# Studies to Evaluate the Effectiveness of Extended-Length Screens at John Day Dam, 2004

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## EXECUTIVE SUMMARY

Submersible traveling screens (STSs) and extended-length submersible bar screens (ESBSs) divert fish from turbine intakes and into juvenile passage systems at Snake and Columbia River Dams. Studies at McNary and The Dalles Dams showed higher fish guidance with the ESBS, and the U.S. Army Corps of Engineers installed and tested these screens at John Day Dam in 1996. The screens were modified and reevaluated in 1999 due to mechanical problems. For the 1999 evaluations, the National Marine Fisheries Service (NMFS) observed descaling and overall mortality by collecting fish from the gate slot of a turbine equipped with an ESBS and operated at approximately 155 MW over a period of 20 h. These evaluations showed unacceptable increases in both descaling and mortality, which were attributed to increased flow in the gatewells.

To reduce gatewell flow, the USACE redesigned the vertical barrier screens (VBSs) used in the gatewells and provided an outlet flow control device (OFC) to further reduce flows if necessary. Additionally, the 3.15-mm (0.125-inch) bar spacing on the ESBS and VBS was replaced with 1.75-mm (0.069-in) spacing to help reduce impingement of salmonid fry and juvenile lamprey on the screens.

Biological testing of the new system was first conducted in 2002. During spring testing with PIT-tagged yearling Chinook salmon, mean fish guidance efficiency (FGE) was 80.0%, and descaling and mortality were low. During summer testing with subyearling Chinook, mean FGE was 63.8%, and mortality and descaling were again low. These results were encouraging; however, after only a few weeks of operation, small holes developed in the VBS panels. Although the cause of the holes is unknown, it is suspected that excess vibration may have caused individual bars to crack and break off. The USACE replaced the existing bar-screen panels with heavier-gauge bar-screen material.

During spring and summer 2004, we evaluated fish condition and survival in turbine unit 7, which was equipped with the newly designed VBS. Chinook salmon smolts from both the spring and summer juvenile migrations were PIT tagged and released into two gate slots of the test unit (7B, 7C), and into two adjacent unmodified (reference) units (6B and 6C). Recoveries were made via the separation-by-code system at the smolt monitoring facility (SMF). Detections of PIT-tagged fish at the SMF also provided timing information for smolts passing through the system.

For yearling Chinook salmon, descaling was 0.0% for releases to 6B and 6C, 0.5% for releases to 7B, and 7.9% for releases to 7C. Median passage time was 24.8 h from 6B and 6C, 1.3 h from 7B, and 1.7 h from 7C. Mortality was 0.3% for releases to 6B and 6C, 1.1% for releases to 7B, and 9.2% for releases to 7C. For subyearling Chinook salmon from 7B and 7C, respectively, descaling was 0.3 and 5.6%, median passage time was 1.1, and 1.8 h, and mortality was 2.0 and 11.9%. Long-term conditions in the prototype gate slot were not favorable for fish. There was also an unaccountable loss of test fish in the prototype gate slot. The small number of downstream PIT-tag detections for fish released to the prototype gate slot suggests mortality.

To lower descaling and mortality associated with the ESBSs, upward flows into the gate slots should be further reduced. This can be achieved by a more aggressive deployment of the OFC or by reducing the load on the turbine unit. However, reducing upward flows into the gate slots could affect the fish guidance efficiency of the ESBSs.

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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 (USACE) and is the third hydroelectric project upstream from the river mouth. Completed in 1968, the dam is equipped with 16 turbine units, 20 spillbays, and a navigation lock (Figure 1).

The juvenile fish collection and bypass system at John Day Dam was installed between 1984 and 1986. The fish-collection portion of the system consists of standard-length submersible traveling screens (STS), which intercept fish passing into the turbine intakes and guide them upward and into the gatewell slots. A 35-cm-diameter (14 in) orifice leads from each gatewell to an enclosed gallery, and a transportation channel carries 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 was evaluated by the National Marine Fisheries Service (NMFS; Absolon et al. 2000).

In 1985 under contract to the USACE, the NMFS began a series of studies to evaluate the partially finished fish-passage system and sampling facilities at John Day Dam (Krcma et al. 1986). Fish guidance efficiency (FGE) of the STSs was estimated for all species of Pacific salmonids *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. Thus, because a reduction in orifice head may reduce OPE, and the fish sampling facilities located on the transportation channel were incomplete at the time, only preliminary evaluations were possible in 1985.

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) were completed later that year. Numerous modifications were also 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).

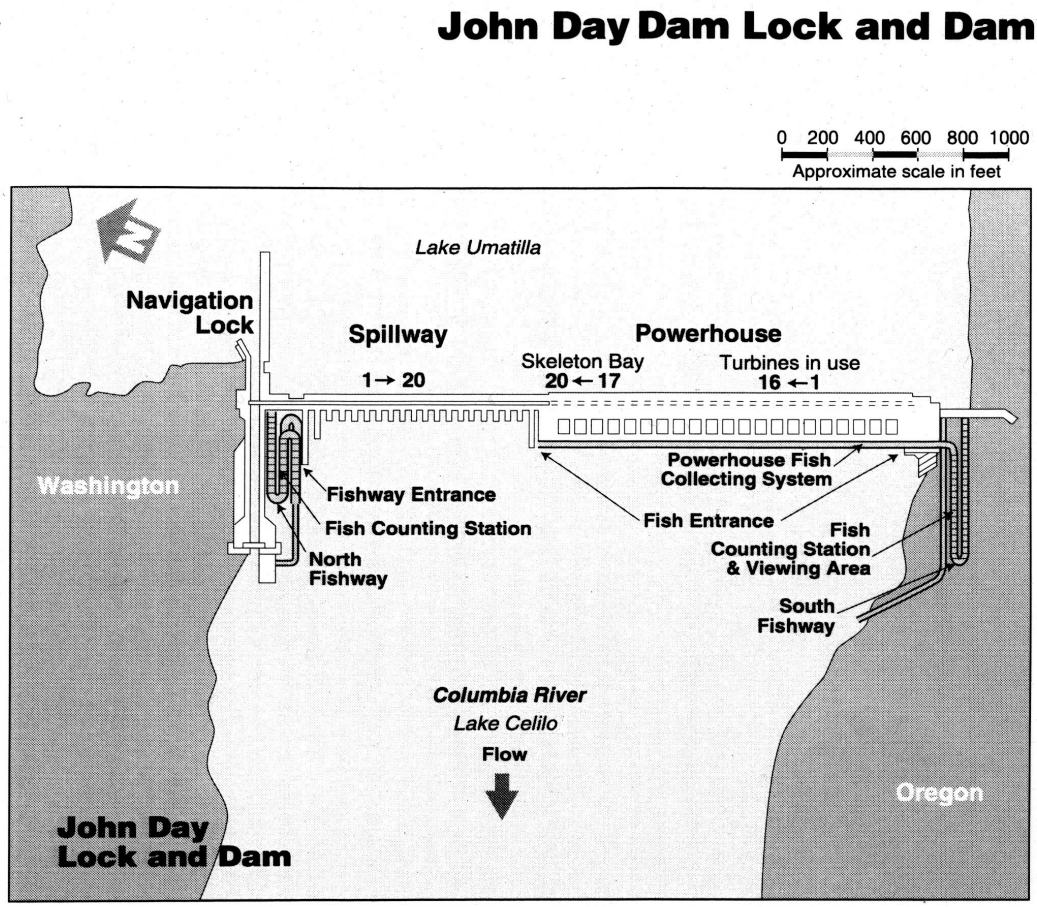


Figure 1. Overview of John Day Dam on the Columbia River showing numbering sequence of turbine units and spillbays.

In 1986, FGE tests conducted with subyearling Chinook salmon averaged only 35% (Brege et al. 1987). This was higher than in 1985, but still considerably lower than target levels (70%). 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 the longer screens.

In 1996, tests were conducted at John Day Dam to evaluate FGE using an extended-length submersible bar screen (ESBS) with an inlet flow vane (Figure 2) and to assess the effects of these guidance devices on descaling of juvenile salmonids. In addition, we evaluated the effects on orifice passage efficiency (OPE) of orifice enlargement from 30 to 35 cm (12 to 14 in) diameter, and of increased gatewell flow produced by the ESBS, from 200 to 700 $ft^3/s$. Fish guidance efficiencies in 1996 were 84, 94, 95, 79, and 60% for yearling Chinook salmon, steelhead, coho salmon *O. kisutch*, sockeye salmon *O. nerka*, 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.

Because of mechanical durability problems with the prototype ESBS first tested at John Day Dam in 1996, the USACE modified its structural design. 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 FGE, OPE, and fish condition using an ESBS with modified perforated plates and an inlet flow vane. Yearling Chinook salmon FGE was 80% for the ESBS, quite similar to 1996 results. In addition, the difference in OPE was even higher, 97.1 and 39.8%, respectively, for the ESBS and the STS slot. However, when the test unit containing the ESBSs was operated at 155 MW over a 20-hour period, increases were seen in both descaling of fish recovered from the gate slot and overall mortality at the smolt monitoring facility (Brege et al. 2001).

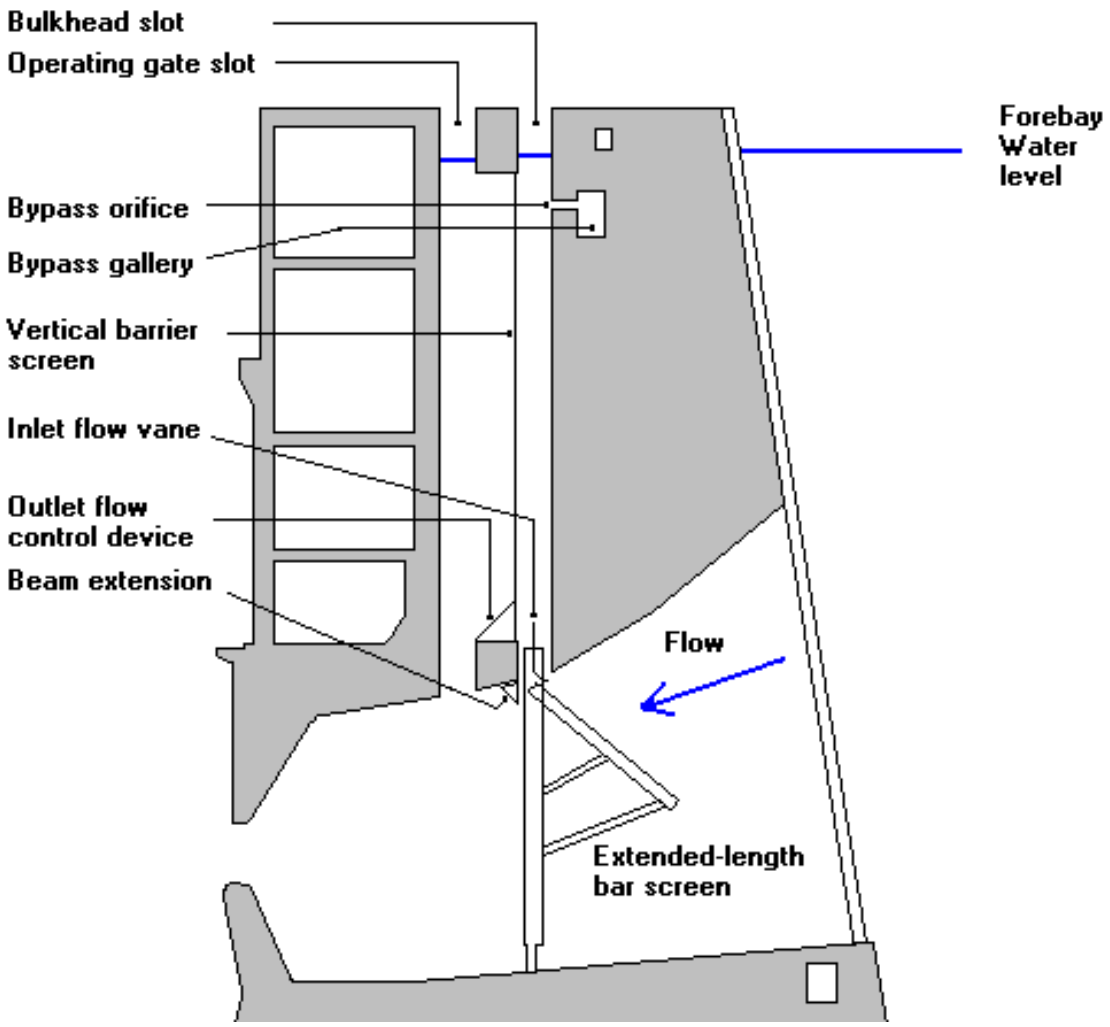


Figure 2. Cross section of a turbine unit at John Day Dam with extended-length bar screen (ESBS) and inlet flow vane in place.

