FISH GUIDANCE EFFICIENCY STUDIES AT BONNEVILLE DAM FIRST AND SECOND POWERHOUSES-1988

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CONTENTS

INTRODUCTION 1

OBJECTIVE 1 - EVALUATION OF MODIFICATIONS TO IMPROVE FGE AT BONNEVILLE DAM SECOND POWERHOUSE 2
Approach 2
Results and Discussion 8
Yearling Fish 8
Subyearling chinook salmon 12
Descaling 13

OBJECTIVE 2 - FGE AND VERTICAL DISTRIBUTION MEASUREMENTS AT BONNEVILLE DAM FIRST POWERHOUSE 13
Approach 13
Results and Discussion 14

CONCLUSIONS 19
Second Powerhouse 19
First Powerhouse 20

LITERATURE CITED 21

APPENDIX A 23
Data Tables 23

INTRODUCTION

At Bonneville Dam First Powerhouse, fish guidance efficiency (FGE) testing with submersible traveling screens (STS) was initially conducted during the early and late portions of the 1981 spring outmigration. Guidance in excess of 70% was observed for all species (Krcma et al. 1982). These results were considered adequate; however, since these tests, further FGE studies at other projects have indicated that FGEs varied considerably from year to year as well as within each field season. Additionally, average FGE measurements on summer migrating subyearling chinook salmon have been less than 50% at McNary Dam (Brege et al. 1988) and John Day Dam (Krcma et al. 1986). Thus, measurements of subyearling chinook salmon FGE during the summer migration were made to provide baseline information prior to completion of the new navigational lock at Bonneville First Powerhouse.

Evaluation of the juvenile bypass and collection system at Bonneville Dam Second Powerhouse began in 1983. The initial FGE estimate of traveling screens was less than 30% for yearling chinook salmon, Oncorhynchus tshawytscha (Krcma et al. 1984). During 1985, streamlined trashracks and a lowered STS increased FGE to > 40%. In 1986, the addition of turbine intake extensions (TIE) improved FGE to over 70% for some tests. In 1987, results from guidance tests indicated that underwater mercury vapor lights could alter the movement of juvenile migrants into and within a turbine intake. Studies in 1988 continued light tests, and initial tests were conducted on the feasibility of using bar screens instead of STSs to improve FGEs.

During the 1988 juvenile salmonid outmigration, NMFS in conjunction with the U.S. Army Corps of Engineers (COE) conducted studies at both Bonneville powerhouses with the following objectives:

1) Continue the FGE and vertical distribution testing program at Bonneville Second Powerhouse to evaluate the following modifications/additions for improving FGE and STS effectiveness:

   a. Turbine intake extensions

   b. Higher porosity guiding device (bar screen)

   c. Internal trashrack deflector

   d. Illuminated trashracks and intake ceiling

2) Conduct standard FGE and vertical distribution measurements at Bonneville First Powerhouse to provide data comparable to 1981 research and baseline data for late summer subyearling chinook salmon migrants.

In addition to these investigations, a complementary physiological study was conducted to determine if relationships existed between the physiological status of the migrant population and the prevailing FGE estimates. Results from that study will be reported in a separate document.

OBJECTIVE 1 - EVALUATION OF MODIFICATIONS TO IMPROVE FGE AT BONNEVILLE DAM SECOND POWERHOUSE

Approach

Fish guidance and vertical distribution studies were conducted with existing fyke nets and net frames. Principles and guidelines were similar to those used at the Second Powerhouse in 1985, 1986, and 1987 (Gessel et al. 1986, 1987, 1988). A dip-basket collected guided fish from the gatewell; a net frame attached to the guiding device (traveling screen or bar screen) supported nets to collect unguided fish.

FGE was calculated as the gatewell catch (number of guided fish (by species)) divided by the total number of fish estimated to have passed into the turbine intake slot during the test period:

$$FGE = GW / (GW + GN + FN + CN) \times 100$$

GW= gatewell catch
GN = gap net catch
FN = fyke net catch[1]
CN = closure net catch

Three to five replicates of each test condition were planned to provide FGE estimates with confidence intervals of ± 3.9 to 4.8%, with 250-300 fish of the target species. The desired number of replicates was not always attained because of the variety of test conditions and the relatively short field season. Data for unreplicated tests are presented as possible trend indicators, but they may have large errors.

All FGE tests were conducted with concurrent vertical distribution measurements of fish entering the turbine intakes. The data were used to determine theoretical FGE (TFGE), which was the estimated percentage of guidable fish during a given FGE test. Generally, this included all fish collected from the gatewell down to and including one-half of the catch from the third net on the vertical distribution frame. To minimize the number of fish captured in the nets, only the center net at each level collected fish, and the number of fish captured was expanded by a factor of three. To estimate TFGE when the internal trashrack deflector was used, fish from the third net and the upper half of the fourth net were included. Dividing FGE by the corresponding TFGE provided an effectiveness measure to compare different test conditions when TFGE estimates varied.

During the period 25 April - 1 May, we conducted a series of vertical distribution measurements in Slots 12A, 12B, 13A, and 13B to determine if vertical distribution varied between adjacent slots with and without a TIE.

[1]Net catch levels with only a middle net were expanded by a factor of three.

Fish guidance and concurrent vertical distribution testing occurred during two phases: 1) 2 May to 5 June, targeting yearling chinook salmon and 2) 6 July to 2 August, targeting subyearling chinook salmon. Data for other species were collected as available. [Subyearling chinook salmon were also captured during late May - June. Guidance for these fish was generally higher than that of late summer migrants and approached yearling chinook salmon FGEs (Krcma et al. 1982; Gessel et al. 1988). However, the major portion of the subyearling smolt migration passed Bonneville Dam during the summer; to be consistent with past Bonneville Dam reports, we continued to designate yearling chinook and coho salmon as the early phase fish and subyearling chinook salmon as the late phase fish.]

All tests began at approximately 2000 hours, and generally lasted from 1-2 hours, depending upon fish numbers. Tests during the spring were conducted with a unit discharge of 18,000 cfs. Due to low river flows, late summer tests were conducted at 14-15,000 cfs. Four units (11, 12, 13, and 17 or 18) were operated during all tests. The FGE tests were conducted in Slots 12A and 12B (the majority in 12B, which was equipped with a TIE), while vertical distribution measurements were taken in Slot 13A (also equipped with a TIE).

In conjunction with COE hydroacoustic studies, we also monitored FGE in Unit 17B. The slot was equipped with 30-inch lowered STSs and streamlined trashracks; no TIE was present. Monitoring began on 12 May and ended 1 June. All procedures were identical to standard FGE testing.

Fish condition (descaling) was monitored by examining fish captured in the gatewell. Descaling was determined by dividing the fish into five equal areas per side; if any two areas on a side were estimated to be 50% or more descaled, the fish was classified as descaled.

Eight test series were conducted during the spring outmigration (Table 1). The initial test series during the early phase provided baseline data for FGEs using the best condition from the 1987 field season [30-inch lowered STS, streamlined trashracks, and TIEs in front of alternate Slots (11A, 11C, 12B, 13A, 13C, and 14B)]. The remaining guidance tests used bar screens in place of the STS, internal trashrack deflectors, and various light combinations. The TIEs remained in the alternate pattern for the duration of the studies. The overall porosity of the bar screen was approximately 45% compared to 22% for the STS. The porosity of the bar screen with a porosity plate on the back was approximately 33%.

In some bar screen tests the internal trashrack deflectors were also used. The deflectors were attached to the trashrack at elevation 2.3 m (7.6 ft) (msl) and positioned to overlap and approximate the angle of the bar screen (Fig. 1). To minimize bias that might occur with fish movement between the slots, deflectors were placed in Slots 12A, 12B, and 12C with Slot 12B as the test slot.

For 1988, 250-watt, mercury vapor lights (12-13,000 lumens/light) were mounted on the trashracks and intake ceiling as follows (see Fig. 1):

1) Trashrack - two lights on the top trashrack section, approximately 2 m from each side and 1 m below the intake ceiling.

2) Intake ceiling - eight lights in two rows of four lights, each row approximately 2 m from each wall, beginning 0.5 m from the gatewell opening and extending toward the trashrack in 1.5 m increments.

3) Bar screen frame - two lights approximately 2 m from each side, and recessed approximately 0.6 m into the gatewell.

In addition, three xenon strobe lights producing 15 joules with a flash rate of once every two seconds (duration 2 milliseconds) were placed on the trashrack about 1 m beneath the hinge point of the internal trashrack deflectors (see Fig. 1). To minimize bias, identical light configurations were used in Slots 12A, 12B, and 12C with Slot 12B as the test slot.

