Evaluation of the Juvenile Collection and Bypass Systems at Bonneville Dam — 1984

by
Michael H. Gessel
Richard F. Krcma
William D. Muir
C. Scott McCutcheon
Lyle G. Gilbreath
and
Bruce H. Monk

May 1985

EVALUATION OF THE JUVENILE COLLECTION AND BYPASS SYSTEMS AT BONNEVILLE DAM - 1984

Annual Report

by
Michael H. Gessel
Richard F. Krcma
William D. Muir
C. Scott McCutcheon
Lyle G. Gilbreath
and
Bruce H. Monk

Financed by
U.S. Army Corps of Engineers
Contract DACW57-84-F-0181

and

Coastal Zone and Estuarine Studies Division
Northwest and Alaska Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
2725 Montlake Boulevard East
Seattle, Washington 98112

May 1985

CONTENTS

Page

INTRODUCTION 1

OBJECTIVE I - EVALUATION OF MODIFICATIONS/ADDITIONS TO STS AND TRASHRACKS AT THE SECOND POWERHOUSE 4

Task 1 - STS FGE Tests 4

Methods and Procedures 7

Results 10

Task 2 - Vertical Distribution Tests 18

Methods and Procedures 18

Results 20

OBJECTIVE II - CONTINUED MONITORING OF THE SECOND POWERHOUSE DSM AND SMOLT INDEXING FACILITIES. 23

Task 1 - Smolt Indexing. 24

Methods and Procedures 24

Results 24

Task 2 - Wet Separator Evaluation. 27

Methods and Procedures 27

Results 29

Task 3 - Modified Sampling System. 31

Task 4 - DSM Improvements Evaluation 31

Task 5 - Sampling During Releases of Lower River Hatchery Fish 31

OBJECTIVE III - EVALUATION OF THE FIRST POWERHOUSE SMOLT INDEXING FACILITIES 32

Task 1 - Utility of Sampling Equipment 34

Methods and Procedures 34

Page

Results 35

Task 2 - Efficiency of Sampling Equipment. 35

Methods and Procedures 35

Results 35

OBJECTIVE IV - MONITOR FISH QUALITY AND STRESS ON FINGERLINGS IN THE BYPASS AND INDEXING FACILITIES AT THE FIRST POWERHOUSE 37

Task 1 - Fish Quality. 37

Methods and Procedures 37

Results 37

Task 2 - Stress Tests. 38

Methods and Procedures 38

Results 39

OBJECTIVE V - MONITOR ORIFICE PASSAGE EFFICIENCY AT BOTH POWERHOUSES . . 39

Methods and Procedures 39

Results 41

GENERAL CONCLUSIONS. 43

GENERAL RECOMMENDATIONS. 44

Second Powerhouse. 44

First Powerhouse 45

ACKNOWLEDGMENTS. 46

LITERATURE CITED 47

APPENDIX 48

INTRODUCTION

Initial studies to evaluate the efficiency of the fingerling collection and bypass system at the Bonneville Dam Second Powerhouse began in 1983. These studies showed a very low fish guiding efficiency (FGE) of less than 30% for the submersible traveling screens (STS) (Krcma et al. 1984). Vertical distribution tests, conducted during the same period, indicated two problem areas in developing acceptable (>70%) FGE. First, a large percentage of the smolts were passing through the intakes at a depth below the STS. Second, significant avoidance and/or rejection of guidance was occurring because FGE was approximately half of the potential indicated by vertical distribution studies. An extensive model study program was initiated to investigate ways of improving the distribution of fish entering the turbine intakes and reducing or eliminating the avoidance/rejection problem, thereby improving the guiding capabilities of the STS. A series of methods for improving FGE was developed.

During the 1984 smolt migration, the National Marine Fisheries Service (NMFS) under contract to the U.S. Army Corps of Engineers (CofE) evaluated various methods that were intended to improve the fingerling collection and bypass efficiency at the Bonneville Dam Second Powerhouse (Figs. 1 and 2). Studies were also conducted to evaluate the operation of the newly completed fingerling bypass and indexing facility at the First Powerhouse and identify problem areas and make recommendations if necessary for improved operation.