Based on 1999 results, the USACE redesigned the vertical barrier screen with a bar screen surface and a more open perforated plate configuration; for the 2002 season, a bar-screen surface replaced the monofilament mesh on the newly designed VBS. Both the VBS and ESBS had bar screens spaced 1.75 mm (0.069 in) to help reduce impingement of salmonid fry and juvenile lamprey on the screens. Previously, bar screen material had been spaced 3.175 mm (0.123 in). In the event that the new VBS did not perform as expected, an outlet flow control device (OFC) was added to further reduce flows.

Biological testing of the new system was conducted in 2002 (Brege et al. 2004). During spring testing, mean FGE was 80.0% for yearling Chinook salmon. Mortality of PIT-tagged yearling Chinook salmon released during accompanying OPE tests was low (0.1%) and descaling was acceptable (4%). During summer testing, mean FGE was 63.8% for subyearling Chinook salmon. Mortality and descaling of released PIT-tagged subyearling Chinook salmon were also low, at 0.1 and 1%, respectively. The outlet flow control device (OFC) was not deployed during the FGE/OPE tests because descaling and mortality were low during initial fish condition tests and remained low throughout the remaining test series.

Results from 2002 biological testing were encouraging; however, after only a few weeks of operation, small holes developed in the redesigned VBS panels. Although the cause of the holes was unknown, it was suspected that excess vibration may have caused individual bars to crack and break off. The USACE replaced the existing Johnson bar-screen panels with heavier-gauge, Hendrix bar-screen material for the 2004 season. We evaluated gatewell fish condition and survival to assess this modification in 2004.

Research objectives during 2004 were:

1) Prior to the main juvenile migration period, determine whether the gatewell environment created by the modified VBS and ESBS is harmful to salmonid swim-up fry.

2) Determine the condition and survival of PIT-tagged yearling and subyearling Chinook salmon passing through a gatewell with the ESBS and 2004 prototype VBS.

Numerous delays in the installation schedule of the VBSs and ESBSs precluded our conducting tests prior to the migration as originally proposed under Objective 1. Therefore, we report here only the results from Objective 2 of this study.

# METHODS

## Fish Collection, Tagging, and Release

River-run test fish were captured from gatewells using a crane-operated dipbasket (Swan et al. 1979). To avoid capture of excessive numbers of fish in individual dips we sampled each gatewell several times, starting with a shallow dip and then increasing depth as appropriate. At intake deck level, the catch was transferred from the sanctuary bag of the dipbasket to 590-L holding tanks using water-to-water technique. The tanks were then moved to the fish examination facility and connected to a water supply provided by a submersible pump located in a nearby gatewell slot.

Fish were anesthetized in small batches within the holding tanks using tricaine methane sulfonate at a concentration of about 50 mg/L. Anesthetized fish were transferred to troughs in the examination facility and sorted to obtain yearling Chinook salmon for the spring test series or subyearling Chinook salmon for the summer test series. We rejected Chinook salmon for use in our tests if the fish were: 1) already PIT tagged or radio tagged, 2) injured, or 3) descaled in excess of 3% on one or both sides of the body. Descaling criteria are detailed below. Chinook salmon not used in tests and bycatch of other species of juvenile salmonids were routed to a 750-L tank, allowed to recover from effects of anesthesia, and released into the juvenile bypass system at the end of the work day.

On tagging dates we produced two separate release groups, each of which contained from 67 to 110 fish (Appendix Table 1). Tagged fish were routed to 240-L cylindrical release canisters (Absolon and Brege 2003) supplied with fresh water inflow. Two canisters were used, one for each release location. Tagged fish were held in canisters for about 1 h before release in order to assess short-term tagging mortality. Mortalities were removed from canisters just prior to release.

Use of the canisters permitted submerged releases of fish into test gatewells. The advantage of submerged over surface release was that release at depth would provide a better simulation of conditions normally encountered by fish as they entered gatewells via turbine intakes. To accomplish releases, canisters were secured in a release frame and the assembly lowered by crane until the canister was 7 m below gatewell orifice level. Personnel standing by at intake deck level then raised the canister plunger by pulling on an attached rope, thereby crowding the fish from the canister into the gatewell. The frame assembly was raised from the gatewell to deck level, the empty canister replaced with one containing the second release group, and the process repeated for the second daily release.

## Descaling and Selection Criteria

We determined descaling of recaptured Chinook salmon using criteria developed in 1991 by the Fish Transportation Oversight Team (Ceballos et al. 1993). By these criteria, if cumulative scale loss on one side of a fish equals or exceeds 20%, the fish is classified as "descaled" (Figure 3). A second category termed "partially descaled" describes cumulative scale loss on one side of a fish that is greater than 3% but less than 20%, and a third category, "non descaled," includes fish with no descaling and also fish with minor descaling up to the 3% level. Visual interpretation of descaling levels can be highly subjective. To allow reliable detection of changes in descaling levels, we selected fish which were initially in the "non descaled" category. To minimize subjectivity in descaling observations, test fish selection and post-recapture examinations were performed by the same individual on all test dates.

## Data Collection and Analysis

Chinook salmon selected for use in the study were measured to the nearest mm (fork length) and injected with PIT tags (Prentice et al. 1990a,b). Tag codes, fork lengths, and other pertinent data were entered into computer tagging files using the PIT Tag3 (P3) software program (PSMFC 2004). Peripheral devices attached to the computer during data entry included a digitizer board (for length measurement), Destron Fearing 2001F transceiver,[†] and benchtop antenna (for reading tag codes). Tagging files were uploaded to PTAGIS, a regional database maintained by the Pacific States Marine Fisheries Commission (PSMFC 1996). Tasks in the tagging process were typically performed by the same individuals throughout the study.

Determination of condition and survival of PIT-tagged juvenile Chinook salmon passing through a gatewell equipped with an ESBS and a 2004 prototype VBS required that fish released in test gatewells be recaptured and examined. We utilized PIT tag technology in order to accomplish this task. As a first step, we requested separation by code (SbyC) support at John Day Dam, a process involving coordination with USACE Portland District, the Fish Passage Advisory Committee, Columbia Basin PIT Tag Information Systems (PTAGIS) personnel, and on-site USACE and Smolt Monitoring Program representatives.

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[†] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

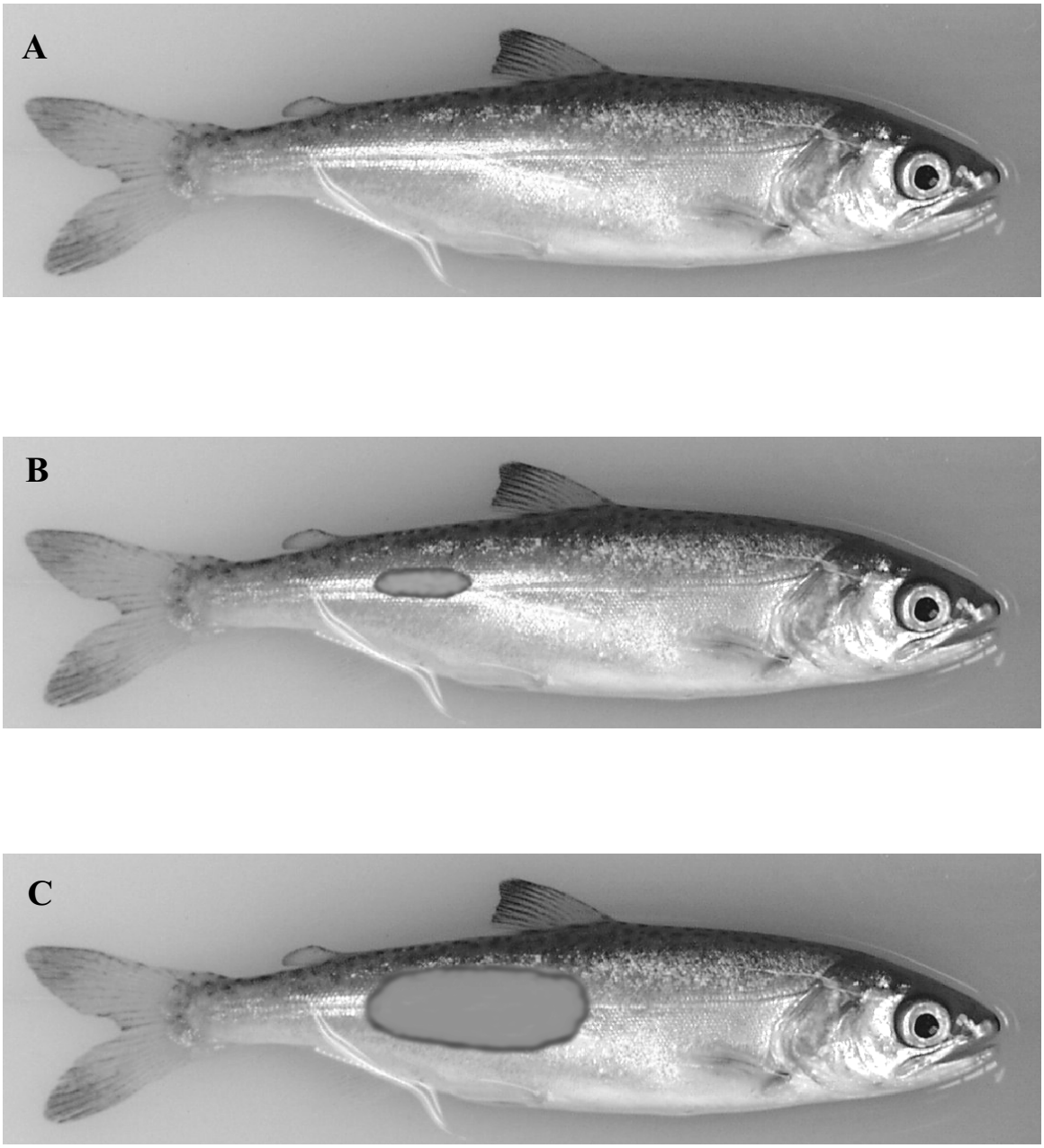


Figure 3. Descaling illustrations: A, no descaling; B, shaded area represents 3% descaling of one side; and C, shaded area represents 20% descaling of one side.

Prior to releasing any tagged fish, we provided PTAGIS personnel with a computer file containing all tag codes to be used in the study. PTAGIS personnel, in turn, programmed the PIT Tag Interrogation System at John Day Dam to separate fish bearing these tags from others passing through the juvenile bypass system. Chinook salmon tagged for the study were diverted to the SbyC East Holding Tank at the John Day Dam Smolt Monitoring Facility (SMF). A plan view of the John Day Dam interrogation site configuration is shown on the internet at http://www.ptagis.org.

The SbyC catch was processed using the pre-anesthesia system, sorting troughs, and recovery tanks available at the SMF. Descaling and mortality data were recorded to computer files using the P3 software program. A digitizer board connected to the laptop computer allowed entry of data via pre-programmed commands, and a Destron Fearing Model 2001F transceiver and benchtop antenna provided automatic entry of PIT tag codes. We had previously entered the complete list of study tag codes into P3 as a tag action. With this feature activated, the computer confirmed the identity of study fish as the fish were scanned. Bycatch (fish incorrectly separated) and Chinook salmon identified as belonging to the study were routed to the facility recovery tank after handling and returned to the river after recovering from the effects of anesthesia.

We utilized the PTAGIS database to determine passage timing through the bypass system and to determine if study fish were observed at downstream interrogation sites. Extraction of these data from PTAGIS involved submission of a registered tag file (list of tag codes used in the study), defining queries based on the registered tag file, and downloading the resulting reports. Data from tagging and recapture files and from the database queries was imported into spreadsheet and database programs for processing and analysis.

Test configurations were evaluated in fairly short time blocks during the course of the juvenile migrations. In each time block, a pair of conditions was tested. We used a two-sample *t*-test to determine statistical significance of differences in various fish passage metrics. The chosen metrics were observed mortality (proportion of examined fish which were dead), estimated mortality (observed mortalities plus all non-detected fish), partial descaling (<20%), descaling ( 20%), and median passage time (h). Although the treatment groups were paired in time, we did not use paired *t*-test, since the results in most cases (except for subyearling Chinook salmon tests) would only have two degrees of freedom. Statistical significance was set at = 0.05 for two-tailed tests.