Table 1.--Submersible traveling screen and bar screen fish guiding efficiency tests conducted at Bonneville Dam Second Powerhouse during the 1988 field season. All testing occurred with four turbine units operating (11, 12, 13, and 17 or 18).

Test series no.	Date(s) of tests	Test unit	Load (kcfs)	Guiding device	Light condition	Internal deflector
1	2,3,4,5 May	12A	17	Traveling screen	No lights	Out
		12B		Traveling screen	No lights	Out
2	6,9,10,11 May	12B	17	Bar screen	No lights	Out
3	12,15,16,26 May	12B	17	Bar screen	Intake ceiling lights (4)	Out
4	13,14,17 May	12B	17	Bar screen	No light	In
5	18 May	12B	17	Bar screen	Intake ceiling lights (4)	In
6	27,28 May 1 June	12B	17	Bar screen	Intake ceiling lights (8) & trashrack (2)	Out
7	29,30,31 May	12B	17	Bar screen	Gatewell lights mounted on bar screen frame (2)	Out
8	2,3,4,5 June	12A	17	Bar screen	No lights	Out
		12B		Bar screen	No lights	Out
9	6,7,8,9 July	12A	14.5	Bar screen	No lights	Out
	6,7,8,9,14 16,18,19 July	12B		Bar screen	No lights	Out
10	10,11,12,13 15,17 July	12B	14.5	Traveling screen	No lights	Out
11	20,21,22 July	12B	14.5	Bar screen	Flashing lights mounted on trashrack (3)	Out
12	23,24,25 July	12B	14.5	Bar screen	Intake ceiling lights (4) and bar screen frame lights (2)	Out
13	26,27,28 July	12B	14.5	Bar screen	All lights on (15)	Out
14	29,30 July	12B	14.5	Bar screen	No lights perforated plate	Out
15	31 July 1,2 August	12B	14.5	Bar screen	All lights on (15) perforated plate	Out

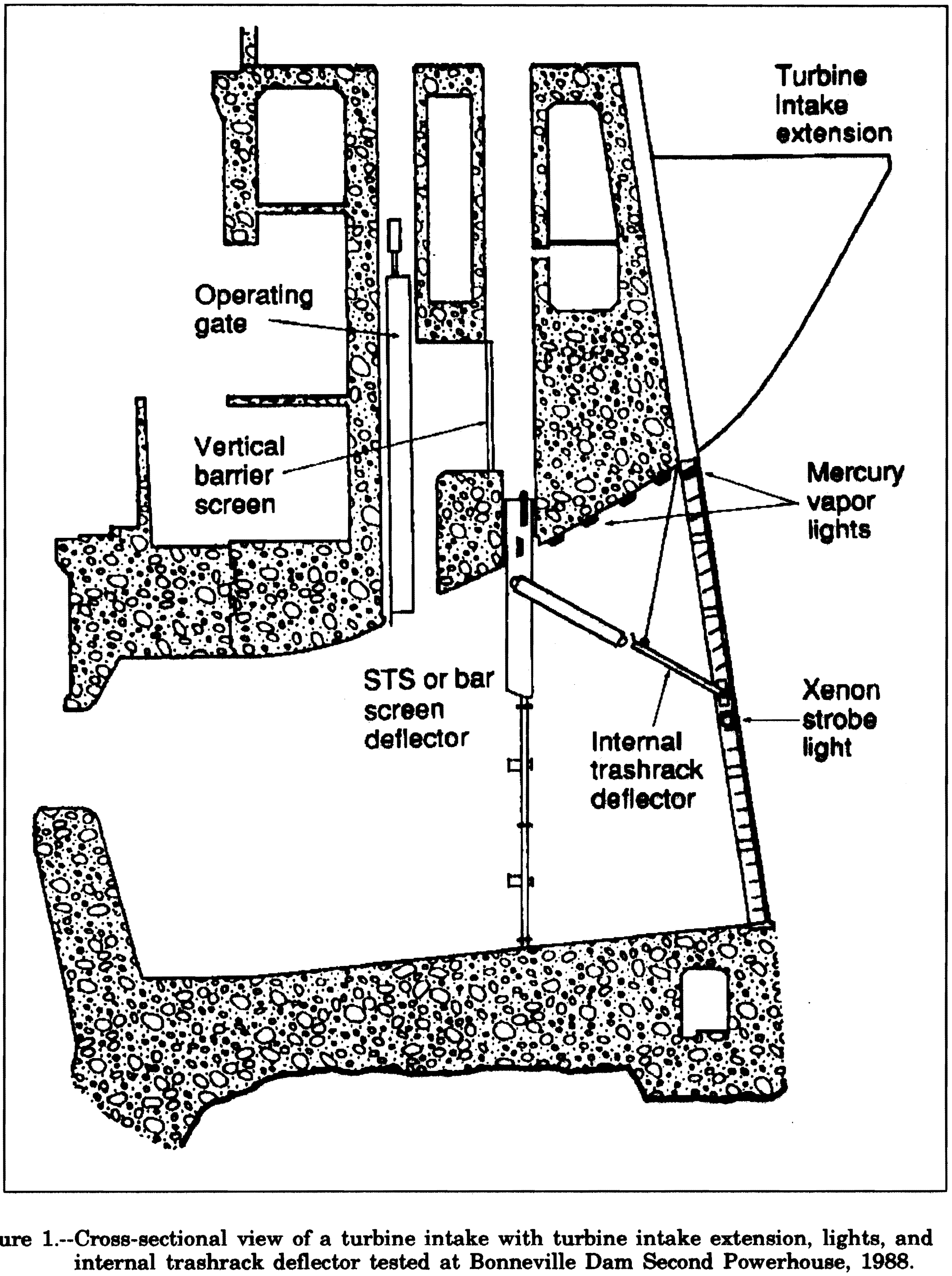

Figure 1.--Cross-sectional view of a turbine intake with turbine intake extension, lights, and internal trashrack deflector tested at Bonneville Dam Second Powerhouse, 1988.

The vertical distribution, FGE, and STS/bar screen effectiveness results were averaged for each test condition and weighted by the number of fish captured.

Results and Discussion

Yearling Fish

Although yearling chinook salmon was the target species, coho salmon was the predominant species during Series 6, 7, and 8. Guidance figures for yearling chinook and coho salmon were combined in 1987 (Gessel et al. 1988) but separated in earlier reports (Gessel et al. 1985, 1986, 1987). Since previous FGE testing indicated guidance for coho salmon was equal to or slightly higher than yearling chinook salmon (Brege et al. 1988; Krcma et al. 1982), coho and chinook salmon results were not combined in this report.

Tests to determine TIE vs non-TIE slot effects on vertical distribution were conducted from 25 through 29 April. The mean TFGE ($n = 4$) was significantly lower in TIE versus non-TIE slots, 67.0 (S.E. = 4.5) and 85.6% (S.E. = 2.7), respectively ($t = 3.5$, $p < 0.05$). Guidance tests conducted from 2 to 5 May (Series 1) in Slots 12A and 12B showed similar differences. The mean FGE ($n = 4$) was significantly lower in TIE versus non-TIE slots, 31.2 (S.E. = 0.8) and 54.2% (S.E. = 2.7), respectively ($t = 8.2$, $p < 0.05$). When FGE and STS effectiveness for Slots 12A and 12B were combined, the mean values were 45.1 (S.E. = 1.9) and 69.8% (S.E. = 3.7), respectively. These results were comparable to but slightly lower than 1987 combined Slot 12A and 12B results when four turbines were operated (47.3 and 70.5%, respectively) (Gessel et al. 1988). Tests in 1987, with seven turbine units operating, had combined FGE and STS effectiveness estimates of 68 and 80%, respectively (Gessel et al. 1988). Similar test conditions were not repeated in 1988. (Appendix Tables 1 and 2 provide details on fish recoveries).

Table 2.--Results of the fish guiding efficiency tests conducted at Bonneville Dam Second Powerhouse during the 1988 field season.

