% (± 11.3%) ($P < 0.05$).

Summer FGE/OPE tests on subyearling chinook salmon were canceled due to yearling chinook salmon mortality observed in the gatewell, which was associated with the high flows generated by the ESBSs.

A recapture efficiency/mortality test on 27 May in Slot 7B with yearling chinook salmon resulted in a recapture efficiency of 99%. During this test, marked fish were recovered in poorer condition than when they were released. Descaling was 8% and mortality 2% during the 1-hour test, indicating less than favorable conditions within the gatewell.

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INTRODUCTION

John Day Dam, located at Columbia River Kilometer 347 (River Mile 216), is operated by the U.S. Army Corps of Engineers (COE) and is the third hydroelectric project upstream from the mouth. Completed in 1968, John Day Dam is equipped with 16 turbine units, 20 spillbays, and a navigation lock (Fig. 1).

Initial renovation of the juvenile fish collection and bypass system originally installed at John Day Dam began in 1984 and continued through 1986. The fish-collection portion of the system consists of standard-length submersible traveling screens (STSs), which intercept fish passing into the turbine intakes and guide them up into the gatewell slots. The system includes a single 35-cm-diameter (14 in) bypass orifice, leading from each gatewell to an enclosed bypass gallery, and a transportation channel to carry fish from the gallery to a tailrace release area approximately 0.4 km downstream from the dam. A state-of-the-art bypass and sampling facility was completed in 1999 and evaluated by Absolon et al. (2000).

In 1985, the National Marine Fisheries Service (NMFS), in cooperation with the COE, began a series of studies to evaluate the partially finished fish-passage system and sampling facilities (Krcma et al. 1986). The fish guidance efficiency (FGE) of the STSs was estimated for all salmonid species (*Oncorhynchus* spp.) and found to be more than 70% for yearling chinook salmon (*O. tshawytscha*) and steelhead (*O. mykiss*), but much lower (21%) for subyearling chinook salmon. In 1985, orifice passage efficiency (OPE) for all juvenile salmonids was greater than 70%. However, with the bypass system connected to only 9 turbine units, orifice head was 1.7 m, considerably higher than the 1.1 m expected when the bypass system was connected to all 16 turbine units. There was a distinct possibility that a reduction in orifice head could result in decreased OPE, but because the fish sampling facilities located on the transportation channel were incomplete in 1985, only preliminary evaluations were possible.

Prior to the 1986 smolt migration, the collection and bypass system for Turbine Units 10, 11, and 12 was completed. The remaining bypass orifices (Units 13, 14, 15, and 16) would be completed during 1986. Numerous modifications had also been made to the temporary juvenile fish sampling and handling facilities. With a completed bypass system in 12 units, orifice head was reduced to about 1.2 m (very close to the expected normal operating head of 1.1 m.).

John Day Dam Lock and Dam

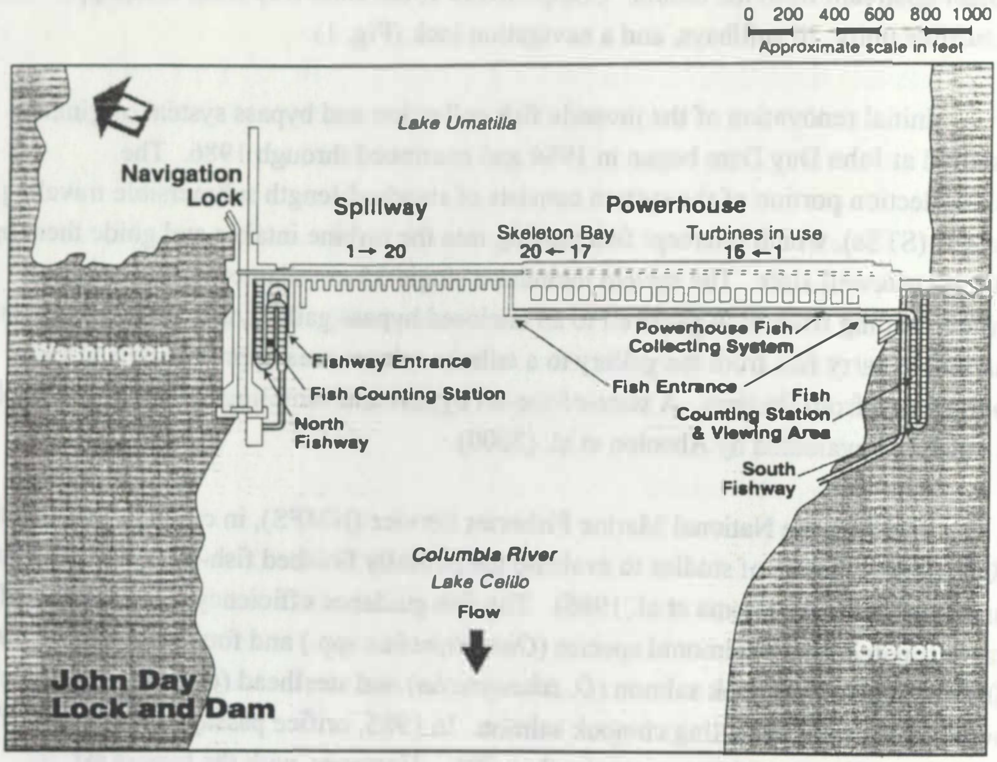

Figure 1. Overview of John Day Dam on the Columbia River showing numbering sequence of turbine units and spillbays.

In 1986, FGE tests conducted with only subyearling chinook salmon averaged 35%. This was higher than in 1985, but still considerably lower than target levels. Seasonal average OPEs were 69 and 66% for yearling and subyearling chinook salmon, respectively. There were no significant differences in seasonal average OPE between the 1985 and 1986 seasons despite the reduction in orifice head.

Encouraging results from tests with extended-length screens at McNary Dam in 1991, 1992, and 1993 (Brege et al. 1992; McComas et al. 1993, 1994) and at The Dalles Dam in 1993 and 1994 (Brege et al. 1994, Absolon et al. 1995) suggested that FGE for both yearling and subyearling chinook salmon at John Day Dam might be improved with longer screens.

In 1996, tests were conducted at John Day Dam to evaluate the FGE of an extended-length submersible bar screen (ESBS), used with an inlet flow vane, and the effects of these guidance devices on descaling of juvenile salmonids. In addition, we evaluated the effects on OPE of enlarged orifices, from 30 to 35 cm diameter (12 to 14 in), combined with an increased flow of 500 cfs into the gatewell, which was produced by the extended-length submersible bar screen. Fish guidance efficiencies in 1996 were 84, 94, 95, 79, and 60% for yearling chinook salmon, steelhead, coho salmon, sockeye salmon, and subyearling chinook salmon, respectively (Brege et al. 1997). Yearling chinook salmon OPE was consistently higher in the ESBS slot than in the STS slot, with a statistically significant difference in mean OPEs of 99 and 80% for the ESBS and STS, respectively. Mean OPE for subyearling chinook salmon was 97% for both the ESBS and STS.

Between 1996 and 1999, the perforated-plate panels and associated mounting hardware on the back of the ESBS were modified extensively to reduce harmonic vibration, which had previously resulted in failure of the perforated-plate attachment structures.

In 1999, tests were conducted at John Day Dam to evaluate the FGE of a modified extended-length submersible bar screen (ESBS) with a modified perforated plate and an inlet flow vane. The effects of these guidance devices on descaling of juvenile salmonids was also evaluated. In addition, the effects on OPE of enlarged orifices, combined with the increased flows into the gatewell produced by the ESBS, were further evaluated. Specific research objectives at John Day Dam in 1999 were these:

1) Evaluate the fish guidance efficiency of an extended-length submersible bar screen with perforated-plate modifications and inlet flow vane.

2) Evaluate the orifice passage efficiency with an extended-length submersible bar screen, modified perforated plate, and inlet flow vane.