For statistical precision in measuring differences between test conditions in survival and fish condition of yearling and subyearling Chinook salmon, the proposal called for the release of 6 replicates of 200 fish, with 100 assigned to each gatewell treatment. A total of 2,400 fish were needed, with 1,200 yearling Chinook and 1,200 subyearling Chinook. This series would have allowed us to discern a minimum difference of 3% between the test and control slots ( = 0.05; = 0.2), assuming a 98% detection rate of marked fish.

However, logistical and coordination problems (described below in the results section) resulted in the loss of 803 study fish for statistical analysis. To compensate for this loss, we marked an additional 760 yearling Chinook salmon.

# RESULTS

## Yearling Chinook Salmon

We began testing the vertical barrier screen (VBS) on 6 May in unit 7, which had slots equipped with the extended-length submersible bar screen. We started by releasing two groups of 101 PIT-tagged yearling Chinook salmon each into a slot equipped with an STS and standard VBS (reference group) and into the prototype slot (test group). However, two serious problems arose as our testing regime began. First, the control room operators were not aware of the need for continuous operation of both the test and reference turbine units, and unit 7 was shut down for a time during our first replicate. This nullified the results for 202 yearling Chinook salmon released on 6 May.

Second, a contractor of the USACE placed the latest modified VBS in gatewell slot 7C rather than in slot 7B. We assumed the test VBS would be placed in 7B because the B gatewell has been the "test" gatewell in previous studies. Unfortunately, we had released 3 more paired replicates of yearling Chinook salmon before the mistake was realized. Although the timing and fish condition information from these releases was useful, they did not provide any useful data on fish condition with regard to the gatewell environment created by the newly modified VBS.

After recognizing this second error, we requested an increase to the numbers of fish allowed on our collection permits. We then rescheduled the tests and continued releases into gatewell slot 7C (the slot containing the test VBS) on 18 May, with the next group of releases made in slots 6C and 7C.

This situation further complicated the testing regime because at John Day Dam, the C slots have the highest flows of the three slots (A, B, and C) associated with each turbine unit. During these releases, higher-than-expected descaling and mortality became apparent in fish released to gatwell slot 7C, which contained the prototype VBS (Table 1 and Appendix Table 2). It was not possible to determine whether this increase was due to gear type (prototype VBS) or slot effects (higher flow in the C slot). Therefore, the prototype VBS was moved to the B gatewell slot, and the standard VBS returned to the C slot. For the remainder of the yearling Chinook juvenile migration, releases were made into the B and C slots of unit 7 (the ESBS-equipped turbine unit) to try to distinguish the cause of the increased descaling.

During the spring season, we handled the following total numbers of juvenile salmonids during marking and recovery operations (numbers in parentheses are handling mortalities and are included in totals): 313 (12) subyearling Chinook salmon; 6,208 (37) yearling Chinook salmon; 1,438 (6) steelhead; 304 (6) coho salmon; 632 (15) sockeye salmon; 10 salmonid fry; 2 juvenile lamprey.

From this group of fish, we PIT tagged 1,960 yearling Chinook salmon. Of these, 1,936 were released alive and 24 died as a result of tagging operations. We recovered 1,644 tagged fish, 48 of which were mortalities, at the smolt monitoring facility via the separation-by-code system in the SMF.

Test results suggested that increased flows in slot 7C, rather than the VBS type, contributed to the increased descaling and mortality of test fish (Table 1). They also indicated that there was an increase (albeit smaller) in descaling and mortality in slot 7B over the standard condition at John Day Dam (slots 6B/6C). To reduce flow into the gate slot, the OFC should be deployed in slot 7C during tests in the upcoming subyearling Chinook salmon juvenile migration.

Table 1. Average descaling and mortality of yearling Chinook salmon in standard and prototype gate slots with various VBS types. Complete data are shown in Appendix Table 2.

| Slot | Partial (<20%) descaling (%) | Descaling (%) | Mortality (%) | Fish guidance screen | Vertical barrier screen |
|---|---|---|---|---|---|
| 6B | 2.9 | 0.0 | 0.6 | STS | Standard |
| 6C | 1.5 | 0.0 | 0.0 | STS | Standard |
| 7B | 4.2 | 0.0 | 1.6 | ESBS | 2002 prototype |
| 7B | 9.2 | 1.1 | 0.6 | ESBS | 2004 prototype |
| 7C | 28.8 | 4.5 | 8.0 | ESBS | 2002 prototype |
| 7C | 20.5 | 11.3 | 10.4 | ESBS | 2004 prototype |

Passage times for releases of PIT tagged yearling Chinook salmon are shown in Table 2. Median passage times of fish released to the standard gate slots (slots 6B/C) exceeded a full day (24.9 h), while those of fish released to test slots were less than 2 h. This became apparent when conducting tests, as nearly all PIT-tagged fish recovered in the afternoon of release were from the ESBS-equipped units.

Table 2. Passage time for the 10th, 50th (median), and 90th percentiles of PIT-tagged yearling Chinook salmon replicates from release in the gatewell to detection at the SMF. Complete data are shown in Appendix Table 3.

| | Passage time by percentile (h) | | |
|---|---|---|---|
| Slot | 10th | 50th (median) | 90th |
| 6B/C | 9.5 | 24.9 | 103.3 |
| 7B | 0.3 | 1.3 | 5.6 |
| 7C | 0.4 | 1.8 | 5.4 |

## Subyearling Chinook Salmon

Tests using subyearling Chinook salmon began on 24 June with releases of 75 fish each in slots 7B and 7C. During the scheduled break between fish runs, the prototype VBS had been moved back to gatewell slot 7C to evaluate the outlet flow control device (OFC). After two releases were made to verify high descaling was still present in the C gatewell slot (Table 3), the OFC was deployed in slot 7C. The OFC was set to the 1.7-ft raised position to reduce upward gate-slot flow by about 100 $ft^3/s$, or to a volume similar to that in the B gatewell slot. Testing was completed on 8 July 2004.

During the summer season, we handled the following numbers of juvenile salmonids during our marking and recovery operations (numbers in parentheses are handling mortalities and are included in totals): 3,051 (80) subyearling Chinook salmon; 8 yearling Chinook salmon; 2 coho salmon; 2 sockeye salmon; 1 salmonid fry.

From this group of fish, we PIT tagged 1,199 subyearling Chinook salmon. Of these 1,182 were released alive and 17 died after tagging. We recovered 843 tagged fish, 24 of which were mortalities, at the smolt monitoring facility via SbyC.

Although flows in 7C were reduced by the deployment of the outlet flow control device, descaling and mortality were still higher in the C slot than in the B slot (Table 3). Passage times were also longer for fish released to the C slot than the B slot (Table 4). In addition, an anomaly occurred in the C slot in that we consistently recovered 10 to 30% fewer fish released from slot 7C than from 7B (Appendix Table 1). The incidence of non-detection via the PIT-tag detection system at John Day Dam was also higher for fish released in slot 7C than those released in 7B (Appendix Table 4). Downstream detection at Bonneville Dam of fish not detected at John Day Dam was also very low (<1%; Appendix Table 5) strongly suggesting that these fish perished in the gate slot after release. For statistical purposes, we included these non-detected fish in mortality estimates.

Table 3. Average descaling and mortality of subyearling Chinook salmon in prototype gate slots before and after deployment of the outlet flow control device (OFC) in slot 7C. Complete data are listed in Appendix Table 2.

| Slot | Partial descaled (%) | Descaled (%) | Mortality (%) | Guidance screen | OFC setting in slot 7C |
|---|---|---|---|---|---|
| 7B | 2.3 | 0.0 | 1.5 | ESBS | Not deployed |
| 7B | 4.5 | 0.3 | 2.0 | ESBS | Deployed |
| 7C | 10.8 | 2.8 | 0.0 | ESBS | Not deployed |
| 7C | 12.3 | 5.6 | 11.9 | ESBS | Deployed |

Table 4. Passage time for the 10th, 50th (median), and 90th percentiles for combined replicates of PIT-tagged subyearling Chinook salmon from release in the gatewell to detection at the SMF. Complete data are shown in Appendix Table 3.

| | Passage time by percentile (h) | | |
|---|---|---|---|
| Slot | 10th | 50th (median) | 90th |
| 7B | 0.27 | 1.13 | 3.04 |
| 7C | 0.42 | 1.81 | 9.52 |

## Statistical Comparisons

As a result of the logistical problems explained previously, the number of replicates per comparison block was much smaller than planned for tests with yearling Chinook salmon. Therefore, we could obtain statistical resolution from these results only for relatively large differences, even if variation between replicates was fairly small. However, the results of comparisons with no statistically significant difference between test conditions should not be interpreted to mean that true differences did not exist, only that we had little power to detect these differences.

In fact, differences in mortality, descaling, and median passage times were apparent (Tables 1-4). Mortality and descaling were higher under the test conditions (slot 7B/C) than under the control conditions (slot 6B/C), whereas passage time was much lower for the test conditions (slot 7B/C) than the control conditions (slot 6B/C).

The statistical significance of these differences is shown in Table 5. For yearling Chinook salmon, the difference in observed mortality and median passage time was nearly significant between 6B and 7B ( = 0.05). Differences between 6C (control) and 7C (test) were significant for mortality, partial descaling, descaling ( 20%), and median passage time. Differences between 7B (control) and 7C (test) were significant for all metrics except descaling ( 20%). For subyearling Chinook salmon, differences were significant for estimated mortality, partial descaling, and descaling ( 20%).

Table 5. Results of two-sample *t*-tests comparing fish condition metrics for gatewell configurations evaluated at John Day Dam, 2004. *P* values less than 0.05 are shown in bold.

| Time block/ comparison | Mortality (%) | | Descaling (%) | | Median passage time (h) |
|---|---|---|---|---|---|
| | Observed | Estimated | Partial | 20% | |
| **Yearling Chinook Salmon** | | | | | |
| 7-12 May/6B vs. 7B (standard STS and standard VBS vs. ESBS and 2002-prototype VBS) | | | | | |
| Difference | -1.9 | 0.7 | -2.6 | 0 | 23.6 |
| *t* | 2.69 | 0.43 | 1.34 | N/A | 2.36 |
| df | 4 | 4 | 4 | 4 | 4 |
| *P* | 0.055 | 0.691 | 0.25 | N/A | 0.078 |
| 18-20 May/6B vs. 7C (standard STS and standard VBS vs. ESBS and 2004-prototype VBS) | | | | | |
| Difference | -10.3 | -18.1 | -19 | -11.3 | 23.6 |
| *t* | 4.39 | 4.56 | 3.54 | 7.34 | 14.34 |
| df | 4 | 4 | 4 | 4 | 4 |
| *P* | **0.012** | **0.01** | **0.024** | **0.002** | **0** |
| 27 May-1 June/7C vs. 7B (ESBS and 2002 prototype VBS vs. ESBS and 2004 prototype VBS) | | | | | |
| Difference | 7 | 31 | 19.6 | 3.4 | 1.8 |
| *t* | 3.48 | 6.15 | 4.53 | 1.77 | 2.83 |
| df | 4 | 4 | 4 | 4 | 4 |
| *P* | **0.025** | **0.004** | **0.011** | 0.151 | **0.047** |
| **Subyearling Chinook Salmon** | | | | | |
| 28 June-8 July/7B vs. 7C (ESBS and 2002 prototype VBS vs. ESBS and 2004 prototype VBS) | | | | | |
| Difference | -2.7 | -19.4 | -10.3 | -6.4 | -0.65 |
| *t* | 1.01 | 3.1 | 3.42 | 3.11 | 0.6 |
| df | 9 | 9 | 9 | 9 | 9 |
| *P* | 0.341 | **0.013** | **0.008** | **0.012** | 0.563 |

## DISCUSSION

In contrast to results during 2004, mortality and descaling at John Day Dam during 2002 were low, at less than 1 and 4%, respectively. However, this work was performed in slot 7B, which has lower flows than slot 7C, the slot used for most releases in 2004. For the 2004 releases of yearling Chinook salmon that were made in slot 7B, descaling and mortality were within acceptable ranges (Table 1). For fish released fish in slot 7C, large increases were observed in partial descaling, descaling, and mortality (Table 1).