The 1984 research had the following primary objectives:

1. Evaluate the various modifications/additions developed during model studies to improve FGE at the Second Powerhouse.

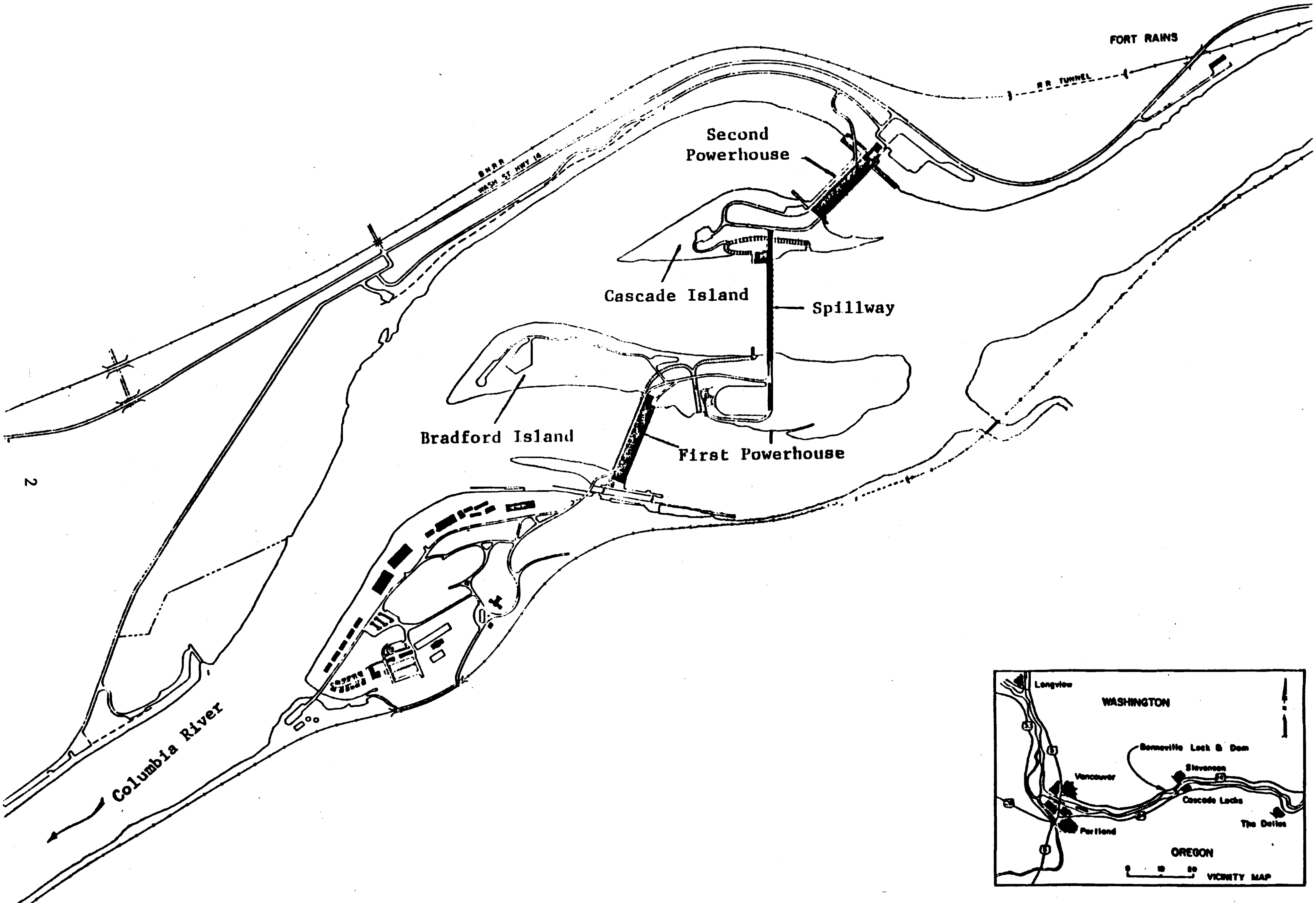


Figure 1.--General overview of Bonneville Dam First and Second Powerhouses.