Test series	Number of reps.	Salmon	Guiding device	Lights	FGE	Guiding device effectiveness (mean)	(S.E.)
1[a]	4	Yearling	STS[b]	OFF	31.2	48.2	1.8
2	4	Yearling	BS[c]	OFF	47.8	78.6	3.3
3	4	Yearling	BS	ON	56.3	86.6	5.6
4	3	Yearling	BS	OFF	53.2	75.0	4.8
5	1	Yearling	BS	ON	46.6	74.2	-
6[e]	3	Coho	BS	ON	57.4	83.7	6.0
7	3	Coho	BS	ON	59.4	88.2	2.2
8	4	Coho	BS	OFF [d]			
9	8	Subyearling	BS	OFF	32.9	60.4	4.1
10	6	Subyearling	STS	OFF	28.9	52.2	5.5
11	3	Subyearling	BS	ON	25.1	60.3	4.9
12	3	Subyearling	BS	ON	19.2	57.1	4.2
13	3	Subyearling	BS	ON	34.3	88.8	18.5
14	2	Subyearling	BS	OFF	12.2	39.0	6.9
15	3	Subyearling	BS	ON	16.9	83.7	16.0

[a] Test series numbers correspond to Table 1, this report.
[b] Submersible traveling screen.
[c] Bar screen.
[d] Small numbers of fish (<100 per replicate) for this test.
[e] One replicate with <200 fish.

The FGE and guiding device efficiency with bar screens were substantially higher (Series 2, 47.8 and 78.6%, respectively) than with STSs (Series 1, 31.2 and 48.2%, respectively). The 30.4% increase in guiding device efficiency of the bar screen compared to the STS was highly significant ($t = 8.1$, $p < 0.01$).

The use of lights in conjunction with the bar screen (Series 3) appeared to provide an additional increase in both FGE and screen effectiveness, however, the effectiveness values were not significantly different ($t = 1.2$, $p > 0.05$) (Fig. 2). There was a redistribution of fish in the fyke nets when the bar screen and associated lights were used (Fig. 3.). The bar screen increased the gatewell catch and decreased all net catches with the exception of a small increase in the gap net catch (Fig. 2). We believe the higher porosity of the bar screen increased the flow above the area of the guiding device and fish did not as actively reject the area as they did with the STS. However, while the addition of the internal deflector increased the amount of area intercepted by the guiding device, it did not increase guidance, so that the effectiveness was slightly lower (Tests 2 & 3 versus 4 & 5, Tables 1 and 2). We hypothesize that in an attempt to increase the area intercepted, flows were slightly changed and some fish rejected the area.

The FGEs and bar screen effectiveness values for chinook and coho salmon during Series 3, 6, and 7 were nearly identical under similar conditions, 56.3, 57.4, and 59.4% and 86.6, 83.7, and 88.2%, respectively (Table 2). This indicated that chinook and coho salmon guidance could be combined without biasing results.

The mean FGE ($n = 4$) for yearling chinook salmon with an STS was considerably lower in Unit 17 than in Unit 12 (15.6 versus 31.2%, respectively). No vertical distribution measurements were made at the north end of the powerhouse, thus comparative STS effectiveness values between the two units were not made. Although these tests were conducted during different time periods (13-16 May and 2-5 May,

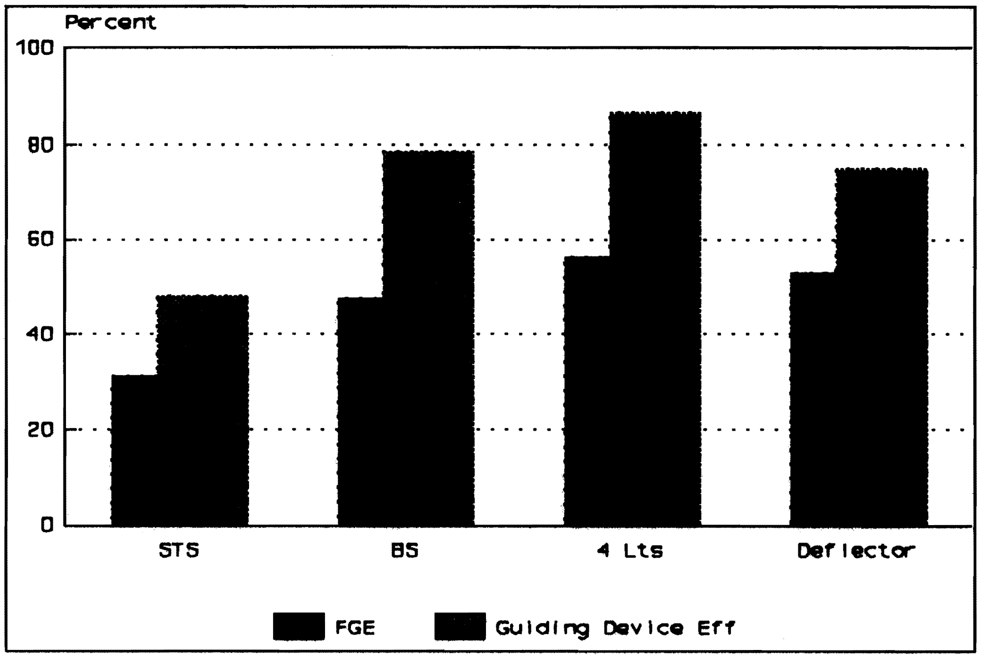

Figure 2.--Spring chinook salmon fish guidance efficiency (FGE) and effectiveness with submersible traveling screen (STS), bar screen (BS), lights (Lts), and internal trash rack deflector at Bonneville Dam Second Powerhouse, 1988.

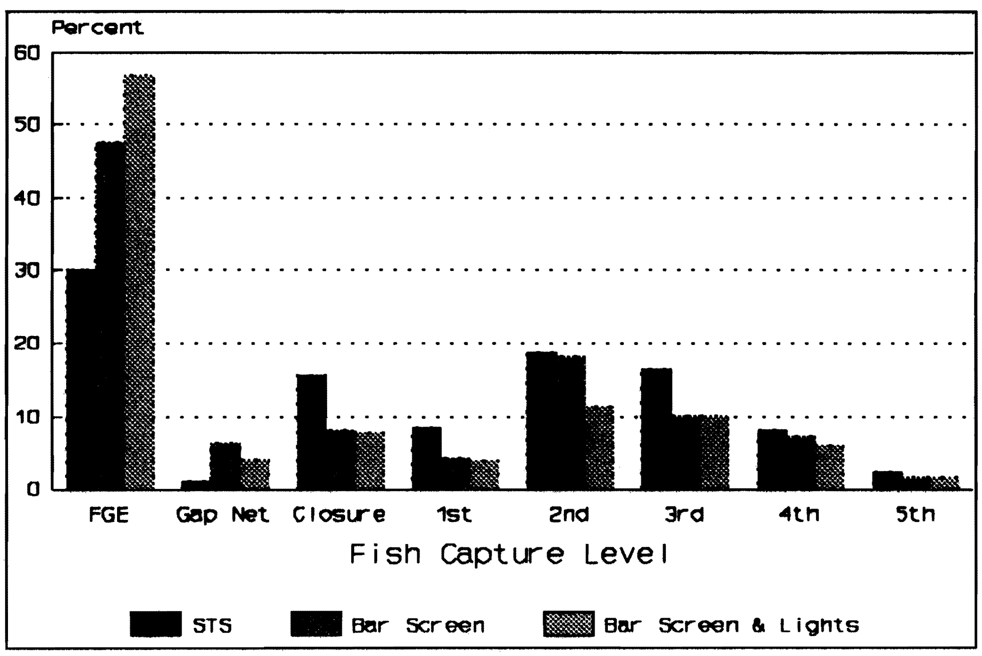

Figure 3.--Distribution of juvenile spring chinook salmon during fish guidance efficiency tests at Bonneville Dam Second Powerhouse, 1988.

respectively), mean TFGE values at the south end of the powerhouse were nearly equal, 65.0% for the early tests and 63.8% for the latter. Since both units had streamlined trashracks and 30-inch lowered STSs, but Unit 17 did not have the benefit of the TIE configuration, we suspect the FGE difference was real and a direct result of no TIEs at the north end of the powerhouse.

Subyearling chinook salmon

Both bar screen and STS tests were conducted during the summer subyearling chinook salmon outmigration (Series 9 through 15, Table 1). None of the test conditions, however, provided statistically significant improvements. The FGE and guidance efficiency results with the bar screen, 32.9 and of 60.4%, respectively, were slightly higher than those with the STS, 28.9 and 52.2%, respectively (Table 2). During the summer, the only substantial variation in guidance device effectiveness occurred when all lights were used (Series 13 and 15) (Table 2). Overall guidance, however, decreased on the last series because the fish were at greater depths. Further tests with lights will be necessary to provide conclusive evidence as to their benefits.