Flow and turbulence are higher in the gatewell slots at John Day Dam than at most other Columbia River dams. The turbine units at John Day Dam are operated at 155 MW, 15% above nameplate loading. At the normal 100-ft head, this correlates to a flow of 20,800 $ft^3/s$ in the main units and upward flows into the gatewell slots are correspondingly higher. At a main unit flow of 20,800 $ft^3/s$, respective flows to the A, B, and C gate slots are 655, 753, and 775 $ft^3/s$. At a similar powerhouse at Lower Granite Dam, which also has a 100 ft of head, main unit flows are 18,300 $ft^3/s$ because the units are run at 135 MW. A flow of 18,300 $ft^3/s$ in the main unit corresponds to a maximum flow of 685 $ft^3/s$ in the gate slot with highest flow (Dan Feil, U.S. Army Corps of Engineers, personal communication).

## CONCLUSIONS AND RECOMMENDATIONS

To reduce descaling and mortality associated with the ESBS at John Day Dam, upward flow to the gate slots should be reduced. This can be achieved by a more aggressive deployment of the OFC or by reducing the load on the turbine unit. However, reducing the upward flows to the gate slots could affect fish guidance efficiencies of the ESBS. Further testing of these alternatives is necessary prior to recommending their implementation at John Day Dam. Results based on work in 2004 are summarized below.

1) Mean yearling Chinook salmon descaling was 0.0, 0.0, and 4.5% for 6B (STS), 7B (ESBS), and 7C (ESBS) with the 2002 prototype VBS, respectively. Mean yearling Chinook salmon descaling was 0.0, 1.1, and 11.3% for 6B (STS), 7B (ESBS), and 7C (ESBS) with the 2004 prototype VBS, respectively.

2) Mean yearling Chinook salmon mortality was 0.6, 1.6, and 8.0% for 6B (STS), 7B (ESBS), and 7C (ESBS) with the 2002 prototype VBS, respectively. Mean yearling Chinook salmon mortality was 0.0, 0.6, and 10.4% for 6B (STS), 7B (ESBS), and 7C (ESBS) with the 2004 prototype VBS, respectively.

3) Passage times for yearling Chinook salmon were shorter for fish exiting the gate slot fitted with an ESBS (7B or 7C) than for the standard gate slot fitted with a STS (6B or 6C). Median passage time for the standard gate slot exceeds a full day, 24.9 h, while that of the ESBS-equipped gate slot is less than 2 h.

4) Mean subyearling Chinook salmon descaling was 0.0 and 2.8% for 7B (ESBS with the 2002 prototype VBS) and 7C (ESBS with the 2004 prototype VBS) prior to the deployment of the OFC. Mean subyearling Chinook salmon descaling was 0.3 and 5.6% for 7B (ESBS with the 2002 prototype VBS) and 7C (ESBS with the 2004 prototype VBS) after the deployment of the OFC.

5) Mean subyearling Chinook salmon mortality was 1.5 and 0.0% for 7B (ESBS with the 2002 prototype VBS) and 7C (ESBS with the 2004 prototype VBS) prior to the deployment of the OFC. Mean subyearling Chinook salmon mortality was 2.0 and 11.9% for 7B (ESBS with the 2002 prototype VBS) and 7C (ESBS with the 2004 prototype VBS) after the deployment of the OFC.

6) Passage times for subyearling Chinook salmon were shorter for fish exiting the 7B gate slot fitted with an ESBS and 2002 prototype VBS than for the 7C gate slot fitted with an ESBS and 2004 prototype VBS.

7) Descaling and mortality in the 7C gate slot with the ESBS were higher than acceptable at the 21 kcfs flow (155 MW load).

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## APPENDIX: Data Tables

Appendix Table 1. Release, detection, and recapture data for PIT-tagged yearling and subyearling Chinook salmon used in fish condition tests at John Day Dam, 2004.

| Release date | Release location and guidance devices[b] | Tagged | Released | Detected[a] No. | Detected[a] % | Recaptured[a] Live | Recaptured[a] Dead | Recaptured[a] Total | Recaptured[a] % |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Yearling Chinook salmon** | | | | | |
| | | | | STS and standard VBS vs. ESBS and 2002 prototype VBS | | | | | |
| 5/06[c] | 6B / STS, std VBS | 101 | 101 | 99 | 98.0 | 84 | 1 | 85 | 84.2 |
| 5/07 | 6B / STS, std VBS | 101 | 100 | 99 | 99.0 | 88 | 0 | 88 | 88.0 |
| 5/11 | 6B / STS, std VBS | 100 | 100 | 100 | 100.0 | 92 | 0 | 92 | 92.0 |
| 5/12 | 6B / STS, std VBS | 99 | 99 | 99 | 100.0 | 89 | 1 | 90 | 90.9 |
| Totals and averages | | 401 | 400 | 397 | **99.3** | 353 | 2 | 355 | 88.8 |
| 5/06 | 7B / ESBS, 2002 VBS | 101 | 101 | 100 | 99.0 | 88 | 0 | 88 | 87.1 |
| 5/07 | 7B / ESBS, 2002 VBS | 101 | 93 | 93 | 100.0 | 82 | 1 | 83 | 89.2 |
| 5/11 | 7B / ESBS, 2002 VBS | 101 | 98 | 96 | 98.0 | 90 | 3 | 93 | 94.9 |
| 5/12 | 7B / ESBS, 2002 VBS | 99 | 99 | 96 | 97.0 | 91 | 2 | 93 | 93.9 |
| Totals and averages | | 402 | 391 | 385 | **98.5** | 351 | 6 | 357 | 91.3 |
| | | | | STS and standard VBS vs. ESBS and 2004 prototype VBS | | | | | |
| 5/18 | 6C / STS, std VBS | 99 | 89 | 89 | 100.0 | 81 | 0 | 81 | 91.0 |
| 5/19 | 6C / STS, std VBS | 100 | 100 | 100 | 100.0 | 91 | 0 | 91 | 91.0 |
| 5/20 | 6C / STS, std VBS | 100 | 100 | 100 | 100.0 | 83 | 0 | 83 | 83.0 |
| Totals and averages | | 299 | 289 | 289 | **100.0** | 255 | 0 | 255 | 88.3 |
| 5/18 | 7C / ESBS 2004 VBS | 100 | 98 | 90 | 91.8 | 66 | 11 | 77 | 78.6 |
| 5/19 | 7C / ESBS 2004 VBS | 100 | 100 | 90 | 90.0 | 76 | 5 | 81 | 81.0 |
| 5/20 | 7C / ESBS 2004 VBS | 100 | 100 | 82 | 82.0 | 67 | 8 | 75 | 75.0 |
| Totals and averages | | 300 | 298 | 262 | **87.9** | 209 | 24 | 233 | 78.2 |
| | | | | ESBS and 2002 prototype VBS vs. ESBS and 2004 prototype VBS | | | | | |
| 5/27 | 7C / ESBS, 2002 VBS | 98 | 98 | 82 | 83.7 | 67 | 3 | 70 | 71.4 |
| 5/27 | 7C / ESBS, 2002 VBS | 78 | 78 | 62 | 79.5 | 49 | 5 | 54 | 69.2 |
| 6/01 | 7C / ESBS, 2002 VBS | 98 | 98 | 60 | 61.2 | 51 | 6 | 57 | 58.2 |
| Totals and averages | | 274 | 274 | 204 | **74.8** | 167 | 14 | 181 | 66.3 |
| 5/27 | 7B / ESBS 2004 VBS | 99 | 99 | 95 | 96.0 | 90 | 0 | 90 | 90.9 |
| 5/27 | 7B / ESBS 2004 VBS | 75 | 75 | 73 | 97.3 | 67 | 0 | 67 | 89.3 |
| 6/01 | 7B / ESBS 2004 VBS | 110 | 110 | 110 | 100.0 | 104 | 2 | 106 | 96.4 |
| Totals and averages | | 284 | 284 | 278 | **97.8** | 261 | 2 | 263 | 92.2 |

Appendix Table 1. Continued.

| Release date | Release location and guidance devices[b] | Tagged | Released | Detected[a] No. | Detected[a] % | Recaptured[a] Live | Recaptured[a] Dead | Recaptured[a] Total | Recaptured[a] % |
|---|---|---|---|---|---|---|---|---|---|
| | **Subyearling Chinook salmon** | | | | | | | | |
| | Tests conducted prior to deployment of the outlet flow-control device in 7C | | | | | | | | |
| 6/24 | 7B / ESBS, 2002 VBS | 75 | 75 | 75 | 100.0 | 64 | 1 | 65 | 86.7 |
| 6/25 | 7B / ESBS, 2002 VBS | 76 | 76 | 76 | 100.0 | 68 | 1 | 69 | 90.8 |
| Totals and averages | | 151 | 151 | 151 | 100.0 | 132 | 2 | 134 | 88.7 |
| 6/24 | 7C / ESBS, 2004 VBS | 75 | 66 | 60 | 90.9 | 51 | 0 | 51 | 77.3 |
| 6/25 | 7C / ESBS, 2004 VBS | 75 | 75 | 68 | 90.7 | 62 | 0 | 62 | 82.7 |
| Totals and averages | | 150 | 141 | 128 | 90.8 | 113 | 0 | 113 | 80.0 |
| | Tests conducted after deployment of the outlet flow-control device in 7C | | | | | | | | |
| 6/28 | 7B / ESBS, 2002 VBS | 75 | 75 | 73 | 97.3 | 55 | 0 | 55 | 73.3 |
| 6/29 | 7B / ESBS, 2002 VBS | 67 | 67 | 67 | 100.0 | 58 | 0 | 58 | 86.6 |
| 6/30 | 7B / ESBS, 2002 VBS | 75 | 75 | 70 | 93.3 | 55 | 0 | 55 | 73.3 |
| 7/06 | 7B / ESBS, 2002 VBS | 76 | 74 | 66 | 89.2 | 53 | 2 | 55 | 74.3 |
| 7/08 | 7B / ESBS, 2002 VBS | 75 | 74 | 73 | 98.6 | 67 | 0 | 67 | 90.5 |
| 7/08 | 7B / ESBS, 2002 VBS | 75 | 75 | 63 | 84.0 | 56 | 5 | 61 | 81.3 |
| Totals and averages | | 443 | 440 | 412 | 93.8 | 344 | 7 | 351 | 79.9 |
| 6/28 | 7C / ESBS, 2004 VBS | 75 | 75 | 49 | 65.3 | 41 | 0 | 41 | 54.7 |
| 6/29 | 7C / ESBS, 2004 VBS | 75 | 75 | 66 | 88.0 | 54 | 0 | 54 | 72.0 |
| 6/30 | 7C / ESBS, 2004 VBS | 75 | 75 | 49 | 65.3 | 35 | 3 | 38 | 50.7 |
| 7/06 | 7C / ESBS, 2004 VBS | 76 | 76 | 14 | 18.4 | 6 | 5 | 11 | 14.5 |
| 7/08 | 7C / ESBS, 2004 VBS | 77 | 75 | 50 | 66.7 | 43 | 3 | 46 | 61.3 |
| 7/08 | 7C / ESBS, 2004 VBS | 77 | 74 | 40 | 54.1 | 30 | 4 | 34 | 45.9 |
| Totals and averages | | 455 | 450 | 268 | 59.6 | 209 | 15 | 224 | 49.8 |

a Based on the number of fish released.

b Fish were released from a submerged canister into the B and C gatewells of turbine units 6 and 7. Fish guidance devices: STS = submersible traveling screen; ESBS = extended-length submersible bar screen; std VBS = standard vertical barrier screen; 2002 VBS = prototype wedge-wire vertical barrier screen first tested in 2002; and 2004 VBS = improved version of the 2002 prototype VBS.

c Turbine unit 7 was shut down during the test on 5/06/04.

