Evaluation of turbine intake modifications at the Bonneville Dam Second Powerhouse, 2002

Fish Ecology Division

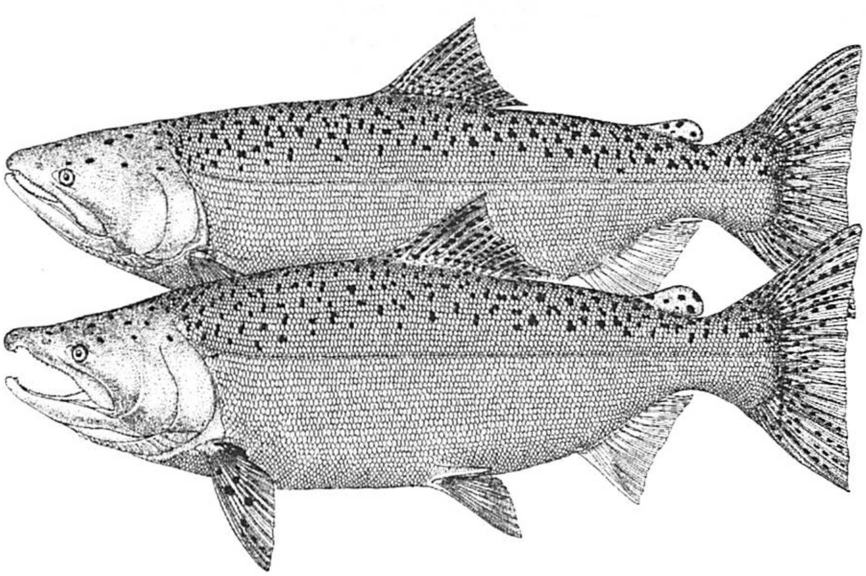
Northwest Fisheries Science Center

National Marine Fisheries Service

Seattle, Washington

by
Bruce H. Monk, Benjamin P. Sandford,
Dean A. Brege, and John W. Ferguson

September 2004



EVALUATION OF TURBINE INTAKE MODIFICATIONS AT THE BONNEVILLE DAM SECOND POWERHOUSE, 2002

Bruce H. Monk, Benjamin P. Sandford, Dean A. Brege, and John W. Ferguson

Report of research by

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

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Portland District
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EXECUTIVE SUMMARY

In 2000, the U.S. Army Corps of Engineers conducted hydraulic model studies to evaluate flow in the second powerhouse intakes at Bonneville Dam. As a result of these evaluations, three modifications were proposed to increase upward flow toward the intake gatewells:

1) Increase the size of the vertical barrier screen (VBS) by removing a portion of the concrete beam below it.
2) Install a turning vane below the picking beam on the submersible traveling screen (STS).
3) Install a gap-closure device on the intake ceiling downstream from the top edge of the STS.

In addition, to meet new design criteria for salmonid fry established by NOAA Fisheries, screen mesh openings on the new VBS were decreased to reduce impingement of fry.

In 2001, with all three of these modifications installed in the B and C gatewells of unit 15, we measured fish guidance efficiency (FGE), orifice passage efficiency (OPE), and fish condition. Mean FGE was 71% for yearling chinook salmon and over 80% for steelhead and coho, the highest values measured at the second powerhouse since testing began in the early 1980s. Improvements in FGE were similar for subyearling chinook salmon. OPE was high for yearling chinook salmon in the spring (94%) and for subyearling chinook salmon in the summer (99%). All fish in the 2001 OPE tests were PIT-tagged, so passage times from release in the gatewell to the detectors at the downstream smolt-monitoring facility could be measured. Median passage time for the 10 replicate tests averaged 1.6 and 0.8 h for yearling and subyearling chinook salmon, respectively. For each species, there was no significant difference between unit 15 and an unmodified unit for either OPE or passage time. During FGE and OPE tests, descaling and injury rates were low for all species, with no significant differences between the modified and unmodified units.

Because of these promising results, the same three intake modifications were installed in turbine unit 17 to determine if the results obtained in the middle of the powerhouse (unit 15) could also be achieved along the northern shoreline, where eddies and cross currents in the forebay were thought to reduce FGE. For all species tested during spring 2002, FGE was higher in gatewell 17B, with no turbine intake extension (TIE), than in either gatewell with a TIE (17A and 17C). Differences were significant

($P = 0.05$) for yearling chinook salmon among all three gatewells. Respective mean FGEs for yearling chinook, steelhead, and coho were 66, 54, and 71% in gatewell 17B (with no TIE), and 47, 49, and 51% in gatewell 17A (with TIE). Although values were not as high as those obtained in unit 15 in 2001, they were higher than those observed in unit 17 in 1994.

Mean FGE during spring 2002 was higher than in 1994 for all yearling species and for both test gatewells. For gatewell 17B, the differences between 2002 and 1994 were 14, 20, and 21% for yearling chinook salmon, coho salmon, and steelhead, respectively. For 17A the differences between 2002 and 1994 were 8, 1, and 17% for yearling chinook salmon, coho salmon, and steelhead, respectively. The higher FGEs observed for all species in 2002 in the gatewell with no TIE (17B) were similar to results observed for the entire second powerhouse in 1993 and 1994. During summer testing, mean FGE for subyearling chinook salmon was 57% in gatewell 17B (identical to that found in 2001 in gatewell unit 15B) and 47% in 17A. Summer FGE studies were not conducted in 1994.

During spring 2002, OPE was not as high for yearling chinook salmon (87%) as it was the previous year (94%). Structural problems with the redesigned VBSs interrupted testing and thus reduced the number of replicates. During FGE and OPE tests, descaling and injury rates were low for all species, with no significant differences between the modified and unmodified unit. Release and recovery of fry-sized coho salmon into the bypass pipe and to gatewell slot 15B during the last two weeks of March indicated minimal impingement or injury.

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INTRODUCTION

In 1970, in response to concerns over the effect of additional dams on juvenile Pacific salmon (*Oncorhynchus* spp.) during their seaward migration, the National Marine Fisheries Service (NMFS) began investigating means to decrease impacts to juvenile salmonids passing through Columbia River dams (Whitney et al. 1997). The NMFS focused on developing submersible traveling screens (STSs) that divert juvenile salmon migrants from turbine intakes and guide them into specially designed bypass systems which convey them to release points below the dam (Matthews et al. 1977). Performance of the STSs was measured by fish guidance efficiency (FGE) tests, which measure the percentage of fish guided into the bypass system by the STS relative to the total number of fish entering the turbine intake.

Bonneville Dam Second Powerhouse was completed in 1982 and NMFS began estimating FGE at this facility in 1983. Initial FGE measurements with standard-length STSs (6.1 m) were less than 25% for yearling chinook (*O. tshawytscha)* and coho salmon (*O. kisutch*) and approximately 33% for steelhead (*O. mykiss*). These guidance levels were considerably lower than the expected level of at leat 70% for all species (Krcma et al. 1984).

From 1984 to 1989, the U.S. Army Corps of Engineers (COE) and NMFS tested various design modifications to improve FGE at Bonneville Dam Second Powerhouse. Results indicated that modifications to increase flows above the STS and smooth flows into and within the turbine intake could substantially increase FGE for yearling chinook salmon (Gessel et al. 1991). Tests in 1985 showed that lowering the STS 0.8 m, in conjunction with streamlining the trash racks, increased FGE to about 40%, while the gap-net catch (percent of fish escaping over the top of STS) remained at less than 1%.

However, these tests also showed that lowering the STS 1.2 m increased the gap-net catch to 12% and reduced FGE to 29% (Gessel et al. 1986). From 1987 to 1989, FGE ranged from 51 to 74% (in 4-5 day test series) in units 11-13, with STSs lowered 0.8 m, streamlined trash racks, and turbine intake extensions (TIEs) installed. Based on these results, in 1991, STSs were lowered 0.8 m, streamlined trash racks were installed across the powerhouse, and TIEs were installed in alternating intake slots (Figure 1).

In 1993 and 1994, FGE was again measured at Bonneville Dam Second Powerhouse (Monk et al. 1994, 1995). In these tests, mean FGE was 57% for yearling

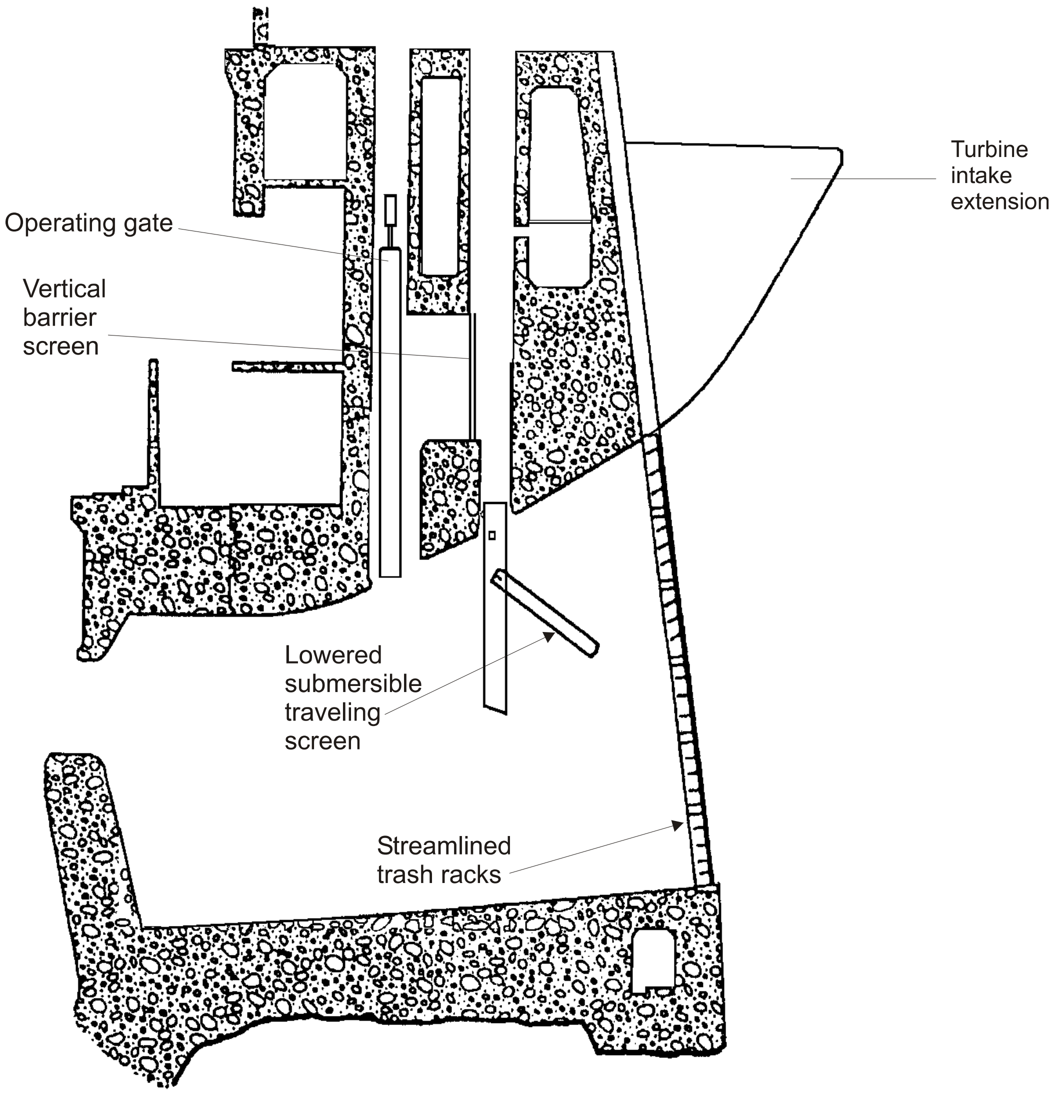

Figure 1. Cross section of standard unit at Bonneville Dam Second Powerhouse showing changes made during the 1980s.

chinook salmon in unit 15 with all eight turbine units in operation. Mean FGE for yearling chinook salmon in units 12 and 17 respectively was 53 and 32% with the 6 highest priority units in operation (units 11-13 and 16-18). During these tests the average gap-net catch for all species combined was less than 1%.