3) Evaluate the effects of an extended-length submersible bar screen, modified perforated plate, and inlet flow vane on juvenile salmonid descaling.

Testing for the above objectives occurred between 5 and 27 May for the 1999 season. Juvenile lamprey were captured incidentally during FGE tests. A summary of the lamprey catch is furnished in Appendix B.

OBJECTIVE 1: EVALUATE THE FISH GUIDANCE EFFICIENCY OF AN EXTENDED-LENGTH SUBMERSIBLE BAR SCREEN WITH MODIFIED PERFORATED PLATE AND INLET FLOW VANE

Approach

Methods for determining FGE were similar to those used in previous FGE studies with extended-length screens (Brege et al. 1992, McComas et al. 1993). Gatewell dip-net catches provided estimates of the number of guided fish (Swan et al. 1979); fyke-net catches provided estimates of the number of unguided fish (Fig. 2). Fish guidance efficiency for each species was calculated as gatewell catch (guided fish) divided by the total number of fish (guided plus unguided), by species, passing through the turbine intake during the test period:

$$FGE = \frac{GW}{GW + FN} \times 100\%$$

where GW = gatewell catch
FN = fyke-net catch

Guided fish were confined to the bulkhead slot by a vertical barrier screen (VBS) that separated the bulkhead slot from the operating-gate slot (Fig. 2). The VBS consisted of ten 2.6-m-high panels, each of which extended across the full width of the slot. The front of each panel was covered with monofilament mesh and the back with either a 14% open, perforated steel plate to control flow or a solid plate to block flow through the screen section. The VBS configuration designed to be used with STSs (Unit 6) consisted of seven 14% porosity panels at the bottom with three solid panels at the top (Fig. 2).

The configuration for the VBS panels of the test slots in Unit 7 was different from that in Unit 6 (and the rest of the units on the powerhouse) due to the higher flows into the gatewell generated by the ESBS and inlet flow vane. The VBS configuration for Unit 7 slots (all with ESBSs) consisted of a solid panel at the bottom, followed by nine 14% porosity panels extending to the top (Fig. 2).

Extended-length bar screens with inlet flow vanes similar to those tested during FGE tests in 1993 and 1994 at The Dalles Dam were used in the test slots (Brege et al. 1994, Absolon et al. 1995). Unit 7, the test unit, had ESBSs with a 25% porosity perforated plate, while Unit 6 had STSs with a 48% porosity perforated plate, the standard condition for STSs at John Day Dam.

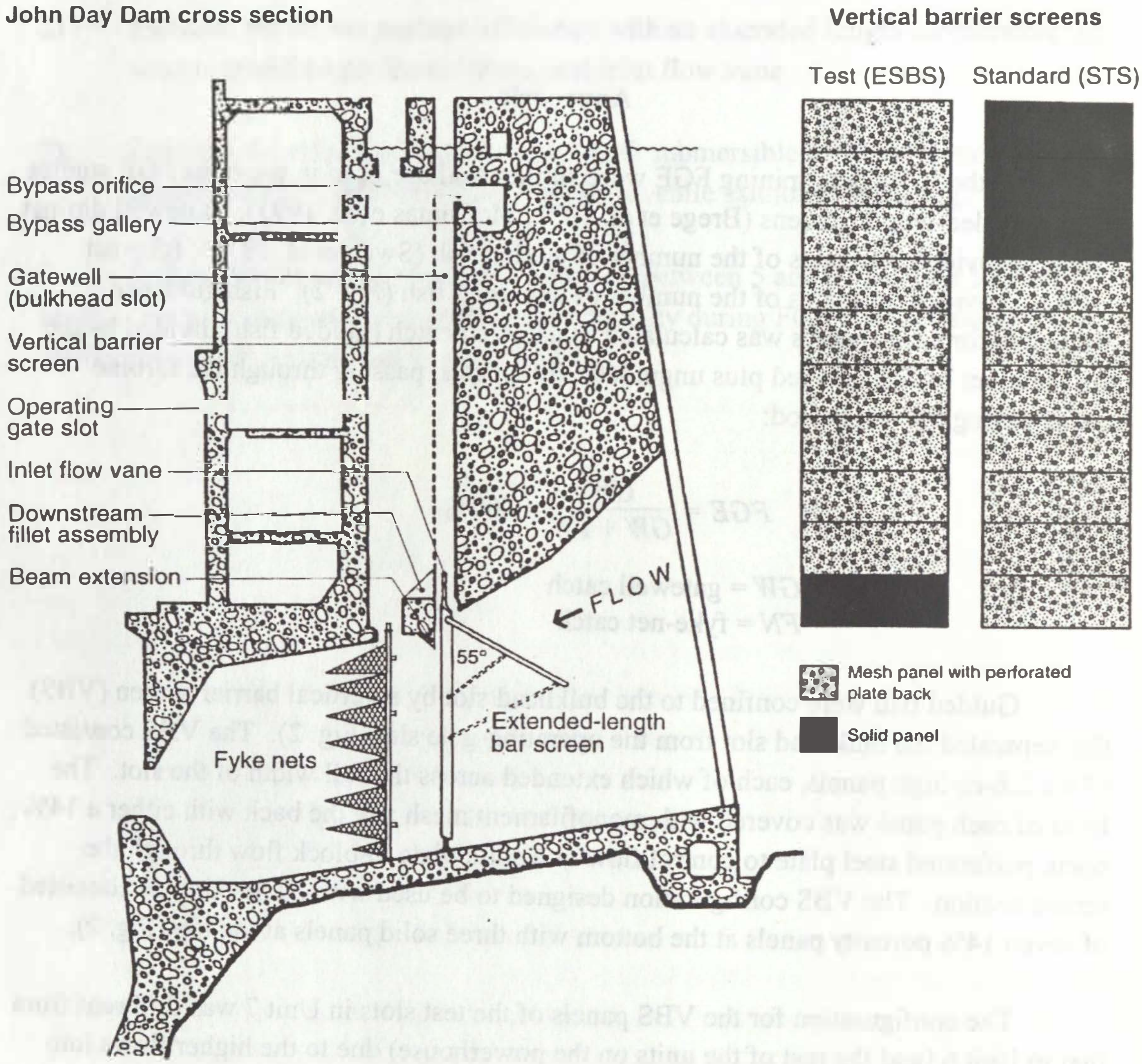

Figure 2. Cross section of a turbine unit at John Day Dam with extended-length bar screen (ESBS) and inlet flow vane in place, and vertical barrier screen configurations used with ESBSs and standard-length submersible traveling screens (STSs).

Each FGE test lasted a minimum of 1 hour and typically began at 2000 h (dusk) and ended between 2100 and 2300 h, when it was estimated by gatewell dipnetting that the target number of fish (200 total) had been collected in the gatewell and fyke nets. Total numbers of fish collected were monitored by dip-netting gatewells at 10- to 15-minute intervals during the test.

Past FGE studies have utilized fyke nets attached to a frame beneath the STS to collect unguided fish. With extended-length screens, this is not possible because the screen framework fills the entire bulkhead slot of the turbine intake (Fig. 2). Therefore, a frame with fyke nets was installed in the downstream gate slot to collect unguided fish. As at The Dalles Dam in 1993 and 1994, redesigned fyke-net frames, more streamlined than older styles, were used to reduce the effect of the frame on flow through the test unit. More open mesh in the fyke nets was also used to minimize water resistance and increase flow through the nets.

With extended-length screens, fyke nets were arranged in three columns (designated as left, middle, and right, as viewed from downstream) and eight levels (numbered from top to bottom) (Fig. 2). The smaller nets at level eight, approximately one-third the size of the nets at other levels, catch very few fish (Appendix Table A1); therefore, the catch from net-level eight was added to that of net-level seven for comparisons to previous FGE studies, since most other studies cite seven net levels. Because the proportion of total fyke-net catch for each column cannot be reliably predicted with extended-length screens, cod ends were placed on all 24 fyke nets used in FGE tests with these screens. An analysis of fyke-net catch by net column with extended-length screens at McNary Dam is reported by McComas et al. (1994).