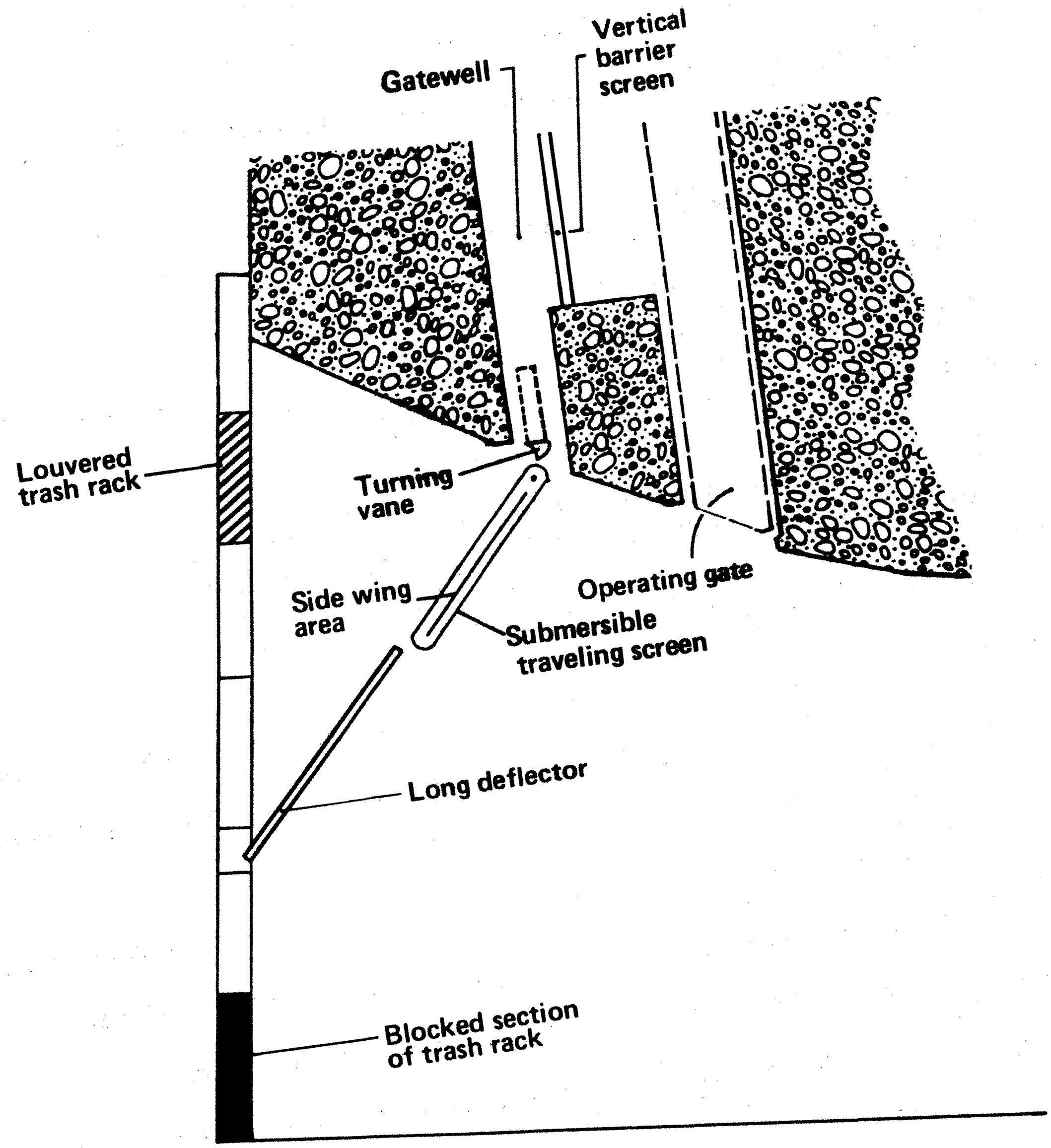


Figure 2.--Cross-section of turbine intake at Bonneville Dam Second Powerhouse showing the items tested in 1984.