In 1999, NMFS reviewed all biological and hydraulic data collected between 1983 and 1998 at Bonneville Dam Second Powerhouse with respect to improving FGE (Monk et al. 1999a). To better understand the reasons for low FGE, the intake design at the second powerhouse was compared to those at other Columbia River dams where FGEs were higher. Differences were noted in forebay hydraulics, configurations of the intake structure, and components of the fish bypass systems, all of which seemed to contribute to the lower FGE at the second powerhouse. The 1999 evaluation concluded that intake flow conditions at the second powerhouse were not conducive to high fish guidance due to hydraulic constraints in the area above the STS leading to the gatewell. Monk et al. (1999a) recommended that efforts to improve FGE at the second powerhouse should focus on increasing flow into the gatewell, and that these flows would need to be 8.0 m^3/s (284 ft^3/s) or greater to be effective.

In a follow-up to the 1999 evaluation, hydraulic model studies of the Bonneville Dam Second Powerhouse intake were conducted by the COE in spring and summer 2000 at the COE Engineering Research and Development Center (ERDC) in Vicksburg, Mississippi and by ENSR Consultants in Redmond, Washington. These studies measured flows of 7.6 m^3/s (270 ft^3/s) in the gatewell slot with corresponding gap flows of 6.1 m^3/s (215 ft^3/s) over the top of the STS. This high percentage of flow through the throat area of the STS (44%) indicated that potential for loss of fish through the gap was substantially larger than that actually measured during previous FGE studies. Three modifications were proposed to increase flow from the turbine intakes into the gatewell while minimizing loss of fish through the gap:

1) Increase the size of the vertical barrier screen (VBS) by removing a portion of the concrete beam below it

2) Install a turning vane below the picking beam on the STS

3) Install a gap closure device on the intake ceiling downstream from the top edge of the STS (Figure 2; Inca Engineers 1999).

To meet new design criteria for salmonid fry established by NMFS, screen mesh openings on the new VBS were decreased from 0.125 to 0.08 in, with a screen porosity of 44%. These proposed modifications, as well as a larger VBS, were tested in hydraulic

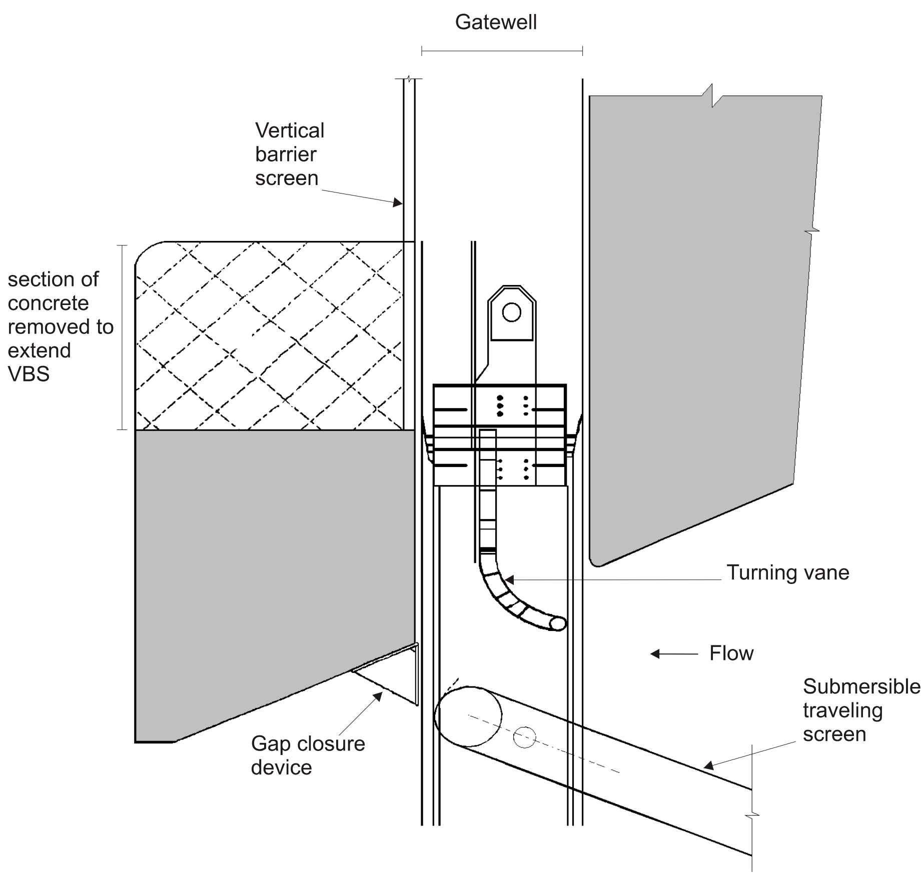

Figure 2. Cross section of unit 15 at Bonneville Dam Second Powerhouse showing the three modifications evaluated in 2002: 1) removal of a section of concrete beam to allow for a longer vertical barrier screen, 2) installation of a turning vane, and 3) installation of a gap closure device.

models at ERDC and ENSR. Results indicated the modifications would increase gatewell flow to 13.6 m^3/s (480 ft^3/s) while decreasing gap flow to 2.5 m^3/s (90 ft^3/s).

In the spring of 2001 all three of these modifications were installed in gatewells 15B and 15C, and two modifications (no gap closure device) were installed in gatewell 15A. During the spring and summer of 2001, measurements of FGE, orifice passage efficiency (OPE), and fish condition were then conducted in gatewells 15A and 15B. During tests in the spring, mean FGE was 71% (SE = 2.5) for yearling chinook salmon and over 80% for steelhead and coho, the highest values measured at the second powerhouse since testing began in the early 1980s (Monk et al. 2002). These values were 15 to 33% higher than comparable values measured in the same unit in 1994. During summer testing, mean FGE for subyearling chinook was 57%, approximately 17% higher than earlier measurements.

In 2001, OPE was high in the spring for yearling chinook salmon (94%) and in the summer for subyearling chinook salmon (99%). All fish in OPE tests were PIT-tagged so that passage times from release in the gatewell to detection at the downstream smolt monitoring facility could be measured. In the 10 replicate tests during 2001, median passage times averaged 1.6 and 0.8 h for yearling and subyearling chinook salmon, respectively. There were no significant differences in OPE or passage time between unit 15 and an unmodified unit. During FGE and OPE tests, descaling and injury rates were low for all species, with no significant differences between the modified and unmodified unit.

Because of these promising results, the same three modifications were installed in unit 17 at Bonneville Dam Second Powerhouse in the spring of 2002, and similar tests of FGE, OPE, and fish condition were conducted in the spring and summer of 2002. These tests were conducted in unit 17 to determine if the results obtained in the middle of the powerhouse could also be achieved on the northern shoreline, where eddies and cross currents were thought to be the cause of lower FGEs (Monk et al. 1999a). Research objectives of these tests were:

1) To estimate FGE of a modified screen system at Bonneville Dam Second Powerhouse during the spring and summer juvenile migrations.

2) To evaluate OPE in a modified screen system unit and compare to a standard unit during spring and summer migrations.

3) To evaluate the effects of a modified screen system on juvenile salmonids (including smaller fry) and lamprey and compare them to the effects of a standard unit during spring and summer juvenile migrations.

OBJECTIVE 1: Estimate Fish Guidance Efficiency of the Modified Screen System

Approach

Tests for estimating FGE were conducted in the A, B, and C gatewells of unit 17. Methods for determining FGE were the same as those used in previous studies (Monk et al. 1994, 1995; Gessel et al. 1991). A fyke-net frame with a net array was hung under the STS, and gap nets and closure nets were used to close off the area directly above and below the STS (Figure 3). Gatewell dip-net catches provided the number of guided fish, and fyke-net catches provided the number of unguided fish. The FGE for each species was calculated as gatewell catch (guided fish) divided by the total number of fish (guided plus unguided) passing through the intake during the test period. Comparisons between gatewells were made using ANOVA ($\alpha = 0.05$).

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

$$GW = Gatewell\ catch$$
$$FN = Fyke\text{-}net\ catch$$

During both the spring and summer, each test was started at 2000 and ended when approximately 200 of the target species had been collected (2130-2230). In 2001, to determine if turbine operating mode would affect FGE, unit 15 had been operated in one of two alternate modes each night: 1) the upper 1% of the efficiency range (for existing net head as prescribed by COE Fish Passage Plan) and, 2) Automatic Governing Control (AGC), which balances the unit load with those of other operating units (presently standard unit operation at the second powerhouse). No significant difference in FGE was detected between the two operating modes in 2001; therefore, all FGE testing in 2002 was done with unit 17 operating on AGC.

During spring testing, load output levels in units 16 and 17 ranged from 52 to 64 MW and averaged 57 MW, while discharge levels ranged from 12.0 to 16.7 kcfs and averaged 13.9 kcfs. On a daily basis, discharge levels between units varied by 1 to 2%. During summer testing, load output levels in units 16 and 17 ranged from 49 to 61 MW and averaged 56 MW, while discharge levels ranged from 12.2 to 16.3 kcfs and averaged 14.9 kcfs. Again, discharge levels between the two units varied by 1 to 2%.

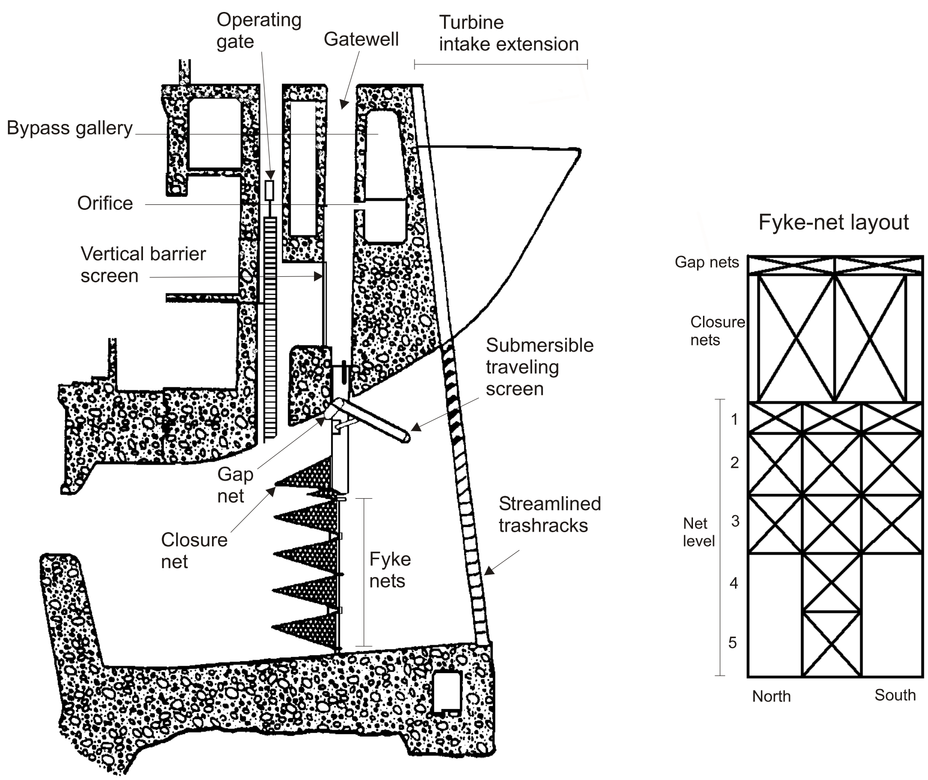

Figure 3. Cross section of unit at Bonneville Dam Second Powerhouse showing layout of fyke nets used during fish guidance efficiency tests in spring and summer 2002.