Fish guidance efficiency tests with an ESBS were conducted in the center slot of Unit 7 during the spring juvenile salmonid outmigration. There were no FGE tests conducted with an STS at John Day Dam in 1999 because FGE estimates with STSs were available from previous studies.

Results and Discussion

Testing for FGE began 5 May and ended 27 May, when fish numbers dropped at the end of the spring outmigration (Appendix Table A1). During the spring FGE tests we handled 21 subyearling chinook salmon, 3,304 yearling chinook salmon, 461 steelhead, 375 coho salmon (*O. kisutch*), and 5,087 sockeye salmon (*O. nerka*), for a total of 9,248 juvenile salmonids. Test Unit 7 and adjacent units were operated at 155 megawatts (MW) with an approximate discharge of 21 thousand cubic feet per second (kcfs) during the test period. River flows were near normal during our test season. Hourly spill patterns at John Day Dam during May were determined by the experimental design of an ongoing hydro-acoustic study to estimate fish passage through the spillway and powerhouse (Johnston and Nealson 1999). The study design called for constant 60% nighttime (1900-0559 h) spill each day and either 0 or 30% daytime (0600-1859 h) spill. Total average river flows were 250 to 300 kcfs with spills of 60 to 100 kcfs during the first 3 weeks of testing. Total average river flows approached 400 kcfs with spills of 100 kcfs or more during the last week of May.

Mean FGEs (with 95% confidence intervals) during spring were as follows: yearling chinook salmon 80.3% (± 4.4%), steelhead 94.0% (± 3.8%), coho salmon 99.5% (± 1.2%), and sockeye salmon 75.4% (± 4.1%). Daily FGE for yearling chinook and sockeye salmon is shown in Figure 3. Coho salmon and steelhead were not present in large enough populations through the season to be included. Yearling chinook salmon FGE compared favorably with the 78 and 80% FGEs obtained with extended-length screens at McNary Dam in 1991 and 1992 (Brege et al. 1992, McComas et al. 1993) and was higher than the 73 and 69% FGEs obtained using ESBSs at The Dalles Dam in 1993 and 1994 (Brege et al. 1994, Absolon et al. 1995). The mean yearling chinook salmon FGE of 80% recorded this spring at John Day Dam was quite similar to the 84% found in 1996 and well above the FGE of 72% estimated in 1985 using STSs with fyke nets deployed directly below the screens (Krcma et al. 1986). Sockeye salmon daily FGE closely mirrored that of yearling chinook salmon through the test period.

FGE and percent catch by net level for all species are shown in Figure 4. For yearling chinook salmon the largest catch was in net-level 5 (5.1%), followed by net-levels 4 and 6 (3.5 and 3.3%, respectively). For sockeye salmon the net-level catches were somewhat higher, but similar. Coho salmon and steelhead net catches were barely discernable, since nearly all fish were guided into the gate slot. Catches by net level for the 1999 season were very similar to those found at John Day Dam in 1996.

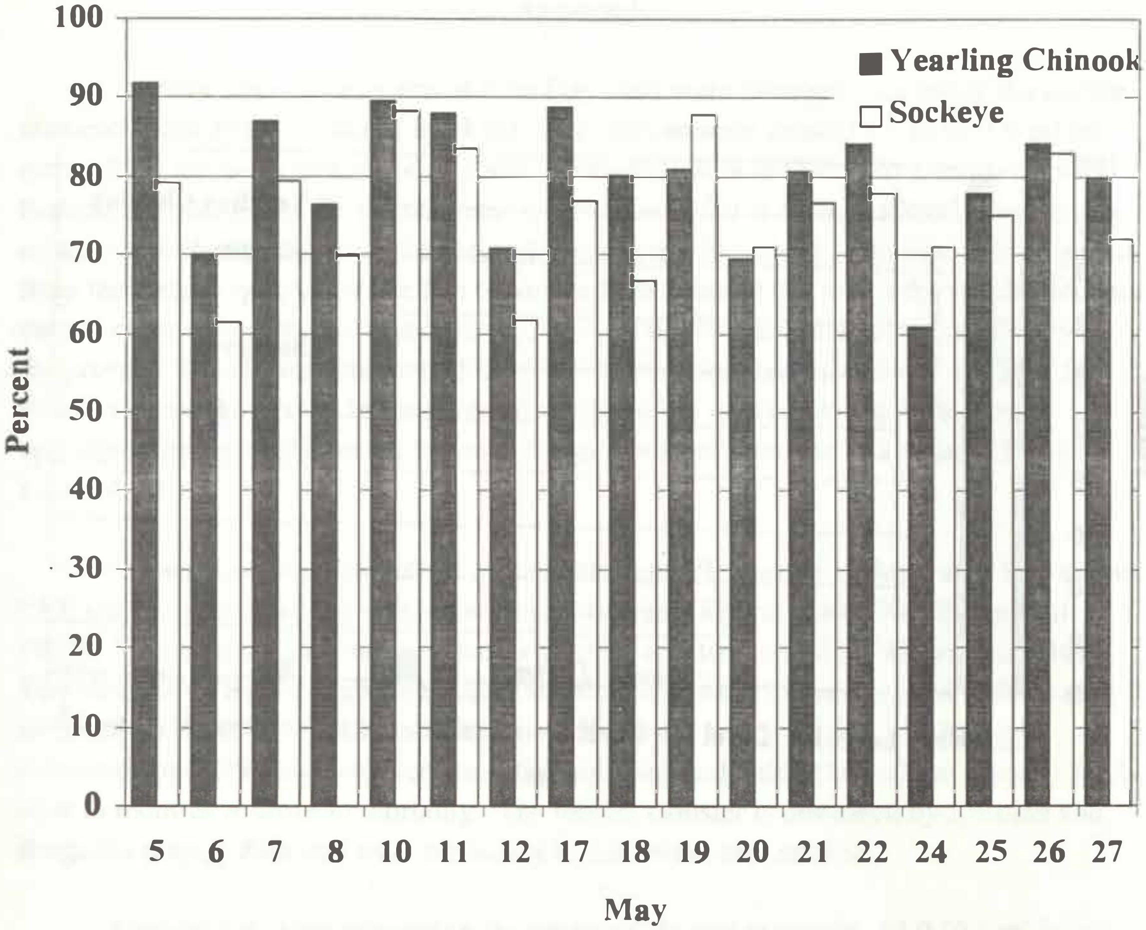

Figure 3. Daily fish guidance efficiency (FGE) for yearling chinook (Yr Chin) and sockeye salmon at John Day Dam, 1999.