The TIE vs non-TIE slot effect was not as apparent during bar screen tests with subyearling chinook salmon as it was during earlier tests with yearling chinook salmon and the STS. During the first four days of Series 9 (Table 2), FGEs were compared between Slots 12A and 12B. The mean FGEs (n = 4) in TIE (Slot 12B) and non-Tie (Slot 12A) slots were 43.9 (S.E. = 4.5) and 46.2% (S.E. = 4.0), respectively, a difference of only 2.3%. During the early phase this difference was over 20%. The surface vortex between slots created by the alternate TIE configuration may not have been as important because the subyearling chinook salmon were distributed much lower in the water column during the summer months. The change in the porosity of the bar screen may also have been a factor.

Descaling

The mean descaling rates on yearling chinook salmon sampled from gatewells where vertical distribution measurements and STS tests were conducted (excluding samples less than 100 fish and using same-day comparisons) were 5.2 and 4.0%, respectively, whereas descaling rates on yearling chinook salmon sampled from gatewells where vertical distribution measurements and bar screen tests were conducted were 7.0 and 18.1%, respectively. For subyearling chinook salmon, mean descaling rates on fish sampled from gatewells during vertical distribution measurements and STS and bar screen tests were 4.5, 4.6, and 13.3%, respectively. The bar screen, while significantly more effective in guiding fish, also increased descaling 2.5 to 3-fold over background levels. Our limited tests to determine if the addition of perforated plate to to reduce the porosity of the bar screen would also reduce descaling on subyearling chinook salmon were inconclusive. Although absolute descaling decreased slightly, comparisons to background levels were not possible as less than 100 fish were captured in the gatewell where vertical distribution was measured. We expected a larger descaling decrease with the perforated plate. Additional testing with alternate screen angles and perforated plate are necessary to develop means to decrease descaling for yearling and subyearling fish.

OBJECTIVE 2 - FGE AND VERTICAL DISTRIBUTION MEASUREMENTS AT BONNEVILLE DAM FIRST POWERHOUSE

Approach

Procedures used to measure FGE and vertical distribution at the First Powerhouse were identical to those used at Bonneville Dam Second Powerhouse. Dip-baskets collected fish from the gatewell; net frames collected fish from the turbine intake.

Measurements were taken during the spring (30 May - 6 June) and late summer (6 July - 27 July) outmigrations, with subyearling chinook salmon as the targeted species for both periods. Data for other species were collected as available. All data were collected in Unit 3B with approximately one vertical distribution measurement for every three FGE measurements. Concurrent FGE and vertical distribution measurements were not conducted since previous data indicated vertical distribution was consistent (Krcma et al. 1982). Also, alternating the measurements minimized the number of fish sacrificed in the nets.

A standard elevation STS was used for all FGE measurements and TFGE was estimated to include all fish from the gatewell down to and including fish in the second net level of the vertical distribution frame. Standard unit operation prevailed with all available units operating at full load. Unit flow ranged from 13,500-15,000 cfs in the spring to 11,900-13,800 cfs in the late summer.

Results and Discussion

During the first series of FGE and vertical distribution measurements (30 May through 6 June), fewer than 100 subyearling chinook salmon were captured on all nights but 2 June. This was fewer fish than we consider desirable, but we feel the results indicated the range of FGE and TFGE that occurred for late spring migrating subyearling chinook salmon at the First Powerhouse. The FGEs for the five replicates ranged from 32.9 to 60.5%, with a weighted mean of 40.7% (S.E. = 6.2). The TFGEs for the three vertical distribution replicates ranged from 62.5 to 100% and averaged 74.3%. [Recapture information for all species is detailed in Appendix 3 and 4].

Although the target species for the first series of tests was subyearling chinook salmon, large numbers of coho salmon (> 250) were captured during one FGE test and two vertical distribution measurements. The FGE on 1 June for coho salmon was

56.8%. On 30 May and 5 June, TFGE for coho salmon was 75.6 and 84.4%, respectively.

During the second series of vertical distribution measurements (6 July through 27 July), TFGE for late summer subyearling chinook salmon ranged from 10.4 to 30.8% with a weighted mean of 21.2% (S.E. = 5.8). An average of 47.6% of these fish were captured in Nets 4 and 5, well below the level intercepted by a standard STS (Fig. 4). The corresponding FGE for subyearling chinook salmon ranged from 5.5 to 28.1% with a weighted mean of 11.4% (S.E. = 2.0) (Fig. 5). The STS-effectiveness for the entire period was 53.8%.

Descaling rates for subyearling chinook salmon collected in the gatewell during FGE tests ranged from 0 to 5.4% with a weighed mean of 1.7% (S.E. = 0.4). Because of low numbers of fish collected in the gatewell, no descaling rate was calculated during vertical distribution measurements.

The FGEs during the late spring were much lower than previous values measured for subyearling chinook salmon at the First Powerhouse (30 April to 6 June, 1981) where FGE averaged 71.5% (Krcma et al. 1982). We do not know the reason as the average vertical distributions were the same this year as in 1981. Lower FGE values in the summer were not as surprising because studies conducted at McNary and the Dalles Dams on the Columbia River indicated that guidance for subyearling chinook salmon approaches that for yearling chinook salmon in early June but decreases significantly by late July (Krcma et al. 1985; Monk et al. 1986). In 1987, Gessel et al. (1988) also observed similar results at Bonneville Dam Second Powerhouse where FGE for subyearling chinook salmon was as high as 62% in the spring but decreased to 17.3% (same unit and same test conditions) by 16 July.

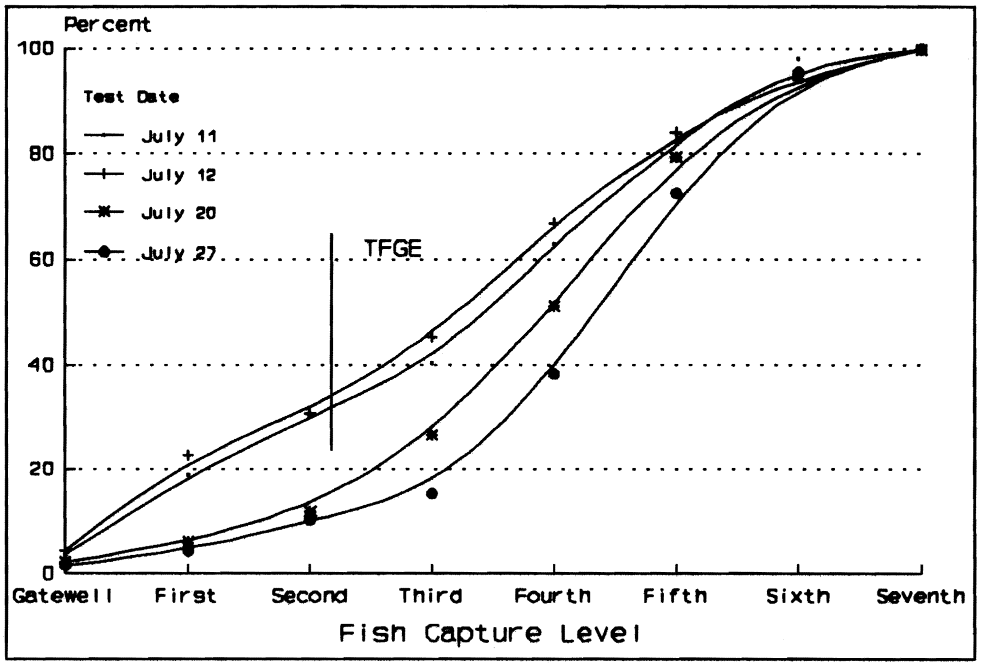

Figure 4.--Vertical distribution measurements and estimated theoretical fish guidance efficiency for subyearling chinook salmon at Bonneville Dam First Powerhouse, 1988.

