Studies to Evaluate the Effectiveness of Extended-Length Screens at McNary Dam, 1993

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Coastal Zone and Estuarine Studies Division

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Northwest Fisheries Science Center

National Marine Fisheries Service

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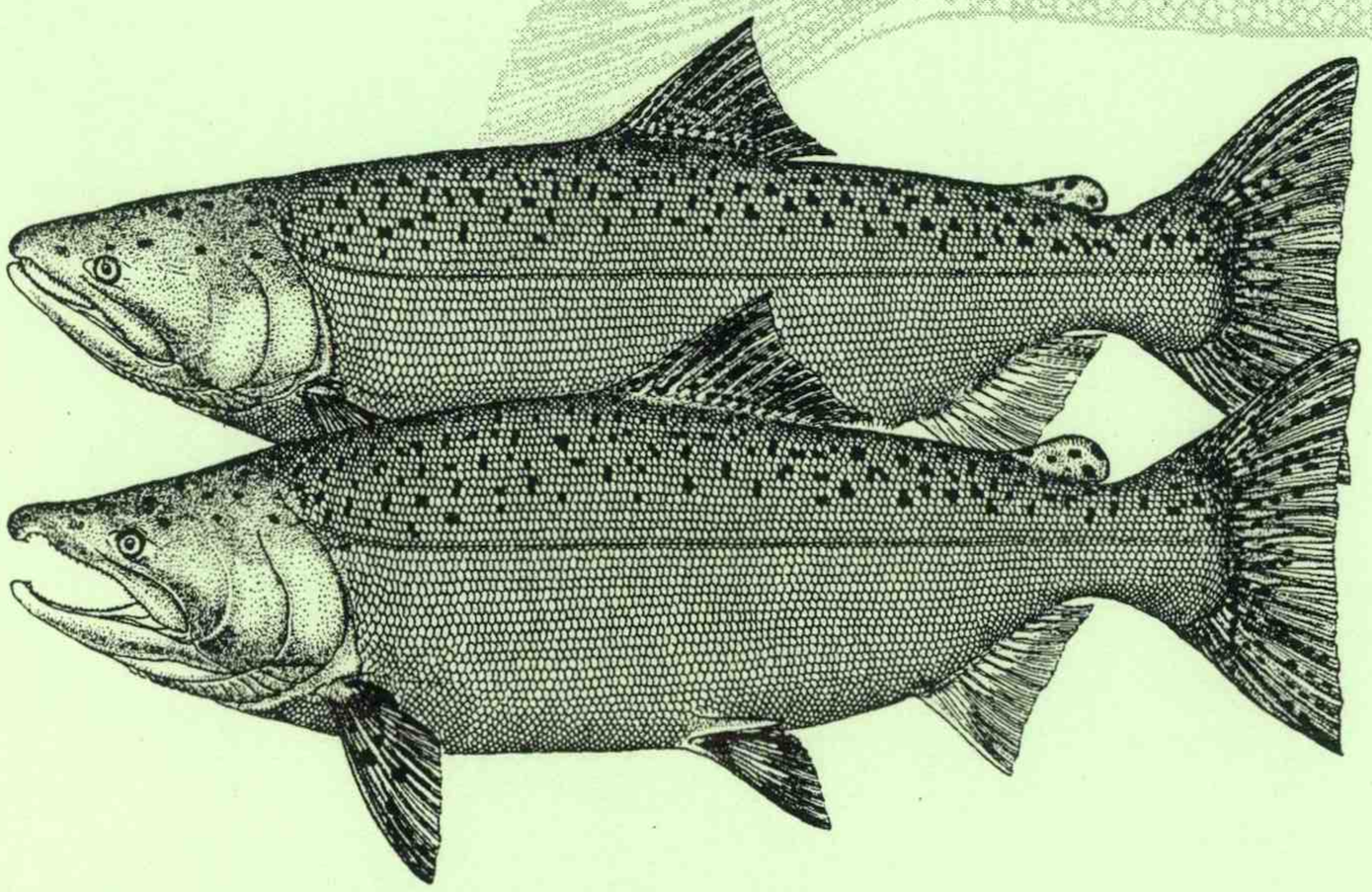

STUDIES TO EVALUATE THE EFFECTIVENESS OF EXTENDED-LENGTH SCREENS AT McNARY DAM, 1993

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INTRODUCTION

McNary Dam, at River Kilometer 467 (River Mile 292), is operated by the U.S. Army Corps of Engineers (COE) and is the fourth hydroelectric project from the mouth of the Columbia River. Prior to 1981, juvenile fish migrants encountering McNary Dam had to use either spillways or turbine intakes for passage downstream. Early estimates of indirect and direct mortality of yearling and subyearling chinook salmon (*Oncorhynchus tshawytscha*) resulting from passage through turbines ranged from 11 to 40% (Schoeneman et al. 1961, Long et al. 1968, Ebel and Raymond 1976, Raymond 1979). More recently, Iwamoto et al. (1994) estimated turbine mortalities of 8 and 18% at Lower Granite and Little Goose Dams, respectively, on the Snake River. Since 1981, a juvenile fish bypass system has been in operation at McNary Dam for collecting migrants for transport by barge or truck to a release site below Bonneville Dam or for release downstream from McNary Dam. The bypass system relies on standard-length submersible traveling screens (STSs) to divert juvenile salmonids away from turbines and guide them into gatewells for collection.

Fish guidance efficiency (FGE) for yearling chinook salmon and steelhead (*O. mykiss*) using the STS has generally been 70% or greater. However, for subyearling chinook salmon, mean guidance has been less than 50% (Krcma et al. 1983, Krcma et al. 1985, Swan and Norman 1987, Brege et al. 1988). One hypothesis for the disparity in FGE values is that the two age-groups migrate at different depths; yearling fish travel nearer the surface and are

more easily diverted than subyearling fish. Hydraulic testing using turbine intake models indicated that a longer screen would deflect more of the water entering the intake, thereby improving flows into the gatewell (Engineering Hydraulics Inc. 1983, Engineering Hydraulics Inc. 1984, Davidson 1989). Subsequent biological testing by the National Marine Fisheries Service (NMFS) using longer guidance devices confirmed that FGE for all species could be enhanced by intercepting fish migrating deeper in the water column (Swan and Norman 1987, Swan et al. 1990).

In 1991, NMFS began testing two extended-length screens as alternatives to the STS: the extended-length submersible bar screen and the extended-length submersible traveling screen. These screens are approximately 12.1 m (40 ft) long, or nearly twice the length of the STS. During initial testing, both extended-length screens increased FGE to over 80% for yearling chinook salmon and 50% for subyearling chinook salmon (Brege et al. 1992). However, the extended-length traveling screen caused unacceptably high levels of descaling, which prompted design modifications to streamline structural members and alter the mesh surface attachment mechanism of this device. Various configurations of the extended-length bar screen were tested against the STS during the 1992 field season, pending changes to the extended-length traveling screen.

In 1993, a redesigned extended-length traveling screen became available for parallel testing against the extended-length bar screen. Specific research objectives for McNary Dam in 1993 were

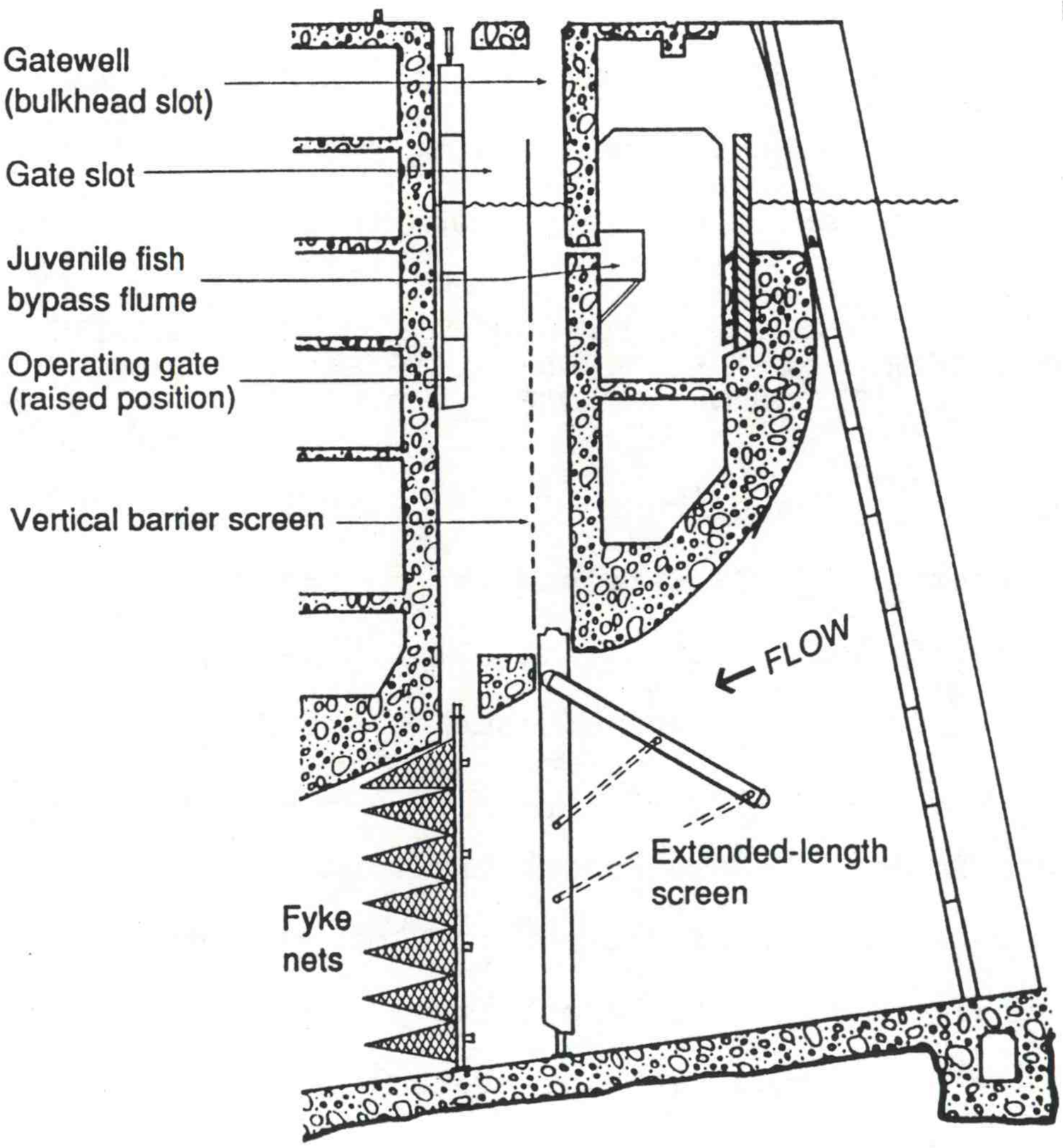
1) To evaluate the ability of the extended-length submersible bar screen and the redesigned extended-length submersible traveling screen to guide juvenile salmonids, especially yearling and subyearling chinook salmon during the spring and summer outmigrations.
2) To determine the effects of the extended-length submersible bar screen and the redesigned extended-length submersible traveling screen on juvenile salmonid descaling.

OBJECTIVE 1: FISH GUIDANCE EFFICIENCY OF THE EXTENDED-LENGTH SUBMERSIBLE BAR SCREEN AND THE EXTENDED-LENGTH SUBMERSIBLE TRAVELING SCREEN

Approach

Methods for determining FGE were similar to those used by Brege et al. (1992) and McComas et al. (1993). Extended-length screens were used in all three slots of each test turbine unit to maintain uniform flows. The test screens were in the center slots with the redesigned extended-length traveling screen in Slot 5B and an extended-length bar screen in Slot 6B (Fig. 1). Since only one redesigned extended-length traveling screen was available, older-style extended-length traveling screens were modified by perforated plate porosity changes to reduce fish descaling. Also, because Slot A flows are normally higher than Slot B and C flows of a given turbine unit, partially raised operating gates were used to restrict flows in Slots 5A and 6A (Fig 1). Initial screen conditions in FGE test units were

McNary Dam cross section



1993 Fyke-net layout
(All nets with cod ends)

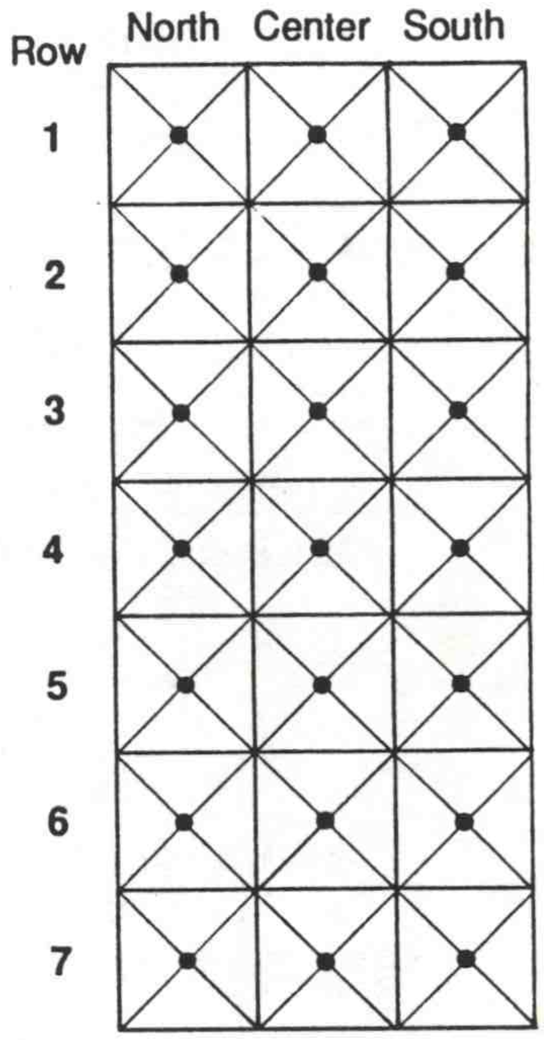


Figure 1.--Cross section of turbine unit at McNary Dam with extended-length screen and fyke nets in place.

Turbine Unit/slot	Screen type	Perforated plate porosity (%)
5A	Extended-length traveling screen	25
5B	Redesigned ext-length traveling screen	36
5C	Extended-length traveling screen	34
6A	Extended-length bar screen	30
6B	Extended-length bar screen	30
6C	Extended-length bar screen	33

All slots in Turbine Units 5 and 6 contained modified balanced-flow vertical barrier screens that separated the bulkhead slot from the downstream gate slot and confined guided fish to the upstream gatewell (Fig. 1). The vertical barrier screens used, including the one in the descaling control slot (7B), have been described in previous reports of FGE studies at McNary Dam (Brege et al. 1992, McComas et al. 1993).

Extended-length screens were maintained at standard elevation throughout both spring and summer test periods, and screen angles were fixed at 55°. Flows through FGE test turbine units were constant at 15,000* cfs for all tests. Turbine-unit loads of about 75 MW (dependent on forebay elevation) and appropriate perforated plate porosities resulted in a screen-approach water velocity of approximately 2.5 fps and a gatewell throat velocity of about 9.0 fps for the extended-length devices; this was comparable to conditions for an STS with no operating gate.

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* Flows through FGE test turbine units were increased by 2,000 cfs to compensate for reductions caused by the fyke-net array and support structure placed in the turbine intake. This adjustment approximated normal turbine operation within the 1% optimal efficiency range without fyke nets.

During FGE tests, estimates of the numbers of fish successfully guided into test gatewells were determined by direct counts from gatewell dipbasket catches. Unguided fish were enumerated from captures in a 21-element fyke-net array (3 columns of 7 rows each) deployed in the operating gate slot, immediately downstream from the test gatewell (Fig. 1). Since the proportion of total fyke-net catch for each column is not sufficiently predictable with extended-length screens, cod ends were placed on all 21 fyke nets during FGE tests (Appendix A). Fish guidance efficiency was calculated as the number of guided fish recovered from the gatewell divided by the total number of fish (by species) entering the turbine intake:

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

where GW = *gatewell catch*
FN = *fyke-net catch.*

Test dates and conditions are listed in Table 1. Testing typically began at 2000 h and terminated when enough fish (≥200) of the target species had been collected from one of the test slots (either 5B or 6B). Minimum test duration was 1 hour.

A 2-day randomized block sampling design was employed using operating gate position and screen type as the only variables for all tests. Operating gate position was alternated between no operating gate (gate removed) and partially raised operating gate (raised 2.4 m above the stored position) in test gatewells on successive days. Fish guidance efficiency tests were conducted simultaneously for each test date in Slots 5B and 6B.

Table 1.--Test schedule for the 1993 field season at McNary Dam. Extended- and standard-length screens were maintained at standard elevation and at a 55° angle for all tests, with modified balanced flow vertical barrier screens in test and descaling control slots.

Test series	Test dates	Test type	Guidance screen	Unit slot	Flow (kcfs)	Operating gate position	Perforated plate porosity (%)
1	28-30 April	FGE[a]	ESTS[b]	5B	15	PROG[c]/NOG[d]	36
	1- 5 May	FGE	ESBS[e]	6B	15	NOG/PROG	30
	18-29 May	Des[f]	STS[g]	7B	- [h]	NOG	48
1a	22-29 May	FGE/Des	ESTS	5B	15	PROG/NOG	36
		FGE/Des	ESBS	6B	15	NOG/PROG	30
2	21-28 June	Des	ESTS	5A	15	PROG	25
	2-29 July	FGE	ESTS	5B	15	PROG/NOG	36
		Des	ESBS	6A	15	PROG	30
		FGE	ESBS	6B	15	PROG/NOG	30
		Des	STS	7B	-	NOG	48

[a] Fish guidance efficiency.
[b] Extended-length submersible traveling screen.
[c] Partially raised operating gate (raised 2.4 m).
[d] No operating gate (fully raised or removed).
[e] Extended-length submersible bar screen.
[f] Descaling test.
[g] Standard-length submersible traveling screen.
[h] Variable unit flow determined by McNary Dam operational requirements.