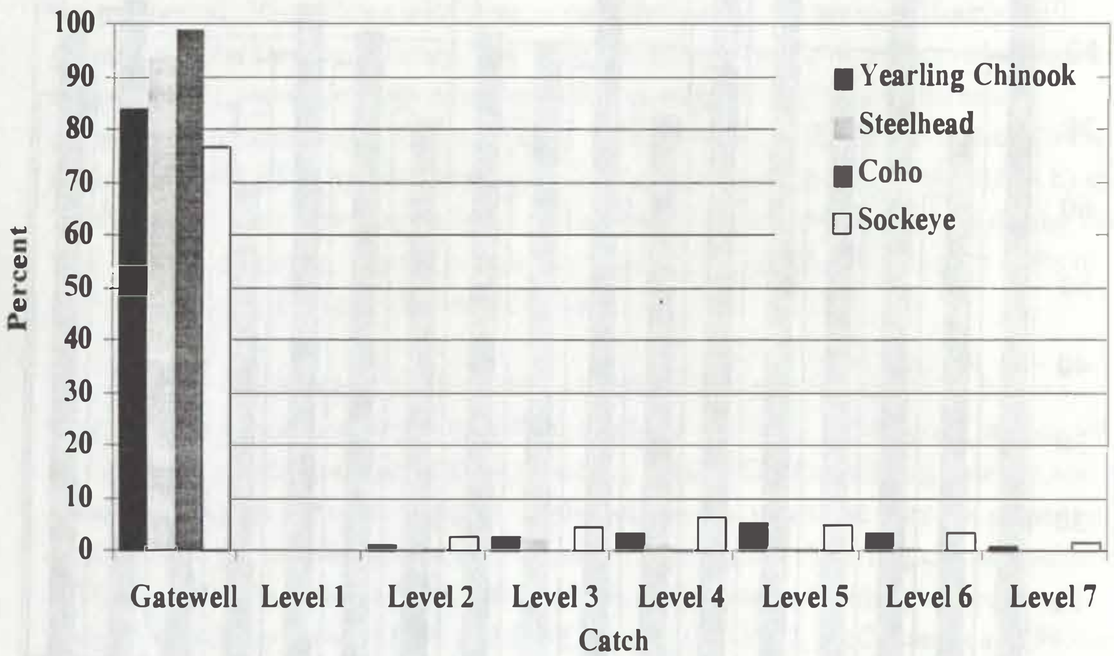

Figure 4. Seasonal catch by net level during fish guidance efficiency (FGE) tests for yearling chinook salmon (Yr Chin), steelhead (STHD), coho salmon, and sockeye salmon at John Day Dam, 1999. Gatewell = gatewell dip-net catch, Level 1 through 7 = fyke net catches (Level 1 is at the top, Level 7 at the bottom of the turbine intake).

OBJECTIVE 2: EVALUATE ORIFICE PASSAGE EFFICIENCY WITH AN EXTENDED-LENGTH SUBMERSIBLE BAR SCREEN WITH MODIFIED PERFORATED PLATE AND INLET FLOW VANE

Approach

In 1994, the orifice inserts at John Day Dam were changed, increasing the orifice diameter from 30 to 35 cm (12 to 14 in). The orifices were located 1.1 m (3 ft 6 in) on center from the north end of the gate slot at elevation 76.4 m (250.5 ft) mean sea level. Normal operating pool for the reservoir is elevation 265.0 ft mean sea level. Depending on the resulting drawdown of the gatewell surface due to turbine operation, submergence from the surface of the juvenile fish bypass orifices is about 4.2 m (14 ft), which is deeper than at other Columbia and Snake River Dams. The head differential between water in the juvenile fish bypass conduit and the forebay level was maintained at 1.4 m (4.5 ft). With a normal drawdown in the gatewell surface of 15 cm (0.5 ft) during turbine operation, the head differential between the gatewell and juvenile fish bypass channel is 1.2 m (4.0 ft).

We used an indirect method of determining OPE, similar to those used in previous OPE studies with traveling screens at John Day Dam (Krcma et al. 1986, Brege et al. 1987). Test slots were dipnetted prior to the start of a test to remove any residual fish. Test slots (6B, 7B) were dipnetted daily and the collected fish anesthetized with tricaine methane sulfonate (MS-222) and examined. From the collected fish, 100 juvenile salmonids per OPE replicate were caudal fin clipped and held in the release canister for 1 hour to monitor short-term mortality. The release canister is described by Absolon and Brege (in prep.). Fish that were obviously injured were not marked.

Marked fish were released in the center of the test gatewells, 30 ft (9.1 m) below the surface, and allowed to exit the gatewells through the juvenile fish bypass orifice. At a specified time each test day, all fish were dipnetted from the gatewells (Swan et al. 1979). A typical OPE test lasted 19 hours, beginning at 2300 h on one day and ending at 1800 h the next day. Turbine Unit 6 was operated continuously during the spring test period. Turbine Unit 7 was operated from 2300 h until 1800 h the next day for OPE tests, shut down from 1800 to 2000 h to lower the fyke-net frame into place, run from 2000 to 2130 h for the FGE test, shut down to raise the fyke-net frame and remove the catch, and started up again about 2300 h for the OPE test. Since OPE tests were being conducted in the same slot as the FGE tests, OPE tests could not begin until FGE tests and associated short-term descaling tests in Slot 6B had concluded for the day.

The gatewell dip-netting technique for OPE relies on the assumptions that 1) fish survive the marking process in good condition, 2) fish exit the gatewell via the bypass orifice, and 3) all of the fish remaining in the gatewell are captured by the dip net. Orifice passage efficiency was calculated as the number of clipped fish that exited the gatewell divided by the total number released.

To ensure the reliability of these assumptions, gatewell efficiency/marked fish mortality tests were conducted periodically throughout the spring outmigration. During these tests, fish were marked, held for 1 hour to monitor short-term mortality, and then placed in the gatewell with the turbine unit running at 100 MW and with the orifice closed. The load on the turbine unit was then raised to 155 MW. After 1 hour the load was reduced to 100 MW, and the gatewell was dipnetted. Then the catch was examined and enumerated. Recapture efficiency was calculated as the number of marked fish recaptured divided by the total number of marked fish released. The study design provided for 20 OPE measurements in each of the two test slots during the spring juvenile salmonid outmigration.

Results and Discussion

Testing for OPE began 5 May and ended 21 May. While OPE tests were being conducted, a fish mortality problem was observed at the fingerling bypass facility and a decision was made to suspend testing to investigate. The results of this investigation are reported in Objective 3. During the spring OPE tests we handled 26 subyearling chinook salmon, 11,455 yearling chinook salmon, 6,565 steelhead, 223 coho salmon, and 2,424 sockeye salmon for a total of 20,693 juvenile salmonids (Appendix Table A2). We marked and released 1,693 yearling chinook salmon (included in the above count) during these tests.

Mean OPEs for yearling chinook salmon with the ESBS (Slot 7B) and the STS (Slot 6B) were 97.1 and 39.8%, respectively. Daily OPE was consistently higher in the ESBS slot than in the STS slot (Fig. 5). The difference in OPE between the ESBS and STS slots was statistically significant at 57.3% (± 11.3%) ($P < 0.05$). Results of OPE tests using the ESBS compare favorably with 1995 yearling chinook salmon OPEs of 79 and 78% for north and south orifices, respectively, at McNary Dam (McComas et al. 1997). At The Dalles Dam in 1995, respective OPEs of 80 and 68% were found in the west and east orifices using ESBSs and the same mark/recapture method (Brege et al. 1997). The mean OPE of 39.8% using the STS for yearling chinook salmon was considerably lower than the 72% recorded in 1985 at John Day Dam. This may be attributed to the low turbidity of the water in the mainstem Columbia River through the entire month of May. Low temperatures and little rainfall resulted in reduced runoff during the spring season. The clear water may have caused fish to stay below the fingerling bypass orifices.