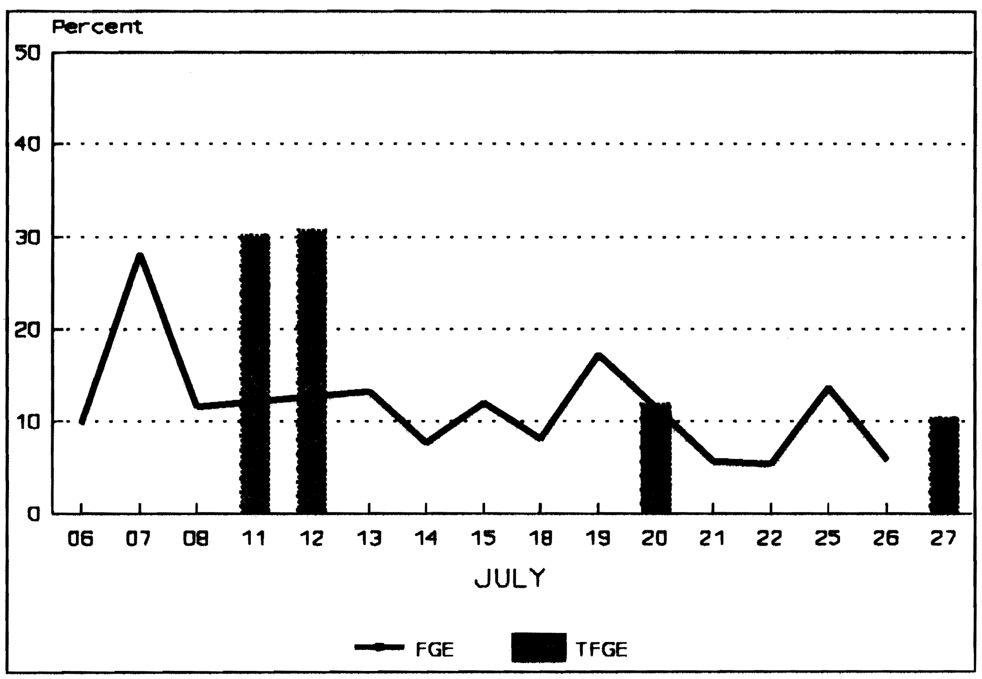

Figure 5.--Fish guidance efficiency and theoretical fish guidance efficiency of subyearling chinook salmon at Bonneville Dam First Powerhouse, 1988.

A comparison of vertical distribution for subyearling chinook salmon in July showed fish entering the Second Powerhouse were higher in the water column than those entering the First Powerhouse. Weighted average gatewell catches during vertical distribution tests for 11, 12, 20, and 27 July were 3.1 (S.E. = 0.7) and 14.1% (S.E. = 1.7) for the First and SecondPowerhouses, respectively (Fig. 6).

In July, there was a similar decrease in TFGE for subyearling chinook salmon at both powerhouses; 20% at the First Powerhouse and 23% at the Second Powerhouse (Fig 7). A decline in FGE and TFGE has also been noted at other dams on the Columbia River and has been attributed to: 1) changing environmental factors such as water temperature, turbidity, or flow; or 2) changing compositions of the migrating population (Krcma et al. 1985; Monk et al. 1986; Brege et al. 1988).

Predation by northern squawfish, Ptychocheilus oregonensis, may also have contributed to the low FGE observed during the summer for subyearling chinook salmon. Squawfish have been identified as a major predator of juvenile salmonids in the Columbia River, especially in the vicinity of dams (Uremovich et al. 1980; Gray et al. 1986). We speculate that during the summer months, squawfish metabolism was increased by higher water temperatures. This, in turn, caused an increase in feeding activity which was enhanced by a decrease in turbidity that made the prey more visible. At Bonneville Dam, Uremovich et al. (1980) estimated that 3.8 million or 11% of the downstream migrant salmonids entering Bonneville pool were eaten by squawfish in one season, and 65% of this predation occurred between 20 July and 16 August. This may have lowered FGE of subyearling chinook salmon by reducing their numbers in the upper water column or, indirectly, by influencing the juveniles to sound in an effort to reduce their predation risk by seeking areas where they were less visible.

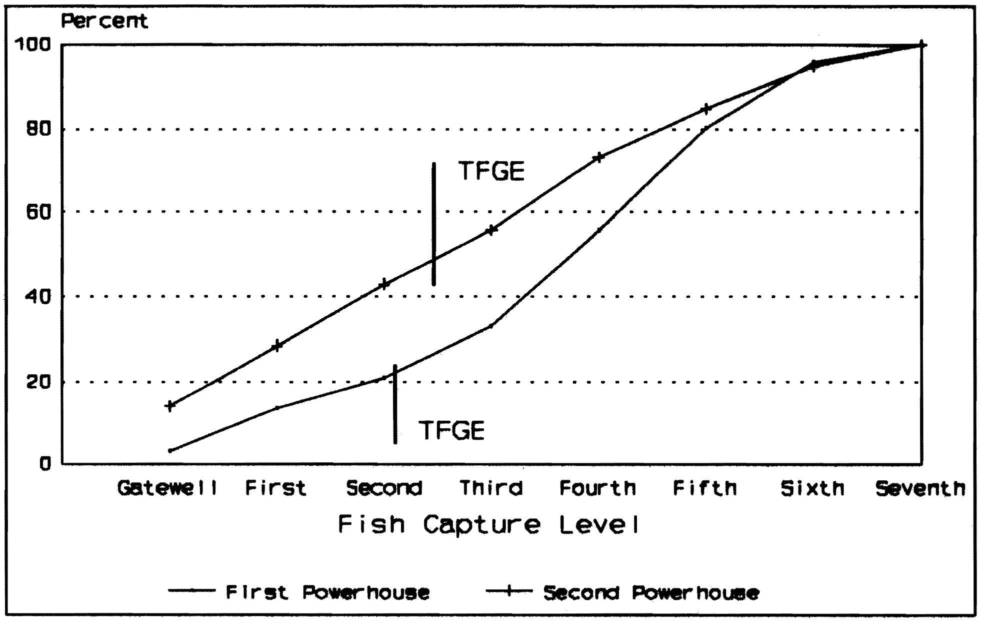

Figure 6.--Weighted average vertical distributions of subyearling chinook salmon at Bonneville Dam First and Second Powerhouses, July 1988.

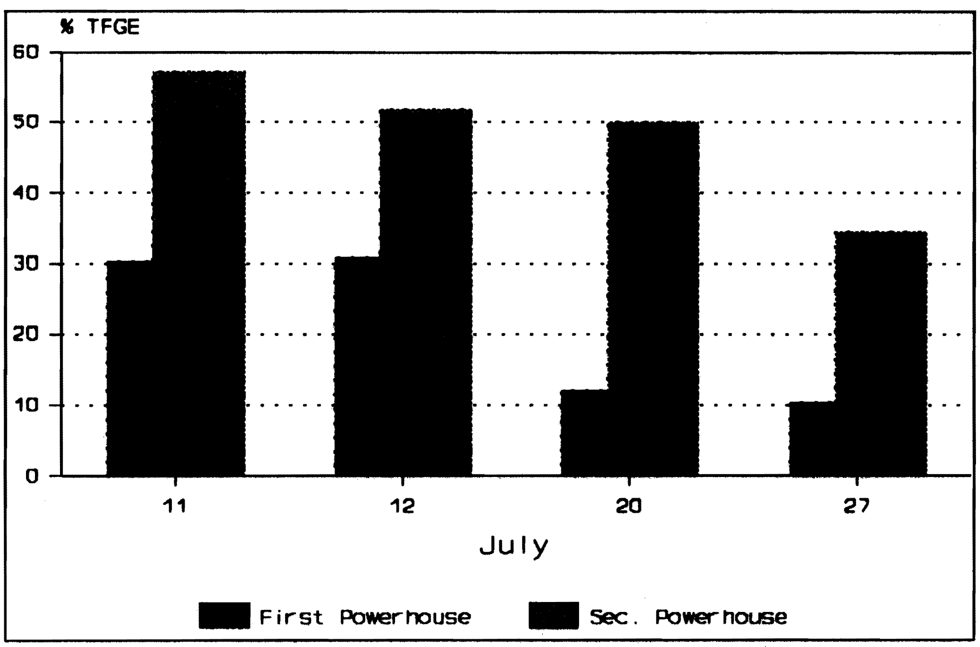

Figure 7.--Comparison of the theoretical fish guidance efficiency of subyearling chinook salmon at Bonneville Dam First and Second Powerhouses, 1988.

CONCLUSIONS

Second Powerhouse

1) Non-TIE slots within the staggered TIE configuration have significantly higher FGE and TFGE than TIE slots, 47.8 and 86.6% versus 31.2 and 48.2%, respectively.

2) Mean FGE and STS effectiveness for yearling chinook salmon with the STS was significantly lower than with bar screens, 31.2 and 48.2% versus 47.8 and 78.6%, respectively.

3) Mean FGE and STS effectiveness for subyearling chinook salmon with the STS was lower than with bar screens, 28.9 and 52.2% versus 32.9 and 60.4%, respectively, but the difference was not significant.

4) Illuminating trashracks and intake ceilings sometimes, but not consistently, increased FGE.

5) The internal trashrack deflector in conjunction with the bar screen did not improve FGE.

6) The descaling rate on both yearling and subyearling chinook guided by the bar screen was approximately 2.5 to 3 times higher than that found in fish captured during vertical distribution measurements.