2. Continue monitoring the downstream migrant system (DSM) and smolt indexing facilities at the Second Powerhouse.

3. Evaluate the operation of the smolt indexing system facilities at the First Powerhouse.

4. Determine fish quality and stress through the juvenile bypass and indexing system at the First Powerhouse.

5. Measure orifice passage efficiency (OPE) of the fingerling bypass orifices at both powerhouses.

OBJECTIVE I - EVALUATION OF MODIFICATIONS/ADDITIONS TO THE STS AND TRASHRACKS AT THE SECOND POWERHOUSE

Task 1 - STS FGE Tests

The following is a list and brief description and/or purpose of the various modifications/additions that were tested at the Second Powerhouse during 1984 to improve STS FGE:

1. Blocked Trashrack Sections - Existing sections of the trashrack were blocked by attaching steel panels. A total of six racks were modified to provide the capability of blocking the bottom one-third of an entire unit (two racks in each section of the penstock). This forced all the water and fish through the upper portion of the trashrack. This condition could only be tested at minimum turbine load (approximately 35 MW; 10,000 cfs).

2. Louvered Trashrack Sections - Four new trashrack sections were constructed with sloping plates attached at a 30° angle to the normal horizontal support members. This created a louver effect that directed approaching flows upward. Model studies indicated that velocities along the intake ceiling and the volume of flow into the gatewell increased when these racks were positioned in the upper portion of the trashrack array.

3. Lowering the STS - The STS was positioned 1 foot lower in the intake enlarging the throat opening and extending the STS deeper into the intake (Fig. 3).

4. Turning Vane - A curved plate attached to the underside of the support beam at the top of the STS to smooth out flows in the throat area and increase flow up the gatewell [used in conjunction with (3)].

5. Trashrack Deflector - A frame with wedge wire screen of equal porosity (32%) as the STS. It attached to a special trashrack section and was designed to simulate a lengthened STS by screening off the area from the trashrack to the STS. When not in use it could be lowered into a non-fishing stream-flow position. A short deflector was used with the 60° angle STS and a longer deflector with the 48° angle STS.

6. Side Wings on the STS - A modification that closed off an area of potential escapement created by a gap along the side of the STS and the wall (due to the side taper of the intakes). One STS was modified with a frame for attaching nets for evaluation, others were modified with solid plates.

7. Raised Operating Gate - Increased flow up the gatewell.

8. Removed Perforated Plate From Inside STS - Allowed more flow to pass through the STS by increasing its overall porosity from 32 to 40%. This was done to minimize flow deflection that might cause smolt avoidance or rejection.

9. Reduced Turbine Load - Lowered intake approach velocities.

10. Lighting the Forebay - Seven portable light towers were used to illuminate the forebay immediately upstream from the powerhouse during some of the tests to attract fingerlings to the surface. Two towers were placed on the powerhouse deck (near Gatewell 11-B) and directed at the forebay upstream