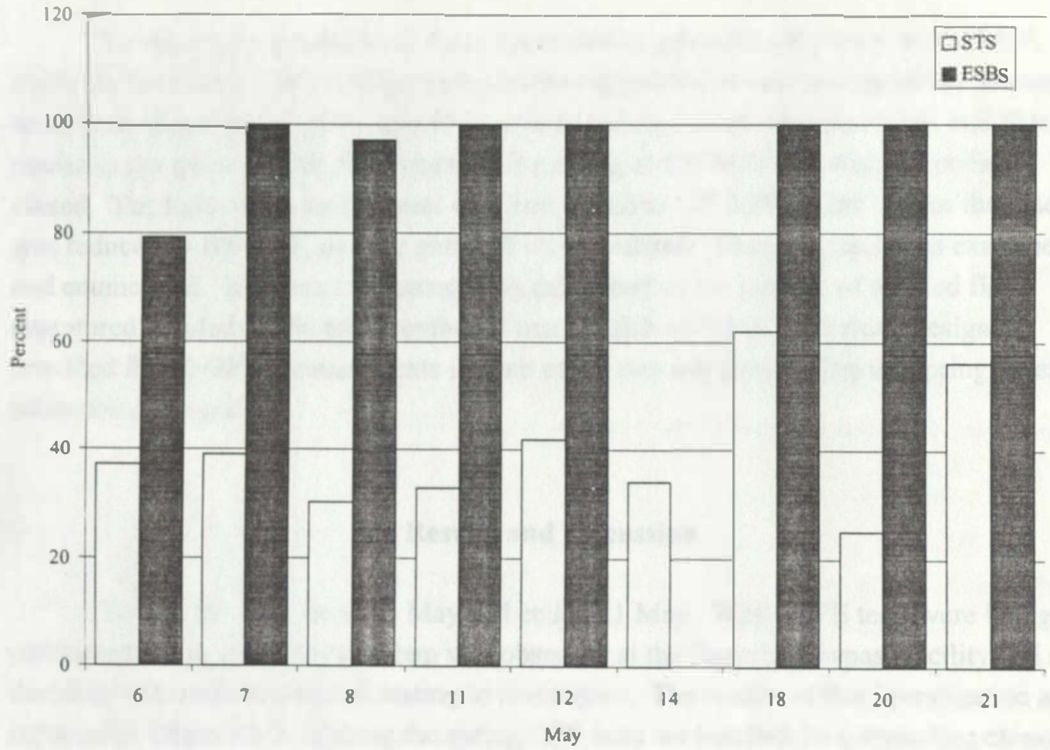

Figure 5. Daily orifice passage efficiency (OPE) for yearling chinook salmon at John Day Dam, 1999.

OBJECTIVE 3: EVALUATE THE EFFECTS OF EXTENDED-LENGTH SUBMERSIBLE BAR SCREENS WITH MODIFIED PERFORATED PLATE AND INLET FLOW VANE ON JUVENILE SALMONID DESCALING

Approach

The condition of fish captured during FGE and OPE tests was monitored using standard Fish Transportation Oversight Team descaling criteria (Ceballos et al. 1993). Fish condition in Slot 6B, containing an STS, was compared to that of fish collected during the FGE test in Slot 7B, (containing an ESBS) during the same time period. Head injuries, such as folded operculum and eye injuries, were recorded. The test slots were dipnetted daily between 1800 and 1830 h. Captured fish were anesthetized with MS-222, identified by species, examined, and enumerated.

Results and Discussion

During FGE tests, fish condition was acceptable and descaling was low (mean 4%) for fish dipnetted from the gate slots. Detailed descaling data are summarized in Appendix Table A2. However, when the test unit containing the ESBSs was operated at 155 MW for about a 20-hour period during the OPE tests, descaling of fish recovered from the gate slot increased (mean 13.1%), and mortality increased by about 1% at the fingerling bypass evaluation facility. At first the increase in mortality seemed circumstantial, but after repeated observations there appeared to be a correlation with the ESBS. It was suspected that fish injury was occurring as a result of exposure to the turbulent conditions within the gate slot caused by increased upward flows in the slot, which resulted from combined use of the ESBS and inlet flow vane. Upward slot flow in the STS-equipped unit was about 200 cfs, whereas upward slot flow in the ESBS-equipped unit was over 700 cfs (Tony Norris, COE, Pers. commun., January 2000).

The intensity of these flows was not reduced enough by the vertical barrier screen. If fish did not find the fingerling bypass orifice shortly after entering the gate slot, they were exposed to turbulent flows until they became injured and left randomly in poor condition. Dead or injured fish are only released from the vertical barrier screen surface when they become buoyant, due to morbidity, or when the unit is shut down. This mortality and injury is not observed during normal FGE tests due to the short time-frame involved.

Upon conclusion of the FGE/OPE test series, an abbreviated injury/mortality test was conducted. Groups of 100 yearling chinook salmon were PIT tagged, held 1 hour for short-term mortality, and released in one of three locations: 1) the fingerling bypass conduit, 2) the ESBS-equipped (test) unit, or 3) an STS-equipped (standard) unit. Three replicates of the above test were conducted, during which we handled 1,909 yearling chinook salmon, 2,631 steelhead, and 1,449 sockeye.

The results of these tests are shown in Figure 6. The average mortality of PIT-tagged yearling chinook salmon released into the ESBS-equipped unit exceeded that of fish released into the bypass conduit and STS-equipped unit by 20%, confirming that a fish-condition problem existed in the ESBS-equipped unit.

A recapture efficiency/mortality test on 27 May in Slot 7B with yearling chinook salmon resulted in a recapture efficiency of 99%. Marked fish were recovered in poorer condition than when they were released. Descaling was 8% and mortality 2% during the 1-hour test, again indicating less than favorable conditions within the gatewell environment.

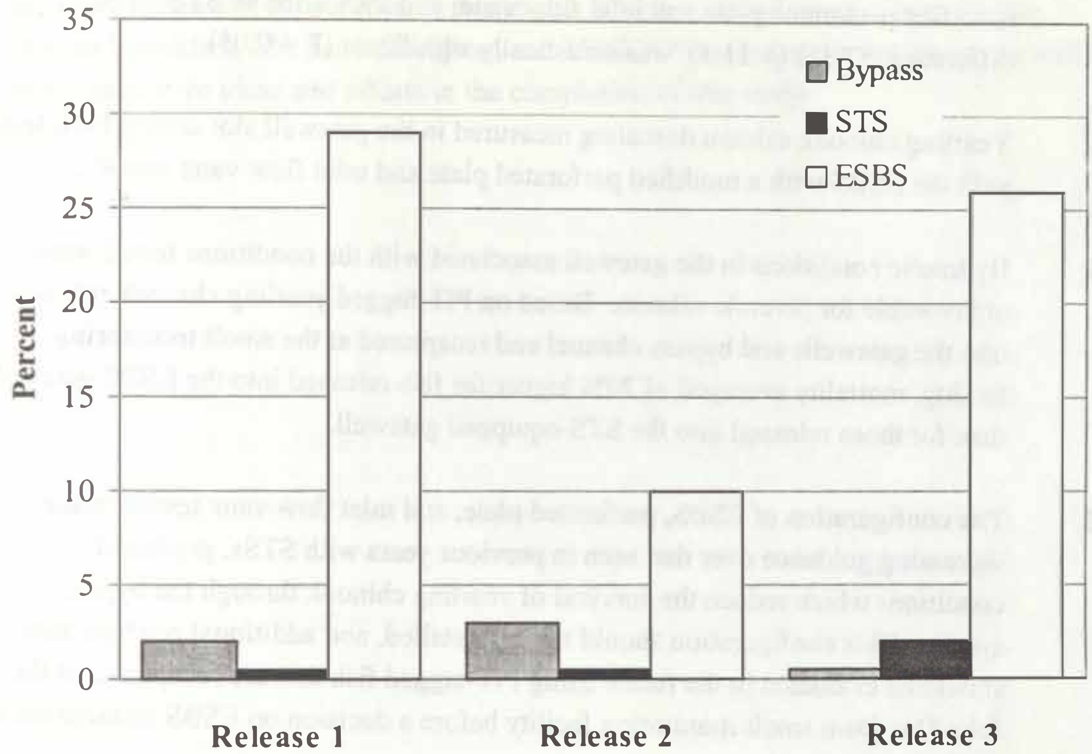

Figure 6. Mortality of PIT-tagged yearling chinook salmon released at three different sites on the intake deck of John Day Dam, 1999. N = 100 for each release.

CONCLUSIONS

1. Mean FGE for yearling chinook salmon was 80.3% (± 4.4) with an ESBS with a modified perforated plate and inlet flow vane.

2. Mean OPEs for yearling chinook salmon were 97.1% for the ESBS with a modified perforated plate and inlet flow vane, and 39.8% for an STS. The difference, 57.3% (± 11.3), was statistically significant ($P < 0.05$).

3. Yearling chinook salmon descaling measured in the gatewell slot during FGE tests with the ESBS with a modified perforated plate and inlet flow vane was 4%.