Two interruptions occurred during the course of FGE tests. A transformer malfunction in Unit 6 halted testing from 11 to 17 May while repairs were made. Sampling was also briefly suspended because of the possibility of excessive fyke-net mortalities when high numbers of subyearling chinook salmon were captured on 28 June and elevated counts were reported by the McNary Dam fish passage facility. Sampling was resumed on 2 July. During the period when daily fish facility counts remained high (>100,000 subyearling chinook salmon, 2 July through 10 July), FGE testing was conducted after 2400 h to avoid the peak hours of fish passage. Orphaned data from two unpaired days resulting from these interruptions (10 May and 28 June) were omitted from statistical analyses.

Dipbasket efficiency testing was conducted as in past FGE studies (Krcma et al. 1985). Freeze-branded yearling chinook salmon and steelhead obtained from the McNary Dam juvenile fish passage facility were released into the gatewell of Slot 5B at the beginning of normal FGE testing and removed after the test along with the gatewell catch. Dipbasket efficiency (DBE) was defined, for each species, as the number of recaptured freeze-branded fish divided by the total number of freeze-branded fish released:

$$DBE = \frac{R}{M} x\ 100\%$$

where R = freeze-branded fish recaptured
M = freeze-branded fish released.

While FGE tests were in progress, periodic dipbasket samples were taken from Slot 5B to monitor the number of guided fish

collected in the test gatewell. Concern was raised during the spring test series that higher FGE associated with Slot 5B (containing the redesigned extended-length traveling screen) may have been a result of dipping that gatewell while the turbine unit was operating; the gatewell of Slot 6B was routinely dipped at the conclusion of the test, after the turbine unit had been shut down. To examine the null hypothesis that there was no difference in FGE values related to whether the unit was operating when the gatewell was dipped, a series of eight replicates was conducted near the end of the spring outmigration, concurrent with FGE testing. Slots 5B and 6B were dipped during testing for 2 days (while the units were running), followed by 2 days when they were dipped only after unit operation had ceased at the end of the test. All combinations of screen type and operating gate position were represented twice for each test slot during the eight trials.

Mean differences between conditions were examined statistically using two-sample t-tests and randomized block analysis of variance (RBANOVA). Fish guidance efficiency estimates were used where sample sizes were at least 30 fish. Estimates of FGE can be assumed to be binomially distributed. A sample size of 30 ensures that the data are approximately normally distributed, which satisfies one assumption in the use of analysis of variance procedures.

Results and Discussion

A dipbasket efficiency test was conducted in Slot 5B during FGE testing on 27 May. Test results indicated a dipbasket

efficiency of 100% for yearling chinook salmon and 98% for steelhead.

For both the spring and summer sampling periods, catch data for individual FGE replicates appear by species in Appendix Table B1. Results of statistical comparisons between treatments are summarized in Appendix Table B2.

Spring Outmigration

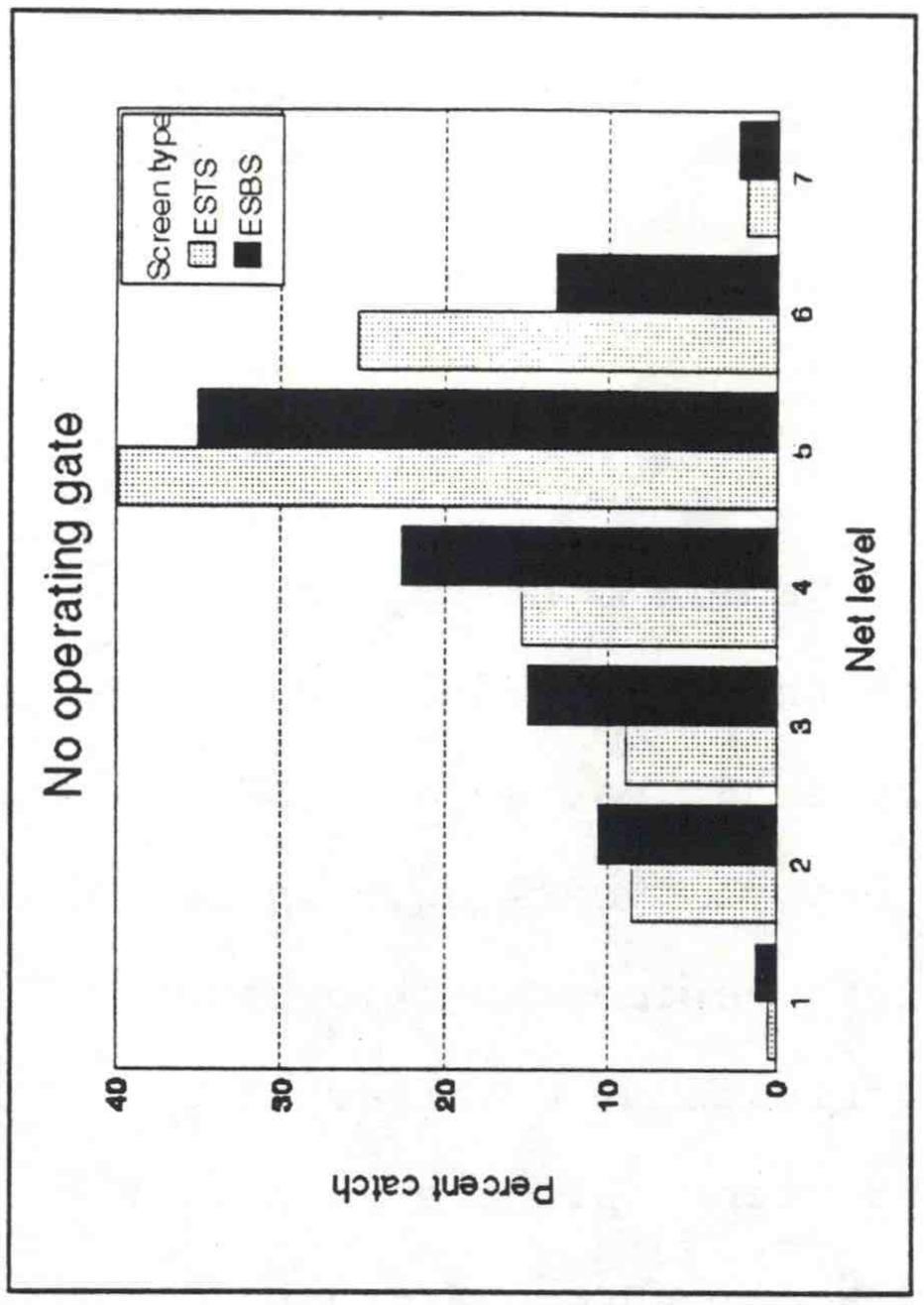
Fish guidance efficiency testing for yearling chinook salmon began 28 April and continued through 29 May, comprising a single series of 20 nights (Table 1, Test Series 1). Guidance was high throughout the sample period, averaging 85% (SE = 0.8) for all extended-length screen tests combined. With no operating gate, mean FGE with yearling chinook salmon was 89% for the extended-length traveling screen, compared to 83% for the extended-length bar screen. With a partially raised operating gate, guidance was 87% for the extended-length traveling screen and 80% for the extended-length bar screen. A two-factor RBANOVA revealed no statistically significant interaction between operating gate position and screen type, and no significant differences in mean FGE values by operating gate position for yearling chinook salmon, steelhead, or sockeye salmon (*O. nerka*). However, when all 20 nights were combined for each screen type without regard to operating gate setting, mean guidance values for the extended-length traveling screen were significantly higher than for the extended-length bar screen for all three species:

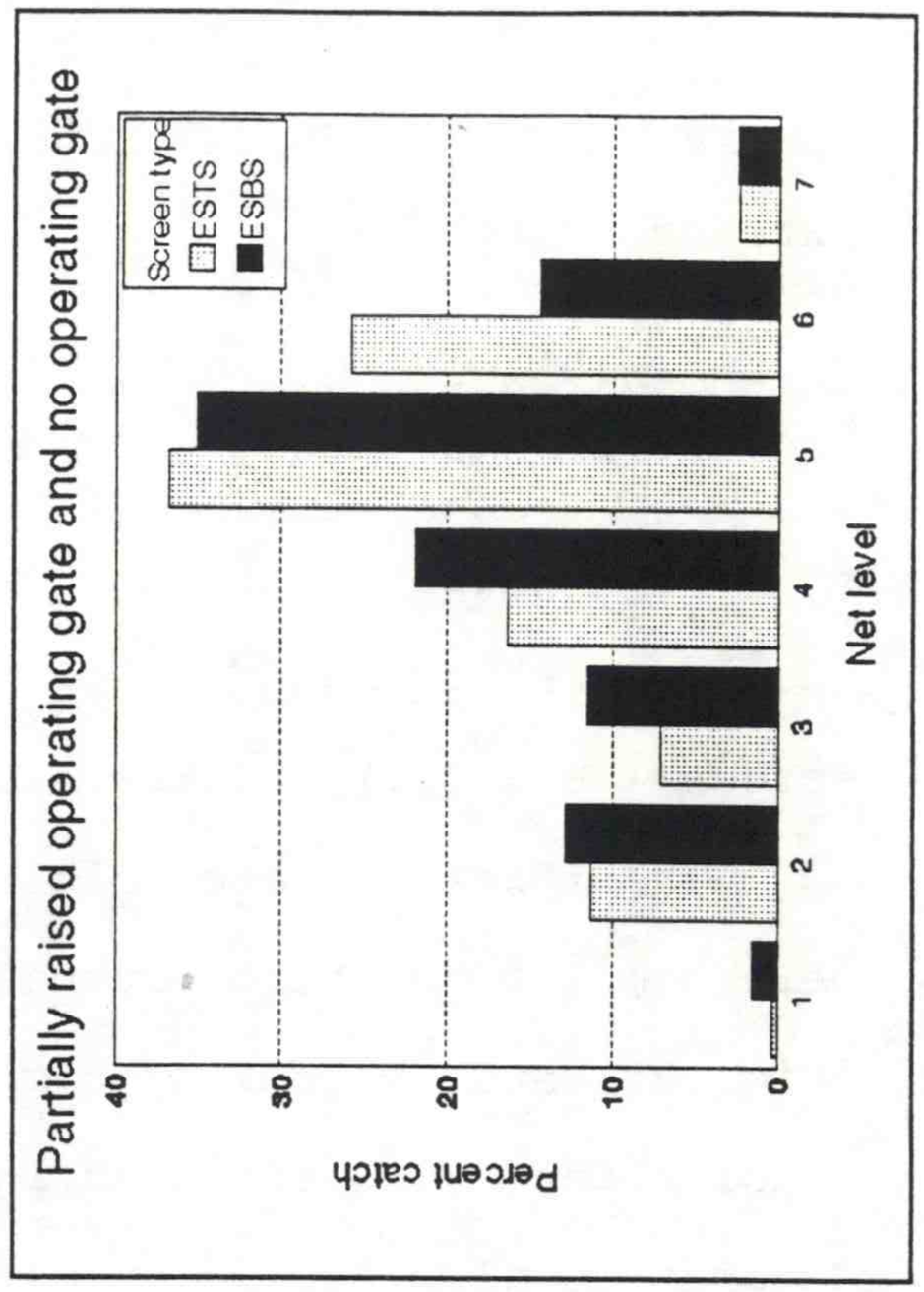
Screen type	FGE (%) Yearling chinook salmon (SE)	Steelhead (SE)	Sockeye salmon (SE)
Extended-length traveling screen	88 (1.1)	93 (0.7)	85 (1.7)
Extended-length bar screen	81 (2.2)	91 (0.7)	73 (1.9)

Fish guidance efficiency for juvenile coho salmon (*O. kisutch*) averaged 98% with both the extended-length traveling screen (SE = 0.7) and the extended-length bar screen (SE = 0.4).

The fyke-net catch distributions for yearling chinook salmon were similar for both extended-length devices in this study (Fig. 2), and typical of catch distributions observed in past FGE studies involving extended-length screens (Brege et al. 1992, McComas et al. 1993). Summed across all three fyke-net columns, mean catches were concentrated in Net Level 5 for both screen types, regardless of operating gate setting. There was a slightly elevated catch in Net Level 2 for both screens, which may have been associated with loss of fish through the gap between the top of the screen and the ceiling of the turbine intake.

Tests for differences between mean FGE values obtained by dipping test gatewells during turbine unit operation and after units had been turned off occurred from 22 to 29 May (Table 1, Test Series 1a). For Units 5 and 6 combined, FGE was 88% (SE = 1.4) for gatewells dipped with the unit running, compared to 87% (SE = 1.7) when the unit was not running. There was no





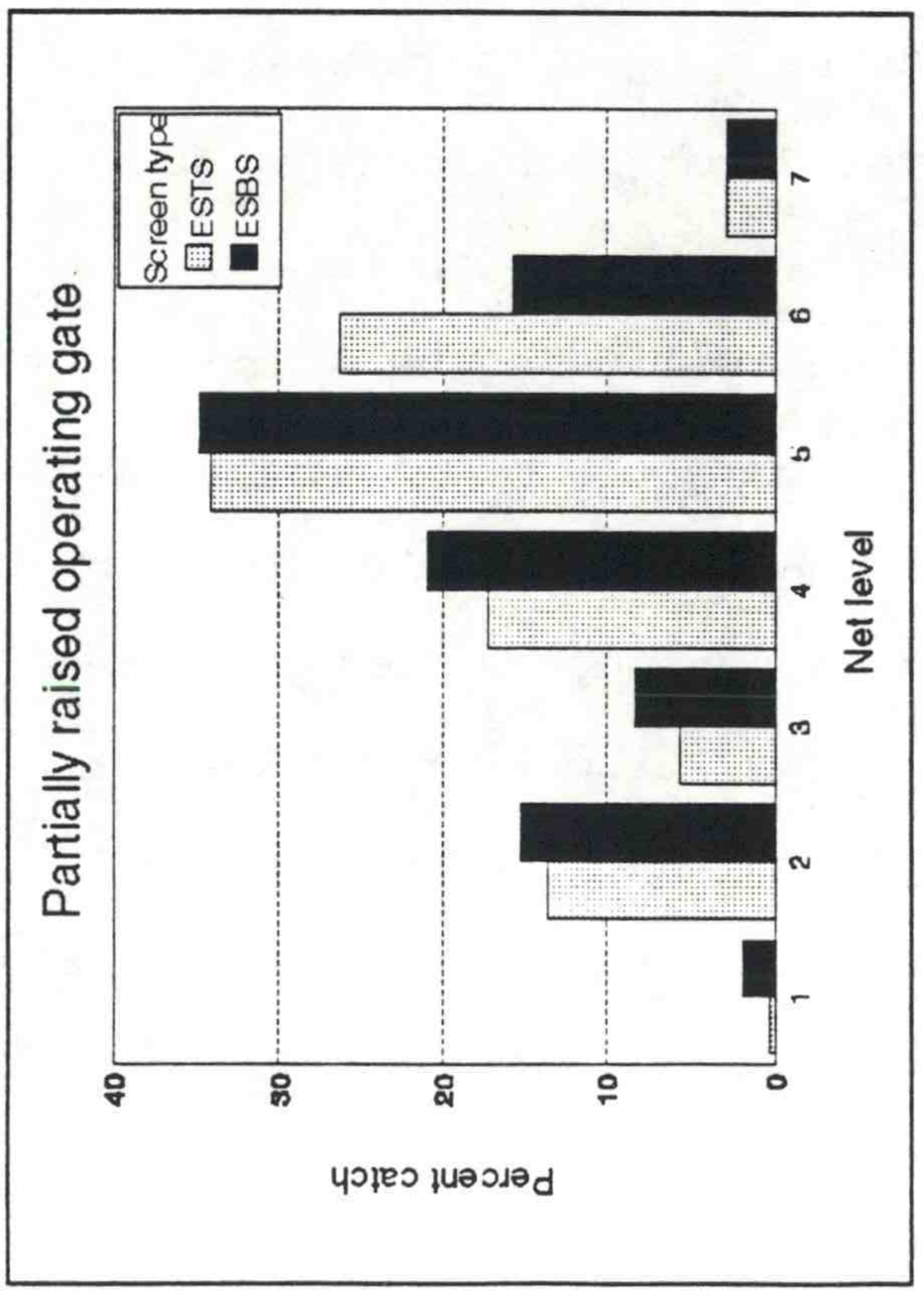


Figure 2.--Percent net catch by fyke-net level for yearling chinook salmon captured during fish guidance efficiency tests using partially raised operating gates and no operating gate in conjunction with extended-length submersible traveling screens (ESTS) and extended-length submersible bar screens (ESBS) at McNary Dam, 1993.

significant difference in guidance between the two treatments (t = 0.345, df = 7, P = 0.7351).

Summer Outmigration

Tests with subyearling chinook salmon during the summer outmigration consisted of a 24-night series from 21 June through 29 July (Table 1, Test Series 2). A statistically significant interaction between operating gate position and extended-length screen type (F = 4.20; df = 11,1; P = 0.0485) precluded combining the data by either of these variables.

With a partially raised operating gate, mean FGE was significantly higher for the extended-length traveling screen (67%, SE = 3.6) than for the extended-length bar screen (52%, SE = 3.7). This was the only statistically significant difference in mean FGE values among all four treatments for subyearling chinook salmon. With no operating gate, FGE was 59% for both the extended-length traveling screen (SE = 3.5) and the extended-length bar screen (SE = 1.7) Therefore, there was no significant difference in FGE between the best guidance condition for the extended-length traveling screen (67%, with a partially raised operating gate) and the best guidance condition for the extended-length bar screen (59%, with no operating gate).