Results and Discussion

Spring Testing

From 22 April to 31 May, 22 FGE tests were completed. Gatewell and fyke-net catches and resulting FGEs from each test in gatewells 17A, 17B, and 17C are given in Appendix Table 1 for yearling and subyearling chinook salmon, coho and sockeye salmon, and steelhead.

In gatewell slot 17A (with TIE), FGE ranged from 23 to 88% for yearling chinook salmon (mean FGE = 47%; SE = 5.9), and mean FGE was 51% for coho salmon (SE = 6.8) and 49% for steelhead (SE = 6.4). Because of small sample sizes, no estimate was made for sockeye salmon.

In gatewell slot 17B (no TIE), FGE ranged from 41 to 86% for yearling chinook salmon (mean = 66%; SE = 4.7). Mean FGE for coho salmon was 71% (SE = 5.7), and mean FGE for steelhead was 54% (SE = 5.3). Figure 4 compares the FGE from all three gatewell slots of unit 17. For yearling chinook salmon, there was a significant difference in FGE between gatewell slots ($P = 0.001$).

Table 1 shows a comparison of FGEs of various species in unit 17 between 1994 (standard conditions) and 2002 (with the three modifications in place). For all species except subyearling chinook salmon during the spring run, the modified condition showed considerable improvement in FGE over the standard condition. Results from FGE tests in gatewell 17C were not compared to previous results because no FGE tests were conducted in the C gatewell prior to 2002.

Summer Testing

From 11 June to 12 July, 20 FGE tests were conducted with subyearling chinook salmon as the target species. Gatewell catches, fyke-net catches, and resulting FGE are given in Appendix Table 1 for all of these tests. Mean FGE was 48% in gatewell slot 17A (with TIE; SE = 2.5) and 57% in gatewell 17B (no TIE; SE = 3.9). The difference was significant ($P = 0.025$).

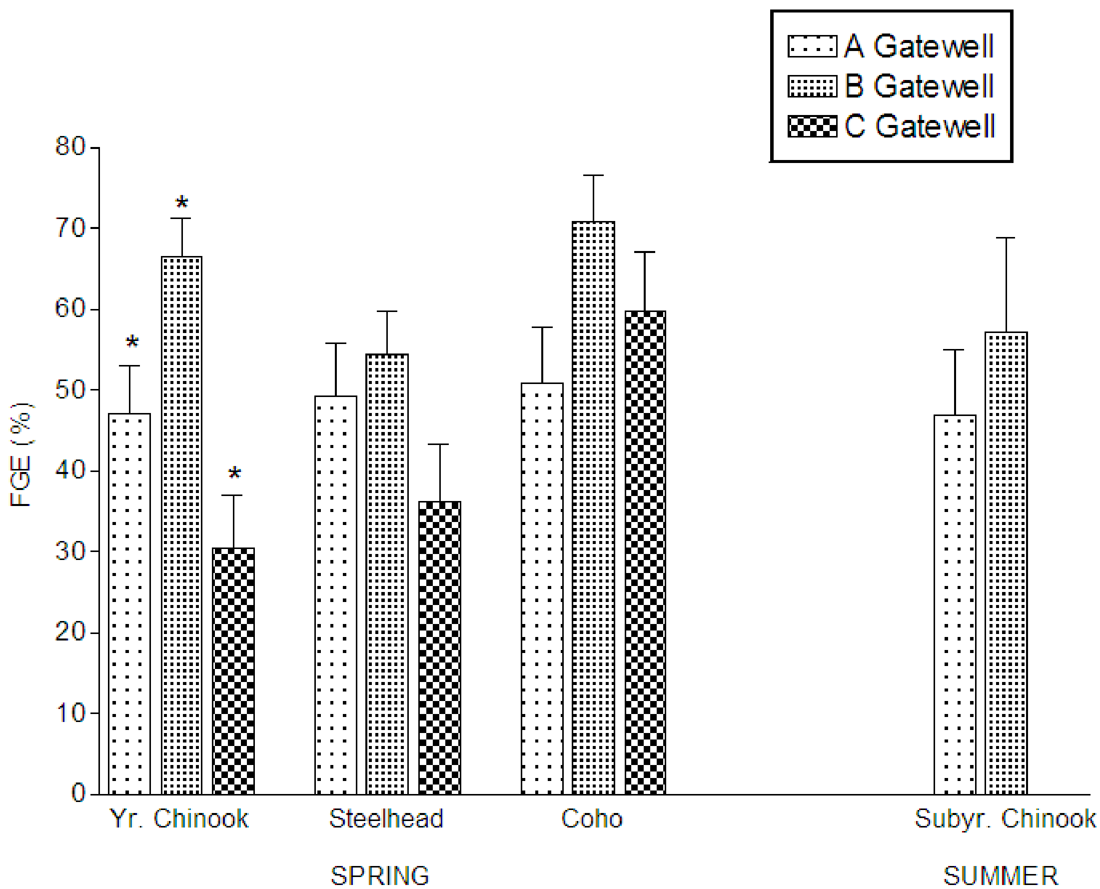

Figure 4. Mean fish guidance efficiency tests and standard errors for tests conducted in spring and summer in unit 17 (A, B, and C gatewells), Bonneville Dam Second Powerhouse, 2002. (*denotes significant difference between gatewell slots $P = 0.05$).

Table 1. Average fish guidance efficiency (FGE) and standard errors for all species tested in unit 17A and 17B in 1994 (standard conditions) and 2002 (with all three modifications in place). Also shown is the difference (Δ) in FGE between the two conditions (2002-1994).

Species	Unit and gatewell	1994	2002	Δ
		Spring		
Subyearling chinook	17A	47 (5.5)	38 (3.5)*	-9
Subyearling chinook	17B	57 (2.3)	67 (9.2)*	10
Yearling chinook	17A	39 (2.7)	47 (5.9)	8
Yearling chinook	17B	42 (4.1)	66 (4.7)	14
Steelhead	17A	32 (4.6)	49 (6.4)	17
Steelhead	17B	33 (4.1)	54 (5.3)	21
Coho	17A	50 (3.2)	51 (6.8)	1
Coho	17B	51 (4.0)	71 (5.7)	20
		Summer		
Subyearling chinook	17A	**	48 (2.5)	
Subyearling chinook	17B	**	57 (3.9)	

* Small sample size

** Fish guidance efficiency tests in summer 1994 were conducted later in the migration so no comparisons were made with 2002.

OBJECTIVE 2: Compare Gatewell Orifice Passage Efficiency for a Modified vs. a Standard Screen System

Approach

To conduct OPE tests, groups of 200 juvenile salmon (yearling chinook in spring and subyearling chinook in summer) were anesthetized, PIT-tagged, held for approximately 5 h, and finally released into gatewell slots 17B (modified unit), 15B (modified in 2001) and 16B (standard unit). Releases were made at approximately 2300 (100 fish released into each gatewell). A 240-L (63 gal.) aluminum canister (Absolon and Brege 2003) was used to lower the fish 4.6 m (15 ft) below the orifice at elevation 14 m (45 ft) msl. All releases were made with the units operating and the orifices open.

Releases made into unit 17 were handled in two different ways. First, if the unit was needed the following day for FGE tests, the orifice was closed for approximately 17 h after the release. All fish remaining in the gatewell were dipped out, any remaining PIT-tagged fish were counted, and OPE was calculated as the percentage of PIT-tagged fish that exited the gatewell during the 17-h test. For all fish that did exit before the gatewell was closed, passage time was calculated as time from release in the gatewell to detection at the second powerhouse monitoring facility.

The second method was used on days when the test unit could be operated without interruption for at least 72 h. During these tests, fish were never removed from the gatewell, so OPE was not obtained. However, since the units were allowed to run for longer periods, it was possible to obtain a better measure of passage time for the entire release group. From these releases, passage time to the second powerhouse monitoring facility was calculated for the 10th, 50th, and 90th percentile for the entire release group. All passage times from releases into units 15 and 16 were calculated using this method.

Results and Discussion

Spring Testing

From 22 April through 22 May, 6 replicates were released for OPE tests in gatewell slot 17B (Appendix Table 2). Yearling chinook salmon OPE ranged from 70 to 100% and averaged 87% (SE = 5.2) for the spring season. This was lower than the OPE of 94% (SE = 2.5) found in gatewell slot 15B during 2001 tests, but still acceptable.

The average median passage time for fish exiting gatewell slot 17B during OPE tests in 2002 was 1.1 h compared to 1.6 h for fish exiting slot 15B in 2001. Testing in gatewell slot 17B was interrupted due to failure of the redesigned VBS. As a result, passage times for the 72-hour tests were inconclusive due to inadequate numbers of replicates for statistical accuracy.

Summer Testing

From 12 June through 8 July, 8 replicates were released for OPE tests in gatewell slot 17B (Appendix Table 2). For subyearling chinook salmon, OPE ranged from 80 to 100% and averaged 96% (SE = 3.2) for the summer season. This compares favorably with OPE of 99% (SE = 0.6) found in gatewell slot 15B during 2001 tests.

Average median passage time for fish exiting gatewell slot 17B during the OPE test series was 0.9 h compared to 0.8 h for fish exiting gatewell slot 15B during 2001. Passage times for the 72-hour tests were inconclusive due to inadequate numbers of replicates for statistical accuracy, again because of unanticipated interruptions in testing.

OBJECTIVE 3: Compare Physical Effects and Vertical Distribution of Juvenile Salmonids and Pacific Lamprey in a Modified vs. a Standard Screen System

Impingement of Salmonid Fry

To determine whether mechanical or structural conditions within the Bonneville Dam Second Powerhouse bypass system were detrimental to salmonid fry, releases of coho fry were made into two locations within the bypass system during the last two weeks of March. The first set of two releases was made into the bypass pipe, 0.5 km above the downstream monitoring facility. These releases ensured that fry-sized fish were not being stranded under the switch-gate (sample gate) at the upstream end of the monitoring facility. The gate had been modified to eliminate this problem after it was observed in 2001. During these releases, the sample gate was set to divert 100% of PIT-tagged fish, so that all fish could be recovered and examined for descaling, injury, and mortality. A net was also placed downstream from the gate so that any fish going under the gate could be recovered and counted.

The second set of two releases was made into gatewell slot 15B (modified in 2001, Monk et al. 2002). These releases were made to determine if any fry-sized salmonids were being impinged on the modified VBS. To determine this, a video camera was lowered into the gatewell to inspect the VBS for impinged fish after each release. During these releases the sample gate at the facility was set to divert 100% of PIT-tagged fish for 24 h; all recovered fish were reexamined for descaling, injury and mortality. The downstream net was kept in place to further assess whether the modified switch-gate was working properly.

Fish for both of these release groups were coho salmon (avg. size = 40.9 mm) from Willard National Fish Hatchery on the Little White Salmon River. The fish were transported to Bonneville Dam, marked by staining with Bismark Brown Y dye (Krcma et al. 1986; Absolon et al. 2000) and divided into four groups of 200 fish each. Using this dye, fish from the release groups could be easily differentiated from naturally migrating fry. Marked groups were held from 1 to 3 days prior to release.

No fish were found in the net behind the switch gate after any of the four releases. Also, no fish from any of the releases or from naturally-migrating fry were observed under the switch gate for 6 h following release (Table 2). During the first two respective releases, only 97 and 98% of the marked fry were recovered. This was probably due to

Table 2. Percentage of coho salmon fry recovered from releases made into bypass pipe and gatewell 15B at Bonneville Dam Second Powerhouse, 2002.