7) The TIEs at the south end of the powerhouse apparently improved FGE (Unit 12) compared with measurements taken at the north end (Unit 17) of the powerhouse where no TIEs were present. No direct measurements of STS effectiveness between the two sites were made.

First Powerhouse

1) Between 6 and 27 July, the FGEs and TFGEs for subyearling chinook salmon averaged 11.4 and 21.2%, respectively.

2) As seen at other dams on the Columbia River, summer subyearling chinook salmon passing through the powerhouse guided poorly and apparently moved to greater depths in the water column as the migration proceeded.

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APPENDIX A

Data Tables

Appendix Table 1.--Numbers of fish collected in the individual replicates of FGE tests at Bonneville Dam Second Powerhouse, 1988 (tests conducted in July and August captured only subyearling chinook salmon).

Date (Test Unit) and (series number)[a]

Location	2 May (12A) (1)					2 May (12B) (1)					3 May (12A) (1)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	--	372	25	75	--	--	131	13	29	--	--	386	50	116	1
Gap Net	--	10	--	--	--	--	2	--	--	--	--	20	1	--	--
Closure	--	54	5	6	--	2	71	1	16	--	--	88	3	13	--
First	--	33	2	--	--	--	27	--	3	--	--	21	3	--	--
Second	--	63	9	9	--	--	71	3	1	--	--	108	3	21	--
Third	--	57	--	--	--	--	71	3	6	--	--	72	--	18	--
Fourth	--	18	--	3	--	--	27	--	--	--	--	18	--	--	--
Fifth	--	--	--	--	--	--	6	--	--	--	--	15	--	--	--
Totals	**0**	**607**	**41**	**93**	**0**	**2**	**406**	**20**	**55**	**0**	**0**	**728**	**60**	**168**	**1**

Location	3 May (12B) (1)					4 May (12A) (1)					4 May (12B) (1)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	--	147	10	33	--	--	307	60	53	2	--	114	12	15	--
Gap Net	--	1	--	--	--	--	8	2	1	--	--	4	1	--	--
Closure	--	80	8	2	--	--	54	5	8	--	--	57	9	4	--
First	--	25	1	4	--	--	18	12	--	--	--	29	6	2	--
Second	--	83	4	4	--	--	93	6	--	--	3	77	6	6	--
Third	--	73	5	10	--	3	60	3	12	--	--	48	7	8	--
Fourth	--	51	--	--	--	--	24	3	3	--	--	21	3	3	--
Fifth	--	3	--	--	--	--	--	--	--	--	--	6	--	--	--
Totals	**0**	**463**	**28**	**53**	**0**	**3**	**564**	**91**	**77**	**2**	**3**	**356**	**44**	**38**	**0**

Location	5 May (12A) (1)					5 May (12B) (1)					6 May (12B) (2)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	--	294	27	91	--	--	117	7	33	--	--	190	25	44	--
Gap Net	1	14	2	1	--	--	2	--	2	--	--	10	--	1	--
Closure	--	60	4	7	--	--	65	7	8	--	--	31	3	7	--
First	--	45	--	--	--	--	35	3	5	--	--	27	3	--	--
Second	--	72	6	21	--	--	73	7	12	--	--	64	6	3	--
Third	--	93	6	3	--	1	71	8	5	--	--	35	3	5	--
Fourth	6	27	--	3	--	--	33	--	6	--	--	30	--	3	--
Fifth	--	3	--	--	--	--	12	--	--	--	--	9	--	3	--
Totals	**7**	**608**	**45**	**126**	**0**	**1**	**408**	**32**	**71**	**--**	**0**	**396**	**40**	**66**	**0**

Location	9 May (12B) (2)					10 May (12B) (2)					11 May (12B) (2)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	1	98	26	49	4	--	74	18	44	--	--	98	20	75	7
Gap Net	--	13	4	4	--	--	12	2	5	--	--	19	--	12	--
Closure	1	13	2	6	--	--	14	2	1	--	1	19	4	14	1
First	--	3	3	--	--	--	3	--	6	--	--	6	3	6	--
Second	--	29	6	10	3	3	32	6	5	--	1	34	5	18	2
Third	1	19	2	6	2	--	22	1	7	--	1	17	2	10	8
Fourth	--	9	6	--	--	--	12	--	3	--	--	18	--	3	3
Fifth	--	--	--	--	--	--	3	--	--	--	--	--	--	--	--
Totals	**3**	**184**	**49**	**75**	**9**	**3**	**172**	**29**	**71**	**0**	**3**	**211**	**34**	**138**	**21**

Appendix Table 1.--Continued.

Date (Test Unit) and (series number)[a]

	12 May (12B) (3)					13 May (12B) (4)					14 May (12B) (4)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	2	221	54	191	23	5	145	96	227	33	5	162	51	136	65
Gap Net	1	12	--	8	--	--	15	4	10	5	--	21	1	8	9
Closure	--	26	10	9	15	1	10	16	12	2	1	14	8	7	6
First	--	15	--	6	3	--	3	3	3	9	--	--	6	--	3
Second	1	42	12	18	18	5	35	20	26	13	2	31	8	21	18
Third	1	26	8	18	9	--	30	21	41	16	1	18	4	12	11
Fourth	3	24	12	9	6	--	21	6	18	3	6	9	3	6	3
Fifth	--	3	--	--	--	--	6	--	9	--	--	--	--	3	--
Totals	**8**	**369**	**96**	**259**	**74**	**11**	**265**	**166**	**346**	**81**	**15**	**255**	**81**	**193**	**115**

	15 May (12B) (3)					16 May (12B) (3)					17 May (12B) (4)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	--	94	27	165	38	1	192	61	309	47	1	90	63	112	41
Gap Net	--	8	--	5	3	1	9	1	14	1	1	11	1	8	4
Closure	--	13	2	8	6	1	25	10	34	14	1	17	7	12	4
First	--	--	3	--	--	--	15	9	3	--	--	--	--	3	9
Second	2	23	6	17	23	3	40	25	40	30	2	49	23	24	32
Third	1	31	13	12	21	--	29	14	34	26	2	38	18	19	18
Fourth	--	6	3	12	12	--	18	9	9	6	--	18	9	15	9
Fifth	--	3	--	--	--	--	6	--	6	--	--	3	3	--	--
Totals	**3**	**178**	**54**	**219**	**103**	**6**	**334**	**129**	**449**	**124**	**7**	**226**	**124**	**193**	**117**

	18 May (12B) (5)					26 May (12B) (3)					27 May (12B) (6)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	6	82	29	62	41	29	20	42	143	34	12	29	21	171	21
Gap Net	--	8	--	2	4	4	3	1	12	1	1	--	1	5	2
Closure	--	5	9	3	12	3	3	5	11	5	--	1	2	7	5
First	--	9	--	--	6	6	3	3	--	9	--	6	--	9	--
Second	--	32	20	14	43	7	5	18	15	15	9	3	15	18	29
Third	--	19	14	7	27	7	12	14	11	14	4	7	6	19	17
Fourth	--	21	3	--	21	15	9	3	18	3	3	6	3	18	--
Fifth	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--
Totals	**6**	**176**	**75**	**88**	**157**	**71**	**55**	**86**	**210**	**81**	**29**	**52**	**48**	**247**	**74**

	28 May (12B) (6)					29 May (12B) (7)					30 May (12B) (1)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	16	20	13	117	2	9	22	21	273	9	10	15	18	226	5
Gap Net	3	1	--	14	2	4	4	--	14	1	4	2	1	19	1
Closure	1	--	1	13	1	2	4	6	40	4	4	5	2	36	3
First	--	--	--	6	--	--	--	--	9	9	--	--	--	9	--
Second	2	6	6	25	3	8	4	1	33	10	3	4	4	44	6
Third	2	9	3	27	7	--	2	5	29	4	3	3	2	39	2
Fourth	6	6	--	36	3	--	6	--	24	3	6	--	3	33	9
Fifth	--	--	--	3	--	--	--	--	3	--	--	--	--	6	--
Totals	**30**	**42**	**23**	**241**	**18**	**23**	**42**	**33**	**425**	**40**	**30**	**29**	**30**	**412**	**26**

Appendix Table 1.--Continued.