Due to the variability encountered in subyearling chinook salmon data, only FGE differences equal to or greater than 8.5% were detectable, resulting in a relatively weak data set for the summer test period. Though the 2-day blocking accounted for a considerable portion of the variability, there was evidence of substantial within-block daily variation during the summer

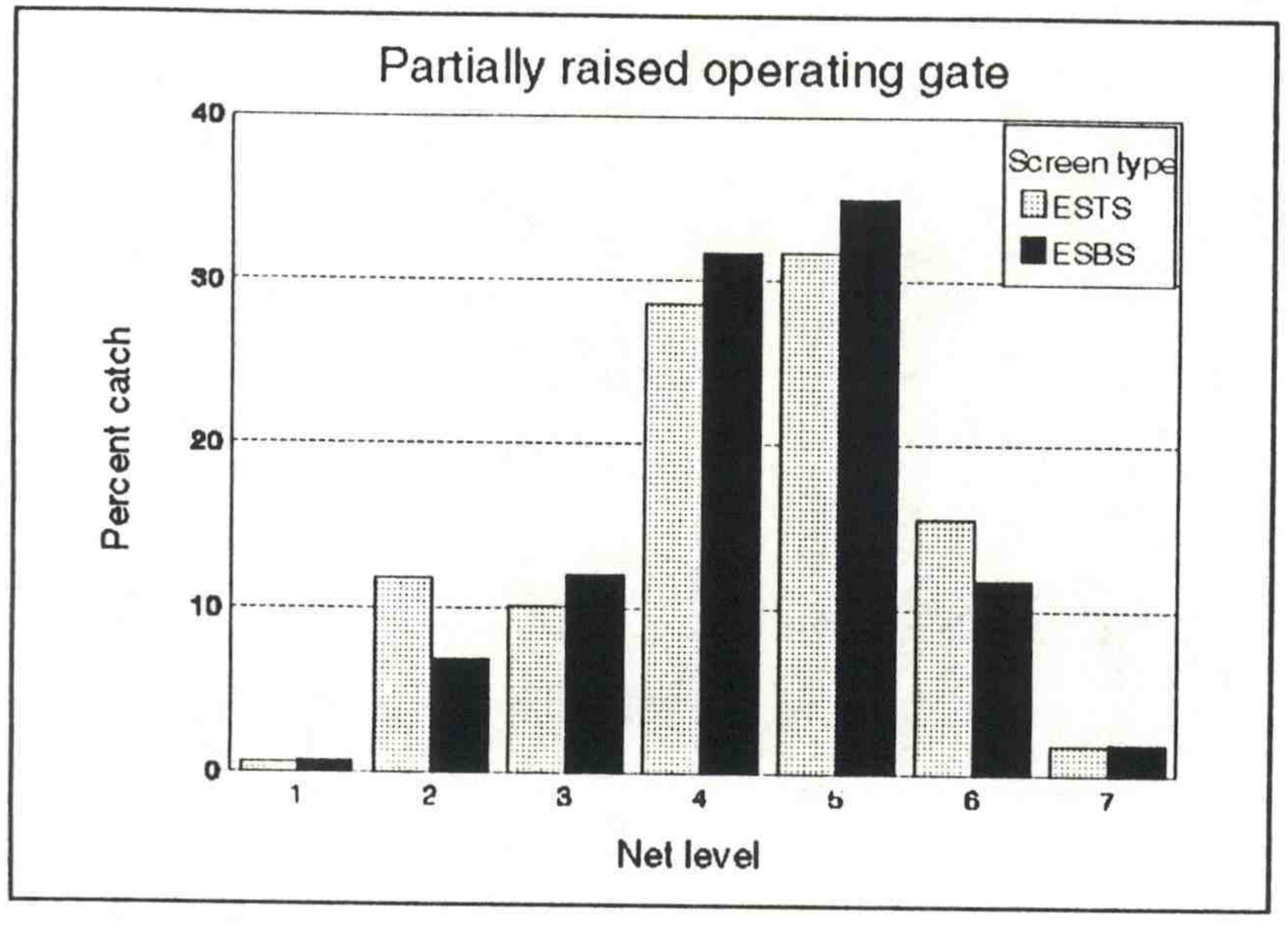
outmigration. For example, the three lowest FGE values recorded for both extended-length screen types occurred on nights when the extended-length traveling screen with no operating gate was paired for testing with the extended-length bar screen and partially raised operating gate combination. Guidance was not nearly as low on other nights within the same 2-day block when the operating gate positions were reversed for each screen. The results of other pairs tested during the season showed the opposite trend, though not of the same magnitude. Whether these variations within each block reflected a day effect or an interaction between operating gate position and guidance device is unknown.

As with the spring outmigration, subyearling chinook salmon fyke-net catch distributions were typical for extended-length screens, with highest mean concentrations in Net Levels 4 and 5 for both devices (Fig. 3). Mean percent catch at Net Level 2 with the extended-length bar screen was lower compared to the yearling chinook salmon results, but was virtually the same with the extended-length traveling screen for both spring and summer tests.

OBJECTIVE 2: EFFECTS OF THE EXTENDED-LENGTH SUBMERSIBLE BAR SCREEN AND THE EXTENDED-LENGTH SUBMERSIBLE TRAVELING SCREEN ON FISH CONDITION

Approach

Fish condition was evaluated for all juvenile salmonids, by species, using standard Fish Transportation Oversight Team descaling criteria (Ceballos et al. 1992). Descaling was defined



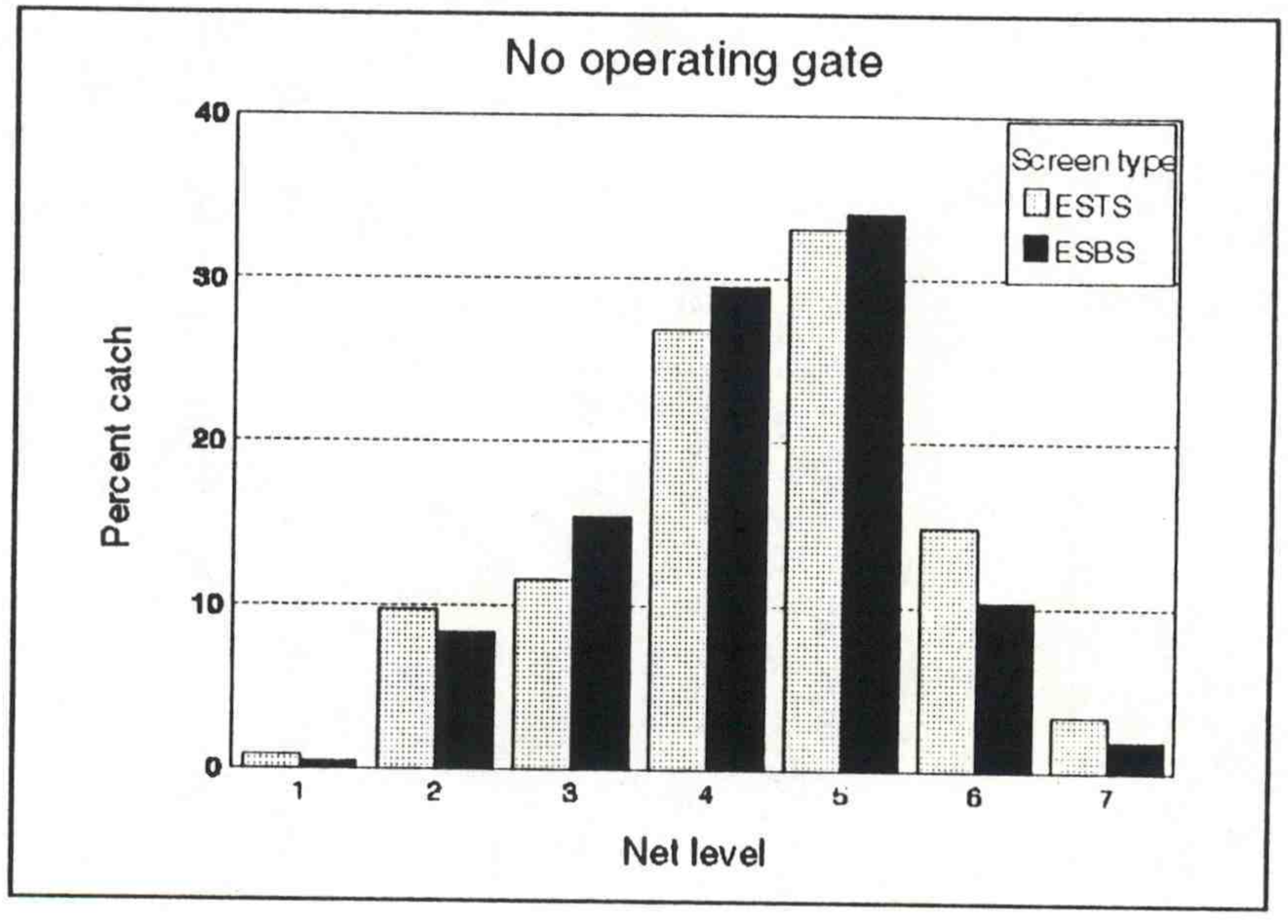
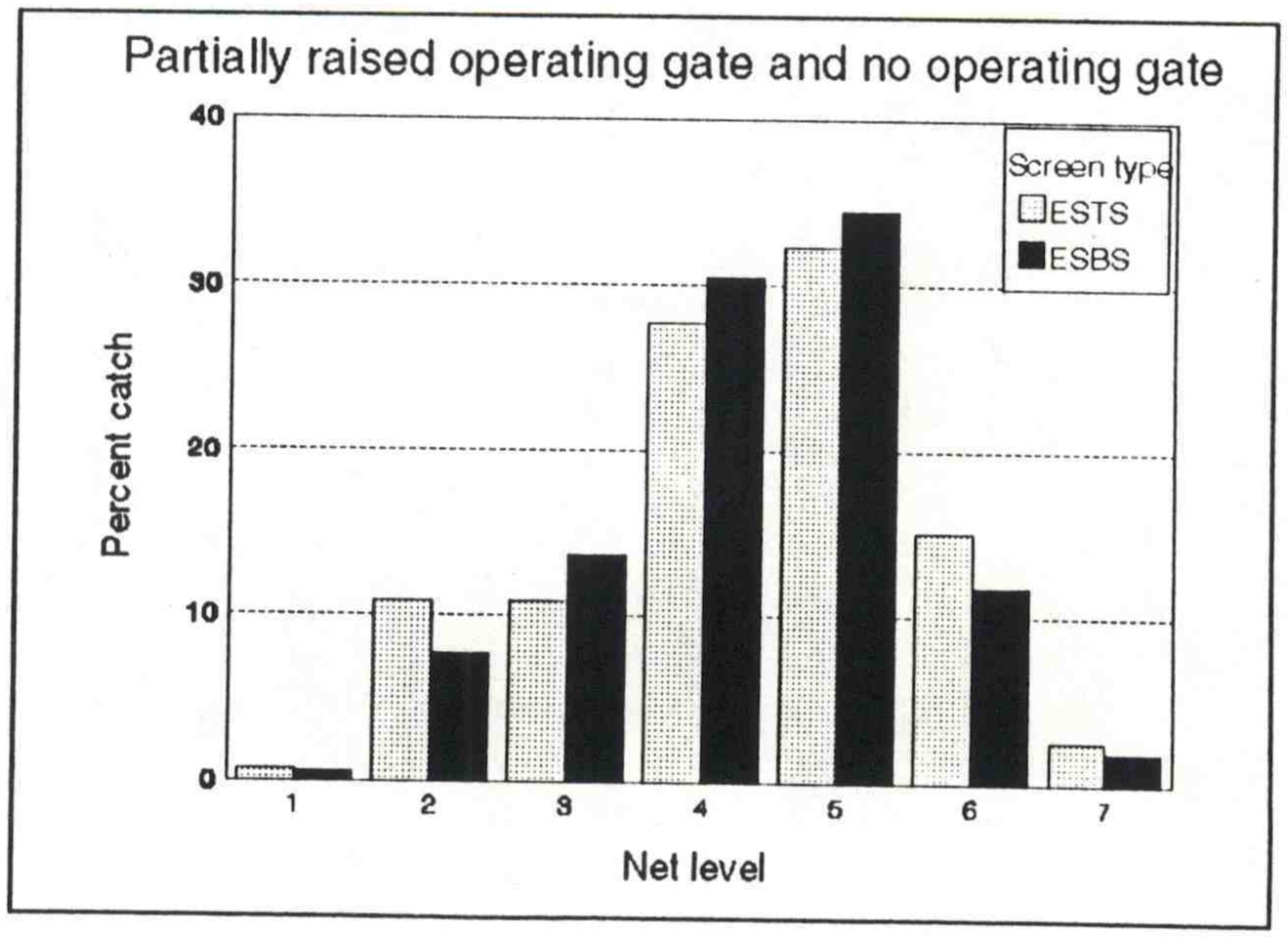


Figure 3.--Percent net catch by fyke-net level for subyearling chinook salmon captured during fish guidance efficiency tests using partially raised operating gates and no operating gate in conjunction with extended-length submersible traveling screens (ESTS) and extended-length submersible bar screens (ESBS) at McNary Dam, 1993.



as the number of descaled guided fish divided by the total number of guided fish. The descaling test design followed the design used for FGE testing of extended-length screens in Slots 5B and 6B. An STS in Slot 7B was used as the descaling control. No operating gate was used with the control STS except during the first four test nights (21 through 24 June), when a stored operating gate was inadvertently placed in the downstream gate slot. Data from these tests were omitted from analyses. Flows through Unit 7 were adjusted daily to accommodate McNary Dam power output demands.

One additional descaling comparison was added to the study design during the subyearling outmigration. As noted previously, older-style extended-length traveling screens were used in Slots 5A and 5C to provide uniform flow into the turbine unit. A major difference between the old-style screen and the redesigned extended-length traveling screen in Slot 5B was the mechanism employed to attach the nylon mesh surface material to the rotating belts. Following use of the new attachment technique for reducing descaling during the yearling chinook salmon outmigration, the question was raised whether similar modifications to the older-style extended-length traveling screens would result in descaling values comparable to those with the extended-length bar screen. To test the hypothesis that there would be no difference in mean descaling between a modified older-style extended-length traveling screen and an extended-length bar screen, the screen in Slot 5A was appropriately modified for comparison to the extended-length bar screen in

Slot 6A during the subyearling chinook salmon outmigration. Descaling samples were collected from Slots 5A and 6A each night during the summer outmigration test period.

As with the FGE data, mean descaling differences between the extended-length traveling screen and the extended-length bar screen were examined using a 2-day RBANOVA. Where gate position was not a factor (as in the comparison between Slots 5A and 6A), 1 day was considered a block and a single factor ANOVA was used. Descaling estimates with a sample size less than 25 were not considered for analysis.

Results and Discussion

Descaling results for individual tests are summarized by test slot and species in Appendix Table B3. Statistical comparisons of descaling results are summarized in Appendix Table B4. In addition, preliminary data and an evaluation of the possible effects of test procedures on descaling results are included in Appendix C.

Spring Outmigration

There was no statistically significant interaction between operating gate position and guidance device type for any salmonid species during the spring outmigration, and no significant differences in mean descaling by species were found for either operating gate position or screen type. By screen type, mean percent descaling values were

Screen type	Percent descaling (SE)			
	Yearling chinook	Steelhead	Coho	Sockeye
Extended-length traveling screen	12.9 (1.1)	5.2 (0.8)	5.8 (1.4)	35.9 (2.3)
Extended-length bar screen	11.2 (1.1)	4.3 (0.6)	8.2 (1.4)	31.5 (3.5)
STS	10.5 (0.7)	5.1 (0.7)	5.6 (1.2)	38.6 (2.1)

For all screen types and operating gate conditions combined, descaling averaged 12.0 (SE = 0.6), 4.8 (SE = 0.4), 6.9 (SE = 0.7), and 33.9% (SE = 1.5) for yearling chinook salmon, steelhead, coho salmon, and sockeye salmon, respectively, over the spring outmigration test period.

No statistically significant descaling differences were found for yearling chinook salmon dipped from gatewells when turbine units were operating and not operating ($t = -0.298$, $df = 7$, $P = 0.7701$). When gatewells were dipped with test units operating, mean descaling for the extended-length traveling screen and extended-length bar screen combined was 14.9% (SE = 1.9), compared to a mean of 15.7% (SE = 2.0) when gatewells were dipped with the test units off.

Summer Outmigration

There was a statistically significant interaction between operating gate position and extended-length screen type for subyearling chinook salmon. For treatments involving operating gate position, the only statistical difference found was that the 12.2% (SE = 2.1) mean descaling for the extended-length traveling

screen with no operating gate was significantly higher than any other operating gate/screen type combination, including the STS with no operating gate. Respective subyearling chinook salmon descaling averaged 5.6 (SE = 0.7) and 5.2% (SE = 1.3) for the extended-length traveling screen and extended-length bar screen with a partially raised operating gate. With no operating gate, mean subyearling chinook salmon descaling values were 6.0% (SE = 1.1) for the extended-length bar screen and 7.7% (SE = 1.0) for the control STS in Slot 7B. These descaling results were not surprising, since higher flows into gate slots associated with the no operating gate condition might be expected to produce more descaling by allowing fish less control in avoiding contact with either the guidance device or the vertical barrier screen.

There was no statistically significant difference in mean descaling between the modified older-style extended-length traveling screen in Slot 5A (6.5%, SE = 0.9) and the extended-length bar screen in Slot 6A (8.5%, SE = 0.8).

When the combined descaling data were compared among all test gatewells without regard to operating gate position, statistically significant differences were found between the redesigned extended-length traveling screen in Slot 5B (8.9%, SE = 1.4) and both the modified extended-length traveling screen in Slot 5A and the extended-length bar screen in Slot 6A. Mean descaling for subyearling chinook salmon was also significantly higher with the extended-length bar screen in Slot 6A than with the extended-length bar screen in Slot 6B (5.7%, SE = 0.9). There was no significant difference in mean descaling between the

control STS in Slot 7B and any of the extended-length screen treatments.

Descaling analyses comparing mean values among all five test slots should take into account the primary objective addressed in each slot. For example, tests in Slots 5B and 6B included a comparison of operating gate position (no operating gate vs. partially raised gate), while there was no change in the partially raised gate condition in the A slots of these units throughout the summer outmigration test period. Also, the detection level for differences in descaling for these data was 2%. While these differences may have statistical validity, little practical distinction exists between descaling rates differing by only two percentage points.