Date	Number Released	Recovered (%)	Number behind gate	Number on VBS
Pipe releases				
3/26	200	97	0	
3/29	200	98	0	
Gatewell releases				
3/27	200	47	0	0
3/28	200	67	0	0

the large amount of debris (small sticks and milfoil) collected when the sample gate was set at 100%. Descaling on recovered fish was 4%, and appeared to be caused primarily by the unusual amount of debris entrained with the sample. Since the sample gate is generally set to divert 5% or less during standard operations at the facility, debris accumulation should not normally be a problem.

Video tape revealed no released fry being impinged on the VBS after the two gatewell releases. The video camera worked well, and a close inspection of the entire VBS was accomplished. After the first release, the VBS was pulled from the gatewell to remove debris, and seven stickleback and two chinook fry were removed by hand (most of these fish had been seen on the video tape). After the second release, seven stickleback were observed on the VBS with the camera, but the screen was not pulled.

Only 47 and 67% of the fish were recovered at the fish monitoring facility during the 24 h of sampling at 100%. Many of the marked fry probably remained in the gatewell for more than 24 h because they were not actively migrating. To collect closer to 100% of the releases, the sample rate at the facility would likely have to be set at 100% for 48 h or longer. However, this could not be accomplished because of debris loads and the presence of other migrating salmonids and stickleback.

Descaling of Salmonid Smolts

All juvenile salmon collected during FGE testing in the modified turbine unit (17) were examined for descaling and injury. Since FGE tests were conducted in all three gatewells of unit 17, the corresponding gatewells in unit 16 were sampled to compare short-term descaling among all gatewells in both the modified and unmodified units. All fish were removed and released from unit 16 prior to initiating FGE tests in unit 17, so that fish from both units were in the gatewells for the same length of time (2-3 h).

Because of increased water velocity inside the gatewells in the modified unit, it was important to determine descaling and injury on fish that might have been in the gatewell and exposed to this velocity for longer periods of time. Therefore, at the end of the 17-hour OPE tests, all fish from 17B were also examined for descaling and injury. To compare these results with descaling in an unmodified unit, fish were sampled from 16B at the same time. Fish entering gatewells during OPE tests could voluntarily exit via the orifice at any time. Therefore, not all fish examined were in the gatewell for the entire 17 h, but a percentage were exposed to the gatewell environment for periods longer than fish examined after the FGE tests (short-term descaling).

A fish was determined to be descaled if cumulative scale loss exceeded 20% on either side (Ceballos et al. 1992). Since the objective was to determine whether the modified gatewell environment was adversely affecting fish condition, fish with scale regeneration or fungal growth were not classified as descaled, and descaling caused by birds, when obvious, was not counted. Although each fish body was examined for injuries, only head injuries were observed, and these were either folded operculums or eye injuries.

The same personnel examined the fish throughout the study period to ensure that evaluations of descaling and injury were as consistent as possible. Short-term and long-term descaling results were compared between the modified and unmodified units using a Student's *t*-test. No statistical comparisons of injury rates between the two units were made because of low numbers.

Appendix Table 3 shows the numbers of fish examined and the numbers classified as descaled or injured in units 16 and 17 during both the FGE (short-term) and OPE (long-term) tests. Differences in descaling between unit 16 (unmodified) and unit 17 (modified) are shown in Figure 5, and differences between short- and long-term descaling are given in Appendix Table 4. For yearling and subyearling chinook salmon and steelhead, no significant descaling differences were observed. For coho salmon, the differnce in descaling between units was nearly significant; however, the small sample size negated the conclusion that the difference was biologically meaningful. Both combined descaling and injury rates were low for all species during the spring season.

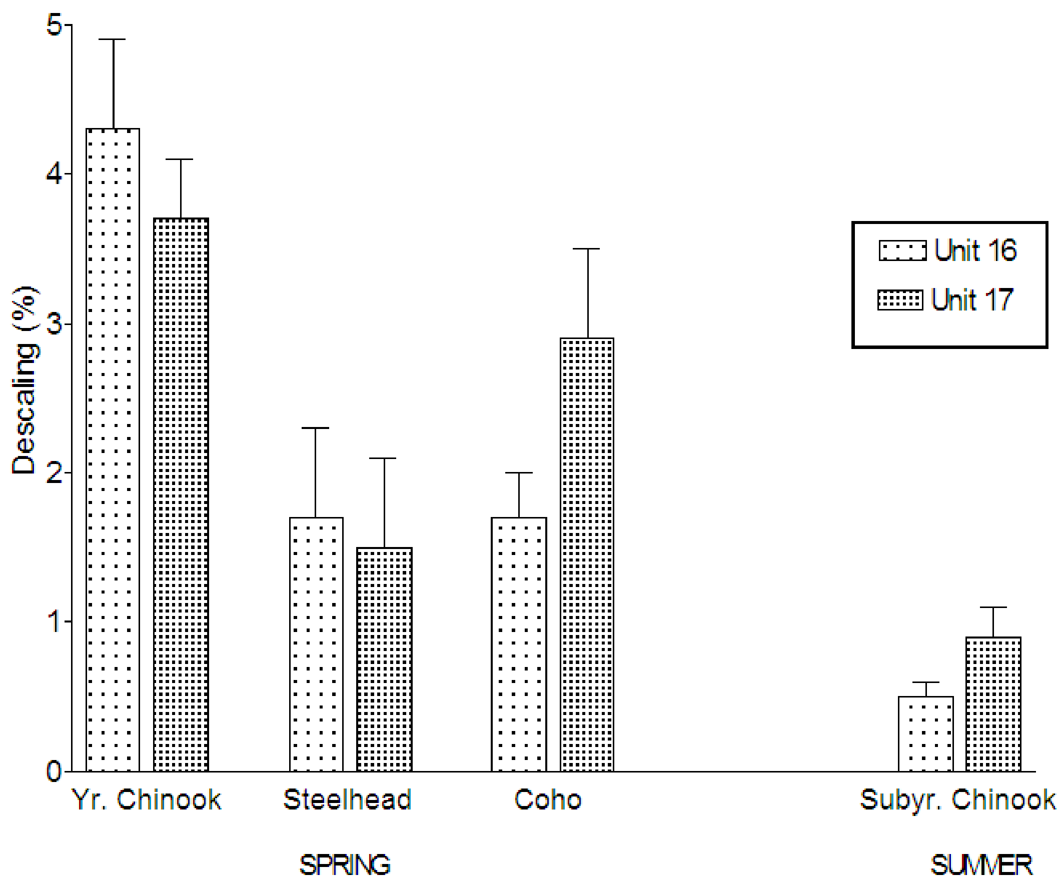

Figure 5. Mean descaling for all species examined during FGE (short term) and OPE (long term) tests in unit 16 and 17 (all three gatewells combined in each unit) in spring and summer testing, Bonneville Dam Second Powerhouse, 2002).

Fyke-Net Distributions of Salmonid Parr and Juvenile Pacific Lamprey

Salmonid Parr

Only five salmonid parr were collected during spring FGE testing at the second powerhouse (Appendix Table 5). None of these fish were caught in the gatewell; all were found in the nets (FGE = 0%). However, two of the five fish were discovered in the gap net, indicating that these fish were high enough in the water column to have been guided by the STS, but were swept over it. This was similar to results at the second powerhouse in 2001 when 20% of the salmonid parr were found in the gap net during FGE tests (Monk et al. 2002).

Juvenile Lamprey

Of the 711 lamprey collected, one was collected from the gatewell and eight from the gap net (Figure 6; Appendix Table 5). The remaining fish were caught in the fyke nets, with 75% caught in net levels 3 and 4 (from elevation -0.3 m to -5.1 m msl; Figure 3). This was comparable to results seen previously at Bonneville Dam First (Monk et al. 1999b, 2001) and Second Powerhouse (Monk et al. 2002). In all cases, most juvenile lamprey were well below an area where they were susceptible to interception by the STS.

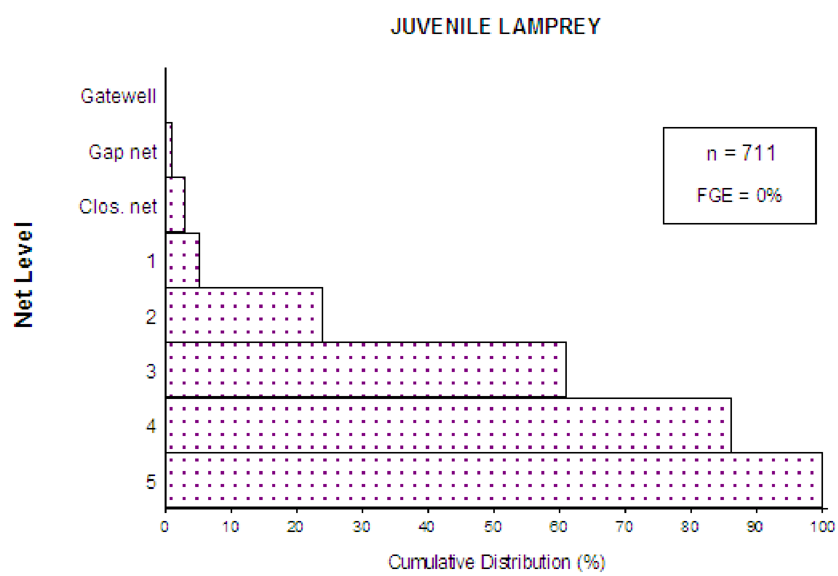

Figure 6. Cumulative distribution of juvenile lamprey caught in gatewell and fyke nets during fish guidance efficiency tests.

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APPENDIX: Data Tables

Appendix Table 1. Numbers of salmonids caught in the gatewell or gap net (guided) or in the closure net or fyke nets1-5 (not guided) and fish guidance efficiency (FGE) for individual tests in unit 17 (A, B or C gatewell) at Bonneville Dam Second Powerhouse, 2002. Abbreviations: NS = data not sufficient, SC = subyearling chinook salmon, YC = yearling chinook salmon, ST = steelhead, CO = coho, SO = sockeye salmon.

	22 April (B)					23 April (A)*					24 April (A)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	0	257	6	20	0	0	142	1	7	0	0	29	4	6	0
Gap net	0	24	1	2	0	0	0	0	0	0	0	1	0	1	0
Closure net	1	24	0	0	0	0	33	0	3	0	0	25	0	2	0
1	0	8	0	0	0	0	4	0	0	0	0	5	0	0	0
2	0	50	0	2	0	0	40	1	0	0	1	39	0	2	0
3	9	25	0	1	0	0	27	0	0	0	0	19	2	1	0
4	0	0	0	0	0	0	6	0	1	0	0	6	0	0	1
5	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0
Totals	10	391	7	25	0	0	252	2	11	0	1	127	6	12	1
FGE (%)	0	66	86	80	NS	NS	56	50	64	NS	0	23	67	50	0

	25 April (B)					26 April (A)[a]					27 April (B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	0	160	13	7	0	0	37	4	2	0	1	137	3	11	0
Gap net	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Closure net	0	10	4	0	0	1	24	11	2	0	0	41	1	1	0
1	0	4	3	0	0	0	12	2	0	0	0	13	0	0	0
2	0	22	8	1	0	0	29	5	0	1	1	59	2	1	0
3	0	6	2	0	0	0	17	8	0	2	0	24	0	1	0
4	0	3	0	0	0	0	8	0	0	3	0	8	0	0	0
5	3	0	0	0	0	0	0	0	0	0	0	5	0	0	0
Totals	3	206	30	8	0	1	128	30	4	6	2	288	6	14	0
FGE (%)	0	78	43	88	NS	0	29	13	50	0	50	48	50	79	NS

Appendix Table 1. Continued.