4. Hydraulic conditions in the gatewell associated with the conditions tested were unfavorable for juvenile salmon. Based on PIT-tagged yearling chinook released into the gatewells and bypass channel and recaptured at the smolt monitoring facility, mortality averaged of 20% higher for fish released into the ESBS gatewell than for those released into the STS-equipped gatewell.

5. The configuration of ESBS, perforated plate, and inlet flow vane tested, while increasing guidance over that seen in previous years with STSs, produced conditions which reduce the survival of yearling chinook through the bypass system. This configuration should not be installed, and additional configurations should be evaluated in the future using PIT-tagged fish that are recaptured at the John Day Dam smolt monitoring facility before a decision on ESBS installation is made.

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APPENDICES

Appendix A: Data Tables

Appendix Table A1. Numbers of fish caught by species and fyke-net catch distribution for each replicate of fish guidance efficiency (FGE) tests at John Day Dam, 1999.

	Subyearling chinook				Yearling chinook				Steelhead				Coho				Sockeye			
Location	L	M	R	Tot[a]	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot
5 May																				
Level 1																				
Level 2					1			1					1			1		1		1
Level 3					1	1	3	5	1		1	2						1	1	2
Level 4					3	2	3	8		1	1	2	1	1		2		1		1
Level 5					2	4	3	9			1	1		1		1			1	1
Level 6					4	2	1	7	1			1							1	1
Level 7																				
Level 8							1	1												
Net total								31				6				4				6
Gatewell								380				46				107				23
Total								411				52				111				29
FGE (%)								92				88				96				79
Desc (%)								2.1				2.2				1.9				4.5
6 May																				
Level 1						1														1
Level 2					3	1		4												
Level 3					1	1		2			1	1					3		3	6
Level 4					3	3	6	12									2	6	1	9
Level 5					4	8	6	18	1			1					1	2	1	4
Level 6					1	2	8	11			1	1						1	3	4
Level 7					1		1	2											2	2
Level 8																				
Net total								50				3				0				25
Gatewell								119				42				8				40
Total								169				45				8				65
FGE (%)								70				93				100				62
Des (%)								1.7				0				0				0
7 May																				
Level 1																				
Level 2										1		1								
Level 3					2		3	5							1	1	2			2
Level 4						3		3			1	1					1		1	2
Level 5					1		1	2					1			1	1		1	2
Level 6						2	2	4										1		1
Level 7																				
Level 8																			1	1
Net total								14				2				2				8
Gatewell								94				48				31				33
Total								108				50				33				41
FGE (%)								87				96				94				81
Des (%)								7.4				7.1				0				12.9

Appendix Table A1. Continued.

Location	Subyearling chinook L	M	R	Tot	Yearling chinook L	M	R	Tot	Steelhead L	M	R	Tot	Coho L	M	R	Tot	Sockeye L	M	R	Tot
8 May																				
Level 1																				
Level 2																				
Level 3					2	1	2	5												
Level 4					3	1	4	8												
Level 5					3	3	4	10												
Level 6					2	1	4	7	1			1								
Level 7						1		1												
Level 8																				
Net total								31				1				0				44
Gatewell								100				18				7				102
Total								131				19				7				146
FGE (%)								76				95				100				70
Des (%)								5.0				5.6				0				15.7
10 May																				
Level 1																				
Level 2					2		2	4			1	1					17	5	9	31
Level 3					5	1		6												21
Level 4					4	1	1	6												37
Level 5					2	2	3	7												26
Level 6						6	3	9												16
Level 7						1	2	3												
Level 8																				
Net total								35				1				0				131
Gatewell								301				61				30				988
Total								336				62				30				1119
FGE (%)								90				98				100				88
Des (%)								2.0				0				0				10.0
11 May																				
Level 1																		1		1
Level 2																	5	1		6
Level 3						2	1	3									5	1	4	10
Level 4					2	1	1	5?									3	3	3	9
Level 5						3	1	4									1	1		2
Level 6						1	1	2									2	1		3
Level 7																			1	1
Level 8										1		1								
Net total								14				1				0				32
Gatewell								103				15				2				161
Total								117				16				2				193
FGE (%)								88				94				100				83
Des (%)								5.8				0				0				16.8

Appendix Table A1. Continued.

Location	Subyearling chinook				Yearling chinook				Steelhead				Coho				Sockeye			
	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot
12 May																				
Level 1																	1			1
Level 2						1	1	2									6	1	8	15
Level 3					3	2		5									12	4	11	27
Level 4					3	1	1	5									19	18	32	69
Level 5					8	6	2	16									15	19	17	51
Level 6						2	1	3									22	19	12	53
Level 7																	4	3	6	13
Level 8																		1		1
Net total								31				0				0				230
Gatewell								75				4				6				369
Total								106				4				6				599
FGE (%)								71				100				100				62
Des (%)								4.0				0				0				18.2
17 May																				
Level 1																	1			1
Level 2						1	1	2									6	1	1	8
Level 3						9	4	13			1	1					8	3	10	21
Level 4					4	3	4	11		1		1					12	4	10	26
Level 5			1	1	2	1	5	8									3	3	13	19
Level 6							2	2									2	7	4	13
Level 7					1			1									4	1	2	7
Level 8																		1	1	2
Net total				1				37				2				0				97
Gatewell				4				295				22				42				322
Total				5				332				24				42				419
FGE (%)				80				90				92				100				77
Des (%)				0				3.1				0				0				11.2
18 May																				
Level 1																				
Level 2						1	1	2										3	4	7
Level 3					1	1	1	3									10	4	14	28
Level 4						1	1	2									7	6	21	34
Level 5						1	1	2									12	10	8	30
Level 6					2	3		5									4	5	4	13
Level 7					1			1									4	2	2	8
Level 8					2			2									11	2		13
Net total				0				17				0				0				133
Gatewell				1				69				10				10				268
Total				1				86				10				10				401
FGE (%)				100				80				100				100				67
Des (%)				0				0				0				0				9.0

Appendix Table A1. Continued.

Location	Subyearling chinook				Yearling chinook				Steelhead				Coho				Sockeye			
	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot
19 May																				
Level 1																				
Level 2					1			1									2	1	1	4
Level 3							1	1									5		1	6
Level 4					1		3	4									6	1	2	9
Level 5					3	2	4	9	1			1						1	5	6
Level 6					2		2	4											1	1
Level 7					1			1												
Level 8																				
Net total								20				1				0				26
Gatewell								85				7				3				188
Total								105				8				3				214
FGE (%)								81				88				100				88
Des (%)								12.9				0				0				16.5
20 May																				
Level 1																				
Level 2																	1	1		2
Level 3					1		2	3										2	1	3
Level 4						2	4	6									1	5	5	11
Level 5					1	1		2									3	2	2	7
Level 6					2		1	3			1	1					1	2	2	5
Level 7																	1	2		3
20 May .																				
Level 8																	1	1		2
Net total								14				1								33
Gatewell								32				2								81
Total								46				3								114
FGE (%)								70				67								71
Des (%)								9.4				0								7.4
21 May																				
Level 1																				
Level 2																	3	3		6
Level 3							1	1			1	1					4	3	3	10
Level 4					1	2		3									5	1	2	8
Level 5							2	2	1			1					2	5	2	9
Level 6					2	2	1	5	1			1						1		1
Level 7																		1	1	2
Level 8																				
Net total								11				3								36
Gatewell								46				6								118
Total								57				9								154
FGE (%)								81				67								77
Des (%)								0				0								14.4

Appendix Table A1. Continued.