CONCLUSIONS

1) For yearling chinook salmon, FGE with the extended-length traveling screen (88%) was significantly higher than with the extended-length bar screen (81%). However no significant difference in FGE or descaling was detected based upon whether the operating gate was partially raised or removed entirely.
2) No significant differences in yearling chinook salmon descaling were found among mean values for the extended-length traveling screen, the extended-length bar screen, and the STS.
3) Mean FGE and descaling values obtained by dipping yearling chinook salmon from gatewells while the turbine unit was operating and while it was off were not significantly different.

4) For subyearling chinook salmon, FGE with the extended-length traveling screen (67%) was significantly higher than with the extended-length bar screen (52%) when both were used with a partially raised operating gate. There was no significant difference in FGE between the best guidance condition for the extended-length traveling screen (67%, with a partially raised operating gate) and the best guidance condition for the extended-length bar screen (59%, with no operating gate).

5) Descaling for subyearling chinook salmon using the extended-length traveling screen (12.2%) was significantly higher than all other operating gate/screen type combinations, including the STS. There were no significant differences among any of the other treatments.

6) The 2-day block sampling design employed in this study always paired the same operating gate position/screen type combinations for testing on alternate nights. At least for the summer outmigration, there was some indication of day to day variation not accounted for with this blocking. These data should be considered in future sample designs involving extended-length guidance devices.

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APPENDIX A

Statistical Analysis of Using the Center Column Fyke-net Catch with an Expansion Factor in Extended-Length Screen Fish Guidance Efficiency Studies

INTRODUCTION

To obtain fish guidance efficiency (FGE) estimates for juvenile fish diversion screens, a determination of the number of unguided fish must be made. In many FGE studies to date, this has been done by deploying an array of fyke nets across the portion of the turbine intake not intercepted by the screen. This net array need only sample a fraction of the unintercepted area if a suitable (precise and unbiased) expansion factor can be found; this can reduce by a considerable amount the number of fish killed in each FGE test. A simple example of this is to fyke net only the center one-third of the unscreened area and expand the total number of fish caught by 3 (the center-net method). This approach has been evaluated for FGE studies with the standard-length submersible traveling screen (STS) and analysis has shown that using the center-net method gives reasonable estimates of the number of unguided fish. Subsequently, FGE estimates for STSs in nearly all studies have employed this technique.

The development of extended-length submersible traveling screens and extended-length submersible bar screens has necessitated a re-examination of this expansion technique. Extended-length screens create different flow patterns in the turbine intake than the STSs, and thus may influence the horizontal distribution of fish. Concern over these possible differences has led researchers to fully fyke net the turbine intake in all extended-length screen FGE studies to date. Because it is necessary to reduce mortalities wherever feasible,

it is important to evaluate the possible use of the center-net method with extended-length screens in light of available information.

METHODS

The appropriateness of using the center-net method with an expansion factor was evaluated by measuring the deviation between FGE (using all fyke nets) and center-column-only FGE (CFGE) where:

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

and,

$$CFGE = \frac{GW}{GW + (CN*E)} \; X \; 100\%$$

where,

GW = the number of fish in the gatewell catch
FN = the number of fish in all the fyke nets
CN = the number of fish in the center column of fyke nets
E = the expansion factor.

The bias (relative to the standard FGE estimate) due to the expansion factor was calculated using the formula bias = CFGE - FGE. The bias was calculated for each FGE test and then averaged over all tests in the data set. The average bias was calculated for a range of E from 1.0 to 9.9 in increments of 0.1. The following statistics were then obtained: the bias of the expansion factor (multiplier) 3, the minimum bias multiplier, and a ± 2% bias multiplier interval.

The analysis was done for yearling chinook salmon in the spring and subyearling chinook salmon in the summer at McNary Dam in 1991-1993, The Dalles Dam in 1993, and Little Goose Dam in 1993 (Little Goose tests did not include summer work).

RESULTS AND DISCUSSION

Yearling Chinook Salmon

A total of 162 individual FGE tests were used in the analysis.

Using the value of 3 as the multiplier of the center-column net total led to an FGE bias ranging from 0.6 to 7.2% with mean values of 1.8, 4.9, and 3.7% for the extended-length traveling screen, extended-length bar screen, and combined tests, respectively (Appendix Table A1). The multiplier which gave the minimum average bias ranged from 3.2 to 5.3 with mean values of 3.4, 4.3, and 3.9 for the extended-length traveling screen, extended-length bar screen, and combined tests, respectively (Appendix Table A2). The ±2% bias multiplier intervals were 2.9-3.9, 3.7-4.9, and 3.4-4.5 for the extended-length traveling screen, extended-length bar screen, and combined tests, respectively (Appendix Table A3).

In all data sets, the 3 multiplier led to a positively biased estimate of FGE; for extended-length traveling screen tests, the bias appeared to be small (i.e., less than 2%), while for extended-length bar screen tests, it was higher (i.e., nearly 5%) (Appendix Table A1). This relationship held in all data sets except for 1991 at McNary.

Appendix Table A1.--Bias of using 3 as the multiplier for FGE tests using only the center column of fyke nets.

Dam	Year	Screen	Turbine unit/slot	Bias of 3 multiplier: Yearling chinook (%)	Bias of 3 multiplier: Subyearling chinook (%)
McNary	1991	ESTS[a]	5B	4.6	0.6
		ESBS[b]	6B	3.2	2.1
		BOTH		3.9	1.3
	1992	ESBS	5B	6.9	3.1
		ESBS	6B	7.2	2.3
		BOTH		7.1	2.6
	1993	ESTS	5B	1.1	0.2
		ESBS	6B	3.9	2.4
		BOTH		2.5	1.3
	ALL	ESTS	5B	2.5	0.4
		ESBS		5.3	2.4
		BOTH		4.4	1.7
The Dalles	1993	ESTS	6B	1.1	-1.9
		ESBS	5B	4.1	2.8
		BOTH		2.6	0.5
Little Goose	1993	ESTS	5B	0.6	
		ESBS	4B	4.0	
		BOTH		2.5	
ALL	ALL	ESTS		1.8	-0.3
		ESBS		4.9	2.5
		BOTH		3.7	1.4

[a] Extended-length submersible traveling screen.
[b] Extended-length submersible bar screen.

Appendix Table A2.--Minimum average bias multiplier for FGE tests using only the center column of fyke nets.

Dam	Year	Screen	Turbine unit/ slot	Min. ave. bias multiplier Yearling chinook	Min. ave. bias multiplier Subyearling chinook
McNary	1991	ESTS[a]	5B	4.3	3.1
		ESBS[b]	6B	3.7	3.3
		BOTH		4.0	3.2
	1992	ESBS	5B	4.9	3.5
		ESBS	6B	5.3	3.3
		BOTH		5.1	3.4
	1993	ESTS	5B	3.4	3.0
		ESBS	6B	4.0	3.3
		BOTH		3.7	3.2
	ALL	ESTS	5B	3.8	3.1
		ESBS		4.4	3.4
		BOTH		4.2	3.2
The Dalles	1993	ESTS	6B	3.2	2.8
		ESBS	5B	3.8	3.4
		BOTH		3.4	3.1
Little Goose	1993	ESTS	5B	3.2	
		ESBS	4B	4.4	
		BOTH		3.8	
ALL	ALL	ESTS		3.4	3.0
		ESBS		4.3	3.4
		BOTH		3.9	3.2

[a] Extended-length submersible traveling screen.
[b] Extended-length submersible bar screen.

Appendix Table A3.--Multipliers of ±2% bias interval for FGE tests using only the center column of fyke nets.

Dam	Year	Screen	Turbine unit/ slot	± 2% bias multiplier interval Yearling chinook	± 2% bias multiplier interval Subyearling chinook
McNary	1991	ESTS[a]	5B	3.7 - 5.0	2.8 - 3.4
		ESBS[b]	6B	3.2 - 4.1	3.0 - 3.7
		BOTH		3.5 - 4.5	2.9 - 3.5
	1992	ESBS	5B	4.3 - 5.6	3.2 - 3.8
			6B	4.6 - 6.0	3.0 - 3.7
		BOTH		4.5 - 5.8	3.1 - 3.7
	1993	ESTS	5B	2.7 - 4.0	2.7 - 3.3
		ESBS	6B	3.5 - 4.6	3.0 - 3.6
		BOTH		3.1 - 4.3	2.9 - 3.5
ALL		ESTS	5B	3.1 - 4.5	2.8 - 3.4
		ESBS		3.8 - 5.0	3.1 - 3.7
		BOTH		3.6 - 4.8	2.9 - 3.6
The Dalles	1993	ESTS	6B	2.9 - 3.4	2.6 - 3.0
		ESBS	5B	3.4 - 4.2	3.1 - 3.7
		BOTH		3.1 - 3.8	2.8 - 3.3
Little Goose	1993	ESTS	5B	2.6 - 3.7	
		ESBS	4B	3.7 - 5.2	
		BOTH		3.1 - 4.4	
ALL	ALL	ESTS		2.9 - 3.9	2.7 - 3.3
		ESBS		3.7 - 4.9	3.1 - 3.7
		BOTH		3.4 - 4.5	2.9 - 3.5

[a] Extended-length submersible traveling screen.
[b] Extended-length submersible bar screen.

The variation between dams appeared to be less than the variation between years at a dam. This, however, is quite speculative as McNary was the only dam with multiple years of testing. Values were much higher for McNary 1992 data than for all other data sets.

Subyearling Chinook Salmon

A total of 177 individual FGE tests were used in the analysis.

Using the value of 3 as the multiplier of the center-column net total led to an FGE bias ranging from -1.9 to 3.1% with mean values of -0.3, 2.5, and 1.4% for the extended-length traveling screen, extended-length bar screen, and combined tests, respectively (Appendix Table A1). The multiplier which gave the minimum average bias ranged from 2.8 to 3.4 with mean values of 3.0, 3.4, and 3.2 for the extended-length traveling screen, extended-length bar screen, and combined tests, respectively (Appendix Table A2). The ±2% bias multiplier intervals were 2.7-3.3, 3.1-3.7, and 2.9-3.5 for the extended-length traveling screen, extended-length bar screen, and combined tests, respectively (Appendix Table A3).

In all data sets but one (The Dalles 1993, extended-length traveling screen), the 3 multiplier led to a small positively biased estimate of FGE; for extended-length traveling screen tests, the bias appeared to be very small (i.e., less than 1%), while for extended-length bar screen tests, it was moderate (i.e., about 2.5%) (Appendix Table A1). This relationship held in all data sets.

The results from the above analysis can only be used to predict the effect of using the center-net method if it is assumed that the horizontal distribution of fish entering the fyke-net array is the same with a full fyke-net array as it is with a center-column only array. Because this assumption remains untested, this analysis should be viewed as preliminary.

CONCLUSIONS

1) The use of the center-column net method with the 3 multiplier appears to produce positively biased (2 to 5%) extended-length screen FGE estimates (relative to the full-net array method) for yearling chinook salmon in the spring with high FGE and low unguided fish numbers.
2) The use of the center-column net method with the 3 multiplier appears to produce little bias (-0.3 to 2.5%) in extended-length screen FGE estimates for subyearling fish in the summer (with low FGE and high unguided fish numbers).
3) The use of the center-column net method with the 3 multiplier appears to positively bias extended-length bar screen FGE estimates by about 3% more than extended-length traveling screen FGE estimates.
4) For a given dam and set of screen types, there appears to be significant yearly variation in the effects (bias) of using the center-column net method.
5) Due to untested assumptions and the variation among species, screen types, and years, it is recommended that the center-column net FGE method not be used with extended-length

screens at this time. If it is used in the future, bias estimates generated from all applicable data should be used to adjust the resultant FGE estimates as needed (i.e., this report should be updated annually).

APPENDIX B

Data Tables

Appendix Table B1.--Numbers of fish caught, by species, for individual replicates of fish guidance efficiency (FGE) tests at McNary Dam, 1993.

28 April (5B, ESTS, PROG)[a]

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot[b]	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2							1	1	2		2	4								
Level 3					1	1	1	3	1		1	2								
Level 4					4		3	7		1	1	2					1			1
Level 5					9	10	11	30		1	3	4								
Level 6					2	4	8	14		1		1							1	1
Level 7						1		1			1	1								
Net total					16	16	24	56	3	3	8	14					1	1		2
Gatewell				4				273				263				9				2
Total				4				339				277				9				4
FGE (%)				100				83				95				100				50

28 April (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1					2	1		3		1		1								
Level 2					2	1	3	6	4	1	2	7								
Level 3					8	1	3	12	1	1		2								
Level 4					13	3	14	30	3		2	5								
Level 5					5	13	10	28		1	1	2								
Level 6					5	2	8	15	3		1	4								
Level 7						1		1												
Net total					35	22	38	95	11	4	6	21								
Gatewell								291				187				7				
Total								387				208				7				
FGE (%)								76				90				100				

[a] Test date (test slot, guidance device type, operating gate position); ESTS = extended-length submersible traveling screen, ESBS = extended-length submersible bar screen, PROG = partially raised operating gate, NOG = no operating gate.

[b] Refers to fyke-net column: L = left, C = center, R = right, Tot = total catch for net level.

Appendix Table B1.--Continued.

29 April (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2					3	1	2	6			1	1								
Level 3					1	1	2	4		1		1								
Level 4						3	1	4												
Level 5					11	12	14	37	1	2	1	4								
Level 6					3	2	11	16		3		3								
Level 7									1			1								
Net total					18	19	30	67	2	6	2	10								
Gatewell				1				226				138				10				
Total				1				293				148				10				
FGE (%)				100				77				93				100				

29 April (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1						1	1	2												
Level 2					1	2		3												
Level 3					1	1		2												
Level 4					3	1	3	7												
Level 5					8	4	6	18	1	1		2								
Level 6					1		3	4	1			1						1		1
Level 7																				
Net total					14	9	13	36	2	1		3						1		1
Gatewell								87				38				3				
Total								123				41				3				1
FGE (%)								71				93				100				0

Appendix Table B1.--Continued.

30 April (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2					2	1	2	5			1	1								
Level 3					2	1	3	6												
Level 4					3	1	3	7		3		3								
Level 5					7	2	4	13		1	1	2						1		1
Level 6					3	4	2	9	2			2								
Level 7					1	1		2												
Net total					18	10	14	42	2	4	2	8						1		1
Gatewell				3				229				230				12				
Total								271				238				12				1
FGE (%)				100				85				97				100				0

30 April (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2							1	1												
Level 3					1		1	2												
Level 4					3	2	3	8			1	1								
Level 5					8	8	8	24		1	1	2								
Level 6					4	2	8	14			1	1								
Level 7						1		1												
Net total					16	13	21	50	1	1	4	6								
Gatewell								167				91				7				
Total								217				97				7				
FGE (%)								77				94				100				

Appendix Table B1.--Continued.

1 May (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2										1	1	2								
Level 3					1		1	2			1	1								
Level 4					2	1	1	4	1			1								
Level 5						1	3	4		1	1	2								
Level 6					4	3	1	8												
Level 7										1		1								
Net total					7	5	6	18	1	3	3	7								
Gatewell				1				152				267				29				3
Total				1				170				274				29				3
FGE (%)				100				89				97				100				100

1 May (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1											1	1								
Level 2					1		2	3	1		2	3								
Level 3					1	2	1	4	2			2								
Level 4					4	3	8	15			1	1								
Level 5					9	6	8	23	1		2	3								
Level 6					5	3	4	12		1	1	2								
Level 7											1	1								
Net total					20	14	23	57	4	1	8	13								
Gatewell								149				121				17				1
Total								206				134				17				1
FGE (%)								72				90				100				100

Appendix Table B1.--Continued.

3 May (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1											1	1								
Level 2					1	2		3												
Level 3									2	2	4	8			1	1				
Level 4					3	6	6	15	1	5		6		1		1				
Level 5					1	9	11	21		3	2	5					1			1
Level 6					6	7	11	24	3	1	3	7						1		1
Level 7		1		1			1	1												
Net total				1	11	24	29	64	6	11	10	27		1	1	2	1	1		2
Gatewell				5				236				299				49				43
Total				6				242				326				51				45
FGE (%)				83				79				92				96				96

3 May (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1			1																
Level 2						1	6	7					1			1			1	1
Level 3					1	1	1	3			2	2							2	2
Level 4		1		1	2	5	6	13	3	4	1	8					1	1	1	3
Level 5					6	5	12	23	3	4	7	14	2	1	1	4			1	1
Level 6						1	1	2									2		1	3
Level 7						1	1	2	1			1								
Net total	1	1		2	9	14	27	50	7	8	10	25	3	1	1	5	3	1	6	10
Gatewell				2				186				123				22				18
Total				4				236				148				27				28
FGE (%)				50				79				83				81				64

Appendix Table B1.--Continued.

4 May (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2					1	1		2	2		1	3	1			1		1		1
Level 3							1	1	2			2								
Level 4					4	3	2	9		1	1	2							1	1
Level 5					1	5	6	12	1	2	2	5						1		1
Level 6					3	4	6	12			1	1					1	1	3	5
Level 7							1	1									1		1	2
Net total					9	13	15	5	5	3	5	13	1			1	2	3	5	10
Gatewell				6				271				160				39				99
Total				6				276				173				40				109
FGE (%)				100				88				92				98				91

4 May (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1											1	1								
Level 2					1	3	4	8	1		1	2						1		1
Level 3							2	2	1	2		3					1	1		2
Level 4					3	3	2	8	1		2	3			1	1	2	1	1	4
Level 5					1	3	11	15	3	2	2	7						4	2	6
Level 6					5	6		11		2	1	3					1	1	3	5
Level 7									1			1								
Net total					10	15	19	44	7	6	7	20			1	1	4	8	6	18
Gatewell				1				160				114				31				32
Total				1				204				134				32				50
FGE (%)				100				78				85				97				64

Appendix Table B1.--Continued.