	29 April (C)					7 May (B)					8 May (C)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	1	89	1	41	0	20	132	32	58	2	4	34	4	40	0
Gap net	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0
Closure net	0	63	0	0	0	6	29	7	8	0	5	19	2	12	2
1	0	17	0	0	0	4	7	2	4	0	2	7	0	1	0
2	0	45	0	0	0	9	47	14	17	2	1	24	3	10	2
3	1	26	1	0	0	2	20	2	4	2	0	20	0	7	1
4	0	0	0	0	0	0	9	1	1	0	0	0	0	3	0
5	0	9	0	0	0	0	12	0	0	0	0	3	0	0	0
Totals	2	249	2	41	0	42	257	58	92	6	12	108	9	73	5
FGE (%)	50	36	50	100	NS	48	51	55	63	33	33	31	44	55	0

	9 May (B)					10 May (C)					11 May (B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	12	107	47	61	10	5	61	26	44	2	29	205	4	158	46
Gap net	0	5	2	2	0	1	0	0	2	0	0	4	0	1	1
Clos. Net	6	44	8	15	3	2	51	7	9	5	9	36	2	20	2
1	3	12	9	6	1	0	19	7	11	6	1	22	0	4	2
2	5	68	25	19	15	3	68	37	53	10	3	35	1	11	3
3	2	22	2	3	14	2	28	14	27	22	2	10	1	2	2
4	0	4	0	4	4	0	5	0	4	1	3	0	0	1	0
5	0	0	3	0	0	0	4	0	0	0	0	0	0	0	0
Totals	28	262	96	110	47	13	236	91	150	46	47	312	8	197	56
FGE (%)	43	41	49	55	21	38	26	29	29	4	62	66	50	80	82

Appendix Table 1. Continued.

	14 May (B)					15 May (C)					16 May (C)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	5	106	9	69	0	1	14	2	57	2	1	31	9	51	3
Gap net	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0
Closure net	0	20	0	5	0	2	4	0	4	0	2	15	2	12	3
1	1	4	3	1	1	0	3	1	1	0	0	7	0	2	0
2	0	14	2	6	1	1	8	1	6	0	3	28	4	10	5
3	0	10	0	6	0	0	9	1	4	0	1	17	5	9	3
4	0	0	0	0	0	0	0	0	0	0	3	4	0	0	5
5	0	6	0	6	0	0	0	0	0	0	0	0	0	3	0
Totals	7	161	14	94	2	4	38	5	72	2	10	103	20	87	19
FGE (%)	71	66	64	73	0	25	37	40	79	100	10	30	45	59	16

	17 May (B)					20 May (B)					21 May (C)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	21	242	9	164	23	25	199	18	97	12	2	12	1	8	3
Gap net	0	3	0	1	0	0	1	1	2	0	0	0	1	0	0
Closure net	2	30	1	23	4	2	18	4	19	5	0	10	0	3	0
1	3	7	0	3	2	0	16	3	5	2	1	5	0	2	0
2	0	22	1	11	4	1	26	9	20	5	0	8	4	3	11
3	0	14	2	8	2	0	9	1	8	3	0	9	4	0	26
4	0	0	0	0	3	0	5	0	4	2	0	5	0	3	6
5	0	3	0	0	0	0	0	0	3	0	0	3	0	3	0
Totals	26	321	13	210	38	28	274	36	158	29	3	52	10	22	46
FGE (%)	81	75	69	78	61	89	73	50	61	41	67	23	10	36	7

Appendix Table 1. Continued.

	22 May (B)					23 May (A)					28 May (A)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	14	205	17	58	11	15	214	19	49	4	0	20	23	3	0
Gap net	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0
Closure net	2	10	5	9	2	0	4	4	3	2	0	4	1	4	0
1	0	4	3	1	2	1	6	2	2	0	0	2	1	2	1
2	0	13	12	11	9	1	10	2	2	6	2	4	4	5	0
3	1	10	12	4	8	1	5	5	3	1	0	6	1	1	4
4	1	5	0	0	4	0	4	0	4	3	3	3	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	18	247	50	84	36	18	243	33	63	16	5	39	30	15	5
FGE (%)	78	83	34	69	31	83	88	58	78	25	0	51	77	20	0

	29 May (B)					30 May (A)					31 May (A)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	16	189	16	18	1	16	65	59	39	1	15	21	32	10	4
Gap net	0	1	0	0	0	0	2	2	1	0	0	0	1	0	0
Closure net	0	6	6	3	0	7	19	20	18	0	9	7	7	3	1
1	1	4	1	0	0	0	7	7	2	0	2	4	2	1	0
2	1	11	7	5	2	6	27	26	10	4	8	8	19	4	4
3	3	9	7	4	1	6	17	24	7	2	4	17	16	2	2
4	0	0	0	0	0	3	5	6	3	3	5	0	3	0	0
5	0	0	0	0	0	0	0	0	3	0		0	0	0	0
Totals	21	220	37	30	4	38	142	144	83	10	43	57	80	20	11
FGE (%)	76	86	43	60	25	42	46	41	47	10	35	37	40	50	36

Appendix Table 1. Continued.

	11 June (B)					12 June (A)					13 June (A)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	94	4	11	2	1	57	4	10	13	0	108	5	8	12	4
Gap net	1	0	0	0	0	0	0	1	1	0	2	0	0	0	0
Closure net	17	0	1	0	0	22	2	1	1	0	21	0	3	2	2
1	10	0	0	0	0	9	2	1	0	2	8	0	1	1	0
2	20	0	1	0	1	22	1	1	1	1	23	3	4	3	1
3	14	1	1	0	0	19	3	0	3	1	13	3	0	0	0
4	4	0	0	3	0	4	0	0	3	0	5	0	0	0	0
5	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Totals	163	5	14	5	2	136	12	14	22	4	180	11	16	18	7
FGE (%)	58	80	79	40	50	42	33	71	59	0	60	45	50	67	57

	14 June (A)					15 June (A)					17 June (B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	49	4	28	10	1	82	4	29	2	2	84	0	3	0	0
Gap net	2	0	0	0	0	1	0	2	0	0	1	0	0	0	0
Closure net	17	0	2	0	0	37	3	2	1	2	43	0	0	1	0
1	6	0	0	0	0	5	0	0	0	0	8	0	0	0	0
2	37	2	0	2	1	43	2	4	3	2	33	0	0	0	0
3	16	0	0	1	0	35	4	2	0	3	16	0	1	0	1
4	6	0	0	0	0	12	0	3	3	0	6	0	0	0	0
5	9	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Totals	142	6	30	13	2	215	13	42	9	9	194	0	4	1	1
FGE (%)	35	67	93	77	50	38.1	31	69	22	22	43	NS	75	0	0

Appendix Table 1. Continued.

	18 June (A)					19 June (B)					20 June (B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	108	0	6	0	2	50	1	1	0	1	110	2	0	0	1
Gap net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Closure net	43	1	1	0	2	11	0	0	0	0	21	0	0	0	0
1	8	0	0	0	0	5	0	0	0	0	1	0	0	0	0
2	20	1	0	0	0	25	1	0	0	0	17	0	2	0	0
3	11	0	0	0	1	12	1	0	0	0	5	0	0	0	0
4	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	190	2	7	0	5	104	3	1	0	1	155	2	2	0	1
FGE (%)	57	0	86	NS	40	48	33	100	NS	100	71	100	0	NS	100

	21 June (A)					24 June (B)					25 June (A)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	99	0	0	0	1	111	0	1	0	0	172	2	0	0	0
Gap net	1	0	0	0	0	2	0	0	0	0	6	0	0	0	0
Closure net	6	0	0	0	0	27	0	0	0	0	85	0	0	0	2
1	7	0	0	0	0	5	0	0	0	0	12	0	0	0	1
2	36	1	0	0	0	33	0	0	0	0	42	0	0	0	0
3	18	0	0	0	0	18	0	0	0	0	19	0	0	0	0
4	6	0	0	0	0	24	0	0	0	0	21	0	0	0	0
5	0	0	0	0	0	3	0	0	0	0	6	0	0	0	0
Totals	173	1	0	0	1	223	0	1	0	0	363	2	0	0	3
FGE (%)	57	0	NS	NS	100	50	NS	100	NS	NS	47	100	NS	NS	0

Appendix Table 1. Continued.

	26 June (B)					27 June (A)					28 June (B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	259	4	1	0	0	165	1	2	0	0	232	2	1	0	2
Gap net	1	0	0	0	0	3	0	0	0	0	3	0	0	0	0
Closure net	36	0	0	0	0	63	0	0	0	1	50	0	0	0	0
1	5	0	0	0	0	19	0	0	0	0	21	0	0	0	0
2	24	0	0	0	0	53	1	1	0	0	55	1	0	0	0
3	17	0	0	0	1	39	0	0	0	0	72	0	0	0	0
4	6	0	0	0	0	27	0	0	0	0	0	0	0	0	0
5	30	0	0	0	0	6	0	0	0	0	12	0	0	0	0
Totals	378	4	1	0	1	375	2	3	0	1	445	3	1	0	0
FGE (%)	69	100	100	NS	0	44	50	67	NS	0	52	67	100	NS	100

	29 June (A)					1 July (A)					2 July (B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	267	0	3	0	1	173	0	0	0	0	112	2	0	0	2
Gap net	1	0	0	0	0	6	0	0	0	0	21	0	0	0	0
Closure net	81	0	0	0	0	56	0	0	0	0	7	0	0	0	0
1	12	0	0	0	0	11	0	0	0	0	11	0	0	0	0
2	43	0	2	0	0	56	2	0	0	1	21	0	0	0	0
3	34	0	0	0	0	37	0	0	0	0	17	0	0	0	0
4	27	0	0	0	0	21	0	0	0	0	30	0	0	0	0
5	3	0	0	0	0	3	0	0	0	0	3	0	0	0	0
Totals	468	0	5	0	1	363	2	0	0	1	222	2	0	0	2
FGE (%)	57	NS	60	NS	100	48	0	NS	NS	0	60	100	NS	NS	100

Appendix Table 1. Continued.

Location	3 July (B)					8 July (A)					9 July (B)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	302	0	0	0	1	78	2	0	1	0	93	0	0	0	0
Gap net	3	0	0	0	0	1	0	0	0	0	4	0	0	0	0
Closure net	18	0	0	0	1	42	0	0	0	0	28	0	0	0	0
1	5	0	0	0	0	10	0	0	0	0	7	0	0	0	0
2	22	0	0	0	0	33	0	0	0	0	14	0	0	0	0
3	13	1	0	0	0	23	0	0	0	0	27	0	0	0	0
4	15	0	0	1	0	12	0	0	0	0	12	0	0	0	0
5	0	0	0	0	0	6	0	0	0	0	9	0	0	0	0
Totals	378	1	0	1	2	205	2	0	1	0	194	0	0	0	0
FGE (%)	80	0	NS	0	50	38	100	NS	100	NS	50	NS	NS	NS	NS

Location	10 July (A)				
	SC	YC	ST	CO	SO
Gatewell	87	0	0	0	0
Gap net		0	0	0	0
Closure net	18	0	0	0	0
1	7	0	0	0	0
2	14	0	0	0	0
3	16	0	0	0	0
4	27	0	0	0	0
5	0	0	0	0	0
Totals	169	0	0	0	0
FGE (%)	51	NS	NS	NS	NS

Appendix Table 2. Numbers of fish released during orifice passage efficiency (OPE) tests in units 15, 16, and 17 at Bonneville Dam Second Powerhouse and median passage times to the smolt monitoring facility in 2002.