Location	Subyearling chinook				Yearling chinook				Steelhead				Coho				Sockeye			
	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot
22 May																				
Level 1																		1		1
Level 2					1		3	4									14	4	7	25
Level 3					5	3	5	13			1	1					11	6	15	32
Level 4					5	3	5	13									10	16	19	45
Level 5					5	10	8	23									9	13	12	34
Level 6					3	3	8	14									4	4	1	9
Level 7						1	2	3												
Level 8																		2		2
Net total								70				1				0				148
Gatewell				8				396				32				68				523
Total				8				466				33				68				671
FGE (%)				100				85				97				100				78
Des (%)				0				8.8				0				4.4				23.7
24 May																				
Level 1																				
Level 2																		1		1
Level 3							5	5									8	2		10
Level 4					1	2	1	4	1								6	5	12	23
Level 5							3	3									7	8	4	19
Level 6					3		1	4									6	1	5	12
Level 7																	2	2	2	6
Level 8																	1			1
Net total								16				1								72
Gatewell								25				2				10				176
Total								41				3				10				248
FGE (%)								61				67				100				71
Des (%)								0				0				0				13.6
25 May																				
Level 1																				
Level 2					2	1	1	4									6	2	4	12
Level 3					1	4	1	6	1		1	2					6	3	9	18
Level 4					3	4	4	11									6	6	5	17
Level 5					9	14	10	33									7	4	5	16
Level 6					3	3	7	13									3	9	3	15
Level 7					1			1									1	2	2	5
Level 8						1		1												
Net total								69				2				0				83
Gatewell								242				48				9				251
Total								311				50				9				334
FGE (%)								78				96				100				75
Des (%)								2.9				4.2				0				17.9

Appendix Table A1. Continued.

Location	Subyearling chinook				Yearling chinook				Steelhead				Coho				Sockeye			
	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot	L	M	R	Tot
26 May																				
Level 1																				
Level 2					3		2	5		1		1					2			2
Level 3					2		3	5			1	1					1		4	5
Level 4					1	4	4	9			1	1					2	1	1	4
Level 5					5	6	3	14			1	1					2	1	1	4
Level 6					8	3	1	12										1	2	3
Level 7					1	1		2									2			2
Level 8																				
Net total								47				4				0				20
Gatewell				1				290				68				69				98
Total				1				337				72				69				118
FGE (%)				100				86				94				100				83
Des (%)				0				1.4				2.9				1.4				16.3
27 May																				
Level 1																				
Level 2					2		2	4									3	2		5
Level 3					2	1	3	6									5	4	4	13
Level 4					2	2	3	7									1	3	4	8
Level 5					3	2	2	7									4	3	4	11
Level 6						2	1	3									3	3	2	8
Level 7					1	1		2									1	1	1	3
Level 8																			1	1
Net total				0				29				0				0				49
Gatewell				5				116				37				5				126
Total				5				145				37				5				175
FGE (%)				100				80				100				100				72
Des (%)				0				0.9				0				0				18.3

L = left, M = middle, and R = right fyke-net column; Tot = total catch for net level.

Appendix Table A2. Descaling data from fish guidance efficiency (FGE), orifice passage efficiency (OPE), and short-term descaling tests at John Day Dam, 1999.

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc	Catch	%	Desc	Catch	%	Desc	Catch	%	Desc	Catch	%	Desc	Catch	%
Unit 7, Slot B (FGE)															
5 May				8	380	2.1	1	46	2.2	2	107	1.9	1	23	4.3
6 May				2	119	1.7		42	0.0		8	0.0		40	0.0
7 May				7	94	7.4	1	14	7.1		4	0.0	9	70	12.9
8 May				5	100	5.0	1	18	5.6		7	0.0	16	102	15.7
10 May				6	301	2.0		61	0.0		30	0.0	99	988	10.0
11 May				6	103	5.8		15	0.0		2	0.0	27	161	16.8
12 May				3	75	4.0		4	0.0		6	0.0	67	369	18.2
17 May				9	295	3.1		22	0.0		42	0.0	36	322	11.2
18 May		1	0.0	0	69	0.0		10	0.0		10	0.0	24	268	9.0
19 May				11	85	12.9		7	0.0		3	0.0	31	188	16.5
20 May				3	32	9.4		2	0.0				6	81	7.4
21 May		1	0.0	0	46	0.0		6	0.0				17	118	14.4
22 May		8	0.0	35	396	8.8		32	0.0	3	68	4.4	124	523	23.7
24 May					25	0.0		2	0.0		1	0.0	24	176	13.6
25 May				7	242	2.9	2	48	4.2		9	0.0	45	251	17.9
26 May		1	0.0	4	290	1.4	2	68	2.9	1	69	1.4	16	98	16.3
27 May		5	0.0	1	116	0.9		37	0.0		5	0.0	23	126	18.3
Unit 7, Slot B (OPE)															
6 May				6	128	4.7		11	0.0	1	29	3.4		26	0.0
7 May				2	13	15.4	2	13	15.4		13	0.0		5	0.0
8 May				7	166	4.2	7	64	10.9		6	0.0	4	24	16.7
11 May				15	179	8.4		37	0.0	1	7	14.3	9	42	21.4
12 May				6	58	10.3		18	0.0		5	0.0	1	12	8.3
18 May				22	216	10.2	1	45	2.2		15	0.0	7	38	18.4
20 May				44	127	34.6	6	43	14.0	3	13	23.1	18	35	51.4
21 May				1	47	2.1	4	21	19.0	2	3	66.7	1	7	14.3

Appendix Table A2 Continued.

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc	Catch	%	Desc	Catch	%	Desc	Catch	%	Desc	Catch	%	Desc	Catch	%
Unit 7, Slot B (OPE), continued															
22 May	2	6	33.3	290	1208	24.0	1	52	1.9	6	14	42.9	42	113	37.2
27 May				10	60	16.7		61	0.0	1	23	4.3	5	12	41.7
Unit 6, Slot B (OPE)															
6 May				84	531	15.8	3	130	2.3		27	0.0		69	0.0
7 May				56	405	13.8	18	414	4.3	2	7	28.6	12	96	12.7
8 May				126	776	16.2	27	793	3.4		6	0.0	34	83	41.0
11 May		1	0.0	131	1097	11.9	13	701	1.9		13	0.0	50	268	18.7
12 May				122	1102	11.1	21	1206	1.7		10	0.0	35	112	31.3
14 May (8B)		2	0.0	146	766	19.1	17	583	2.9		2	0.0	34	117	41.0
18 May (8B)		5	0.0	34	937	3.6	3	231	1.3	0	9	0.0	34	268	14.5
20 May		2	0.0	255	1366	18.7	19	559	3.4		4	0.0	67	212	31.6
21 May	2	10	20.0	247	891	27.7	47	1119	4.2		4	0.0	36	108	33.3
24 May				25	240	10.4	4	25	16.0	1	3	33.3	11	66	16.7
Unit 6, Slot B (short-term descaling tests)															
5 May				4	213	1.9		17	0.0	1	62	1.6		8	0.0
6 May				1	225	0.4	0	45	0.0	0	18	0.0		62	0.0
7 May				14	157	8.9	0	13	0.0		5	0.0	13	67	19.4
8 May				18	259	6.9		21	0.0	0	8	0.0	30	166	18.1
10 May				1	100	1.0		27	0.0		27	0.0	17	197	8.6
11 May		1	0.0	37	248	14.9	6	96	6.3		6	0.0	145	482	30.1
12 May					75	0.0		17	0.0		4	0.0	12	105	11.4
17 May (8B)		2	0.0	3	77	3.9		4	0.0	1	10	10.0	12	71	16.9
18 May (8B)				1	14	7.1					1	0.0	5	17	29.4
19 May				8	97	7.6		6	0.0		5	0.0	10	82	12.2
20 May				5	50	10.0		6	0.0				3	26	11.5
21 May				6	33	18.2	3	27	11.1		5	0.0	34	94	36.2
22 May		3	0.0	11	97	11.3	2	12	16.7		11	0.0	17	123	13.8
24 May		1	0.0	2	44	4.5		13	0.0				21	97	21.7

Appendix Table A3. Numbers released and recaptured and condition of juvenile yearling chinook salmon marked during PIT tag evaluations at John Day Dam, 1999

Release site	Number released	Number recaptured	Mortality %	Descaling %
Hatchery fish				
6B	77	59	31*	12
7B	64	60	22	10
BC	74	68	3	7
6B	87	71	0	3
7B	83	77	6	12
BC	77	71	4	6
6B	73	64	3	2
7B	67	52	25	12
BC	78	68	0	4
Wild fish				
6B	23	16	62*	6
7B	36	33	42	12
BC	26	24	0	17
6B	13	10	0	0
7B	14	13	31	15
BC	19	18	0	28
6B	24	21	0	0
7B	15	14	29	0
BC	21	18	0	0
Hatchery and wild fish combined				
6B	100	75	38*	11
7B	100	93	29	11
BC	100	92	2	10
6B	100	81	0	3
7B	97	90	10	12
BC	96	89	3	10
6B	97	85	2	2
7B	82	66	26	9
BC	99	86	0	3

* Inadequate water level problem in holding tank, disregard data.