5 May (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1					1			1												
Level 2					8	1	9	18			1	1					5	5	5	15
Level 3					3		1	4		1		1			1	1	1		1	2
Level 4					4	2	5	11		2	2	4		1		1	3		2	5
Level 5					9	3	8	20	2	4		6					3	4		7
Level 6	1			1	9	8	4	21	2	1		3					1		2	3
Level 7						1		1		1	2	3								
Net total	1			1	34	15	27	76	4	9	5	18		1	1	2	13	9	10	32
Gatewell				4				657				298				136				409
Total				5				733				316				138				441
FGE (%)				80				90				94				99				93

5 May (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1									1		1	2					1		1	2
Level 2					3		8	11	1		2	3						2	5	7
Level 3					2		7	9	1	3	1	5					1	1	5	7
Level 4					3	4	8	15	1	1	1	3					4	3	4	11
Level 5					6	9	9	24			1	1	1	2		3	4	5	6	15
Level 6					1	5	8	14	1			1					3	2	3	8
Level 7							2	2		1		1					1	2	1	4
Net total					15	18	42	75	5	5	6	16	1	2		3	14	15	25	54
Gatewell				2				355				140				79				309
Total				2				430				156				82				313
FGE (%)				100				83				90				96				85

Appendix Table B1.--Continued.

6 May (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1						1		1											1	1
Level 2						3	2	5			2	2					5	1	5	11
Level 3					3	2	2	7	2			2			1	1	3	1	2	6
Level 4					6	5	5	16		3	3	6					6	3	6	15
Level 5					9	3	5	17	1	2	3	6					2	3	3	8
Level 6					2	2	6	10	2			2			1	1	1	1	2	4
Level 7					1	2		3		1		1					1	1		2
Net total					21	18	20	59	5	6	8	19			2	2	18	10	19	47
Gatewell				1				328				272				150				414
Total				1				387				291				152				461
FGE (%)				100				85				93				99				90

6 May (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1					1		1	2										1	1	2
Level 2					3		6	9	3	1	5	9					7	1	9	17
Level 3					3		7	10	1	3	2	6					1	3	5	9
Level 4					4	7	6	17		2	1	3					8	6	8	22
Level 5					3	8	9	20	2	1	4	7		1		1	4	4	6	14
Level 6					4	2	2	8									5	4	2	11
Level 7					1	1	1	3	1			1						1		1
Net total					19	18	32	69	7	7	12	26		1		1	25	20	31	76
Gatewell								189				225				136				156
Total								258				251				137				232
FGE (%)								73				90				99				67

Appendix Table B1.--Continued.

10 May (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1											1	1					1	1		2
Level 2		2		2	2	2	6	10	3	1	2	6					15	6	17	38
Level 3					2	1	3	6		1	1	2					6	7	11	24
Level 4					7	2	2	11	2	2	2	6					5	5	2	12
Level 5					4	5	9	18	2	1	3	6					5	5	6	16
Level 6					5	3	9	17	1	1		2					5	1	4	10
Level 7						1		1		2		2					2	1		3
Net total		2		2	20	14	29	63	8	8	9	25					39	26	40	105
Gatewell		13				525				451				105				1042		
Total		15				588				476				105				1147		
FGE (%)		87				89				95				100				91		

10 May (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1						1		1									1		1	2
Level 2			1	1			5	5	1	1		2					9	3	11	23
Level 3			1	1	1		4	5		1	1	2					8	5	12	25
Level 4					2	1	2	5	3	1	1	5					7	5	6	18
Level 5					5	4	7	16	8	2	3	13					7	5	11	23
Level 6					2	3	1	6	1	2	1	4					3	1	3	7
Level 7									1	2	2	5					1	2		3
Net total			2	2	10	9	19	38	14	9	8	31					36	21	44	101
Gatewell				5				117				159				29				467
Total				7				155				190				29				568
FGE (%)				71				75				84				100				82

Appendix Table B1.--Continued.

18 May (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																			1	1
Level 2			3	3	1			1	1	1		2					1		2	3
Level 3			3	3			1	1		1	6	7					2		1	3
Level 4					2	2	1	5		2	1	3					1		4	5
Level 5					2	3	4	9	1	1	2	4					1	1	1	3
Level 6					2		1	3	1	2	1	4					1			1
Level 7							1	1												
Net total			6	6	7	5	8	20	3	7	10	20					6	1	9	16
Gatewell			33				213			309					10				83	
Total			39				233			329					10				99	
FGE (%)			85				91			94					100				84	

18 May (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2		2	1	3	2		3	5									1		4	5
Level 3			1	1	3	1	6	10									2	1	3	6
Level 4		3		3	5		2	7	1			1					2	2	1	5
Level 5	1			1	3	3	4	10	2	2	2	6							4	4
Level 6					4			4			2	2							4	4
Level 7			2	2																
Net total	1	5	4	10	17	4	15	36	3	2	4	9					7	5	16	28
Gatewell				11				205				128				5				82
Total				21				241				137				5				110
FGE (%)				52				85				93				100				75

Appendix Table B1.--Continued.

19 May (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1			1							1	1								
Level 2	1	2	5	8	1		2	3			1	1					3	3	3	9
Level 3	2	1		3		2		2												
Level 4	1	1		2					1	1	1	3							1	1
Level 5	2			2	1	3		4	1	1	1	3					2		3	5
Level 6	2			2			1	1		1	2	3						1	2	3
Level 7																			1	1
Net total	9	4	5	18	2	5	3	10	2	3	6	11					5	4	10	19
Gatewell				22				86				171				2				154
Total				40				96				182				2				173
FGE (%)				55				90				94				100				89

19 May (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2			2	2		3	1	4	2		1	3					5	1	1	7
Level 3	2	1	3	6	1	1	2										4	2	1	7
Level 4			1	1	1		2	3											6	6
Level 5		1		1		1		1		1	2	3					1	1		2
Level 6	2	1	1	4													1			1
Level 7							1	1												
Net total	4	3	7	14	1	1	5	7	2	1	3	6					11	4	8	23
Gatewell				14				63				79				1				94
Total				28				70				85				1				117
FGE (%)				50				85				93				100				80

Appendix Table B1.--Continued.

20 May (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			1	1																
Level 2			1	1	1		7	8									5	4	3	12
Level 3																	5	2	4	11
Level 4					1	1	2	4	1	1	3	5					2	3	3	8
Level 5			1	1	5	4	6	15	1	1	1	3					4	4	8	16
Level 6						3	2	7	12								1	2		3
Level 7																	1			1
Net total			3	3	10	7	22	39	2	2	4	8					18	15	18	51
Gatewell				19				175				250				14				305
Total				22				214				258				14				356
FGE (%)				86				82				97				100				86

20 May (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																	1			1
Level 2						1		1	1		2	3					5	3	5	13
Level 3	1		1	2	1		3	4									8	3	12	23
Level 4					2		3	5		1	1	2					6	3	12	21
Level 5		2		2	7	2	8	17	1	3	3	7					7	10	6	23
Level 6	1			1	1		1	2	1	1	1	3					4			4
Level 7																	2			2
Net total	2	2	1	5	11	3	15	29	3	5	7	15					33	19	35	87
Gatewell				18				215				148				14				347
Total				23				244				163				14				434
FGE (%)				78				88				91				100				80

Appendix Table B1.--Continued.

21 May (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	3	2		5					1			1					3	3	7	13
Level 3		1		1	2			2	1		1	2					2		1	3
Level 4	1			1			1	1		1	1	2					3	3	2	8
Level 5	1			1	2		1	3	1	1		2					3	5	2	10
Level 6			2	2					1	1		2						2		2
Level 7																		2		2
Net total	4	3	2	9	4		2	6	4	3	2	9					11	15	12	38
Gatewell				29				140				109				21				181
Total				38				146				118				21				219
FGE (%)				76				96				92				100				83

21 May (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																			2	2
Level 2			1	1			1	1		1	1	2					3	1	8	12
Level 3			3	3			1	1		2		2					4		2	6
Level 4		1		1	2		2	4	1		1	2					1	2	6	9
Level 5		2	1	3	2	1	2	5			1	1					5	2	3	10
Level 6		1	1	2		1		1										1		1
Level 7	1			1					1			1								
Net total	1	4	6	11	4	2	6	12	2	3	3	8					13	6	21	40
Gatewell				12				96				58				25				158
Total				23				108				66				25				198
FGE (%)				52				89				88				100				80

Appendix Table B1.--Continued.

22 May (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2		1		1						4		4					3		2	5
Level 3			1	1													1	4	2	7
Level 4			1	1		1		1									5	1	6	12
Level 5			2	2	2			2	2			2					4	4	1	9
Level 6							1	1		1		1					2	9	7	18
Level 7					1		1	2									1		3	4
Net total		1	4	5	3	1	2	6	2	5		7					16	18	21	55
Gatewell				45				58				66				49				145
Total				50				64				63				19				200
FGE (%)				90				91				90				100				73

22 May (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			1	1																
Level 2	1			1			1	1	1		1	2					4	1	3	8
Level 3	2		1	3	3		2	5										4	4	8
Level 4	1		2	3	3	1		4									5	5	4	14
Level 5			1	1	1		1	2		2		2					5	5	8	18
Level 6		2		2													2	3	4	9
Level 7					1	1		2												
Net total	4	2	5	11	8	2	4	14	1	2	1	4					16	18	23	57
Gatewell				37				86				62				19				93
Total				48				100				66				19				150
FGE (%)				77				86				94				100				62

Appendix Table B1.--Continued.

23 May (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	3	1		4		2		2			1	1					2	1		3
Level 3	1			1	2			2									1	2	1	4
Level 4			1	1	2	1		3	1			1	1			1	1	1	1	3
Level 5		1	2	3	2	1	4	7									3	2	1	6
Level 6					3	5	3	11		1		1					1	4	1	6
Level 7	2	1		3														1		1
Net total	6	3	3	12	9	9	7	25	1	1	1	3	1			1	8	11	4	23
Gatewell				24				131				45				38				68
Total				36				156				48				39				91
FGE (%)				67				84				94				97				75

23 May (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	4	2		6		2	4	6									5	1	6	12
Level 3		1		1		1	1	2									3		3	6
Level 4	1	1		2	4	3	2	9		1		1					3	2	5	10
Level 5	2	1	1	4	3	1	3	7	1	3		4					5	3	3	11
Level 6		1	1	2	2		1	3						1		1	2	2	1	5
Level 7		1		1																
Net total	7	7	2	16	9	7	11	27	1	4		5		1		1	18	8	18	44
Gatewell				34				170				55				56				88
Total				50				197				60				57				132
FGE (%)				68				86				92				98				67

Appendix Table B1.--Continued.

24 May (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	2			2		1		1	1			1			1	1		1		1
Level 3					1	1		2												
Level 4	1			1		1	1	2	1			1			2	2	5		1	6
Level 5	1	1	1	3	1	2	1	4			2	2			1	1	1		1	2
Level 6					1			1			1	1					1		1	2
Level 7																				
Net total	4	1	1	6	3	5	2	10	2		3	5			4	4	7	1	3	11
Gatewell				17				117				39				52				28
Total				23				127				44				56				39
FGE (%)				74				92				89				93				72

24 May (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			1	1			1	1												
Level 2	2	1	2	5	1			1			1	1						2		2
Level 3	1	1	1	3		1	3	4											3	3
Level 4		2	4	6	5	1	2	8									3		2	5
Level 5		1	3	4	1	3	1	5			1	1	1			1	1	1	1	3
Level 6		2	3	5		3		3			1	1							1	1
Level 7																				
Net total	3	7	4	24	7	8	7	22			3	3	1			1	4	3	7	14
Gatewell				27				125				39				84				32
Total				51				147				42				85				46
FGE (%)				53				85				93				99				70

Appendix Table B1.--Continued.

25 May (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	1	5	2	8		2	1	3									5	1	4	10
Level 3	1	1	1	3			1	1		1		1					2		1	3
Level 4						4	1	5		1	1	2					2	1	1	4
Level 5		1	1	2	5	5	4	14									5	2	3	10
Level 6		1	3	4	1	2	4	7		1	1	2					1		2	3
Level 7		1		1	1			1	1			1								
Net total	2	9	7	18	7	13	11	31	1	3	2	6					15	4	11	30
Gatewell				13				264				37				86				99
Total				31				295				43				86				129
FGE (%)				42				89				86				100				77

25 May (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			1	1		1		1										1		1
Level 2	6		2	8	1	2	5	8					1			1	4	3	9	16
Level 3	2			2	3	1	2	6									2		5	7
Level 4		2	1	3	2	1	3	6									2	1	5	8
Level 5	1	1		2	7	9	7	23		1	1	2					1	3	2	6
Level 6	2	2		4	3	4	11	18		1	1	2					2			2
Level 7					1	3	4	8							1	1	1	1		2
Net total	11	5	4	20	17	21	32	70		2	2	4	1		1	2	12	9	21	42
Gatewell				17				302				38				73				137
Total				37				372				42				75				179
FGE (%)				46				81				90				97				77

Appendix Table B1.--Continued.

26 May (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			1	1																
Level 2	2	1	1	4	1	1	7	9	1			1					4	3		7
Level 3					2	1	1	4										1	1	2
Level 4					2		3	5					1			1	1	2	6	9
Level 5		2		2	1	3	1	5	2	2	3	7					3	3	1	7
Level 6	2			2	3	2	2	7											2	2
Level 7																				
Net total	4	3	2	9	9	7	14	30	3	2	3	8	1			1	8	9	10	27
Gatewell				6				354				107				86				164
Total				15				384				115				87				191
FGE (%)				40				92				93				99				86

26 May (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1					1			1											1	1
Level 2	1		1	2	7		4	11									4	2	5	11
Level 3	1	1	2	4	2	5	6	13									7	4	6	17
Level 4			2	2	3	2	2	7		1		1					4	5	9	18
Level 5	1			1	9	3	7	19					1			1	8	3	4	15
Level 6						3	1	4		1		1							2	2
Level 7					1			1									2			2
Net total	3	1	5	9	23	13	20	56		2		2	1			1	25	14	27	66
Gatewell				14				350				128				138				224
Total				23				406				130				139				290
FGE (%)				61				86				98				99				77

Appendix Table B1.--Continued.

27 May (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	4			4			1	1									4	1	4	9
Level 3	1			1		2		2		2	1	3								
Level 4		1		1	1			1			1	1						1	2	3
Level 5			1	1	1	1	5	7		1	1	2								
Level 6						2		2		1		1								
Level 7									1			1						1		1
Net total	5	1	1	7	2	5	6	13	1	4	3	8					4	3	6	13
Gatewell				11				239				55				77				67
Total				18				252				63				77				80
FGE (%)				61				95				87				100				84

27 May (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1						1		1												
Level 2		1		1	3	4	9	16			1	1					8	2	6	16
Level 3			2	2	1	1	3	5									5			5
Level 4					1		3	4									2	1	2	5
Level 5					6	4	5	15	2			2					3	2		5
Level 6					4	1	1	6	1			1								
Level 7																				
Net total		1	2	3	15	11	21	47	3		1	4					18	5	8	31
Gatewell				15				240				60				52				124
Total				18				287				64				52				155
FGE (%)				83				84				94				100				80

Appendix Table B1.--Continued.

28 May (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																		1		1
Level 2	3		1	4	2			2	1			1							3	3
Level 3																	1			1
Level 4	1		1	2	1	3		4												
Level 5	2			2	1		1	2									1		1	2
Level 6	2			2	1			1												
Level 7					1			1										1		1
Net total	8		2	10	6	3	1	10	1			1					2	2	4	8
Gatewell				11				82				26				12				46
Total				21				92				27				12				54
FGE (%)				52				89				96				100				85

28 May (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	3	1	1	5	1		2	3											2	2
Level 3	1		1	2	3	1		4	1	1	1	3					2		1	3
Level 4						2	2	4										1	2	3
Level 5		2	1	3		2	2	4	1			1							1	1
Level 6		1		1			1	1										1		1
Level 7	1			1	1			1					1			1				
Net total	5	4	3	12	5	5	7	17	2	1	1	4	1			1	2	2	6	10
Gatewell				17				118				32				30				21
Total				29				135				36				31				31
FGE (%)				59				87				89				97				68

Appendix Table B1.--Continued.

29 May (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	1	1	3	5	1	1		2									1	5	3	9
Level 3			1	1	1		1	2			1	1						1		1
Level 4										1		1					1		1	2
Level 5			1	1	2	4	1	7	3		1	4	1			1	3	2	3	8
Level 6					1	1	2	4		1		1					2	1		3
Level 7						1		1												
Net total	1	1	5	7	5	7	4	16	3	2	2	7	1			1	7	9	7	23
Gatewell				3				216				53				28				142
Total				10				232				60				29				165
FGE (%)				30				93				88				97				86

29 May (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1					1		1	2											1	1
Level 2		1	1	2	2	2	3	7	1			1					5	2	10	17
Level 3					1			1									6	2	7	15
Level 4					3	3	10	16		1		1					12	3	11	26
Level 5					10	7	4	21			2	2					6	3	7	16
Level 6		1		1			4	4	3	1		4					3	3	3	9
Level 7											1	1								
Net total		2	1	3	17	12	22	51	4	2	3	9					32	13	39	84
Gatewell				2				203				68				61				138
Total				5				254				77				61				222
FGE (%)				40				80				88				100				62

Appendix Table B1.--Continued.

21 June (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	3	2	4	9																
Level 3	3	5	1	9																
Level 4	8	7	9	24		1		1												
Level 5	7	4	3	14																
Level 6	3	2	4	9	1			1												
Level 7																				
Net total	24	20	21	65	1	1		2												
Gatewell				224				18								1				1
Total				285				20								1				1
FGE (%)				79				90								100				100

21 June (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	3	1	4	8																
Level 3	9	4	13	26			1	1												
Level 4	22	10	10	42																
Level 5	16	7	7	30	1	3	3	7												
Level 6	2	1	3	6	1		2	3												
Level 7	1	1		2																
Net total	53	24	37	114	2	3	6	11												
Gatewell				241				20				3				1				8
Total				355				31				3				1				8
FGE (%)				68				65				100				100				100

Appendix Table B1.--Continued.