Spring				
Date	Unit	Number released	OPE (%)	Median passage time (min)
4/22	17B	100	73	40
4/24	17B	100	70	111
4/29	17B	100	98	59
5/8	17B	100	100	53
5/10	17B	100	93	*751
5/22	17B	100	89	*552

Unit 15 (modified)					Unit 17				
		Percentile passage time					Percentile passage time		
Date	Number Released	10th5	0th	90th	Date	Number Released	1 0th	50th	90th
4/29	100	48	65	189	5/1	100	42	52	60
5/1	100	53	89	111	5/17	100	46	0	*1539
5/6	100	46	58	*1174	5/29	100	*380	??	*1000
5/8	100	49	138	385	5/31	100	38	58	*1215

Appendix Table 2. Continued.

Summer				
Date	Unit	Number released	OPE (%)	Median passage time (min)
6/12	17B	100	98	48
6/17	17B	100	100	93
6/19	17B	100	---	46
6/24	17B	100	100	497*
6/26	17B	100	80	45
6/28	17B	100	---	56
7/1	17B	100	99	333*
7/8	17B	100	99	465*

Unit 17 (modified)					Unit 16 (not modified)				
		Percentile passage time					Percentile passage time		
Date	Number Released	10th	50th	90th	Date	Number Released	10th	50th	90th
6/14	100	42	50	70	6/12	100	40	46	390*
6/21	100	43	53	463*	6/14	100	39	43	70
7/3	100	41	615*	1,010*	6/19	100	39	50	442*
7/10	100	37	47	104	6/21	100	40	269*	972*

* Technical problems with PIT tag release/retrieval invalidates these data

--- Test not completed

Appendix Table 3. Numbers of fish examined and numbers classified as descaled or injured during FGE (short-term) and OPE (long-term) tests in unit 16 (unmodified unit) and unit 17 (modified unit) at Bonneville Dam Second Powerhouse, 2002. Short- and long-term tests are designated ST and LT, respectively.

Yearling chinook salmon, Spring															
	Unit 16							Unit 17							
	Gate	Test	No.	Descaled		Injured		Gate	Test	No.	Descaled		Injured		
Date	slot	term	fish	No.	%	No.	%	slot	term	fish	No.	%	No.	%	
4-22								B	ST	257	0	0	1	0.4	
4-23	B	LT	264	11	4.2	0	0	B	LT	235	2	0.9	0	0	
4-23	A	ST	221	3	1.4	0	0	A	ST	142	5	3.5	0	0	
4-24	A	ST	205	4	2.0	0	0	A	ST	29	1	3.4	0	0	
4-25	B	LT	171	4	2.3	0	0	B	LT	380	8	2.1	0	0	
4-25	B	ST	203	4	2.0	0	0	B	ST	160	2	1.3	0	0	
4-26	A	ST	224	2	0.9	0	0	A	ST	37	1	2.7	0	0	
4-27	B	LT	132	3	2.3	0	0	B	LT	482	11	2.3	2	0.4	
4-27	B	ST	123	2	1.6	0	0	B	ST	137	1	0.7	0	0	
4-29	C	ST	54	2	3.7	1	1.9	C	ST	89	2	2.2	0	0	
4-30	B	LT	202	6	3.0	0	0	B	LT	322	4	1.2	0	0	
5-7	B	ST	134	2	1.5	0	0	B	ST	132	2	1.5	0	0	
5-8	C	ST	253	4	1.6	0	0	C	ST	39	0	0	0	0	
5-9	B	LT	75	4	5.3	0	0	B	LT	35	1	2.9	0	0	
5-9	B	ST	133	5	3.8	0	0	B	ST	107	3	2.8	0	0	
5-10	C	ST	93	2	2.2	0	0	C	ST	61	3	4.9	0	0	
5-11	B	LT	44	4	9.1	0	0	B	LT	89	5	5.6	0	0	
5-11	B	ST	137	5	3.7	0	0	B	ST	205	7	3.4	1	0.5	
5-14	B	ST	102	6	5.9	1	1.0	B	ST	106	4	3.8	0	0	
5-15	C	ST	88	7	8.0	0	0	C	ST	14	2	14	0	0	
5-16	C	ST	32	4	12.5	0	0	C	ST	31	3	9.7	0	0	
5-17	B	ST	81	6	7.4	0	0	B	ST	242	9	3.7	0	0	
5-20	B	ST	101	4	4.0	1	1.0	B	ST	199	6	3.0	0	0	
5-21	C	ST	65	5	7.7	0	0	C	ST	12	1	8.3	0	0	
5-22	B	ST	58	2	3.4	0	0	B	ST	205	7	3.4	0	0	
5-23	B	LT	44	2	4.5	0	0	B	LT	226	9	4.0	0	0	
5-23	A	ST	67	3	4.5	0	0	A	ST	214	7	3.3	2	0.9	
5-28	A	ST	43	5	11.6	0	0	A	ST	20	1	5.0	0	0	
5-29	B	ST	49	3	6.1	0	0	B	ST	189	8	4.2	0	0	
5-30	B	LT	23	2	8.7	0	0	A	ST	65	5	7.7	1	1.5	
5-30	A	ST	202	6	3.0	0	0	B	LT	89	7	7.9	0	0	
5-31	A	ST	51	1	2.0	0	0	A	ST	21	1	4.8	0	0	

Appendix Table 3. Continued.

	Subyearling chinook salmon, Spring													
	Unit 16							Unit 17						
	Gate	Test	No.	Descaled		Injured		Gate	Test	No.	Descaled		Injured	
Date	slot	term	fish	No.	%	No.	%	slot	term	fish	No.	%	No.	%
4-22								B	ST	0				
4-23	B	LT	3	0	0	0	0	B	LT	3	0	0	0	0
4-23	A	ST	0					A	ST	0				
4-24	A	ST	0					A	ST	1	0	0	0	0
4-25	B	LT	1	0	0	0	0	B	LT	8	0	0	0	0
4-25	B	ST	0					B	ST	0				
4-26	A	ST	0					A	ST	0				
4-27	B	LT	0					B	LT	2	1	50.0	0	0
4-27	B	ST	0					B	ST	1	0	0	0	0
4-29	C	ST	0					C	ST	1	0	0	0	0
4-30	B	LT	1	0	0	0	0	B	LT	3	0	0	0	0
5-7	B	ST	26	0	0	0	0	B	ST	20	0	0	0	0
5-8	C	ST	63	0	0	0	0	C	ST	4	0	0	0	0
5-9	B	LT	15	1	6.7	0	0	B	LT	31	0	0	0	0
5-9	B	ST	5	0	0	0	0	B	ST	12	0	0	0	0
5-10	C	ST	6	0	0	0	0	C	ST	5	0	0	0	0
5-11	B	LT	10	0	0	0	0	B	LT	34	0	0	0	0
5-11	B	ST	10	1	10.0	0	0	B	ST	29	0	0	0	0
5-14	B	ST	4	0	0	0	0	B	ST	5	0	0	0	0
5-15	C	ST	5	0	0	0	0	C	ST	1	0	0	0	0
5-16	C	ST	3	0	0	0	0	C	ST	1	0	0	0	0
5-17	B	ST	9	0	0	0	0	B	ST	21	0	0	0	0
5-20	B	ST	2	0	0	0	0	B	ST	25	0	0	0	0
5-21	C	ST	7	0	0	0	0	C	ST	2	0	0	0	0
5-22	B	ST	7	0	0	0	0	B	ST	14	0	0	0	0
5-23	B	LT	8	2	25.0	0	0	B	LT	29	1	3.4	0	0
5-23	A	ST	3	0	0	0	0	A	ST	15	0	0	0	0
5-28	A	ST	8	1	12.5	0	0	A	ST	0				
5-29	B	ST	11	0	0	0	0	B	ST	16	0	0	0	0
5-30	B	LT	3	1	33.3	0	0	A	ST	16	3	18.8	0	0
5-30	A	ST	23	2	8.7	0	0	B	LT	30	2	6.7	0	0
5-31	A	ST	22	1	4.5	0	0	A	ST	15	0	0	0	0

Appendix Table 3. Continued.

	Steelhead, Spring														
	Unit 16							Unit 17							
	Gate	Test	No.	Descaled		Injured		Gate	Test	No.	Descaled		Injured		
Date	slot	term	fish	No.	%	No.	%	slot	term	fish	No.	%	No.	%	
4-22								B	ST	6	0	0	0	0	
4-23	B	LT	24	1	4.2	0	0	B	LT	5	0	0	0	0	
4-23	A	ST	6	0	0	0	0	A	ST	1	0	0	0	0	
4-24	A	ST	5	0	0	0	0	A	ST	4	0	0	0	0	
4-25	B	LT	10	0	0	0	0	B	LT	2	0	0	0	0	
4-25	B	ST	5	0	0	0	0	B	ST	13	0	0	0	0	
4-26	A	ST	9	0	0	0	0	A	ST	4	0	0	0	0	
4-27	B	LT	20	0	0	0	0	B	LT	6	1	16.7	0	0	
4-27	B	ST	2	0	0	0	0	B	ST	3	0	0	0	0	
4-29	C	ST	2	0	0	0	0	C	ST	1	0	0	0	0	
4-30	B	LT	14	1	7.1	0	0	B	LT	10	0	0	0	0	
5-7	B	ST	31	0	0	1	3.2	B	ST	32	1	3.1	1	3.1	
5-8	C	ST	12	1	8.3	1	8.3	C	ST	4	0	0	0	0	
5-9	B	LT	7	1	14.3	0	0	B	LT	7	0	0	0	0	
5-9	B	ST	64	2	3.1	0	0	B	ST	47	1	2.1	0	0	
5-10	C	ST	89	1	1.1	0	0	C	ST	26	1	3.8	0	0	
5-11	B	LT	25	0	0	0	0	B	LT	19	0	0	0	0	
5-11	B	ST	10	0	0	0	0	B	ST	9	1	11.1	0	0	
5-14	B	ST	12	2	16.7	1	1.0	B	ST	9	1	11.1	0	0	
5-15	C	ST	11	0	0	0	0	C	ST	2	0	0	0	0	
5-16	C	ST	15	0	0	0	0	C	ST	9	1	11.1	0	0	
5-17	B	ST	23	1	4.3	0	0	B	ST	9	1	11.1	0	0	
5-20	B	ST	58	0	0	0	0	B	ST	18	0	0	0	0	
5-21	C	ST	12	1	8.3	0	0	C	ST	1	0	0	0	0	
5-22	B	ST	36	0	0	0	0	B	ST	17	0	0	0	0	
5-23	B	LT	7	0	0	0	0	B	LT	16	0	0	0	0	
5-23	A	ST	13	0	0	0	0	A	ST	19	0	0	0	0	
5-28	A	ST	34	0	0	1	2.9	A	ST	23	0	0	0	0	
5-29	B	ST	38	1	2.6	0	0	B	ST	16	1	6.3	0	0	
5-30	B	LT	18	1	5.6	0	0	B	ST	3	1	33.3	1	33.3	
5-30	A	ST	48	0	0	0	0	A	LT	59	1	1.7	0	0	
5-31	A	ST	30	0	0	0	0	A	ST	32	0	0	0	0	

Appendix Table 3. Continued.