Appendix Table 2. Mortality and descaling data for PIT-tagged yearling and subyearling Chinook salmon used in fish condition tests at John Day Dam, 2004.

| Release date | Release location and guidance devices [b] | Number released | Number recaptured | | | Mortality (%) | Descaling[a] | |
|---|---|---|---|---|---|---|---|---|
| | | | Live | Dead | Total | | Partial | ≥20% |
| **Yearling Chinook salmon** | | | | | | | | |
| STS and standard VBS vs. ESBS and 2002 prototype VBS | | | | | | | | |
| 5/06[c] | 6B / STS, std VBS | 101 | 84 | 1 | 85 | 1.2 | 6.0 | 0.0 |
| 5/07 | 6B / STS, std VBS | 100 | 88 | 0 | 88 | 0.0 | 0.0 | 0.0 |
| 5/11 | 6B / STS, std VBS | 100 | 92 | 0 | 92 | 0.0 | 2.2 | 0.0 |
| 5/12 | 6B / STS, std VBS | 99 | 89 | 1 | 90 | 1.1 | 3.4 | 0.0 |
| Totals and averages | | **400** | **353** | **2** | **355** | **0.6** | **2.9** | **0.0** |
| 5/06[c] | 7B / ESBS, 2002 VBS | 101 | 88 | 0 | 88 | 0.0 | 3.4 | 0.0 |
| 5/07 | 7B / ESBS, 2002 VBS | 93 | 82 | 1 | 83 | 1.2 | 1.2 | 0.0 |
| 5/11 | 7B / ESBS, 2002 VBS | 98 | 90 | 3 | 93 | 3.2 | 5.6 | 0.0 |
| 5/12 | 7B / ESBS, 2002 VBS | 99 | 91 | 2 | 93 | 2.2 | 6.6 | 0.0 |
| Totals and averages | | **391** | **351** | **6** | **357** | **1.6** | **4.2** | **0.0** |
| STS and standard VBS vs. ESBS and 2004 prototype VBS | | | | | | | | |
| 5/18 | 6C / STS, std VBS | 89 | 81 | 0 | 81 | 0.0 | 1.2 | 0.0 |
| 5/19 | 6C / STS, std VBS | 100 | 91 | 0 | 91 | 0.0 | 3.3 | 0.0 |
| 5/20 | 6C / STS, std VBS | 100 | 83 | 0 | 83 | 0.0 | 0.0 | 0.0 |
| Totals and averages | | **289** | **255** | **0** | **255** | **0.0** | **1.5** | **0.0** |
| 5/18 | 7C / ESBS, 2004 VBS | 98 | 66 | 11 | 77 | 14.3 | 22.7 | 14.3 |
| 5/19 | 7C / ESBS, 2004 VBS | 100 | 76 | 5 | 81 | 6.2 | 10.5 | 9.2 |
| 5/20 | 7C / ESBS, 2004 VBS | 100 | 67 | 8 | 75 | 10.7 | 28.4 | 10.4 |
| Totals and averages | | **298** | **209** | **24** | **233** | **10.4** | **20.5** | **11.3** |
| ESBS and 2002 prototype VBS vs. ESBS and 2004 prototype VBS | | | | | | | | |
| 5/27 | 7C / ESBS, 2002 VBS | 98 | 67 | 3 | 70 | 4.3 | 22.4 | 1.5 |
| 5/27 | 7C / ESBS, 2002 VBS | 78 | 49 | 5 | 54 | 9.3 | 32.7 | 4.1 |
| 6/01 | 7C / ESBS, 2002 VBS | 98 | 51 | 6 | 57 | 10.5 | 31.4 | 7.8 |
| Totals and averages | | **274** | **167** | **14** | **181** | **8.0** | **28.8** | **4.5** |
| 5/27 | 7B / ESBS, 2004 VBS | 99 | 90 | 0 | 90 | 0.0 | 14.4 | 0.0 |
| 5/27 | 7B / ESBS, 2004 VBS | 75 | 67 | 0 | 67 | 0.0 | 4.5 | 1.5 |
| 6/01 | 7B / ESBS, 2004 VBS | 110 | 104 | 2 | 106 | 1.9 | 8.7 | 1.9 |
| Totals and averages | | **284** | **261** | **2** | **263** | **0.6** | **9.2** | **1.1** |

Appendix Table 2. Continued.

| Release date | Release location and guidance devices [b] | Number released | Number recaptured | | | Mortality (%) | Descaling[a] | |
|---|---|---|---|---|---|---|---|---|
| | | | Live | Dead | Total | | Partial | ≥20% |
| | | | **Subyearling Chinook salmon** | | | | | |
| | | | Tests conducted prior to deployment of the outlet flow-control device | | | | | |
| 6/24 | 7B / ESBS, 2002 VBS | 75 | 64 | 1 | 65 | 1.5 | 1.6 | 0.0 |
| 6/25 | 7B / ESBS, 2002 VBS | 76 | 68 | 1 | 69 | 1.4 | 2.9 | 0.0 |
| Totals and averages | | **151** | **132** | **2** | **134** | **1.5** | **2.3** | **0.0** |
| 6/24 | 7C / ESBS, 2004 VBS | 66 | 51 | 0 | 51 | 0.0 | 11.8 | 3.9 |
| 6/25 | 7C / ESBS, 2004 VBS | 75 | 62 | 0 | 62 | 0.0 | 9.7 | 1.6 |
| Totals and averages | | **141** | **113** | **0** | **113** | **0.0** | **10.8** | **2.8** |
| | | | Tests conducted after deployment of the outlet flow-control device | | | | | |
| 6/28 | 7B / ESBS, 2002 VBS | 75 | 55 | 0 | 55 | 0.0 | 1.8 | 0.0 |
| 6/29 | 7B / ESBS, 2002 VBS | 67 | 58 | 0 | 58 | 0.0 | 3.4 | 0.0 |
| 6/30 | 7B / ESBS, 2002 VBS | 75 | 55 | 0 | 55 | 0.0 | 3.6 | 1.8 |
| 7/06 | 7B / ESBS, 2002 VBS | 74 | 53 | 2 | 55 | 3.6 | 11.3 | 0.0 |
| 7/08 | 7B / ESBS, 2002 VBS | 74 | 67 | 0 | 67 | 0.0 | 3.0 | 0.0 |
| 7/08 | 7B / ESBS, 2002 VBS | 75 | 56 | 5 | 61 | 8.2 | 3.6 | 0.0 |
| Totals and averages | | **440** | **344** | **7** | **351** | **2.0** | **4.5** | **0.3** |
| 6/28 | 7C / ESBS, 2004 VBS | 75 | 41 | 0 | 41 | 0.0 | 22.0 | 7.3 |
| 6/29 | 7C / ESBS, 2004 VBS | 75 | 54 | 0 | 54 | 0.0 | 9.3 | 0.0 |
| 6/30 | 7C / ESBS, 2004 VBS | 75 | 35 | 3 | 38 | 7.9 | 20.0 | 11.4 |
| 7/06 | 7C / ESBS, 2004 VBS | 76 | 6 | 5 | 11 | 45.5 | 0.0 | 0.0 |
| 7/08 | 7C / ESBS, 2004 VBS | 75 | 43 | 3 | 46 | 6.5 | 9.3 | 4.7 |
| 7/08 | 7C / ESBS, 2004 VBS | 74 | 30 | 4 | 34 | 11.8 | 13.3 | 10.0 |
| Totals and averages | | **450** | **209** | **15** | **224** | **11.9** | **12.3** | **5.6** |

a Percentage of fish recaptured live which were descaled. Descaling categories: partial indicates a fish was >3<20% descaled on at least one side and descaled indicates a fish was ≥20% descaled on at least one side.

b Fish were released from a submerged canister into the B and C gatewells of turbine units 6 and 7. Fish guidance devices: STS = submersible traveling screen; ESBS = extended-length submersible bar screen; std VBS = standard vertical barrier screen; 2002 VBS = prototype wedge-wire vertical barrier screen first tested in 2002; and 2004 VBS = improved version of the 2002 prototype VBS.

c Turbine unit 7 was shut down during the test on 5/6/04.

Appendix Table 3. Travel times (h) of PIT-tagged yearling and subyearling Chinook salmon during fish condition tests at John Day Dam, 2004.

| Release date | Release location and guidance devices[a] | Number of fish[b] | Passage percentile 10th | median | 90th | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| | | | **Yearling Chinook salmon** | | | | |
| | | | STS and standard VBS vs. ESBS and 2002 prototype VBS | | | | |
| 5/06[c] | 6B / STS, std VBS | 84 | 17.63 | 25.92 | 35.61 | 2.52 | 98.28 |
| 5/07 | 6B / STS, std VBS | 88 | 3.76 | 5.29 | 75.71 | 0.86 | 86.54 |
| 5/11 | 6B / STS, std VBS | 92 | 9.01 | 33.35 | 167.97 | 1.56 | 283.46 |
| 5/12 | 6B / STS, std VBS | 89 | 8.22 | 36.86 | 221.63 | 4.37 | 268.30 |
| Totals and averages | | **353** | **9.66** | **25.36** | **125.23** | | |
| 5/06[c] | 7B / ESBS, 2002 VBS | 88 | 0.26 | 12.07 | 24.15 | 0.14 | 59.95 |
| 5/07 | 7B / ESBS, 2002 VBS | 82 | 0.29 | 1.50 | 8.21 | 0.17 | 44.71 |
| 5/11 | 7B / ESBS, 2002 VBS | 90 | 0.50 | 1.40 | 5.54 | 0.19 | 45.02 |
| 5/12 | 7B / ESBS, 2002 VBS | 91 | 0.50 | 2.57 | 9.24 | 0.12 | 45.19 |
| Totals and averages | | **351** | **0.39** | **4.39** | **11.79** | | |
| | | | STS and standard VBS vs. ESBS and 2004 prototype VBS | | | | |
| 5/18 | 6C / STS, std VBS | 81 | 12.94 | 22.80 | 86.04 | 2.90 | 193.37 |
| 5/19 | 6C / STS, std VBS | 91 | 8.52 | 22.85 | 74.33 | 0.12 | 303.00 |
| 5/20 | 6C / STS, std VBS | 83 | 6.60 | 27.67 | 61.97 | 1.25 | 200.06 |
| Totals and averages | | **255** | **9.35** | **24.44** | **74.11** | | |
| 5/18 | 7C / ESBS, 2004 VBS | 66 | 0.22 | 0.88 | 3.07 | 0.19 | 7.22 |
| 5/19 | 7C / ESBS, 2004 VBS | 76 | 0.14 | 0.22 | 1.46 | 0.14 | 1.80 |
| 5/20 | 7C / ESBS, 2004 VBS | 67 | 0.31 | 1.34 | 2.70 | 0.17 | 5.88 |
| Totals and averages | | **209** | **0.22** | **0.81** | **2.41** | | |
| | | | ESBS and 2002 prototype VBS vs. ESBS and 2004 prototype VBS | | | | |
| 5/27 | 7C / ESBS, 2002 VBS | 67 | 0.21 | 1.49 | 9.57 | 0.14 | 50.54 |
| 5/27 | 7C / ESBS, 2002 VBS | 49 | 0.96 | 3.50 | 9.17 | 0.36 | 29.66 |
| 6/01 | 7C / ESBS, 2002 VBS | 51 | 0.84 | 3.00 | 6.41 | 0.19 | 19.80 |
| Totals and averages | | **167** | **0.67** | **2.66** | **8.38** | | |
| 5/27 | 7B / ESBS, 2004 VBS | 90 | 0.19 | 0.55 | 4.33 | 0.10 | 10.34 |
| 5/27 | 7B / ESBS, 2004 VBS | 67 | 0.18 | 0.60 | 3.41 | 0.12 | 5.38 |
| 6/01 | 7B / ESBS, 2004 VBS | 104 | 0.24 | 1.30 | 3.12 | 0.17 | 4.87 |
| Totals and averages | | **261** | **0.20** | **0.82** | **3.62** | | |

Appendix Table 3. Continued.