22 June (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	6	6	4	16																
Level 3	8	2	3	13																
Level 4	8	9	10	27	1			1												
Level 5	8	9	8	25			1	1												
Level 6	7	3	2	12																
Level 7	4	3	3	10																
Net total	41	32	30	103	1		1	2												
Gatewell				471				4								1				1
Total				574				6								1				1
FGE (%)				82				67								100				100

22 June (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1			1																
Level 2	10	9	11	30						1		1								
Level 3	10	8	9	27																
Level 4	20	22	21	63																
Level 5	19	19	22	60		1		1												
Level 6	8	3	8	19	1			1												
Level 7	3		4	7																
Net total	71	61	75	207	1	1		2		1		1								
Gatewell				683				14				1								5
Total				890				16				2								5
FGE (%)				76				88				50								100

Appendix Table B1.--Continued.

23 June (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	6	2	1	9																
Level 3	1	1	2	4																
Level 4	1	3	5	9																
Level 5	2	3	2	7	1			1												
Level 6	1		4	5																
Level 7		1	1	2																
Net total	11	10	15	36	1			1												
Gatewell				240				3												
Total				276				4												
FGE (%)				87				75												

23 June (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	4		1	5																
Level 3	3	1	3	7																
Level 4	2	8	4	14																
Level 5	5	1	4	10																
Level 6	1	1	1	3																
Level 7	1			1																
Net total	16	11	13	40																
Gatewell				150				5												5
Total				190				5												5
FGE (%)				79				100												100

Appendix Table B1.--Continued.

24 June (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1		1	1	2																
Level 2	12	13	13	38																
Level 3	10	3	10	23																
Level 4	23	23	10	56																
Level 5	30	15	20	65			1	1									1			1
Level 6	7	4	6	17			1	1												
Level 7	1			1																
Net total	83	59	60	202			2	2									1			1
Gatewell				757				2				1								4
Total				959				4				1								5
FGE (%)				79				60				100								80

24 June (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1		1	2																
Level 2	7	12	12	31																
Level 3	8	4	7	19																
Level 4	25	23	23	71																
Level 5	26	21	28	75	1			1												
Level 6	5	4	7	16			1	1												
Level 7	4	1		5																
Net total	76	65	78	219	1		1	2												
Gatewell				389				5												3
Total				608				7												3
FGE (%)				64				71												100

Appendix Table B1.--Continued.

28 June (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			1	1																
Level 2	17	11	11	39																
Level 3	4	11	6	21																
Level 4	13	16	10	39																
Level 5	17	12	22	51																
Level 6	7	1	8	16																
Level 7																				
Net total	58	51	58	167																
Gatewell				831				2												
Total				998				2												
FGE (%)				83				100												

28 June (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1	1		2																
Level 2	10	5	17	32																
Level 3	9	9	12	30																
Level 4	20	25	21	66																
Level 5	21	22	25	68																
Level 6	4		5	9																
Level 7		3		3																
Net total	65	65	80	210																
Gatewell				704																
Total				914																
FGE (%)				77																

Appendix Table B1.--Continued.

2 July (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			1	1																
Level 2	16	7	9	32																
Level 3	7	5	6	18																
Level 4	35	32	30	97																
Level 5	33	26	37	96	1	1	1	3												
Level 6	12	15	22	49																
Level 7	3	4		7																
Net total	106	89	105	300	1	1	1	3												
Gatewell				777				16												
Total				1077				19												
FGE (%)				72				84												

2 July (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	4	2	7	13																
Level 3	17	8	18	43																
Level 4	46	36	33	115																
Level 5	50	45	41	136			1	1												
Level 6	17	18	5	40																
Level 7	2	3	4	9																
Net total	136	112	108	356			1	1												
Gatewell				342				5												1
Total				689				6												1
FGE (%)				49				83												100

Appendix Table B1.--Continued.

3 July (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			1	1																
Level 2	2	2	2	6																
Level 3	2	1	2	5																
Level 4	15	11	7	33																
Level 5	20	11	10	41																
Level 6	2	4	7	13																
Level 7	1		8	9																
Net total	42	29	37	108																
Gatewell				235				2												
Total				343				2												
FGE (%)				69				100												

3 July (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	4	1	5	10																
Level 3	2	3	12	17																
Level 4	22	11	12	17																
Level 5	24	12	15	51																
Level 6	6	3	7	16			1	1												
Level 7	1		2	3																
Net total	59	30	53	142			1	1												
Gatewell				288				3												
Total				430				4												
FGE (%)				67				75												

Appendix Table B1.--Continued.

7 July (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	4	3	4	11																
Level 3	6	3	9	18																
Level 4	9	21	19	49																
Level 5	23	16	15	54																
Level 6	6	7	9	22	1		1	2												
Level 7	2	2	1	5																
Net total	50	52	57	159	1		1	2												
Gatewell				234				2												
Total				393				4												
FGE (%)				60				50												

7 July (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	5	2	9	16																
Level 3	6	4	12	22																
Level 4	8	13	21	42																
Level 5	17	12	12	41																
Level 6	4	5	9	18	1			1												
Level 7	3	1	1	5																
Net total	43	37	64	144	1			1												
Gatewell				198																
Total				242				1												
FGE (%)				58				0												

Appendix Table B1.--Continued.

8 July (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	4	1	6	11																
Level 3	1		1	2																
Level 4	9	10	6	25																
Level 5	9	8	3	20																
Level 6	4		7	11																
Level 7		1	1	2																
Net total	27	20	24	71																
Gatewell				174				4												
Total				245				4												
FGE (%)				71				100												

8 July (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2		1	2	3																
Level 3	7	7	6	20																
Level 4	9	7	15	31			1	1												
Level 5	11	8	14	33																
Level 6	7	6	6	19																
Level 7	1	1		2																
Net total	35	30	43	108			1	1												
Gatewell				105				2												1
Total				213				3												1
FGE (%)				49				67												100

Appendix Table B1.--Continued.

9 July (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	3	1	4	8																
Level 3	1	1	6	8																
Level 4	10	11	5	26																
Level 5	5	12	10	27		1		1												
Level 6	2	3	5	10																
Level 7		2	1	3																
Net total	21	30	31	82		1		1												
Gatewell				177																1
Total				259			1													1
FGE (%)				68			0													100

9 July (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1			1																
Level 2	3	1	3	7																
Level 3	4	1	9	14																
Level 4	16	18	18	52		1		1												
Level 5	25	14	26	65																
Level 6	10	6	7	23																
Level 7	3	3	2	8																
Net total	62	43	65	170		1		1												
Gatewell				149																
Total				319			1													
FGE (%)				47			0													

Appendix Table B1.--Continued.

10 July (5B, ESTS, NOG) (0000 h)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	2	4	3	9																
Level 3	7	6	4	17																
Level 4	19	19	16	54	1			1												
Level 5	18	22	18	58																
Level 6	12	15	8	35																
Level 7	3	4		7																
Net total	61	70	49	180	1			1												
Gatewell				64				2												
Total				244				3												
FGE (%)				26				67												

10 July (6B, ESBS, PROG) (0000 h)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1		2	3																
Level 2	2	1	8	11																
Level 3	5	14	11	30																
Level 4	27	33	26	86																
Level 5	27	25	21	73	1			1												
Level 6	13	12	11	36																
Level 7			1	1																
Net total	75	85	80	240	1			1												
Gatewell				113				5				1								
Total				353				6				1								
FGE (%)				32				83				100								

Appendix Table B1.--Continued.

10 July (5B, ESTS, PROG) (2000 h)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1		1	1	2																
Level 2		2		2																
Level 3	4	2	2	8																
Level 4	18	9	9	33																
Level 5	14	15	16	45		1		1												
Level 6	7	11	7	25			1	1												
Level 7																				
Net total	43	40	32	115		1	1	2												
Gatewell				129				1												
Total				244				3												
FGE (%)				53				33												

10 July (6B, ESBS, NOG) (2000 h)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	10	6		16																
Level 3	8	13	24	45																
Level 4	18	20	26																	
Level 5	26	30	34	90																
Level 6	8	5	8	21			1	1												
Level 7			2																	
Net total	70	74	94	238			1	1												
Gatewell				346				1												
Total				584				2								1				1
FGE (%)				59				50								100				100

Appendix Table B1.--Continued.

11 July (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1	2		3																
Level 2	6	2	5	13	1	1		2												
Level 3	7	9	11	27	1			1												
Level 4	24	31	21	76	1			1												
Level 5	32	32	41	105																
Level 6	9	16	23	48																
Level 7	2	5	3	10																
Net total	81	97	104	282	3	1		4												
Gatewell				187				1												
Total				469				5												
FGE (%)				40				6												

11 July (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	4	4	3	11																
Level 3	10	7	12	29																
Level 4	34	34	26	94	1			1												
Level 5	31	32	41	104																
Level 6	4	11	8	23																
Level 7	4	1	1	6	1			1												
Net total	87	89	91	267	2			2												
Gatewell				166				3				1								1
Total				38				60				100								100
FGE (%)																				

Appendix Table B1.--Continued.

12 July (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1		2		2																
Level 2	29	20	31	80																
Level 3	7	7	11	25																
Level 4	12	16	13	41																
Level 5	24	21	15	60																
Level 6	8	4	3	15																
Level 7																				
Net total	80	70	73	223																
Gatewell				936																
Total				1159																
FGE (%)				81																

12 July (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1		1		1																
Level 2	12	5	17	34																
Level 3	7	10	12	29	1			1												
Level 4	21	12	19	52																
Level 5	25	22	17	64																
Level 6	3	3	1	7																
Level 7	1			1																
Net total	69	53	66	188	1			1												
Gatewell				420																
Total				608				1												
FGE (%)				69				0												

Appendix Table B1.--Continued.

13 July (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1		2	3																
Level 2	9	2	4	15																
Level 3	3	9	6	18																
Level 4	11	16	10	37																
Level 5	20	20	14	54																
Level 6	8	7	9	24																
Level 7		2		2																
Net total	52	56	45	153																
Gatewell				329																
Total				482																
FGE (%)				68																

13 July (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1		1	2	3																
Level 2	3	5	5	13																
Level 3	6	18	15	39																
Level 4	26	38	37	101																
Level 5	44	48	51	143																
Level 6	25	13	19	57																
Level 7	4	3	4	11																
Net total	108	126	133	367																
Gatewell				280																
Total				647																
FGE (%)				43																

Appendix Table B1.--Continued.

14 July (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1		2	1	3																
Level 2	3	2		5																
Level 3	7	2	6	15																
Level 4	7	7	9	23																
Level 5	8	7	9	24																
Level 6	1	5	5	11																
Level 7		1		1																
Net total	26	26	30	82																
Gatewell				159																
Total				241																
FGE (%)				66																

14 July (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			2	2																
Level 2	1	2	2	5																
Level 3	1	1	1	3																
Level 4	5	4	7	16																
Level 5	4	4	8	16																
Level 6	2		1	3																
Level 7	1			1																
Net total	14	11	21	46																
Gatewell				67																
Total				113																
FGE (%)				59																

Appendix Table B1.--Continued.

15 July (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	1	5	5	11																
Level 3		18	7																	
Level 4	10	16	10	36																
Level 5	14	14	16	44																
Level 6	3	15	7	25																
Level 7	1	1	1	3																
Net total	29	69	46	144																
Gatewell				70																
Total				214																
FGE (%)				33																

15 July (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	3		1	4																
Level 3	11	9	7	27																
Level 4	13	26	23	62																
Level 5	28	1	25	64																
Level 6	5	11	10	26																
Level 7			2	2																
Net total	60	57	68	185																
Gatewell				107																
Total				292																
FGE (%)				37																

Appendix Table B1.--Continued.

19 July (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	5	3	3	11																
Level 3	11	9	4	24																
Level 4	29	32	22	83																
Level 5	15	30	27	72																
Level 6	26	21	20	67																
Level 7	2	2	2	6																
Net total	88	97	78	263																
Gatewell				202																
Total				465																
FGE (%)				43																

19 July (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2			1	1																
Level 3	6	8	7	21																
Level 4	12	17	19	48																
Level 5	19	17	22	58																
Level 6	8	11	11	30																
Level 7	1	2		3																
Net total	46	55	60	161																
Gatewell				106																
Total				40																
FGE (%)																				

Appendix Table B1.--Continued.

20 July (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	2		1	3																
Level 3	1		1	2																
Level 4	3	3	3	9																
Level 5	2	1	2	5																
Level 6	1	4	2	7																
Level 7																				
Net total	9	8	9	26																
Gatewell				27				1												
Total				53				1												
FGE (%)				51				100												

20 July (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2		2	1	3																
Level 3		2	2	4																
Level 4	6	7	2	15																
Level 5	2	2	9	13																
Level 6	1	2	1	4																
Level 7																				
Net total	9	15	15	39																
Gatewell				59																
Total				88																
FGE (%)				60																

Appendix Table B1.--Continued.

21 July (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	2	1		3																
Level 3	1	2		3																
Level 4	6	5	7	18																
Level 5	6	7	7	20																
Level 6	4	1		5														1		1
Level 7			1	1																
Net total	19	16	15	50														1		1
Gatewell				95				4				1								1
Total				145				4				1								2
FGE (%)				66				100				100								50

21 July (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	2	2	2	6																
Level 3	3	5	5	13																
Level 4	5	7	9	21							1	1								
Level 5	11	5	5	21																
Level 6	5	1	5	11			1	1												
Level 7																				
Net total	26	20	26	72			1	1			1	1								
Gatewell				75																
Total				147				1				1								
FGE (%)				51				0				0								

Appendix Table B1.--Continued.

22 July (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	4	1		5																
Level 3	3	2	1	6																
Level 4	1	5	5	11																
Level 5	11	4	8	23																
Level 6	3	3	3	9																
Level 7		1	1	2																
Net total	21	17	18	56																
Gatewell				109				4												
Total				165				4												
FGE (%)				66				100												

22 July (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	1	2	3	6																
Level 3	1	6	4	11																
Level 4	9	15	7	31																
Level 5	8	15	15	38	1			1												
Level 6	7	3	3	13																
Level 7			1	1	1			1												
Net total	26	41	33	100	2			2												
Gatewell				107				3												
Total				207				5												
FGE (%)				52				60												

Appendix Table B1.--Continued.

26 July (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1		1		1																
Level 2	2	5	10	17																
Level 3	10	11	6	27																
Level 4	12	15	19	46																
Level 5	27	25	30	82																
Level 6	8	9	7	24																
Level 7			2	2																
Net total	59	66	74	199																
Gatewell				270																
Total				469																
FGE (%)				58																

26 July (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	2			2																
Level 2	16	7	29	52																
Level 3	17	36	23	76																
Level 4	29	38	39	76																
Level 5	39	33	55	127																
Level 6	11	10	16	37																
Level 7		3	2	5																
Net total	114	127	164	405																
Gatewell				526																
Total				931																
FGE (%)				56																

Appendix Table B1.--Continued.

27 July (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			3	3																
Level 2	11	5	9	25																
Level 3	8	12	8	28																
Level 4	5	9	5	19																
Level 5	14	6	17	37																
Level 6	1	3	1	5																
Level 7			1	1																
Net total	39	35	44	118																
Gatewell				295																
Total				413																
FGE (%)				71																

27 July (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1	1		3	4																
Level 2	9	3	3	15																
Level 3	2	2	8	12																
Level 4	6	6	8	20																
Level 5	6	16	9	31																
Level 6	3	1	2	6																
Level 7																				
Net total	27	28	33	88																
Gatewell				126																
Total				214																
FGE (%)				59																

Appendix Table B1.--Continued.

28 July (5B, ESTS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1		1		1																
Level 2	1	2	6	9																
Level 3	3	4	2	9																
Level 4	5	12	10	27		1		1												
Level 5	12	9	5	26																
Level 6	3	6	8	17																
Level 7	1	1		2																
Net total	25	35	31	91		1		1												
Gatewell				117				1												
Total				208				2												
FGE (%)				56				50												

28 July (6B, ESBS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1		1		1																
Level 2	2		2	4																
Level 3	2	5	2	9																
Level 4	7	5	6	18																
Level 5	7	6	9	22	1	1		2												
Level 6	2	3	1	6																
Level 7																				
Net total	20	20	20	60	1	1		2												
Gatewell				68				1												1
Total				128				3												1
FGE (%)				53				33												100

Appendix Table B1.--Continued.

29 July (5B, ESTS, NOG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1																				
Level 2	2	1		3																
Level 3	6	5	6	17																
Level 4	23	16	7	46																
Level 5	18	20	12	50															1	1
Level 6	10	10	10	30			1	1												
Level 7	2	1	2	5																
Net total	61	53	37	151			1	1											1	1
Gatewell				143				1												1
Total				294				2												2
FGE (%)				49				50												50

29 July (6B, ESBS, PROG)

Location	Subyearling Chinook				Yearling Chinook				Steelhead				Coho				Sockeye			
	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot	L	C	R	Tot
Level 1			1	1																
Level 2	2	4	2	8																
Level 3	2	3	7	12																
Level 4	12	8	13	33																
Level 5	8	11	16	35			1	1												
Level 6	4	2	1	7																
Level 7		1		1			1	1												
Net total	28	29	40	97			2	2												
Gatewell				101				2												
Total				198				4												
FGE (%)				51				50												

Appendix Table B2.--Statistical analyses of mean fish guidance efficiency estimates for tests at McNary Dam, 1993. Asterisks indicate statistically significant differences between means.