	Coho salmon, Spring													
	Unit 16							Unit 17						
	Gate	Test	No.	Descaled		Injured		Gate	Test	No.	Descaled		Injured	
Date	slot	term	fish	No.	%	No.	%	slot	term	fish	No.	%	No.	%
4-22								B	ST	20	0	0	0	0
4-23	B	LT	424	7	1.6	0	0	B	LT	38	0	0	0	0
4-23	A	ST	48	2	4.2	0	0	A	ST	7	0	0	0	0
4-24	A	ST	44	0	0	0	0	A	ST	6	0	0	0	0
4-25	B	LT	55	0	0	1	1.8	B	LT	79	2	2.5	1	1.3
4-25	B	ST	14	1	7.1	0	0	B	ST	7	1	14.3	0	0
4-26	A	ST	64	1	1.6	0	0	A	ST	2	1	50.0	0	0
4-27	B	LT	57	1	1.8	0	0	B	LT	63	0	0	0	0
4-27	B	ST	20	0	0	0	0	B	ST	11	0	0	0	0
4-29	C	ST	7	1	14.3	0	0	C	ST	41	0	0	0	0
4-30	B	LT	58	1	1.7	1	1.7	B	LT	55	2	3.6	0	0
5-7	B	ST	610	4	0.7	0	0	B	ST	58	0	0	0	0
5-8	C	ST	521	5	1.0	0	0	C	ST	40	2	5.0	0	0
5-9	B	LT	644	12	1.9	0	0	B	LT	45	0	0	0	0
5-9	B	ST	69	2	2.9	0	0	B	ST	61	0	0	1	1.6
5-10	C	ST	232	4	1.7	0	0	C	ST	44	1	2.3	0	0
5-11	B	LT	485	6	1.2	0	0	B	LT	408	6	1.5	0	0
5-11	B	ST	292	7	2.4	0	0	B	ST	158	2	1.3	0	0
5-14	B	ST	621	6	1.0	0	0	B	ST	69	2	2.9	0	0
5-15	C	ST	394	2	0.5	0	0	C	ST	57	1	1.8	1	1.8
5-16	C	ST	412	2	0.5	0	0	C	ST	51	0	0	0	0
5-17	B	ST	247	4	1.6	0	0	B	ST	164	5	3	0	0
5-20	B	ST	465	4	0.9	0	0	B	ST	97	2	2.1	0	0
5-21	C	ST	449	5	1.1	0	0	C	ST	8	0	0	0	0
5-22	B	ST	345	5	1.4	0	0	B	ST	58	3	5.2	0	0
5-23	B	LT	286	4	1.4	0	0	B	LT	169	4	2.4	0	0
5-23	A	ST	87	1	1.1	0	0	A	ST	49	3	6.1	0	0
5-28	A	ST	101	3	3.0	0	0	A	ST	3	0	0	0	0
5-29	B	ST	63	1	1.6	0	0	B	ST	18	1	5.6	0	0
5-30	B	LT	101	3	2.7	1	0.9	A	ST	39	4	10.3	0	0
5-30	A	ST	52	3	5.8	0	0	B	LT	44	3	6.8	0	0
5-31	A	ST	114	2	1.8	0	0	A	ST	10	5	50.0	0	0

Appendix Table 3. Continued.

Sockeye salmon, Spring														
	Unit 16							Unit 17						
	Gate	Test	No.	Descaled		Injured		Gate	Test	No.	Descaled		Injured	
Date	slot	term	fish	No.	%	No.	%	slot	term	fish	No.	%	No.	%
4-22								B	ST	0				
4-23	B	LT	0					B	LT	0				
4-23	A	ST	0					A	ST	0				
4-24	A	ST	1	0	0	0	0	A	ST	0				
4-25	B	LT	0					B	LT	0				
4-25	B	ST	0					B	ST	0				
4-26	A	ST	0					A	ST	0				
4-27	B	LT	3	0	0	0	0	B	LT	0				
4-27	B	ST	0					B	ST	0				
4-29	C	ST	0					C	ST	0				
4-30	B	LT	5	0	0	0	0	B	LT	3	1	33.3	0	0
5-7	B	ST	4	0	0	0	0	B	ST	2	0	0	0	0
5-8	C	ST	1	0	0	0	0	C	ST	0				
5-9	B	LT	39	2	5.1	0	0	B	LT	10	0	0	0	0
5-9	B	ST	2	0	0	0	0	B	ST	10	2	20.0	1	10.0
5-10	C	ST	0					C	ST	2	0	0	0	0
5-11	B	LT	75	4	5.3	1	1.3	B	LT	25	5	20.0	0	0
5-11	B	ST	2	0	0	0	0	B	ST	40	0	0	0	0
5-14	B	ST	13	323.1	0	0	B	ST	0					
5-15	C	ST	9	1	11.1	0	0	C	ST	2	0	0	0	0
5-16	C	ST	6	1	16.7	1	16.7	C	ST	3	0	0	0	0
5-17	B	ST	40	615.0	0	0	B	ST	23	4	17.4	0	0	
5-20	B	ST	79	6	7.6	0	0	B	ST	12	0	0	0	0
5-21	C	ST	102	7	6.9	1	1.0	C	ST	3	0	0	0	0
5-22	B	ST	197	8	4.1	0	0	B	ST	11	1	9.1	0	0
5-23	B	LT	121	8	6.6	0	0	B	LT	26	4	15.4	0	0
5-23	A	ST	19	3	15.8	0	0	A	ST	4	0	0	0	0
5-28	A	ST	8	2	25.0	0	0	A	ST	20	1	5.0	0	0
5-29	B	ST	5	1	20.0	0	0	B	ST	189	8	4.2	0	0
5-30	B	LT	7	0	0	0	0	A	ST	65	5	7.7	1	1.5
5-30	A	ST	1	0	0	0	0	B	LT	89	7	7.9	0	0
5-31	A	ST	10	0	0	0	0	A	ST	21	1	4.8	0	0

Appendix Table 3. Continued.

Yearling chinook salmon, Summer															
	Unit 16							Unit 17							
	Gate	Test	No.	Descaled		Injured		Gate	Test	No.	Descaled		Injured		
Date	slot	term	fish	No.	%	No.	%	slot	term	fish	No.	%	No.	%	
6-11	B	ST	6	0	0	0	0	B	ST	4	1	25.1	0	0	
6-12	A	ST	10	1	10	0	0	A	ST	4	0	0	0	0	
6-13	B	LT	28	2	7.1	0	0	B	LT	70	7	10.0	0	0	
6-13	B	ST	12	0	0	0	0	B	ST	5	1	20.0	0	0	
6-14	A	ST	14	1	7.1	0	0	A	ST	4	0	0	0	0	
6-15	B	LT	14	1	7.1	0	0	B	LT	21	1	4.8	0	0	
6-15	A	ST	8	0	0	0	0	A	ST	4	0	0	0	0	
6-17	B	ST	1	0	0	0	0	B	ST	0	0	0	0	0	
6-18								B	LT	2	0	0	0	0	
6-18	A	ST	9	0	0	0	0	A	ST	0	0	0	0	0	
6-19	B	ST	2	0	0	0	0	B	ST	1	0	0	0	0	
6-20	B	LT	3	0	0	0	0	B	LT	0					
6-20	B	ST	6	0	0	0	0	B	ST	2	0	0	0	0	
6-21	A	ST	4	0	0	0	0	A	ST	0					
6-24	B	ST	0					B	ST	0					
6-25	B	LT	2	1	50.0	0	0	B	LT	3	133.3	0	0		
6-25	A	ST	3	2	66.7	0	0	A	ST	2	0	0	0	0	
6-26	B	ST	6	0	0	0	0	B	ST	4	0	0	0	0	
6-27	B	LT	0					B	LT	2	0	0	0	0	
6-27	A	ST	3	0	0	0	0	A	ST	1	0	0	0	0	
6-28	B	ST	0					B	ST	2	0	0	0	0	
6-29	B	LT	0					B	LT	0					
6-29	A	ST	1	0	0	0	0	A	ST	0					
7-1	A	ST	1	0	0	0	0	A	ST	0					
7-2	B	LT	0					B	LT	2	0	0	0	0	
7-2	B	ST	2	0	0	0	0	B	ST	1	0	0	0	0	
7-3	B	ST	1	0	0	0	0	B	ST	0					
7-8	A	ST	13	0	0	0	0	A	ST	2	0	0	0	0	
7-9	B	LT	11	0	0	0	0	B	LT	0					
7-9	B	ST	5	0	0	0	0	B	ST	0					
7-10	A	ST	15	1	6.7	0	0	A	ST	3	0	0	0	0	

Appendix Table 3. Continued.

Subyearling chinook salmon, Summer														
	Unit 16							Unit 17						
	Gate	Test	No.	Descaled		Injured		Gate	Test	No.	Descaled		Injured	
Date	slot	term	fish	No.	%	No.	%	slot	term	fish	No.	%	No.	%
6-11	B	ST	109	0	0	0	0	B	ST	94	0	0	0	0
6-12	A	ST	68	0	0	0	0	A	ST	57	0	0	0	0
6-13	B	LT	102	0	0	0	0	B	LT	247	0	0	0	0
6-13	B	ST	60	0	0	0	0	B	ST	108	0	0	0	0
6-14	A	ST	80	1	1.3	1	1.3	A	ST	49	0	0	0	0
6-15	B	LT	88	0	0	0	0	B	LT	251	2	0.8	0	0
6-15	A	ST	96	1	1.0	0	0	A	ST	82	0	0	0	0
6-17	B	ST	32	0	0	0	0	B	ST	84	0	0	0	0
6-18								B	LT	105	0	0	0	0
6-18	A	ST	136	0	0	0	0	A	ST	108	2	1.9	0	0
6-19	B	ST	65	0	0	0	0	B	ST	50	0	0	0	0
6-20	B	LT	142	1	0.7	0	0	B	LT	149	3	2.0	0	0
6-20	B	ST	160	1	0.6	0	0	B	ST	110	1	0.9	0	0
6-21	A	ST	229	2	0.9	0	0	A	ST	99	1	1.0	0	0
6-24	B	ST	166	2	1.2	0	0	B	ST	111	0	0	0	0
6-25	B	LT	317	5	1.6	4	1.3	B	LT	400	2	0.5	1	0.3
6-25	A	ST	325	3	0.9	0	0	A	ST	172	3	1.7	0	0
6-26	B	ST	533	3	0.6	2	0.4	B	ST	259	3	1.2	0	0
6-27	B	LT	143	2	1.4	1	0.7	B	LT	1072	10	0.9	3	0.3
6-27	A	ST	163	0	0	0	0	A	ST165	0	0	0	0	
6-28	B	ST	273	0	0	0	0	B	ST	232	0	0	0	0
6-29	B	LT	192	0	0	0	0	B	LT	656	8	1.2	0	0
6-29	A	ST	212	0	0	1	0.5	A	ST	267	2	0.7	1	0.4
7-1	A	ST	527	6	1.1	0	0	A	ST	173	2	1.2	0	0
7-2	B	LT	260	3	1.2	2	0.8	B	LT	349	4	1.1	2	0.6
7-2	B	ST	358	0	0	2	0.6	B	ST	112	0	0	0	0
7-3	B	ST	153	0	0	0	0	B	ST	302	2	0.7	1	0.3
7-8	A	ST	423	2	0.5	0	0	A	ST	78	0	0	0	0
7-9	B	LT	268	2	0.7	0	0	B	LT	108	2	1.9	0	0
7-9	B	ST	184	0	0	0	0	B	ST	93	0	0	0	0
7-10	A	ST	276	1	0.4	0	0	A	ST	87	2	2.3	0	0

Appendix Table 3. Continued.