| Release date | Release location and guidance devices[a] | Number of fish[b] | Passage percentile 10th | median | 90th | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| | | | **Subyearling Chinook salmon** | | | | |
| | | | Tests conducted prior to deployment of the outlet flow-control device in 7C | | | | |
| 6/24 | 7B / ESBS, 2002 VBS | 64 | 0.17 | 2.78 | 9.50 | 0.14 | 22.85 |
| 6/25 | 7B / ESBS, 2002 VBS | 68 | 0.17 | 0.26 | 2.47 | 0.14 | 8.78 |
| Totals and averages | | **132** | **0.17** | **1.52** | **5.99** | | |
| 6/24 | 7C / ESBS, 2004 VBS | 51 | 0.17 | 3.79 | 25.99 | 0.14 | 34.25 |
| 6/25 | 7C / ESBS, 2004 VBS | 62 | 0.17 | 0.70 | 3.36 | 0.14 | 7.44 |
| Totals and averages | | **113** | **0.17** | **2.25** | **14.68** | | |
| | | | Tests conducted after deployment of the outlet flow-control device in 7C | | | | |
| 6/28 | 7B / ESBS, 2002 VBS | 55 | 1.07 | 4.51 | 7.36 | 0.31 | 19.32 |
| 6/29 | 7B / ESBS, 2002 VBS | 58 | 0.17 | 0.38 | 1.54 | 0.17 | 9.00 |
| 6/30 | 7B / ESBS, 2002 VBS | 55 | 0.13 | 0.36 | 0.72 | 0.12 | 1.08 |
| 7/06 | 7B / ESBS, 2002 VBS | 53 | 0.17 | 0.36 | 1.64 | 0.12 | 7.15 |
| 7/08 | 7B / ESBS, 2002 VBS | 67 | 0.14 | 0.19 | 0.43 | 0.12 | 0.84 |
| 7/08 | 7B / ESBS, 2002 VBS | 56 | 0.14 | 0.25 | 0.64 | 0.12 | 8.42 |
| Totals and averages | | **344** | **0.30** | **1.01** | **2.06** | | |
| 6/28 | 7C / ESBS, 2004 VBS | 41 | 2.02 | 4.82 | 7.90 | 0.36 | 18.84 |
| 6/29 | 7C / ESBS, 2004 VBS | 54 | 0.22 | 0.36 | 6.11 | 0.14 | 12.53 |
| 6/30 | 7C / ESBS, 2004 VBS | 35 | 0.25 | 2.71 | 7.33 | 0.14 | 9.62 |
| 7/06 | 7C / ESBS, 2004 VBS | 6 | 0.12 | 0.24 | 8.78 | 0.12 | 9.65 |
| 7/08 | 7C / ESBS, 2004 VBS | 43 | 0.14 | 0.65 | 8.72 | 0.12 | 46.10 |
| 7/08 | 7C / ESBS, 2004 VBS | 30 | 0.30 | 1.20 | 7.97 | 0.12 | 8.46 |
| Totals and averages | | **209** | **0.51** | **1.66** | **7.80** | | |

a Fish were released from a submerged canister into the B and C gatewells of turbine units 6 and 7. Fish guidance devices: STS = submersible traveling screen; ESBS = extended-length submersible bar screen; std VBS = standard vertical barrier screen; 2002 VBS = prototype wedge-wire vertical barrier screen first tested in 2002; and 2004 VBS = improved version of the 2002 prototype VBS.

b Timing data are based on passage times of fish recaptured live.

c Turbine unit 7 was shut down during the test on 5/6/04. Data from releases on this date is not included in calculation of average timing values.

Appendix Table 4. Detection summary for PIT-tagged yearling and subyearling Chinook salmon used in fish condition tests at John Day Dam, 2004.

| Release date | Release location | Number released | Tags detected by location[a] | | | | | Detected[b] | | Undetected[b] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | East-1 | East-2 | West | River | SMP | No. | % | No. | % |
| **Yearling Chinook salmon** | | | | | | | | | | | |
| STS and standard VBS vs. ESBS and 2002 prototype VBS | | | | | | | | | | | |
| 5/06[c] | 6B | 101 | 85 | 1 | 0 | 3 | 10 | 99 | 98.0 | 2 | 2.0 |
| 5/07 | 6B | 100 | 88 | 0 | 0 | 2 | 9 | 99 | 99.0 | 1 | 1.0 |
| 5/11 | 6B | 100 | 92 | 1 | 1 | 2 | 4 | 100 | 100.0 | 0 | 0.0 |
| 5/12 | 6B | 99 | 90 | 0 | 0 | 2 | 7 | 99 | 100.0 | 0 | 0.0 |
| **Overall** | | **400** | **355** | **2** | **1** | **9** | **30** | **397** | **99.3** | **3** | **0.7** |
| 5/06[c] | 7B | 101 | 88 | 1 | 0 | 3 | 8 | 100 | 99.0 | 1 | 1.0 |
| 5/07 | 7B | 93 | 83 | 1 | 0 | 1 | 8 | 93 | 100.0 | 0 | 0.0 |
| 5/11 | 7B | 98 | 93 | 0 | 0 | 3 | 0 | 96 | 98.0 | 2 | 2.0 |
| 5/12 | 7B | 99 | 93 | 0 | 0 | 3 | 0 | 96 | 97.0 | 3 | 3.0 |
| **Overall** | | **391** | **357** | **2** | **0** | **10** | **16** | **385** | **98.5** | **6** | **1.5** |
| STS and standard VBS vs. ESBS and 2004 prototype VBS | | | | | | | | | | | |
| 5/18 | 6C | 89 | 81 | 0 | 0 | 3 | 5 | 89 | 100.0 | 0 | 0.0 |
| 5/19 | 6C | 100 | 91 | 0 | 0 | 3 | 6 | 100 | 100.0 | 0 | 0.0 |
| 5/20 | 6C | 100 | 83 | 0 | 0 | 4 | 13 | 100 | 100.0 | 0 | 0.0 |
| **Overall** | | **289** | **255** | **0** | **0** | **10** | **24** | **289** | **97.3** | **0** | **0.0** |
| 5/18 | 7C | 98 | 78 | 0 | 0 | 4 | 8 | 90 | 91.8 | 8 | 8.2 |
| 5/19 | 7C | 100 | 81 | 0 | 0 | 4 | 5 | 90 | 90.0 | 10 | 10.0 |
| 5/20 | 7C | 100 | 75 | 1 | 0 | 1 | 5 | 82 | 82.0 | 18 | 18.0 |
| **Overall** | | **298** | **234** | **1** | **0** | **9** | **18** | **262** | **87.9** | **36** | **12.1** |
| ESBS and 2002 prototype VBS vs. ESBS and 2004 prototype VBS | | | | | | | | | | | |
| 5/27 | 7C | 98 | 71 | 0 | 0 | 1 | 10 | 82 | 83.7 | 16 | 16.3 |
| 5/27 | 7C | 78 | 55 | 3 | 0 | 3 | 1 | 62 | 79.5 | 16 | 20.5 |
| 6/01 | 7C | 98 | 57 | 0 | 0 | 2 | 1 | 60 | 61.2 | 38 | 38.8 |
| **Overall** | | **274** | **183** | **3** | **0** | **6** | **12** | **204** | **74.8** | **70** | **25.2** |
| 5/27 | 7B | 99 | 90 | 1 | 0 | 2 | 2 | 95 | 96.0 | 4 | 4.0 |
| 5/27 | 7B | 75 | 67 | 0 | 0 | 2 | 4 | 73 | 97.3 | 2 | 2.7 |
| 6/01 | 7B | 110 | 106 | 0 | 0 | 2 | 2 | 110 | 100.0 | 0 | 0.0 |
| **Overall** | | **284** | **263** | **1** | **0** | **6** | **8** | **278** | **97.8** | **6** | **2.2** |

Appendix Table 4. Continued.

| Release date | Release location | Number released | Tags detected by location[a] | | | | | Detected[b] | | Undetected[b] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | East-1 | East-2 | West | River | SMP | No. | % | No. | % |
| **Subyearling Chinook salmon** | | | | | | | | | | | |
| Tests conducted prior to deployment of the outlet flow-control device | | | | | | | | | | | |
| 6/24 | 7B | 75 | 65 | 3 | 0 | 3 | 4 | 75 | 100.0 | 0 | 0.0 |
| 6/25 | 7B | 76 | 69 | 0 | 0 | 5 | 2 | 76 | 100.0 | 0 | 0.0 |
| **Overall** | | **151** | **134** | **3** | **0** | **8** | **6** | **151** | **100.0** | **0** | **0.0** |
| 6/24 | 7C | 66 | 52 | 2 | 0 | 3 | 3 | 60 | 90.9 | 6 | 9.1 |
| 6/25 | 7C | 75 | 62 | 0 | 0 | 2 | 4 | 68 | 90.7 | 7 | 9.3 |
| **Overall** | | **141** | **114** | **2** | **0** | **5** | **7** | **128** | **90.8** | **13** | **9.2** |
| Tests conducted after deployment of the outlet flow-control device | | | | | | | | | | | |
| 6/28 | 7B | 75 | 56 | 1 | 0 | 6 | 10 | 73 | 97.3 | 2 | 2.7 |
| 6/29 | 7B | 67 | 58 | 1 | 0 | 4 | 4 | 67 | 100.0 | 0 | 0.0 |
| 6/30 | 7B | 75 | 55 | 1 | 0 | 3 | 11 | 70 | 93.3 | 5 | 6.7 |
| 7/06 | 7B | 74 | 60 | 2 | 0 | 4 | 0 | 66 | 89.2 | 8 | 10.8 |
| 7/08 | 7B | 74 | 70 | 1 | 0 | 2 | 0 | 73 | 98.6 | 1 | 1.4 |
| 7/08 | 7B | 75 | 61 | 1 | 0 | 1 | 0 | 63 | 84.0 | 12 | 16.0 |
| **Overall** | | **440** | **360** | **7** | **0** | **20** | **25** | **412** | **93.8** | **28** | **6.2** |
| 6/28 | 7C | 75 | 41 | 1 | 0 | 2 | 5 | 49 | 65.3 | 26 | 34.7 |
| 6/29 | 7C | 75 | 57 | 0 | 0 | 2 | 7 | 66 | 88.0 | 9 | 12.0 |
| 6/30 | 7C | 75 | 41 | 1 | 0 | 1 | 6 | 49 | 65.3 | 26 | 34.7 |
| 7/06 | 7C | 76 | 14 | 0 | 0 | 0 | 0 | 14 | 18.4 | 62 | 81.6 |
| 7/08 | 7C | 75 | 46 | 0 | 0 | 4 | 0 | 50 | 66.7 | 25 | 33.3 |
| 7/08 | 7C | 74 | 36 | 0 | 0 | 4 | 0 | 40 | 54.1 | 34 | 45.9 |
| **Overall** | | **450** | **235** | **2** | **0** | **13** | **18** | **268** | **59.6** | **182** | **40.4** |

a Locations: East-1 = east separation-by-code raceway (correct diversion, fish recaptured with tag in place); East-2 = east separation-by-code raceway (correct diversion, tag found loose in raceway); West = west separation-by-code raceway (incorrectly diversion); River = fish passed to river (diversion failure); and SMP = diverted to smolt monitoring program sample (correct diversion).

b Based on number of fish released.

c Turbine unit 7 was shut down during the test on 5/6/04.

Appendix Table 5. PIT-tag detections at Bonneville Dam (Bonn.) for yearling and subyearling Chinook salmon released into John Day Dam turbine gatewells during fish condition tests conducted in spring and summer, 2004. Data are compared for test fish examined and returned live to the river following detection at John Day Dam and for test fish which were not detected passing through the John Dam juvenile bypass system.

| | | Detected at John Day Dam | | | Undetected at John Day Dam | | |
|---|---|---|---|---|---|---|---|
| | | | Later detected at Bonn. | | | Later detected at Bonn. | |
| Release date | Release location, guidance devices[a] | Released live (No.) | No. | % | No. | No. | % |
| **Yearling Chinook salmon** | | | | | | | |
| 5/06[b] | 6B / STS, std VBS | 84 | 3 | 3.6 | 2 | 0 | 0.0 |
| | 6B / STS, std VBS | 88 | 6 | 6.8 | 1 | 0 | 0.0 |
| 5/11 | 6B / STS, std VBS | 92 | 5 | 5.4 | 0 | -- | -- |
| 5/12 | 6B / STS, std VBS | 89 | 7 | 7.9 | 0 | -- | -- |
| Overall | | **353** | **21** | **5.9** | **3** | **0** | **0.0** |
| 5/06[b] | 7B / ESBS, 2002 | 88 | 4 | 4.5 | 1 | 0 | 0.0 |
| | 7B / ESBS, 2002 | 82 | 3 | 3.7 | 0 | -- | -- |
| 5/11 | 7B / ESBS, 2002 | 90 | 4 | 4.4 | 2 | 0 | 0.0 |
| 5/12 | 7B / ESBS, 2002 | 91 | 4 | 4.4 | 3 | 0 | 0.0 |
| Overall | | **351** | **15** | **4.3** | **6** | **0** | **0.0** |
| 5/18 | 6C / STS, std VBS | 81 | 8 | 9.9 | 0 | 0 | -- |
| 5/19 | 6C / STS, std VBS | 91 | 10 | 11.0 | 0 | 0 | -- |
| 5/20 | 6C / STS, std VBS | 83 | 10 | 12.0 | 0 | 0 | -- |
| Overall | | **255** | **28** | **11.0** | **0** | **0** | **--** |
| 5/18 | 7C / ESBS, 2004 | 66 | 8 | 12.1 | 8 | 0 | 0.0 |
| 5/19 | 7C / ESBS, 2004 | 76 | 8 | 10.5 | 10 | 0 | 0.0 |
| 5/20 | 7C / ESBS, 2004 | 67 | 9 | 13.4 | 18 | 1 | 5.6 |
| Overall | | **209** | **25** | **12.0** | **36** | **1** | **2.8** |
| 5/27 | 7C / ESBS, 2002 | 67 | 2 | 3.0 | 16 | 0 | 0.0 |
| 5/27 | 7C / ESBS, 2002 | 49 | 6 | 12.2 | 16 | 0 | 0.0 |
| 6/01 | 7C / ESBS, 2002 | 51 | 4 | 7.8 | 38 | 2 | 5.3 |
| Overall | | **167** | **12** | **7.2** | **70** | **2** | **2.9** |
| 5/27 | 7B / ESBS, 2004 | 90 | 10 | 11.1 | 4 | 0 | 0.0 |
| 5/27 | 7B / ESBS, 2004 | 67 | 2 | 3.0 | 2 | 0 | 0.0 |
| 6/01 | 7B / ESBS, 2004 | 104 | 16 | 15.4 | 0 | 0 | -- |
| Overall | | **261** | **28** | **10.7** | **6** | **0** | **0.0** |