Test series	Test dates	Species	Analysis type	Analysis source	Calculated test statistic	df	P
1	28-30 April	Yearling chinook salmon	RBANOV[a]	Screen type (ESTS[b] vs. ESBS[c])	28.50*	9,1	<0.0001
	1-5 May	Steelhead	RBANOV		4.22*	9,1	0.0498
	18-29 May	Coho salmon	1-ANOV[d]		0.07	9	0.8013
		Sockeye salmon	RBANOV		24.15*	7,1	0.0001
		Yearling chinook salmon	RBANOV	Operating gate position (NOG[e] vs. PROG[f])	3.51	9,1	0.0721
		Steelhead	RBANOV		0.24	9,1	0.6341
		Coho salmon	1-ANOV		0.15	9	0.7112
		Sockeye salmon	RBANOV		0.24	7,1	0.6384
		Yearling chinook salmon	RBANOV	Operating gate position vs. screen type	0.61	9,1	0.4510
		Steelhead	RBANOV		1.42	9,1	0.2432
		Coho salmon	1-ANOV		1.87	9	0.1908
		Sockeye salmon	RBANOV		0.21	7,1	0.6549
1a	22-29 May	Yearling chinook salmon	2 t-test[g]	Dipping slot with or without unit operating	0.35	7	0.7351
2	21-24 June 2-29 July	Subyearling chinook salmon	RBANOV	Screen type (ESTS vs. ESBS)	6.30*	11,1	0.0171
		Subyearling chinook salmon	RBANOV	Operating gate position (NOG vs. PROG)	0.11	11,1	0.7488
		Subyearling chinook salmon	RBANOV	Operating gate position vs. screen type	4.20*	11,1	0.0485

[a] Randomized block analysis of variance.

[b] Extended-length submersible traveling screen.

[c] Extended-length submersible bar screen.

[d] Single factor analysis of variance.

[e] No operating gate (fully raised or removed).

[f] Partially raised operating gate (raised 2.4 m).

[g] Two sample Student's t-test.

Appendix Table B3.--Descaling data from fish guidance efficiency and descaling tests at McNary Dam, 1993.

Unit 5, Slot A

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc.[a]	Catch[b]	%[c]	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%
21 June	21	172	12.2	1	19	5.3				1		0.0	1	5	20.0
22 June	18	182	9.9		2	0.0									
23 June	3	132	2.3		3	0.0									
24 June	21	358	5.9	0	4	0.0									
28 June	1	187	2.7	1	1	100.0									
2 July	6	156	3.9		6	0.0									
3 July	9	131	6.9		6	0.0									
7 July	11	141	7.8		3	0.0									
8 July	4	147	2.7		6	0.0									
9 July	7	142	4.9		1	0.0									
10 July	10	90	11.1												
10 July		59	0.0		1	0.0									
11 July	8	80	10.0												
12 July	4	155	2.6												
13 July	5	151	3.3							1		0.0			
14 July	4	135	3.0												
15 July	6	52	11.5		3	0.0									
19 July	6	84	7.1												
20 July	5	25	20.0		1	0.0									
21 July	4	39	10.3		1	0.0									
22 July	5	49	10.2		4	0.0				2		0.0			
26 July	9	182	4.8												
27 July	6	163	3.7		1	0.0							1		0.0
28 July		31	0.0		1	0.0									
29 July	4	85	4.7		4	0.0									

[a] Number of descaled fish captured by dipnet from gatewell.

[b] Total gatewell catch.

[c] Percent descaling [(number descaled/total gatewell catch) x 100].

Appendix Table B3.--Continued.

Unit 5, Slot B

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%
28 April		4	0.0	8	273	2.9	4	263	1.5		9	0.0		2	0.0
29 April	1	1	100.0	35	226	15.5	10	138	93.2		10	0.0			
30 April		3	0.0	22	229	9.6	5	230	2.2		12	0.0			
1 May		1	0.0	19	152	12.5	7	267	2.6		29	0.0		3	0.0
3 May		5	0.0	19	236	8.1	22	299	7.4	3	49	6.1	10	43	23.3
4 May		6	0.0	19	271	7.0	6	160	3.8	2	39	5.1	27	99	27.3
5 May		4	0.0	71	657	10.8	12	298	4.0	8	136	5.9	176	409	43.0
6 May		1	0.0	30	328	9.2	9	272	3.3	2	150	1.3	104	414	25.1
10 May		13	0.0	37	525	7.1	16	451	3.6	1	105	1.0	261	1040	25.1
18 May		33	0.0	31	213	14.6	20	309	6.5		10	0.0	39	83	83.8
19 May		22	0.0	12	86	14.0	15	171	8.8		2	0.0	47	154	30.5
20 May		19	0.0	19	175	10.9	11	250	4.4		14	0.0	142	305	46.6
21 May		29	0.0	22	140	95.9	4	109	3.7	1	21	4.8	79	181	43.7
22 May		45	0.0	6	58	10.3	6	66	9.1	1	19	5.3	49	145	33.8
23 May		24	0.0	18	131	13.7	8	45	17.8		38	0.0	21	68	30.9
24 May		17	0.0	20	117	17.1	1	39	2.6	6	52	11.5	10	28	35.7
25 May		13	0.0	62	264	23.5	1	37	2.7	12	86	14.0	39	99	39.4
26 May		6	0.0	46	354	13.0	3	107	2.8	2	86	2.3	83	164	50.6
27 May		11	0.0	24	239	10.0	4	55	7.3	8	77	10.4	20	67	29.9
28 May		11	0.0	20	82	24.4		26	0.0	1	12	8.3	21	46	45.7
29 May		3	0.0	33	216	15.3	2	53	3.8	2	28	7.1	31	142	21.8
21 June	16	244	6.6	5	18	27.8					1	0.0		1	0.0
22 June	88	471	18.7	1	4	25.0					1	0.0		1	0.0
23 June	5	240	2.1		3	0.0									
24 June	71	757	9.4	2	3	66.7		1	0.0					4	0.0
28 June	50	831	6.0		2	0.0									
2 July	29	777	3.7		16	0.0									
3 July	18	235	7.7		2	0.0									
7 July	24	234	10.3		2	0.0									
8 July	22	174	12.6		4	0.0									
9 July	20	177	11.3											1	0.0
10 July	12	64	18.8		2	0.0									
10 July	9	129	7.0		1	0.0									
11 July	14	187	7.5		1	0.0									
12 July	41	936	4.4												
13 July	15	329	4.6												
14 July	4	159	2.5												
15 July	3	70	4.3												
19 July	16	202	7.9												
20 July	7	27	25.9		1	0.0									

Appendix Table B3.--Continued.

Unit 5, Slot B

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%
21 July	3	95	3.2		4	0.0		1	0.0					1	0.0
22 July	25	109	22.9		4	0.0									
26 July	11	270	4.1												
27 July	15	295	5.1												
28 July	4	117	3.4		1	0.0									
29 July	13	143	9.1	1	1	100.0							1	1	100.0

Unit 6, Slot A

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%
21 June	30	272	11.0	2	20	1.0.	3	0.0		1	0.0		2	6	33.3
22 June	59	588	10.0		11	0.0				1	0.0		1	4	25.0
23 June	5	147	3.4												
24 June	28	496	5.6		5	0.0								4	0.0
28 June	9	174	5.2												
2 July	14	305	4.6	1	3	33.3									
3 July	25	286	8.7	1	4	25.0	1	0.0							
7 July	15	188	8.0	2	2	100.0									
8 July	12	131	9.1		1	0.0									
9 July	20	168	11.9											1	0.0
10 July	19	112	17.0		4	0.0				1	0.0			1	100.0
10 July	29	418	6.9		4	0.0									
11 July	12	141	8.5		2	0.0									
12 July	7	178	3.9												
13 July	9	153	5.9												
14 July	8	198	4.0												
15 July	7	91	7.7		2	0.0									
19 July	10	129	7.8											1	0.0
20 July	2	35	5.7												
21 July	15	79	19.0		1	0.0									
22 July	10	78	12.8		3	0.0									
26 July	0	159	5.7												
27 July	15	180	8.3												
28 July	7	86	8.1												
29 July	16	113	14.2												

Appendix Table B3.--Continued.

Unit 6, Slot B

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%
28 April				15	291	5.2	9	187	4.8		7	0.0			
29 April				7	87	8.0	1	38	2.6		3	0.0			
30 April				17	167	10.2	4	91	4.4		7	0.0			
1 May				8	149	5.4	5	121	4.1		17	0.0		1	0.0
3 May		2	0.0	20	186	10.8	15	123	12.2	3	22	13.6	9	18	50.0
4 May		1	0.0	13	160	8.1	3	114	2.6	1	31	3.2	7	32	21.9
5 May		2	0.0	17	355	4.8	4	140	2.9	8	79	10.1	54	309	17.5
6 May				17	189	9.0	5	225	2.2	7	136	5.1	35	156	22.4
10 May		5	0.0	12	117	10.3	6	159	3.8	2	29	6.9	45	467	9.6
18 May		11	0.0	33	205	16.1	1	128	0.8		5	0.0	20	82	24.4
19 May		14	0.0	6	63	9.5	4	79	5.1		1	0.0	24	94	25.5
20 May		18	0.0	20	215	9.3	3	148	2.0	2	14	14.3	57	347	16.4
21 May		12	0.0	11	96	11.5	2	58	3.4		25	0.0	34	158	21.5
22 May		37	0.0	17	86	19.8	3	62	4.8	2	19	10.5	57	93	61.3
23 May		34	0.0	43	170	25.3	5	55	9.1	5	56	8.9	37	88	42.1
24 May		27	0.0	18	125	14.4	2	39	5.1	9	84	10.7	10	32	31.3
25 May		17	0.0	26	302	8.6	1	38	2.6	12	73	16.4	57	137	41.6
26 May		14	0.0	38	350	10.9	8	128	6.3	6	138	4.3	83	224	37.1
27 May		15	0.0	38	240	15.8	2	60	3.3	6	52	11.5	67	124	54.0
28 May		17	0.0	14	118	11.9		32	0.0	1	30	3.3	9	21	42.9
29 May		3	0.0	33	216	15.3	2	53	3.8	2	28	7.1	31	142	21.8
21 June	21	241	8.7	5	20	25.0		3	0.0		1	0.0	3	8	37.5
22 June	105	638	16.5	2	14	14.3		1	0.0				1	5	20.0
23 June	7	150	4.7	2	5	40.0							3	5	60.0
24 June	46	389	11.8		5	0.0							1	3	33.3
28 June	17	704	2.4												
2 July	11	342	3.2		5	0.0									
3 July	6	288	2.1		3	0.0									
7 July	10	198	5.1												
8 July		105	0.0		2	0.0								1	0.0
9 July	10	149	6.7												
10 July	7	113	6.2	2	5	40.0		1	0.0						
10 July	15	346	4.3		1	0.0					1	0.0		1	0.0
11 July	5	166	3.0		3	0.0		1	0.0					1	0.0
12 July	11	420	2.6												
13 July	10	280	3.6												
14 July	2	67	3.0												
15 July	4	107	3.7												
19 July	18	106	17.0										1	1	100.0

Appendix Table B3.--Continued.

Unit 6, Slot B

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%
20 July	3	59	5.1												
21 July	4	75	5.3												
22 July	7	107	6.5		3	0.0									
26 July	19	526	3.6												
27 July	3	126	2.4												
28 July	8	68	11.8		1	0.0									
29 July	1	101	1.0		2	0.0									

Unit 7, Slot B

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%
28 April				5	123	4.1	3	47	6.4		1	0.0			
29 April				3	43	7.3	1	52	1.9						
30 April				11	112	9.8	2	125	1.6		2	0.0	1	2	50.0
1 May		1	0.0	8	95	8.4	2	153	1.3		9	0.0		1	0.0
3 May		1	0.0	15	152	9.9	8	171	4.7		15	0.0	1	18	5.6
4 May				15	207	7.3	7	151	4.6		2	0.0	14	48	29.2
5 May		2	0.0	12	105	11.4	5	61	8.2		10	0.0	16	61	26.2
6 May		2	0.0	18	196	9.2	8	273	2.9	1	33	3.0	169	487	34.7
10 May		6	0.0	5	59	8.5	6	125	5.0		16	0.0	93	350	26.6
18 May		22	0.0	50	289	17.3	20	130	15.4	2	4	50.0	52	142	36.6
19 May		33	0.0	15	142	10.6	5	144	3.5	1	6	16.7	50	169	29.6
20 May		12	0.0	33	315	10.5	4	307	1.3		18	0.0	143	337	42.4
21 May		24	0.0	20	165	12.1	5	95	5.3	1	19	5.3	66	154	42.9
22 May		35	0.0	12	71	16.9	2	47	4.3		18	0.0	40	76	52.6
23 May		18	0.0	19	149	12.8	5	90	5.6	2	52	3.9	43	82	52.4
24 May		66	0.0	25	178	7.1	8	92	8.7	7	98	7.1	20	55	36.4
25 May		62	0.0	60	515	11.7	5	147	3.4	6	91	6.6	66	154	42.9
26 May		12	0.0	28	354	7.9	4	104	3.8	2	65	3.1	52	125	41.6
27 May		17	0.0	28	251	11.2	9	124	7.3	1	62	1.6	41	94	43.6
28 May		29	0.0	22	191	11.5	3	60	5.0	9	72	12.5	25	51	49.0
29 May		5	0.0	9	167	5.4	6	93	6.5	6	83	7.2	18	56	32.1
21 June	39	253	15.4	1	6	16.7	1	2	50.0						
22 June	56	380	14.7		1	0.0									

Appendix Table B3.--Continued.

Unit 7, Slot B

Test date	Subyearling chinook			Yearling chinook			Steelhead			Coho			Sockeye		
	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%	Desc.	Catch	%
23 June	12	72	15.6	1	3	33.3									
24 June	42	380	11.1	4	44	9.1		1	0.0					1	0.0
28 June	5	504	1.0												
2 July	40	316	12.7		2	0.0					1	0.0			
3 July	9	209	4.3		1	0.0									
7 July	14	166	8.4		1	0.0									
8 July	25	388	6.4	1	1	100.0								3	0.0
9 July	34	208	16.4		1	0.0		1	0.0						
10 July	14	125	11.2												
10 July	9	156	5.8											1	0.0
11 July	9	90	10.0												
12 July	3	133	2.3												
13 July	1	169	0.6												
14 July	3	91	3.3		1	0.0									
15 July	3	71	4.2										1	1	100.0
19 July	43	284	15.1		1	0.0									
20 July	5	31	16.1		1	0.0		1	0.0					1	0.0
21 July	9	90	10.0		1	0.0									
22 July	10	92	10.9		3	0.0									
26 July	10	155	6.5												
27 July	7	228	3.1		1	0.0									
28 July	5	55	9.1												
29 July	7	80	8.8												

Appendix Table B4.--Statistical analyses of mean descaling values for tests at McNary Dam, 1993. Asterisks indicate statistically significant differences between means.

Test series	Test dates	Species	Analysis type	Analysis source	Calculated test statistic	df	P
1	28-30 April	Yearling chinook salmon	RBANOV[a]	Screen type (ESTS[b] vs. ESBS[c])	1.50	9,1	0.2317
	1-5 May	Steelhead	RBANOV		1.33	9,1	0.2598
	18-29 May	Coho salmon	1-ANOV[d]		1.10	1	0.3092
		Sockeye salmon	RBANOV		1.15	7,1	0.2967
		Yearling chinook salmon	RBANOV	Operating gate position (NOG[e] vs. PROG[f])	0.38	9,1	0.5479
		Steelhead	RBANOV		2.29	9,1	0.1447
		Coho salmon	1-ANOV		0.05	1	0.8236
		Sockeye salmon	RBANOV		1.65	7,1	0.2124
		Yearling chinook salmon	RBANOV	Operating gate position vs. screen type	0.19	9,1	0.6718
		Steelhead	RBANOV		0.22	9,1	0.6485
		Coho salmon	1-ANOV		0.36	9	0.5635
		Sockeye salmon	RBANOV		1.38	7,1	0.2536
1a	22-29 May	Yearling chinook salmon	2 t-test[g]	Dipping slot with or without unit operating	-0.30	7	0.7701
2	21-24 June 2-29 July	Subyearling chinook salmon	RBANOV	Screen type (ESTS vs. ESBS)	6.51*	11,1	0.0155
		Subyearling chinook salmon	RBANOV	Operating gate position (NOG vs. PROG)	10.29*	11,1	0.0030
		Subyearling chinook salmon	RBANOV	Operating gate position vs. screen type	5.04*	11,1	0.0316

[a] Randomized block analysis of variance.

[b] Extended-length submersible traveling screen.

[c] Extended-length submersible bar screen.

[d] Single factor analysis of variance.

[e] No operating gate (fully raised or removed).

[f] Partially raised operating gate (raised 2.4 m).

[g] Two sample Student's t-test.