	Steelhead, Summer															
	Unit 16								Unit 17							
	Gate	Test	No.	Descaled		Injured			Gate	Test	No.	Descaled		Injured		
Date	slot	term	fish	No.	%	No.	%		slot	term	fish	No.	%	N o.	%	
6-11	B	ST	14	1	7.1	0	0		B	ST	11	0	0	0	0	
6-12	A	ST	15	1	6.7	0	0		A	ST	10	0	0	0	0	
6-13	B	LT	10	0	0	0	0		B	LT	2	0	0	0	0	
6-13	B	ST	7	0	0	0	0		B	ST	8	0	0	0	0	
6-14	A	ST	8	0	0	0	0		A	ST	28	1	3.6	0	0	
6-15	A	LT	13	2	15.4	0	0		A	LT	3	1	33.3	0	0	
6-15	A	ST	28	2	7.1	2	7.1		A	ST	29	2	6.9	2	6.9	
6-17	B	ST	0						B	ST	3	0	0	0	0	
6-18	B	LT	0						B	LT	0					
6-18	A	ST	4	0	0	0	0		A	ST	6	0	0	0	0	
6-19	B	ST	1	0	0	0	0		B	ST	1	0	0	0	0	
6-20	B	LT	3	0	0	0	0		B	LT	0					
6-20	B	ST	2	0	0	0	0		B	ST	0					
6-21	A	ST	2	0	0	0	0		A	ST	0					
6-24	B	ST	0						B	ST	1	0	0	0	0	
6-25	B	LT	0						B	LT	0					
6-25	A	ST	1	0	0	0	0		A	ST	0					
6-26	B	ST	2	0	0	0	0		B	ST	1	0	0	0	0	
6-27	B	LT	3	0	0	0	0		B	LT	0					
6-27	A	ST	2	0	0	0	0		A	ST	2	0	0	0	0	
6-28	B	ST	0						B	ST	1	0	0	0	0	
6-29	B	LT	0						B	LT	0					
6-29	A	ST	2	0	0	0	0		A	ST	3	0	0	0	0	
7-1	A	ST	0	0	0	0	0		A	ST	0					
7-2	B	LT	0						B	LT	0					
7-2	B	ST	0						B	ST	0					
7-3	B	ST	0						B	ST	0					
7-8	A	ST	0						A	ST	0					
7-9	B	LT	0						B	LT	0					
7-9	B	ST	0						B	ST	0					
7-10	A	ST	0						A	ST	0					

Appendix Table 3. Continued.

Coho salmon, Summer														
	Unit 16							Unit 17						
	Gate	Test	No.	Descaled		Injured		Gate	Test	No.	Descaled		Injured	
Date	slot	term	fish	No.	%	No.	%	slot	term	fish	No.	%	No.	%
6-11	B	ST	18	1	5.6	0	0	B	ST	2	0	0	0	0
6-12	A	ST	33	2	6.1	0	0	A	ST	13	1	7.7	0	0
6-13	B	LT	43	3	7	0	0	B	LT	32	2	6.3	0	0
6-13	B	ST	13	1	7.7	0	0	B	ST	12	0	0	0	0
6-14	A	ST	24	0	0	0	0	A	ST	10	0	0	0	0
6-15	A	LT	11	0	0	0	0	A	LT	7	0	0	0	0
6-15	A	ST	12	1	8.3	0	0	A	ST	2	0	0	0	0
6-17	B	ST	1	0	0	0	0	B	ST	0				
6-18	B	LT	0					B	LT	7	0	0	0	0
6-18	A	ST	14	0	0	0	0	A	ST	0				
6-19	B	ST	1	0	0	0	0	B	ST	0				
6-20	B	LT	1	0	0	0	0	B	LT	0				
6-20	B	ST	2	0	0	0	0	B	ST	0				
6-21	A	ST	2	0	0	0	0	A	ST	0				
6-24	B	ST	0					B	ST	0				
6-25	B	LT	0					B	LT	0				
6-25	A	ST	1	0	0	0	0	A	ST	0				
6-26	B	ST	0					B	ST	1	0	0	0	0
6-27	B	LT	3	0	0	0	0	B	LT	0				
6-27	A	ST	0					A	ST	2	0	0	0	0
6-28	B	ST	0					B	ST	1	0	0	0	0
6-29	B	LT	0					B	LT	0				
6-29	A	ST	0					A	ST	3	0	0	0	0
7-1	A	ST	0					A	ST	0				
7-2	B	LT	1	0	0	0	0	B	LT	0				
7-2	B	ST	0					B	ST	0				
7-3	B	ST	0					B	ST	0				
7-8	A	ST	11	0	0	0	0	A	ST	1	0	0	0	0
7-9	B	LT	2	0	0	0	0	B	LT	0				
7-9	B	ST	0					B	ST	0				
7-10	A	ST	1	0	0	0	0	A	ST	2	0	0	0	0

Appendix Table 3. Continued.

Sockeye salmon, Summer															
	Unit 16							Unit 17							
	Gate	Test	No.	Descaled		Injured		Gate	Test	No.	Descaled		Injured		
Date	slot	term	fish	No.	%	No.	%	slot	term	fish	No.	%	N	o.	%
6-11	B	ST	6	0	0	0	0	B	ST	1	0	0		0	0
6-12	A	ST	7	1	14.3	0	0	A	ST	0					
6-13	B	LT	19	1	5.3	0	0	B	LT	19	3	15.8		0	0
6-13	B	ST	2	0	0	0	0	B	ST	4	1	25.0		0	0
6-14	A	ST	5	1	20	0	0	A	ST	1	0	0		0	0
6-15	A	LT	12	1	8.3	0	0	A	LT	11	3	27.3		0	0
6-15	A	ST	4	0	0	0	0	A	ST	2	0	0		0	0
6-17	B	ST	0					B	ST	0					
6-18	B	LT	0					B	LT	2	0	0		0	0
6-18	A	ST	7	1	14.3	0	0	A	ST	2	0	0		0	0
6-19	B	ST	1	0	0	0	0	B	ST	1	0	0		0	0
6-20	B	LT	4	0	0	0	0	B	LT	4	0	0		0	0
6-20	B	ST	1	0	0	0	0	B	ST	1	0	0		0	0
6-21	A	ST	3	0	0	0	0	A	ST	1	0	0		0	0
6-24	B	ST	5	0	0	0	0	B	ST	0					
6-25	B	LT	3	0	0	0	0	B	LT	2	0	0		0	0
6-25	A	ST	4	0	0	0	0	A	ST	0					
6-26	B	ST	4	0	0	0	0	B	ST	0					
6-27	B	LT	1	0	0	0	0	B	LT	4	0	0		0	0
6-27	A	ST	1	0	0	0	0	A	ST	0					
6-28	B	ST	2	0	0	0	0	B	ST	2	0	0		0	0
6-29	B	LT	3	0	0	0	0	B	LT	0					
6-29	A	ST	1	0	0	0	0	A	ST	1	0	0		0	0
7-1	A	ST	6	1	16.7	0	0	A	ST	0					
7-2	B	LT	1	0	0	0	0	B	LT	5	0	0		0	0
7-2	B	ST	2	0	0	0	0	B	ST	0					
7-3	B	ST	1	0	0	0	0	B	ST	1	0	0		0	0
7-8	A	ST	3	0	0	0	0	A	ST	0					
7-9	B	LT	1	0	0	0	0	B	LT	0					
7-9	B	ST	0					B	ST	0					
7-10	A	ST	1	0	0	0	0	A	ST	0					

Appendix Table 4. Results of Student's *t*-tests comparing mean descaling between units 16 and 17 (all three gatewells pooled) for both short-term (ST) and long-term (LT) descaling at Bonneville Dam Second Powerhouse, 2002.

Species	Time	Mean descaling (SE) Unit 16	Unit 17	Difference (16 - 17)	*t*	*P*
Spring						
Yearling chinook	ST	4.3 (0.7)	4.0 (0.7)	0.13 (0.6)	0.24	0.81
	LT	4.4 (1.3)	3.4 (0.8)	1.1 (1.5)	0.68	0.51
Steelhead	ST	1.5 (0.6)	2.5 (0.9)	-1.0 (1.0)	-0.93	0.37
	LT	3.3 (0.8)	3.0 (0.3)	0.3 (0.1)	0.32	0.77
Coho	ST	1.7 (0.3)	3.6 (1.4)	-1.9 (1.4)	-1.35	0.19
	LT	1.5 (0.3)	2.1 (0.8)	-0.6 (0.8)	-0.71	0.50
Summer						
Subyearling chinook	ST	0.4 (0.1)	0.5 (0.2)	-0.1 (0.2)	-0.83	0.42
	LT	0.7 (0.2)	0.9 (0.2)	-0.3 (0.3)	-1.16	0.28

Appendix Table 5. Numbers of juvenile lamprey and salmon parr caught in gatewell or fyke nets (1-5) and fish guidance efficiency for individual replicates of tests in unit 15 (B) from 26 April to 12 July at Bonneville Dam Second Powerhouse, 2002.

	Juvenile lamprey									
	4/22	4/23	4/24	4/25	4/26	4/27	4/29	5/7	5/8	5/9
Gatewell	0	0	1	0	0	0	0	0	0	0
Gap net	0	2	1	0	0	0	0	0	0	0
Closure net	6	0	1	0	0	0	0	0	0	0
1	0	3	1	2	0	0	0	0	0	0
2	30	12	7	14	7	7	1	3	3	3
3	29	20	10	4	2	2	7	3	6	7
4	0	12	0	3	12	12	0	0	0	3
5	12	3	3	0	0	0	3	0	0	0
Totals	77	52	24	23	21	21	11	6	9	13
FGE (%)	0	0	4	0	0	0	0	0	0	0

	5/10	5/11	5/14	5/15	5/16	5/17	5/20	5/21	5/22	5/23	5/28
Gatewell	0	0	0	0	0	0	0	0	0	0	0
Gap net	0	0	0	0	0	0	1	0	0	0	0
Closure net	0	0	0	0	1	0	0	0	0	0	0
1	0	0	0	0	0	1	0	0	0	0	0
2	1	0	0	0	0	2	1	1	2	1	0
3	4	1	0	2	1	0	2	4	5	0	3
4	3	0	0	0	3	0	12	3	3	3	9
5	0	6	0	3	0	0	0	6	3	0	0
Totals	8	7	0	5	5	3	16	14	13	4	12
FGE (%)	0	0		0	0	0	0	0	0	0	0

Appendix Table 5. Continued

Juvenile lamprey			
	5/29	5/30	5/31
Gatewell	0	0	0
Gap net	0	0	0
Closure net	0	0	0
1	1	1	0
2	2	3	1
3	10	6	16
4	0	6	3
5	3	6	6
Totals	16	22	26
FGE (%)	0	0	0

	6/11	6/12	6/13	6/14	6/15	6/17	6/18	6/19	6/20	6/21
Gatewell	0	0	0	0	0	0	0	0	0	0
Gap net	0	0	1	1	1	0	0	0	0	0
Closure net	0	0	0	1	0	0	0	0	0	0
1	2	0	0	1	0	1	0	0	0	0
2	8	2	4	3	6	0	1	4	2	0
3	10	9	10	5	16	10	9	6	7	5
4	3	3	6	3	15	3	6	3	3	0
5	3	0	0	3	6	3	9	3	3	6
Totals	26	14	21	17	44	17	25	16	15	11
FGE (%)	0	0	0	0	0	0	0	0	0	0

Appendix Table 5. Continued

Juvenile lamprey										
	6/24	6/25	6/28	6/29	7/1	7/2	7/3	7/8	7/9	7/10
Gatewell	0	0	0	0	0	0	0	0	0	0
Gap net	0	0	0	0	0	0	1	0	0	0
Closure net	0	0	0	0	0	0	0	0	1	0
1	1	0	0	0	0	1	0	0	0	0
2	2	0	0	0	0	0	2	0	0	0
3	1	2	2	6	5	3	3	1	2	1
4	6	0	3	6	3	3	3	3	6	0
5	3	0	0	0	3	3	0	0	0	0
Totals	13	2	5	12	11	10	9	4	9	1
FGE (%)	0	0	0		0	0		0	0	0

Salmonid parr			
	4/22	5/11	5/15
Gatewell	0	0	0
Gap net	0	1	1
Closure net	1	0	0
1	0	2	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
Totals	1	3	1
FGE (%)	0	0	0