Appendix Table 5. Continued.

| Release date | Release location, guidance devices[a] | Detected at John Day Dam: Released live (No.) | Detected at John Day Dam: Later detected at Bonn. No. | Detected at John Day Dam: Later detected at Bonn. % | Undetected at John Day Dam: No. | Undetected at John Day Dam: Later detected at Bonn. No. | Undetected at John Day Dam: Later detected at Bonn. % |
|---|---|---|---|---|---|---|---|
| | | | **Subyearling Chinook salmon** | | | | |
| 6/24 | 7B / ESBS, 2002 | 64 | 8 | 12.5 | 0 | -- | -- |
| | 7B / ESBS, 2002 | 68 | 7 | 10.3 | 0 | -- | -- |
| Overall | | **132** | **15** | **11.4** | **0** | **--** | **--** |
| 6/24 | 7C / ESBS, 2004 | 51 | 5 | 9.8 | 6 | 0 | 0.0 |
| 6/25 | 7C / ESBS, 2004 | 62 | 8 | 12.9 | 7 | 0 | 0.0 |
| Overall | | **113** | **13** | **11.5** | **13** | **0** | **0.0** |
| 6/28 | 7B / ESBS, 2002 | 55 | 9 | 16.4 | 2 | 0 | 0.0 |
| 6/29 | 7B / ESBS, 2002 | 58 | 7 | 12.1 | 0 | -- | -- |
| 6/30 | 7B / ESBS, 2002 | 55 | 4 | 7.3 | 5 | 0 | 0.0 |
| 7/06 | 7B / ESBS, 2002 | 53 | 1 | 1.9 | 8 | 0 | 0.0 |
| 7/08 | 7B / ESBS, 2002 | 67 | 2 | 3.0 | 1 | 0 | 0.0 |
| 7/08 | 7B / ESBS, 2002 | 56 | 2 | 3.6 | 12 | 0 | 0.0 |
| Overall | | **344** | **25** | **7.3** | **28** | **0** | **0.0** |
| 6/28 | 7C / ESBS, 2004 | 41 | 4 | 9.8 | 26 | 0 | 0.0 |
| 6/29 | 7C / ESBS, 2004 | 54 | 8 | 14.8 | 9 | 0 | 0.0 |
| 6/30 | 7C / ESBS, 2004 | 35 | 2 | 5.7 | 26 | 0 | 0.0 |
| 7/06 | 7C / ESBS, 2004 | 6 | 1 | 16.7 | 62 | 0 | 0.0 |
| 7/08 | 7C / ESBS, 2004 | 43 | 0 | 0.0 | 25 | 0 | 0.0 |
| 7/08 | 7C / ESBS, 2004 | 30 | 1 | 3.3 | 34 | 1 | 2.9 |
| Overall | | **209** | **16** | **7.7** | **182** | **1** | **0.5** |

a Fish were released from a submerged canister into the B and C gatewells of turbine units 6 and 7. Fish guidance devices: STS = submersible traveling screen; ESBS = extended-length submersible bar screen; std VBS = standard vertical barrier screen; 2002 VBS = prototype wedge-wire vertical barrier screen first tested in 2002; and 2004 VBS = improved version of the 2002 prototype VBS.

b Turbine unit 7 was shut down during the test on 5/6/04.

Appendix Table 6. Estimated descaling of PIT-tagged yearling and subyearling Chinook salmon recaptured after passage through the John Day Dam juvenile bypass system during spring and summer 2004. Results are given as percentages of the number of fish recaptured live which were judged as descaled in each category.

| | | | Descaling categories[a] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Release | Release location, | Number | Not | Partial | | Descaled | | | |
| date | guidance devices[b] | examined | desc. | A | B | C | D | E | F |
| **Yearling Chinook salmon** | | | | | | | | | |
| 5/06 | 6B / STS, std VBS | 84 | 94.0 | 4.8 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5/07 | 6B / STS, std VBS | 88 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5/11 | 6B / STS, std VBS | 92 | 97.8 | 2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5/12 | 6B / STS, std VBS | 89 | 96.6 | 3.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | **Overall** | **353** | **97.2** | **2.6** | **0.3** | **0.0** | **0.0** | **0.0** | **0.0** |
| 5/06[c] | 7B / ESBS, 2002 | 88 | 96.6 | 0.0 | 3.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5/07 | 7B / ESBS, 2002 | 82 | 98.8 | 0.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5/11 | 7B / ESBS, 2002 | 90 | 94.4 | 4.4 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5/12 | 7B / ESBS, 2002 | 91 | 93.4 | 4.4 | 2.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| | **Overall** | **351** | **95.7** | **2.3** | **2.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| 5/18 | 6C / STS, std VBS | 81 | 98.8 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5/19 | 6C / STS, std VBS | 91 | 96.7 | 3.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5/20 | 6C / STS, std VBS | 83 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | **Overall** | **255** | **98.4** | **1.6** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| 5/18 | 7C / ESBS, 2004 | 66 | 62.1 | 4.5 | 18.2 | 12.1 | 1.5 | 1.5 | 0.0 |
| 5/19 | 7C / ESBS, 2004 | 76 | 80.3 | 7.9 | 2.6 | 2.6 | 1.3 | 1.3 | 3.9 |
| 5/20 | 7C / ESBS, 2004 | 67 | 61.2 | 7.5 | 20.9 | 10.4 | 0.0 | 0.0 | 0.0 |
| | **Overall** | **209** | **68.4** | **6.7** | **13.4** | **8.1** | **1.0** | **1.0** | **1.4** |
| 5/27 | 7C / ESBS, 2002 | 67 | 76.1 | 14.9 | 7.5 | 1.5 | 0.0 | 0.0 | 0.0 |
| 5/27 | 7C / ESBS, 2002 | 49 | 63.3 | 22.4 | 10.2 | 4.1 | 0.0 | 0.0 | 0.0 |
| 6/01 | 7C / ESBS, 2002 | 51 | 60.8 | 27.5 | 3.9 | 3.9 | 2.0 | 2.0 | 0.0 |
| | **Overall** | **167** | **67.7** | **21.0** | **7.2** | **3.0** | **0.6** | **0.6** | **0.0** |
| 5/27 | 7B / ESBS, 2004 | 90 | 85.6 | 13.3 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5/27 | 7B / ESBS, 2004 | 67 | 94.0 | 4.5 | 0.0 | 1.5 | 0.0 | 0.0 | 0.0 |
| 6/01 | 7B / ESBS, 2004 | 104 | 89.4 | 7.7 | 1.0 | 1.9 | 0.0 | 0.0 | 0.0 |
| | **Overall** | **261** | **89.3** | **8.8** | **0.8** | **1.1** | **0.0** | **0.0** | **0.0** |

Appendix Table 6. Continued.

| Release date | Release location, guidance devices[b] | Number examined | Descaling categories[a] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Not desc. | Partial | | Descaled | | | |
| | | | | A | B | C | D | E | F |
| **Subyearling Chinook salmon** | | | | | | | | | |
| **Tests conducted prior to deployment of the outlet flow-control device in 7C** | | | | | | | | | |
| 6/24 | 7B / ESBS, 2002 | 64 | 98.4 | 1.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6/25 | 7B / ESBS, 2002 | 68 | 97.1 | 2.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | **Overall** | **132** | **97.7** | **2.3** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| 6/24 | 7C / ESBS, 2004 | 51 | 84.3 | 7.8 | 3.9 | 3.9 | 0.0 | 0.0 | 0.0 |
| 6/25 | 7C / ESBS, 2004 | 62 | 88.7 | 8.1 | 1.6 | 1.6 | 0.0 | 0.0 | 0.0 |
| | **Overall** | **113** | **86.7** | **8.0** | **2.7** | **2.7** | **0.0** | **0.0** | **0.0** |
| **Tests conducted after deployment of the outlet flow-control device in 7C** | | | | | | | | | |
| 6/28 | 7B / ESBS, 2002 | 55 | 98.2 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6/29 | 7B / ESBS, 2002 | 58 | 96.6 | 3.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6/30 | 7B / ESBS, 2002 | 55 | 94.5 | 3.6 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0 |
| 7/06 | 7B / ESBS, 2002 | 53 | 88.7 | 11.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7/08 | 7B / ESBS, 2002 | 67 | 97.0 | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7/08 | 7B / ESBS, 2002 | 56 | 96.4 | 3.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | **Overall** | **344** | **95.3** | **4.4** | **0.0** | **0.3** | **0.0** | **0.0** | **0.0** |
| 6/28 | 7C / ESBS, 2004 | 41 | 70.7 | 9.8 | 12.2 | 7.3 | 0.0 | 0.0 | 0.0 |
| 6/29 | 7C / ESBS, 2004 | 54 | 90.7 | 7.4 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6/30 | 7C / ESBS, 2004 | 35 | 68.6 | 11.4 | 8.6 | 5.7 | 5.7 | 0.0 | 0.0 |
| 7/06 | 7C / ESBS, 2004 | 6 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7/08 | 7C / ESBS, 2004 | 43 | 86.0 | 7.0 | 2.3 | 4.7 | 0.0 | 0.0 | 0.0 |
| 7/08 | 7C / ESBS, 2004 | 30 | 76.7 | 10.0 | 3.3 | 3.3 | 3.3 | 3.3 | 0.0 |
| | **Overall** | **209** | **80.4** | **8.6** | **5.3** | **3.8** | **1.4** | **0.5** | **0.0** |

a Descaling categories: not desc. = not descaled; A = descaled ≥5<10% on at least one side; B = descaled ≥10<20% on at least one side; C = descaled ≥20<30% on at least one side; D = descaled ≥30<40% on at least one side; E = descaled ≥40<50% on at least one side; and F = descaled ≥50% on at least one side.

b Fish were released from a submerged canister into the B and C gatewells of turbine units 6 and 7. Fish guidance devices: STS = submersible traveling screen; ESBS = extended-length submersible bar screen; std VBS = standard vertical barrier screen; 2002 VBS = prototype wedge-wire vertical barrier screen first tested in 2002; and 2004 VBS = improved version of the 2002 prototype VBS.

c Known shutdown of turbine unit 7 during the test on 5/6/04.