Appendix Table A4. Condition and travel time of juvenile yearling chinook salmon marked, released, and recaptured during PIT tag evaluations at John Day Dam, 1999

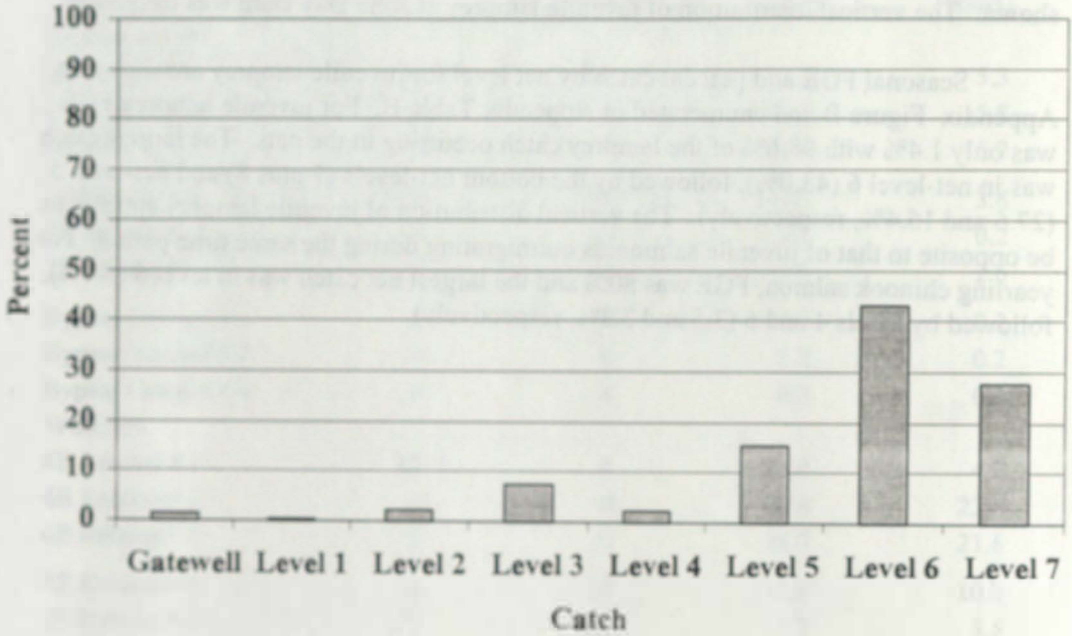
Release site	Mortality (%)	Descaling (%)	Average travel time (hours)	Median travel time (hours)
Hatchery fish				
6B Release # 1	31 *	12	22.2	5.3
6B Release # 2	0	3	21.1	15.8
6B Release # 3	3	2	21.4	16.7
7B Release # 1	22	10	11.7	3.8
7B Release # 2	6	12	5.6	0.2
7B Release # 3	25	12	9.0	2.6
Bypass Conduit # 1	3	7	0.3	0.2
Bypass Conduit # 2	4	6	0.2	0.2
Bypass Conduit # 3	0	4	0.3	0.2
Wild fish				
6B Release # 1	62 *	6	15.0	4.2
6B Release # 2	0	0	23.4	23.8
6B Release # 3	0	0	24.7	21.6
7B Release # 1	42	12	16.6	10.9
7B Release # 2	31	15	5.7	3.5
7B Release # 3	29	0	12.1	2.6
Bypass Conduit # 1	0	17	0.2	0.2
Bypass Conduit # 2	0	28	0.2	0.2
Bypass Conduit # 3	0	0	0.2	0.2
Hatchery and wild fish combined				
6B Release # 1	38 *	11	20.7	5.3
6B Release # 2	0	3	21.4	15.9
6B Release # 3	2	2	22.2	17.2
7B Release # 1	29	11	13.5	4.8
7B Release # 2	10	12	5.6	0.2
7B Release # 3	26	9	9.6	2.6
Bypass Conduit # 1	2	10	0.3	0.2
Bypass Conduit # 2	3	10	0.2	0.2
Bypass Conduit # 3	0	3	0.2	0.2

* Inadequate water level problem in holding tank, disregard data.

Appendix B: Juvenile Lamprey Fyke-Net Catch

The following information on juvenile lamprey is being provided at the request of fishery agencies present at the COE annual AFEP review of research held in Walla Walla in November, 1999. During the presentation of results of this FGE study a figure showing seasonal juvenile lamprey catch by net level, similar to Appendix Figure B, was shown. The vertical distribution of juvenile lamprey at John Day Dam was discussed.

Seasonal FGE and percent catch by net level for juvenile lamprey are shown in Appendix Figure B and enumerated in Appendix Table B. For juvenile lamprey FGE was only 1.4% with 98.6% of the lamprey catch occurring in the nets. The largest catch was in net-level 6 (43.0%), followed by the bottom net-levels (7 plus 8) and net-level 5 (27.6 and 15.4%, respectively). The vertical distribution of juvenile lamprey appears to be opposite to that of juvenile salmonids outmigrating during the same time period. For yearling chinook salmon, FGE was 80% and the largest net catch was in level 5 (5.1%), followed by levels 4 and 6 (3.5 and 3.3%, respectively).



Appendix Figure B. Seasonal catch by net level during fish guidance efficiency (FGE) tests for juvenile pacific sea lamprey at John Day Dam, 1999. Gatewell = gatewell dipnet catch, Level 1 through 7 = fyke net catches (Level 1 is at the top, Level 7 at the bottom of the turbine intake).

Appendix Table B. Juvenile lamprey catch by net level during fish guidance efficiency (FGE) tests at John Day Dam, 1999.

	Date of test																		
Net Level	5	6	7	8	10	11	12	17	18	19	20	21	22	24	25	26	27	Total	% of total
Gatewell		1									1						1	3	1.4
One								1										1	0.5
Two											2						3	5	2.3
Three	1					1		1	1	1	2	1			1	3	4	16	7.5
Four							1		1						1	1	1	5	2.3
Five	1	1	1	1	3	1		2	1	1	2		3	2	2	5	7	33	15.4
Six	4	3	5		1	7	4	7	2	2	4	8	3	8	8	11	15	92	43.0
Seven		1		1	3	4		4	1	6	4	4	2		3	9	5	47	22.0
Eight	2			1	1			1	3					2		1	1	12	5.6
Total	8	6	6	3	8	13	5	16	9	10	15	13	8	12	15	30	37	214	100.0

Appendix C: Addendum to Report of Flows in the Gate Slot

In a phone conversation with with Tony Norris, USACE, on Jan 6, 2000 at 3:30 PM, we discussed flow up the slot at John Day Dam using the standard STS versus the ESBS and inlet flow vane. Tony said that there had not been any modeling done with exact John Day STS conditions, but preliminary modeling had been done at Lower Granite Dam, a similar powerhouse. Based on preliminary model studies at 21,000 cfs turbine discharge, flow up the slot was 208 cfs with an STS. Flow up the slot at John Day Dam using similar model studies for the ESBS used in conjunction with an inlet flow vane was 740 cfs.