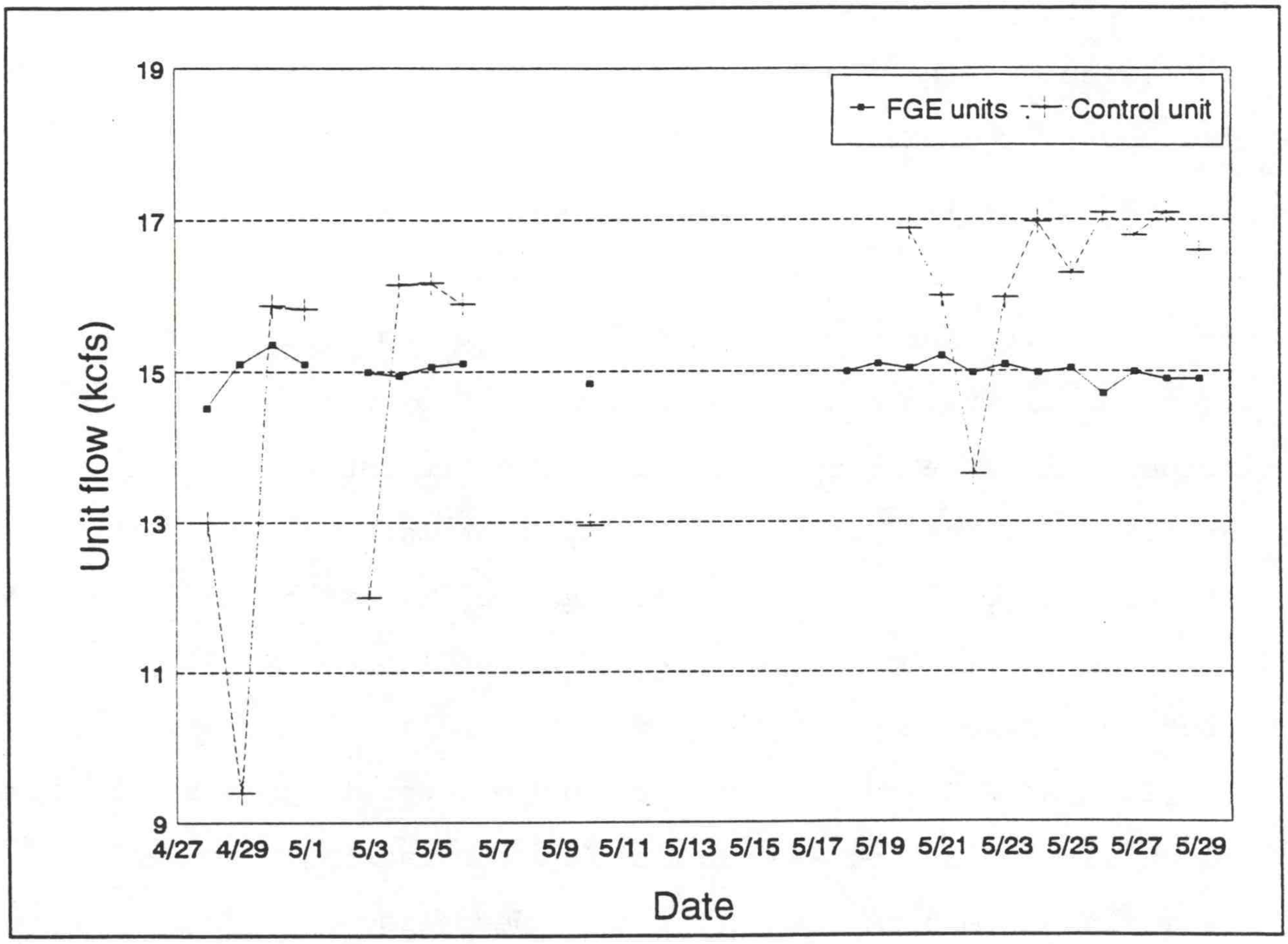
APPENDIX C

A Direct Method for Determining the Descaling Fraction Attributable to Handling during Fish Guidance Efficiency Testing

INTRODUCTION

Descaling is the criterion commonly used as a condition index for juvenile salmonids during fish guidance efficiency (FGE) testing at Columbia and Snake Rivers hydroelectric facilities. At McNary Dam, descaling values obtained during FGE testing are sometimes higher than those observed in the fish passage facility. It is assumed that, in addition to the descaling present before the fish arrive at the dam and the descaling associated with the equipment being tested, there is a descaling fraction caused by handling. Typically, this handling includes dipbasket removal of fish from the gatewell, emptying the fish from the dipbasket into the fish cart, transporting the fish to the workup shack, dipnetting the fish from the cart, and sliding the fish into a methane tricanesulfonate (MS-222) solution before they are checked for descaling.

In past FGE studies, an estimate of descaling caused by the prototype test system was obtained by subtracting a control descaling value from FGE test system descaling. The subtraction method assumed no bias in the comparison between test and control gatewells except the conditions being tested. In some cases, this assumption may be less valid than in others. For example, at McNary Dam in 1993, Slot 7B was used as a descaling control for comparison to data collected during FGE tests conducted in Slots 5B and 6B. While flows through Units 5 and 6 were relatively constant for all tests, flow through Unit 7 was changed to meet daily power demands during outmigration test periods (Appendix Fig. C1). Flows through Unit 7 were also



Appendix Figure C1.--Unit flows for fish guidance efficiency (FGE) test units and the descaling control unit, McNary Dam, 1993.

subject to fluctuation during a given FGE test, though every attempt was made to keep conditions constant until the test was completed. In addition to flow differences, there may be other sources of unit dependent bias which would make either test or control units more or less likely to cause descaling.

Given these considerations, it would be beneficial to have a method that is independent of possible unit bias which would establish the descaling fraction directly attributable to handling during FGE tests. The purpose of this pilot work was to test a direct method for determining the proportion of total descaling due to handling.

METHODS

Tests for determining the contribution of handling to total observed descaling were conducted prior to FGE tests 24 June and 26-28 June. Before beginning daily FGE testing, residual fish were normally removed from test and control slots. For the handling test series, fish retrieved during the cleanout process were taken to the workup shack and checked for descaling. Individuals found noticeably descaled (≥2-3%) were rejected for handling test purposes.

Non-descaled fish were sorted into two groups of about 100 each. In a random manner, the first 100 individuals, regardless of species, were placed in a holding container (110-L garbage can) with running water. A second group was then sorted from the catch and held in a similar manner. The only restriction on the second group was that it contained a species mix in approximately

the same proportions as the first group. Both groups were allowed to recover from the effects of the anesthetic 0.5 hours following selection of the second group. One of the groups was then designated the control, and the other the test group.

With the turbine unit off, both containers were individually lowered by crane into the upstream gatewell of Slot 5B. The control group container was lowered to water level and then returned to the intake deck, where it was supplied with running water until the end of the test. The test group container was lowered completely under the water, the container was upended, and the fish were allowed to swim free.

Test group fish were retrieved from the gatewell as soon as the dipbasket could be attached to the crane, usually within 15 minutes of release. Test fish were treated in the same manner as those retrieved during FGE tests. After removal from the gatewell with the dipbasket, the fish were emptied into a fish cart, transported to the workup shack, removed from the cart with a dipnet, and placed in an MS-222 solution. Condition (descaling) was recorded by species for each individual.

Following analysis of the test group, the control group was examined in a similar manner. However, to avoid possible descaling caused by dipnetting, the water level in the control container was lowered and MS-222 added. Control fish were then removed and inspected directly from their holding container.

RESULTS AND DISCUSSION

Results of the four individual handling tests are summarized in Appendix Table C1, and descaling from prototype FGE and descaling tests for the same nights are summarized in Appendix Table C2.

There were minor differences in the numbers of fish released compared to the numbers recovered during the handling tests. Where fewer fish were recovered, there may have been escapees or dipbasket efficiency may not have been 100%. Unit 5 was not operating during these tests, which theoretically allowed test fish the opportunity to escape capture by exiting the gatewell (downward) or avoiding the dipbasket. Where more fish were recovered than released, it is possible that we captured strays from the gatewell, since this pilot work was done with unmarked fish. In either case, the number actually retrieved was used as the test group total for condition analysis. This may have resulted in slight handling-descaling estimation errors.

No descaling was found for any of the control groups examined. Mean test group handling-descaling values from all four tests were 7.8% (SE = 0.9) for yearling chinook salmon, 4.0% (SE = 0.3) for steelhead, 3.0% (SE = 0.3) for coho salmon, and 22.5% (SE = 1.4) for sockeye salmon.

Appendix Table C3 provides estimates of system descaling using data from the two methods (direct and subtraction), as well as descaling values from the McNary Dam Fish Passage Facility for the week during which handling tests were conducted. Slightly negative values obtained for steelhead using the direct method

Appendix Table C1.--Descaling results for individual replicates of tests to determine the descaling caused by handling during fish guidance efficiency tests at McNary Dam, 1993.

Test date	Treatment group		Yearling chinook salmon	Steelhead	Coho salmon	Sockeye salmon
5/24/93	Test	released	61	12	6	33
		recaptured	60	11	6	30
		descaled	6	0	0	8
		% descaled	10.0	0.0	0.0	26.7
	Control	captured	68	12	3	31
		% descaled	0.0	0.0	0.0	0.0
5/26/93	Test	released	71	4	13	13
		recaptured	73	5	13	12
		descaled	6	1	0	2
		% descaled	8.2	20.0	0.0	16.7
	Control	captured	70	9	8	13
		% descaled	0.0	0.0	0.0	0.0
5/27/93	Test	released	65	8	11	16
		recaptured	67	8	11	16
		descaled	7	0	1	3
		% descaled	10.5	0.0	9.1	18.8
	Control	captured	65	6	12	13
		% descaled	0.0	0.0	0.0	0.0
5/28/93	Test	released	86	1	3	13
		recaptured	84	1	3	13
		descaled	3	0	0	3
		% descaled	3.6	0	0	23.1
	Control	captured	68	1	4	29
		% descaled	0.0	0.0	0.0	0.0
Mean, all tests	Test	released	70.8	6.3	8.3	18.8
		recaptured	71.0	6.3	8.3	17.8
		descaled	5.5	0.3	0.3	4.0
		% descaled	7.8	4.0	3.0	22.5
	Control	captured	67.8	6.3	8.3	18.8
		% descaled	0.0	0.0	0.0	0.0

Appendix Table C2.--Percent of descaled juvenile salmonids captured from fish guidance efficiency test slots on dates of handling-descaling tests.

Test date	Test unit/slot (conditions)	Yearling chinook salmon	Steelhead	Coho salmon	Sockeye salmon
5/24/93	5B (ESTS[a], PROG[b]	17.1	2.6	11.5	31.7
	6B (ESBS[c], NOG[d])	14.4	5.1	10.7	31.3
	7B (STS[e], NOG)	14.0	8.7	7.1	36.4
5/26/93	5B (ESTS, PROG)	13.0	2.8	2.3	50.6
	6B (ESBS, NOG)	10.9	6.3	4.4	37.1
	7B (STS, NOG)	7.9	3.9	3.1	41.6
5/27/93	5B (ESTS, PROG)	10.0	7.3	10.4	28.9
	6B (ESBS, PROG)	15.8	3.3	11.5	54.0
	7B (STS, NOG)	11.2	7.3	1.6	43.6
5/28/93	5B (ESTS, PROG)	24.4	0.0		45.7
	6B (ESBS, NOG)	11.9	0.0	3.3	
	7B (STS, NOG)	11.5	5.0	12.5	49.0
Mean, all dates	5B	16.1	3.1	6.1	40.2
	6B	13.2	3.7	7.5	30.6
	7B	11.2	6.2	6.1	42.7

[a] Extended-length submersible traveling screen.
[b] Partially raised operating gate (raised 2.4 m above the stored position).
[c] Extended-length submersible bar screen.
[d] No operating gate (fully raised or removed).
[e] Standard-length submersible traveling screen.

Appendix Table C3.--Mean system dependent descaling obtained using two methods during fish guidance efficiency tests at McNary Dam, 1993, and descaling values for the same period from the McNary Dam Fish Passage Facility.

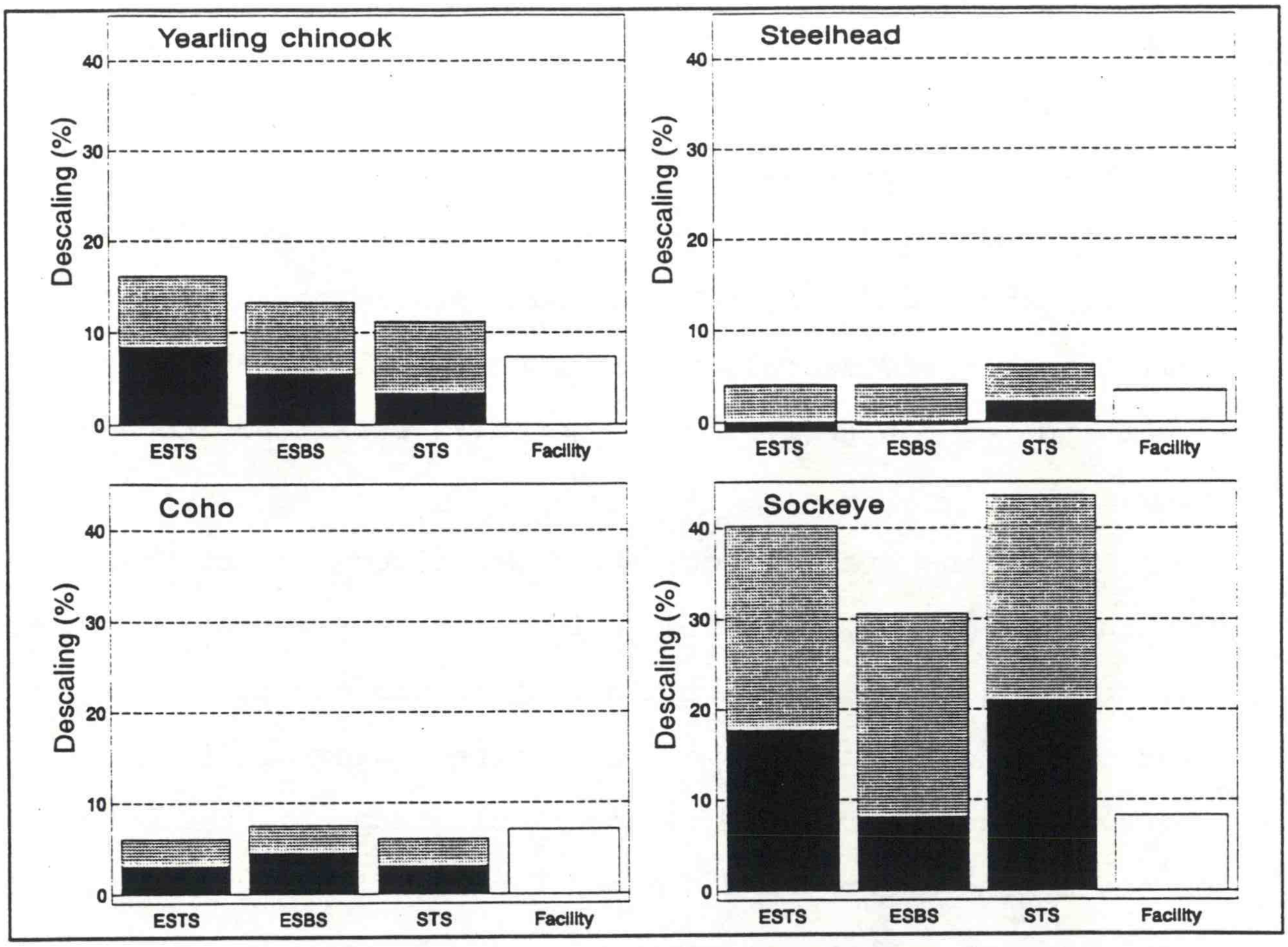
Method	Test unit/slot/screen	Descaling (%) Yearling chinook salmon	Steelhead	Coho salmon	Sockeye salmon
Direct	5B, ESTS[a]	8.4	-0.9	3.0	17.7
	6B, ESBS[b]	5.5	-0.3	4.5	8.1
	7B, STS[c]	3.4	2.2	3.1	20.1
Subtraction	5B, ESTS	5.0	-3.1	-0.01	-2.4
	6B, ESBS	2.1	-2.5	1.4	-12.1
McNary Dam Fish Passage Facility		7.4	3.4 (w[d])	7.1	8.2 (w)
			11.7 (h[e])		21.1 (h)

[a] Extended-length submersible traveling screen.
[b] Extended-length submersible bar screen.
[c] Standard-length submersible traveling screen.
[d] Wild smolts.
[e] Hatchery-reared smolts.

may have been an artifact resulting from low catch numbers of these species late in the spring outmigration. Larger negative values for steelhead and sockeye salmon were obtained using the subtraction method because mean descaling in the control slot (7B) was actually higher than in the test slots (5B and 6B) on days when handling tests were conducted. Using the direct method, handling during FGE testing appeared to account for about half the observed descaling for juvenile salmon, and over two-thirds of the descaling for juvenile steelhead (Appendix Fig. C2).

With either the direct method described here or the subtraction method, descaling using extended-length screens was within +5% (i.e., 5 descaling units) of the control value for yearling chinook salmon over the limited interval of this study. Moreover, the subtraction method results suggest that both extended-length screens had a beneficial effect on descaling for steelhead and sockeye salmon.

Comparing test system descaling results to McNary Dam Fish Passage Facility descaling is deceptive. Assuming there is a descaling fraction attributable to the fish bypass system and descaling is unit independent, we would expect the mean passage facility descaling value to be greater than that for any single test unit (excluding, possibly, FGE test gatewells) when adjusted for handling. This is the case with the data for yearling chinook salmon, steelhead, and coho salmon from the control gatewell (7B), though not for wild sockeye salmon (Appendix Table C3).



Appendix Figure C2.--Mean percent descaling for species captured with an extended-length traveling screen (ESTS), extended-length bar screen (ESBS), and standard-length submersible traveling screen (STS) during fish guidance efficiency tests at McNary Dam, 1993. Bars are separated into descaling components attributable to handling (gray portion of bar) determined by direct estimation, and system dependent (dark portion of bar). Height of bar represents total mean descaling detected for a given screen for the 4 days when handling tests were run. McNary Fish Passage Facility (Facility) weekly mean descaling for 5/24-5/30 is shown for comparison.

In addition to the low numbers of replicates and test fish, there were two other problems with this brief study. First, it would be desirable to cover the entire spring outmigration period to account for seasonal variation in smolt susceptibility to descaling. Second, FGE test conditions (i.e., screen type and operating gate position) were not equally represented during this study. In future studies of the effects of handling on descaling results, all guidance conditions should be equally represented in comparisons.

CONCLUSIONS

1) The direct method of estimating the fraction of total descaling due to handling procedures during FGE testing accounted for approximately 50% of juvenile salmon descaling and 67% of the steelhead descaling for the last week of the spring outmigration at McNary Dam in 1993.
2) Both the direct method described here and simply subtracting control descaling from FGE test gatewell descaling yielded similar results for yearling chinook salmon. However, the subtraction method did not appear to be as consistent as the direct method for steelhead and sockeye salmon.
3) The direct method of estimating handling descaling incorporated only four samples from 1 week near the end of the spring outmigration in 1993. The sample period for this type of study should be expanded to include a series of replicates over the entire spring outmigration test period, and should include all guidance conditions being tested.