Appendix Table 7. Summary data for PIT-tagged yearling and subyearling Chinook salmon used in fish condition tests at John Day Dam, 2004.

| Release date | Release location and guidance devices[a] | Number released | Detected | | Recaptured | | | | Not recap. | Percent mortality | | Percent descaled | | Median passage time (h) | Bonneville detections (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. | (%) | Live | Dead | Total | (%) | | Obs. | Est. | Partial | ≥20% | | |
| **Yearling Chinook salmon** | | | | | | | | | | | | | | | |
| 5/06 | 6B / STS, std VBS | 101 | 99 | --[b] | 84 | 1 | 85 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5/07 | 6B / STS, std VBS | 100 | 99 | 99.0 | 88 | 0 | 88 | 88.0 | 12 | 0.0 | 12.0 | 0.0 | 0.0 | 5.3 | 6.8 |
| 5/11 | 6B / STS, std VBS | 100 | 100 | 100.0 | 92 | 0 | 92 | 92.0 | 8 | 0.0 | 8.0 | 2.2 | 0.0 | 33.4 | 5.4 |
| 5/12 | 6B / STS, std VBS | 99 | 99 | 100.0 | 89 | 1 | 90 | 90.9 | 9 | 1.1 | 10.1 | 3.4 | 0.0 | 36.9 | 7.9 |
| | **Totals and averages** | **299** | **298** | **99.7** | **269** | **1** | **270** | **90.3** | **29** | **0.4** | **10.0** | **1.9** | **0.0** | **25.4** | **6.7** |
| | **Standard Errors** | | | **0.3** | | | | **1.2** | | **0.4** | **1.2** | **1.0** | **0.0** | **10.0** | **0.7** |
| 5/06 | 7B / ESBS, 2002 | 101 | 100 | -- | 88 | 0 | 88 | -- | -- | -- | -- | -- | -- | -- | -- |
| 5/07 | 7B / ESBS, 2002 | 93 | 93 | 100.0 | 82 | 1 | 83 | 89.2 | 10 | 1.2 | 11.8 | 1.2 | 0.0 | 1.5 | 3.7 |
| 5/11 | 7B / ESBS, 2002 | 98 | 96 | 98.0 | 90 | 3 | 93 | 94.9 | 5 | 3.2 | 8.2 | 5.6 | 0.0 | 1.4 | 4.4 |
| 5/12 | 7B / ESBS, 2002 | 99 | 96 | 97.0 | 91 | 2 | 93 | 93.9 | 6 | 2.2 | 8.1 | 6.6 | 0.0 | 2.6 | 4.4 |
| | **Totals and averages** | **290** | **285** | **98.3** | **263** | **6** | **269** | **92.8** | **21** | **2.2** | **9.3** | **4.5** | **0.0** | **1.8** | **4.2** |
| | **Standard Errors** | | | **0.9** | | | | **1.8** | | **0.6** | **1.2** | **1.7** | **0.0** | **0.4** | **0.2** |
| 5/18 | 6C / STS, std VBS | 89 | 89 | 100.0 | 81 | 0 | 81 | 91.0 | 8 | 0.0 | 9.0 | 1.2 | 0.0 | 22.8 | 9.9 |
| 5/19 | 6C / STS, std VBS | 100 | 100 | 100.0 | 91 | 0 | 91 | 91.0 | 9 | 0.0 | 9.0 | 3.3 | 0.0 | 22.9 | 11.0 |
| 5/20 | 6C / STS, std VBS | 100 | 100 | 100.0 | 83 | 0 | 83 | 83.0 | 17 | 0.0 | 17.0 | 0.0 | 0.0 | 27.7 | 12.0 |
| | **Totals and averages** | **289** | **289** | **100.0** | **255** | **0** | **255** | **88.2** | **34** | **0.0** | **11.8** | **1.5** | **0.0** | **24.4** | **11.0** |
| | **Standard Errors** | | | **0.0** | | | | **2.7** | | **0.0** | **2.7** | **1.0** | **0.0** | **1.6** | **0.6** |

Appendix Table 7. Continued.

| Release date | Release location and guidance devices[a] | Number released | Detected | | Recaptured | | | | Not recap. | Percent mortality | | Percent descaled | | Median passage time (h) | Bonneville detections (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. | (%) | Live | Dead | Total | (%) | | Obs. | Est. | Partial | ≥20% | | |
| **Yearling Chinook salmon (continued)** | | | | | | | | | | | | | | | |
| 5/18 | 7C / ESBS 2004 VBS | 98 | 90 | 91.8 | 66 | 11 | 77 | 78.6 | 21 | 14.3 | 32.7 | 22.7 | 14.3 | 0.9 | 12.1 |
| 5/19 | 7C / ESBS 2004 VBS | 100 | 90 | 90.0 | 76 | 5 | 81 | 81.0 | 19 | 6.2 | 24.0 | 10.5 | 9.2 | 0.2 | 10.5 |
| 5/20 | 7C / ESBS 2004 VBS | 100 | 82 | 82.0 | 67 | 8 | 75 | 75.0 | 25 | 10.7 | 33.0 | 28.4 | 10.4 | 1.3 | 13.4 |
| | **Totals and averages** | **298** | **2 62** | **87.9** | **209** | **24** | **233** | **78.2** | **65** | **10.3** | **29.9** | **20.5** | **11.3** | **0.8** | **12.0** |
| | **Standard Errors** | | | **3.0** | | | | **1.7** | | **2.3** | **2.9** | **5.3** | **1.5** | **0.3** | **0.8** |
| 5/27 | 7C / ESBS, 2002 | 98 | 82 | 83.7 | 67 | 3 | 70 | 71.4 | 28 | 4.3 | 31.6 | 22.4 | 1.5 | 1.5 | 3.0 |
| 5/27 | 7C / ESBS, 2002 | 78 | 62 | 79.5 | 49 | 5 | 54 | 69.2 | 24 | 9.3 | 37.2 | 32.7 | 4.1 | 3.5 | 12.2 |
| 6/01 | 7C / ESBS, 2002 | 98 | 60 | 61.2 | 51 | 6 | 57 | 58.2 | 41 | 10.5 | 48.0 | 31.4 | 7.8 | 3.0 | 7.8 |
| | **Totals and averages** | **274** | **2 04** | **74.5** | **167** | **14** | **181** | **66.1** | **93** | **7.7** | **39.1** | **28.8** | **4.5** | **2.7** | **7.2** |
| | **Standard Errors** | | | **6.9** | | | | **4.1** | | **1.9** | **4.8** | **3.2** | **1.8** | **0.6** | **2.7** |
| 5/27 | 7B / ESBS 2004 VBS | 99 | 95 | 96.0 | 90 | 0 | 90 | 90.9 | 9 | 0.0 | 9.1 | 14.4 | 0.0 | 0.6 | 11.1 |
| 5/27 | 7B / ESBS 2004 VBS | 75 | 73 | 97.3 | 67 | 0 | 67 | 89.3 | 8 | 0.0 | 10.7 | 4.5 | 1.5 | 0.6 | 3.0 |
| 6/01 | 7B / ESBS 2004 VBS | 110 | 1 10 | 100.0 | 104 | 2 | 106 | 96.4 | 4 | 1.9 | 5.5 | 8.7 | 1.9 | 1.3 | 15.4 |
| | **Totals and averages** | **284** | **2 78** | **97.9** | **261** | **2** | **263** | **92.6** | **21** | **0.8** | **8.1** | **9.2** | **1.1** | **0.8** | **10.7** |
| | **Standard Errors** | | | **1.2** | | | | **2.2** | | **0.6** | **1.5** | **2.9** | **0.6** | **0.2** | **3.6** |
| **Subyearling Chinook salmon** | | | | | | | | | | | | | | | |
| 6/24 | 7B / ESBS, 2002 | 75 | 75 | 100.0 | 64 | 1 | 65 | 86.7 | 10 | 1.5 | 14.7 | 1.6 | 0.0 | 2.8 | 12.5 |
| 6/25 | 7B / ESBS, 2002 | 76 | 76 | 100.0 | 68 | 1 | 69 | 90.8 | 7 | 1.4 | 10.5 | 2.9 | 0.0 | 0.3 | 10.3 |
| | **Totals and averages** | **151** | **1 51** | **100.0** | **132** | **2** | **134** | **88.7** | **17** | **1.5** | **12.6** | **2.3** | **0.0** | **1.5** | **11.4** |

Appendix Table 7. Continued.

| Release date | Release location and guidance devices[a] | Number released | Detected | | Recaptured | | | | Not recap. | Percent mortality | | Percent descaled | | Median passage time (h) | Bonneville detections (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. | (%) | Live | Dead | Total | (%) | | Obs. | Est. | Partial ≥20% | | | |
| **Subyearling Chinook salmon (continued)** | | | | | | | | | | | | | | | |
| 6/24 | 7C / ESBS, 2004 | 66 | 60 | 90.9 | 51 | 0 | 51 | 77.3 | 15 | 0.0 | 22.7 | 11.8 | 3.9 | 3.8 | 9.8 |
| 6/25 | 7C / ESBS, 2004 | 75 | 68 | 90.7 | 62 | 0 | 62 | 82.7 | 13 | 0.0 | 17.3 | 9.7 | 1.6 | 0.7 | 12.9 |
| | **Totals and averages** | **141** | **1 28** | **90.8** | **113** | **0** | **113** | **80.1** | **28** | **0.0** | **19.9** | **10.8** | **2.8** | **2.3** | **11.5** |
| 6/28 | 7B / ESBS, 2002 | 75 | 73 | 97.3 | 55 | 0 | 55 | 73.3 | 20 | 0.0 | 26.7 | 1.8 | 0.0 | 4.5 | 16.4 |
| 6/29 | 7B / ESBS, 2002 | 67 | 67 | 100.0 | 58 | 0 | 58 | 86.6 | 9 | 0.0 | 13.4 | 3.4 | 0.0 | 0.4 | 12.1 |
| 6/30 | 7B / ESBS, 2002 | 75 | 70 | 93.3 | 55 | 0 | 55 | 73.3 | 20 | 0.0 | 26.7 | 3.6 | 1.8 | 0.4 | 7.3 |
| 7/06 | 7B / ESBS, 2002 | 74 | 66 | 89.2 | 53 | 2 | 55 | 74.3 | 19 | 3.6 | 28.4 | 11.3 | 0.0 | 0.4 | 1.9 |
| 7/08 | 7B / ESBS, 2002 | 74 | 73 | 98.6 | 67 | 0 | 67 | 90.5 | 7 | 0.0 | 9.5 | 3.0 | 0.0 | 0.2 | 3.0 |
| 7/08 | 7B / ESBS, 2002 | 75 | 63 | 84.0 | 56 | 5 | 61 | 81.3 | 14 | 8.2 | 25.3 | 3.6 | 0.0 | 0.3 | 3.6 |
| | **Totals and averages** | **440** | **4 12** | **93.6** | **344** | **7** | **351** | **79.8** | **169** | **2.0** | **26.3** | **4.5** | **0.3** | **1.0** | **7.3** |
| | **Standard Errors** | | | **2.5** | | | | **3.0** | | **1.4** | **3.3** | **1.4** | **0.3** | **0.7** | **2.4** |
| 6/28 | 7C / ESBS, 2004 | 75 | 49 | 65.3 | 41 | 0 | 41 | 54.7 | 34 | 0.0 | 45.3 | 22.0 | 7.3 | 4.8 | 9.8 |
| 6/29 | 7C / ESBS, 2004 | 75 | 66 | 88.0 | 54 | 0 | 54 | 72.0 | 21 | 0.0 | 28.0 | 9.3 | 0.0 | 0.4 | 14.8 |
| 6/30 | 7C / ESBS, 2004 | 75 | 49 | 65.3 | 35 | 3 | 38 | 50.7 | 37 | 7.9 | 53.3 | 20.0 | 11.4 | 2.7 | 5.7 |
| 7/06 | 7C / ESBS, 2004 | 76 | 14 | -- | 6 | 5 | 11 | -- | -- | -- | -- | -- | -- | -- | -- |
| 7/08 | 7C / ESBS, 2004 | 75 | 50 | 66.7 | 43 | 3 | 46 | 61.3 | 29 | 6.5 | 42.7 | 9.3 | 4.7 | 0.7 | 0.0 |
| 7/08 | 7C / ESBS, 2004 | 74 | 40 | 54.1 | 30 | 4 | 34 | 45.9 | 40 | 11.8 | 59.5 | 13.3 | 10.0 | 1.2 | 3.3 |
| | **Totals and averages** | **374** | **2 54** | **67.9** | **203** | **10** | **213** | **57.0** | **161** | **4.7** | **45.7** | **14.8** | **6.7** | **1.7** | **7.4** |
| | **Standard Errors** | | | **5.5** | | | | **4.5** | | **2.3** | **5.3** | **2.7** | **2.0** | **0.8** | **2.4** |

a Fish were released from a submerged canister into the B and C gatewells of turbine units 6 and 7. Fish guidance devices: STS = submersible traveling screen; ESBS = extended-length submersible bar screen; std VBS = standard vertical barrier screen; 2002 VBS = prototype wedge-wire vertical barrier screen first tested in 2002; and 2004 VBS = improved version of the 2002 prototype VBS.

b Dashes indicate faulty data which were not used in computations.