Date (Test Unit) and (series number)[a]

Location	31 May (12B) (7)					1 June (12B) (6)					2 June (12B (8)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	11	12	15	186	19	18	13	10	55	1	44	11	15	42	5
Gap Net	3	1	1	14	1	3	1	--	6	--	6	4	--	6	1
Closure	3	3	3	26	3	2	--	3	7	1	15	1	--	6	6
First	--	3	--	6	--	--	--	--	3	--	6	--	3	3	--
Second	6	--	--	30	6	18	3	3	24	--	27	3	6	12	6
Third	--	--	9	18	12	6	--	--	9	3	12	3	3	--	9
Fourth	3	3	--	21	12	21	3	9	6	--	3	--	--	--	3
Fifth	3	--	--	15	--	--	--	--	--	--	--	--	--	--	--
Totals	**29**	**22**	**28**	**316**	**53**	**68**	**20**	**25**	**110**	**5**	**113**	**22**	**27**	**69**	**30**

Location	2 June (12A) (8)					3 June (12B) (8)					3 June (12A) (8)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	52	14	13	47	15	23	6	10	34	4	23	5	21	53	3
Gap Net	10	2	2	9	--	14	--	--	8	--	10	--	--	14	1
Closure	9	--	7	8	5	4	--	6	8	1	9	--	--	7	1
First	9	6	--	6	9	--	--	--	9	--	6	--	--	12	--
Second	30	--	3	9	9	9	--	12	6	3	9	--	15	24	3
Third	--	9	3	3	--	12	--	6	3	3	9	3	9	15	6
Fourth	21	--	6	3	--	6	--	--	--	6	3	--	--	15	3
Fifth	--	--	--	--	--	--	--	--	3	--	--	--	3	--	--
Totals	**131**	**32**	**34**	**85**	**38**	**68**	**6**	**34**	**71**	**17**	**69**	**8**	**48**	**140**	**17**

Location	4 June (12B) (8)					4 June (12A) (8)					5 June (12B) (8)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	12	8	14	38	16	14	12	21	35	19	18	10	26	66	9
Gap Net	7	2	--	3	--	6	2	1	6	--	5	1	--	19	3
Closure	9	3	1	10	4	8	--	7	5	1	5	3	5	15	3
First	3	--	6	3	3	--	3	6	3	--	--	--	3	--	--
Second	6	3	3	6	12	9	9	15	3	12	6	--	9	15	12
Third	--	--	3	--	9	12	12	6	12	3	12	3	6	9	--
Fourth	--	--	--	--	6	--	--	--	9	6	3	6	--	3	3
Fifth	--	--	--	--	--	3	--	--	3	--	--	--	--	3	--
Totals	**37**	**16**	**27**	**60**	**50**	**52**	**38**	**56**	**76**	**41**	**49**	**23**	**49**	**130**	**30**

Location	5 June (12A) (8)				
	SC	YC	ST	CO	SO
Gatewell	20	19	34	59	8
Gap Net	3	--	--	5	--
Closure	7	2	1	9	3
First	3	3	--	9	--
Second	15	6	12	6	6
Third	9	3	9	6	--
Fourth	9	--	3	6	6
Fifth	--	--	--	--	--
Totals	**66**	**33**	**59**	**100**	**23**

Appendix Table 1.--Continued.

Date (Test Unit) and (series number)[a]

Location	6 July (12A) (9)					6 July (12B) (9)					7 July (12A) (9)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	474					465					200				
Gap Net	98					124					35				
Closure	70					82					33				
First	48					39					15				
Second	129					39					66				
Third	75					117					39				
Fourth	48					66					12				
Fifth	15					9					--				
Total	**957**					**941**					**400**				

Location	7 July (12B) (9)					8 July (12A) (9)					9 July (12B) (9)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	254					92					89				
Gap Net	43					13					17				
Closure	54					16					20				
First	--					15					15				
Second	66					18					27				
Third	75					30					27				
Fourth	42					21					9				
Fifth	12					3					--				
Total	**543**					**208**					**204**				

Location	9 July (12A) (9)					9 July (12B) (9)					10 July (12A) (10)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	137					166					95				
Gap Net	24					58					4				
Closure	34					39					79				
First	36					33					36				
Second	75					111					132				
Third	48					84					126				
Fourth	30					33					63				
Fifth	6					9					12				
Totals	**390**					**533**					**547**				

Location	11 July (12B) (10)					12 July (12B) (10)					13 July (12B) (10)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	141					295					216				
Gap Net	9					9					15				
Closure	70					130					67				
First	39					69					30				
Second	63					150					75				
Third	99					129					54				
Fourth	60					78					27				
Fifth	21					15					3				
Totals	**502**					**875**					**487**				

Appendix Table 1.--Continued.

Date (Test Unit) and (series number)[a]

	14 July (12B) (9)					15 July (12B) (10)					16 July (12B) (9)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	124					118					81				
Gap Net	32					10					16				
Closure	38					57					48				
First	42					36					48				
Second	96					96					189				
Third	96					90					180				
Fourth	30					57					156				
Fifth	--					6					48				
Totals	**458**					**470**					**766**				

	17 July (12B) (10)					18 July (12B) (9)					19 July (12B) (9)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	51					161					120				
Gap Net	3					28					28				
Closure	30					44					34				
First	15					42					21				
Second	54					150					72				
Third	60					129					45				
Fourth	54					72					9				
Fifth	18					30					6				
Totals	**285**					**656**					**335**				

	20 July (12B) (11)					21 July (12B) (11)					22 July (12B) (11)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	86					121					79				
Gap Net	18					21					16				
Closure	38					38					22				
First	12					27					33				
Second	51					51					81				
Third	72					78					75				
Fourth	48					66					54				
Fifth	9					9					33				
Totals	**334**					**411**					**393**				

	23 July (12B) (12)					24 July (12B) (12)					25 July (12B) (12)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	89					90					114				
Gap Net	13					12					15				
Closure	48					41					40				
First	18					3					30				
Second	123					87					90				
Third	153					129					72				
Fourth	120					108					36				
Fifth	36					39					18				
Totals	**600**					**509**					**415**				

Appendix Table 1.--Continued.

Date (Test Unit) and (series number)[a]

Location	26 July (12B) (13) SC	YC	ST	CO	SO	27 July (12B) (13) SC	YC	ST	CO	SO	28 July (12B) (13) SC	YC	ST	CO	SO
Gatewell	193					82					111				
Gap Net	11					10					8				
Closure	60					39					42				
First	18					6					12				
Second	33					81					69				
Third	45					90					57				
Fourth	24					45					39				
Fifth	--					24					27				
Totals	384					377					365				

Location	29 July (12B) (14) SC	YC	ST	CO	SO	30 July (12B) (14) SC	YC	ST	CO	SO	31 July (12B) (15) SC	YC	ST	CO	SO
Gatewell	106					86					81				
Gap Net	5					5					5				
Closure	78					74					43				
First	36					42					36				
Second	159					186					123				
Third	237					225					159				
Fourth	129					162					183				
Fifth	21					24					33				
Totals	771					804					663				

Location	1 August (12B) (15) SC	YC	ST	CO	SO	2 August (12B) (15) SC	YC	ST	CO	SO
Gatewell	52					70				
Gap Net	1					5				
Closure	25					42				
First	12					27				
Second	27					84				
Third	36					72				
Fourth	30					42				
Fifth	9					3				
Totals	192					345				

[a]Test numbers correspond to those in Table 1, this report.
SC = Subyearling chinook salmon
YC = Yearling chinook salmon
ST = Steelhead
CO = Coho salmon
SO = Sockeye salmon

Appendix Table 2.--Vertical distribution data for yearling and subyearling chinook salmon and coho salmon, collected at Bonneville Dam Second Powerhouse during the 1988 field season.

YEARLING CHINOOK SALMON

Test Unit	13A	12B	13A	13B	12A	13B	12B	13B	12B	13A
Test Date	25 April	25 April	26 April	27 April	27 April	28 April	28 April	29 April	29 April	2 May
Gatewell	237	124	165	484	172	487	54	360	71	232
First Net	138	108	60	702	165	819	99	756	63	177
Second Net	147	84	126	318	84	342	60	387	90	147
Third Net	102	63	93	114	42	105	33	168	63	138
Fourth Net	60	36	72	84	63	69	27	114	75	99
Fifth Net	48	60	54	48	15	27	24	108	57	84
Sixth Net	42	33	45	42	--	9	18	51	36	72
Seventh Net	21	--	18	12	--	3	6	27	18	36
Totals	795	508	633	1804	541	1861	321	1971	473	985

Test Unit	13A	13A	13A	13A	13A	13A	13A	13A	13A	13A
Test Date	3 May	4 May	5 May	6 May	9 May	10 May	11 May	12 May	13 May	14 May
Gatewell	227	172	254	166	108	63	50	65	71	104
First Net	213	141	237	96	96	57	36	78	66	72
Second Net	180	141	141	135	66	51	33	51	57	105
Third Net	108	111	141	84	60	48	42	39	33	51
Fourth Net	123	108	129	93	60	45	60	51	54	24
Fifth Net	54	81	81	63	33	33	18	30	39	39
Sixth Net	75	45	57	33	18	30	9	6	30	27
Seventh Net	27	12	21	12	9	3	15	3	24	6
Totals	1007	811	1061	682	450	330	263	323	374	428

Appendix Table 2.--Continued.

	YEARLING CHINOOK SALMON				COHO SALMON					
Test Unit	**13A**	**13A**	**13A**	**13A**	**13A**	**13A**	**13A**	**13A**	**13A**	**13A**
Test Date	**15 May**	**16 May**	**17 May**	**18 May**	**26 May**	**27 May**	**28 May**	**29 May**	**30 May**	**31 May**
Gatewell	71	103	38	44	83	61	110	115	53	62
First Net	66	108	21	33	84	108	156	192	111	120
Second Net	45	99	48	72	78	81	102	144	87	72
Third Net	57	54	54	51	27	54	69	93	72	36
Fourth Net	96	21	45	30	18	42	42	66	69	33
Fifth Net	45	39	54	30	18	24	51	36	39	24
Sixth Net	15	21	36	12	12	24	39	48	21	21
Seventh Net	6	6	6	6	9	3	33	21	24	15
Totals	**401**	**451**	**302**	**278**	**329**	**397**	**602**	**715**	**476**	**383**

	COHO SALMON					SUBYEARLING CHINOOK SALMON		
Test Unit	**13A**	**13A**	**13A**	**13A**	**13A**	**13A**	**13A**	**13A**
Test Date	**1 June**	**2 June**	**3 June**	**4 June**	**5 June**	**6 July**	**7 July**	**8 July**
Gatewell	7	8	16	10	22	354	211	57
First Net	33	9	12	21	45	348	156	60
Second Net	36	18	18	12	33	336	150	57
Third Net	12	6	15	9	21	183	87	27
Fourth Net	18	15	6	18	24	171	75	24
Fifth Net	18	15	9	9	9	144	57	27
Sixth Net	6	9	3	3	3	144	51	21
Seventh Net	3	6	12	3	--	45	12	3
Totals	**133**	**86**	**91**	**85**	**157**	**1725**	**799**	**276**

Appendix Table 2.--Continued.

SUBYEARLING CHINOOK SALMON

Test Unit	13A	13A	13A	13A	13A	13A	13A	13A	13A	13A
Test Date	9 July	10 July	11 July	12 July	13 July	14 July	15 July	16 July	17 July	18 July
Gatewell	96	110	156	214	157	90	110	86	67	92
First Net	123	117	144	159	135	198	117	54	42	114
Second Net	129	168	132	237	153	114	105	72	72	84
Third Net	39	108	120	228	72	129	96	144	57	114
Fourth Net	102	159	117	204	120	132	117	186	93	81
Fifth Net	60	126	69	150	72	96	84	228	54	144
Sixth Net	78	99	81	147	30	105	99	165	48	114
Seventh Net	39	51	39	60	33	51	33	126	48	48
Totals	666	938	858	1399	772	915	761	1061	481	791

SUBYEARLING CHINOOK SALMON

Test Unit	13A	13A	13A	13A	13A	13A	13A	13A	13A	13A
Test Date	19 July	20 July	21 July	22 July	23 July	24 July	25 July	26 July	27 July	28 July
Gatewell	57	60	68	62	48	55	69	66	38	58
First Net	51	93	75	30	42	36	54	42	36	78
Second Net	75	54	81	48	63	60	72	42	54	111
Third Net	78	60	111	66	63	39	84	63	30	93
Fourth Net	96	84	117	54	105	90	105	93	87	138
Fifth Net	36	54	48	117	99	117	66	96	60	198
Sixth Net	42	48	57	153	120	117	57	72	36	180
Seventh Net	12	21	21	60	69	60	36	54	27	123
Totals	447	474	578	590	609	574	543	528	368	979

Appendix Table 2.--Continued.

SUBYEARLING CHINOOK SALMON

Test Unit	13A	13A	13A	13A
Test Date	30 July	31 July	1 August	2 August
Gatewell	65	20	12	18
First Net	75	60	9	6
Second Net	123	63	18	9
Third Net	156	27	33	42
Fourth Net	153	156	30	54
Fifth Net	213	141	27	57
Sixth Net	195	150	24	66
Seventh Net	42	69	30	36
Totals	1022	686	183	288

Appendix Table 3.--Numbers of fish collected in the individual replicates of FGE tests at Bonneville Dam First Powerhouse, 1988 (tests conducted in July and August captured only subyearling chinook salmon).

Date (Test Unit)

	1 June (3B)					2 June (3B)					3 June (3B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	25	9	30	204	3	51	2	17	83	4	25	5	46	89	6
Gap Net	2	1	--	49	--	9	--	--	10	1	7	--	3	19	1
Closure	7	1	3	37	1	14	--	2	8	4	6	1	6	14	1
First	3	6	3	12	--	9	--	12	12	--	6	--	3	21	3
Second	9	--	3	36	--	42	--	6	18	3	15	--	12	30	9
Third	9	--	3	15	3	18	--	--	6	6	9	--	12	6	6
Fourth	--	--	--	6	--	12	--	--	3	3	3	--	6	3	--
Totals	**55**	**17**	**42**	**359**	**7**	**155**	**2**	**37**	**140**	**21**	**71**	**6**	**88**	**182**	**26**

	4 June (3B)					6 June (3B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	26	4	14	26	4	19	8	12	38	2
Gap Net	1	1	--	1	1	1	--	--	8	1
Closure	1	--	3	6	1	2	--	1	5	1
First	3	3	6	6	--	3	--	--	--	6
Second	6	--	6	6	3	9	6	3	9	--
Third	6	3	6	3	3	--	3	9	3	6
Fourth	--	--	--	3	3	--	--	--	--	--
Totals	**43**	**11**	**35**	**51**	**15**	**34**	**17**	**25**	**63**	**16**

	6 July (3B)					7 July (3B)					8 July (3B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	120					188					84				
Gap Net	11					19					7				
Closure	41					41					36				
First	45					54					36				
Second	351					138					225				
Third	381					141					192				
Fourth	276					87					144				
Totals	**1225**					**668**					**724**				

	13 July (3B)					14 July (3B)					15 July (3B)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	46					60					95				
Gap Net	10					13					13				
Closure	20					59					33				
First	18					60					45				
Second	93					255					198				
Third	105					225					264				
Fourth	57					111					150				
Totals	**349**					**783**					**798**				

Appendix Table 3.--Continued.

Date (Test Unit)

Location	18 July (3B) SC	YC	ST	CO	SO	19 July (3B) SC	YC	ST	CO	SO	21 July (3B) SC	YC	ST	CO	SO
Gatewell	46					84					37				
Gap Net	3					7					2				
Closure	43					22					49				
First	39					21					18				
Second	195					105					228				
Third	180					165					207				
Fourth	63					81					105				
Totals	569					485					646				

Location	22 July (3B) SC	YC	ST	CO	SO	25 July (3B) SC	YC	ST	CO	SO	26 July (3B) SC	YC	ST	CO	SO
Gatewell	32					200					47				
Gap Net	2					15					6				
Closure	40					91					12				
First	18					57					12				
Second	171					405					147				
Third	180					438					387				
Fourth	135					267					186				
Totals	578					1473					797				

SC = Subyearling chinook salmon
YC = Yearling chinook salmon
ST = Steelhead
CO = Coho salmon
SO = Sockeye salmon

Appendix Table 4.--Vertical distribution data for subyearling chinook and coho salmon, collected at Bonneville Dam First Powerhouse, 1988.

	COHO SALMON			SUBYEARLING CHINOOK SALMON			
Test Unit	3B	3B	3B	3B	3B	3B	3B
Test Date	30 May	31 May	5 June	11 July	12 July	20 July	27 July
Gatewell	16	21	46	19	40	17	9
First Net	12	123	108	75	162	30	15
Second Net	9	33	57	57	72	45	33
Third Net	--	39	21	51	132	114	27
Fourth Net	6	12	15	111	186	192	126
Fifth Net	--	6	--	99	156	216	186
Sixth Net	--	--	3	78	96	120	126
Seventh Net	--	--	--	9	45	39	24
Totals	43	234	250	499	889	773	546