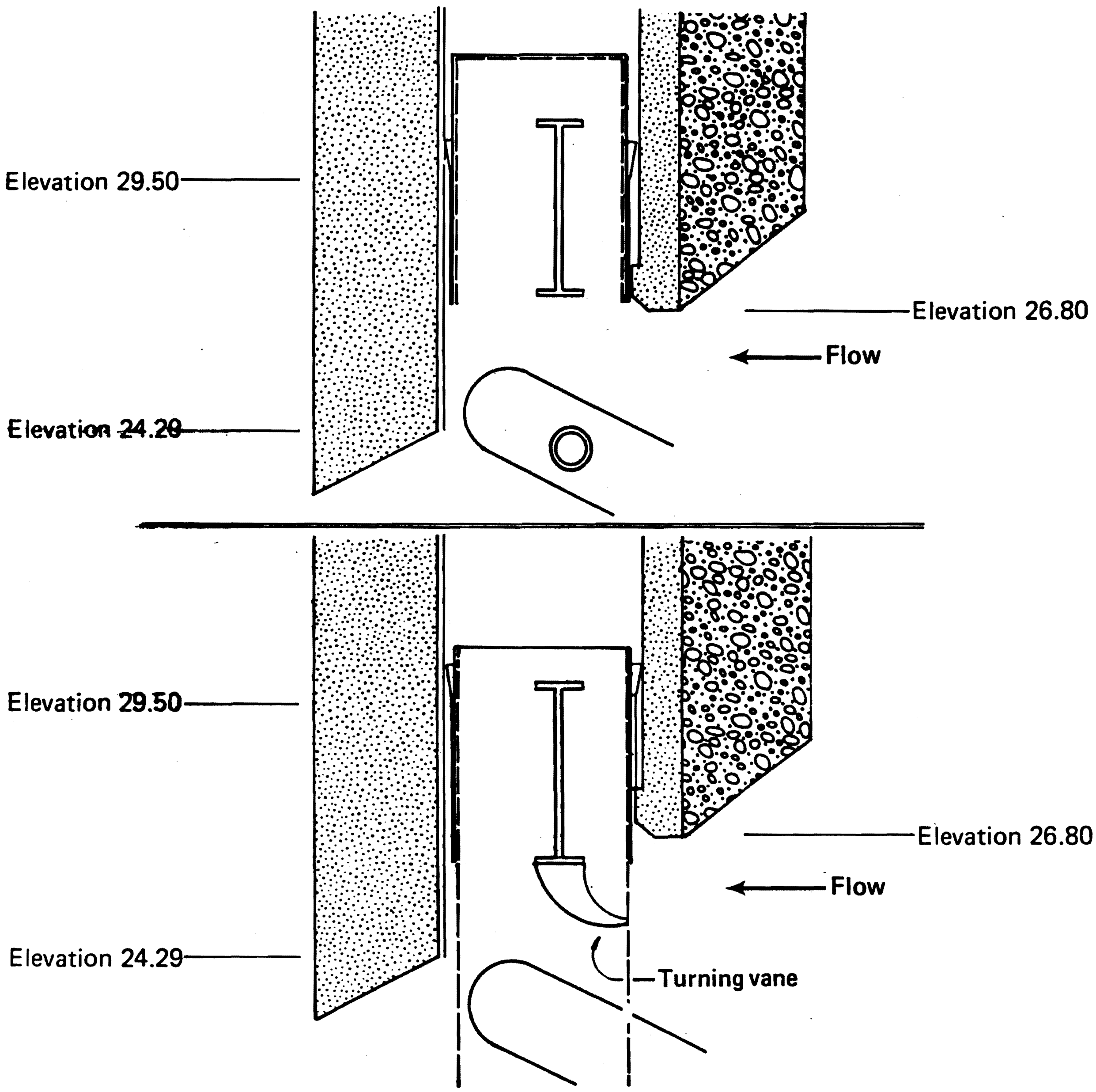


Figure 3.--Approximate position of the STS in the gateslot at Bonneville Dam Second Powerhouse in the normal (upper figure) and lowered positions, 1984.

from Turbine Unit 12. The remaining five towers were placed along Cascade Island from the powerhouse towards the upstream tip of the island at approximately 200-foot intervals (Fig. 1). Each light tower had four 1,000 watt metal halide lights.

Methods and Procedures

To obtain a substantial increase in FGE, several of the changes were incorporated into single tests. Also, since a large number of conditions were possible, different test combinations were conducted in the A and B Gatewells of Unit 12 simultaneously.

FGE tests were conducted using the same procedures developed in previous years. A net frame attached to the traveling screen supported nets that were used to collect unguided fish (Fig. 4). A standard replicate began by closing the orifice, lowering the STS and net frame into the intake, setting the STS at the required operating angle, dipnetting the gatewell to remove all residual fish, and starting the turbine. As an added precaution against biasing the tests, the turbine was operated only during the hours of actual testing. The gatewell was then dipnetted periodically until sufficient numbers of fish had entered the unit. Each test was ended by lowering the dipnet and leaving it open, shutting the unit off, closing the dipnet and making a final clean-out dip, raising the STS and net frame, and emptying the catch from each net into marked containers. Species identification and number were determined for all fish. Testing occurred from 2000 to 2400 h each test day. During the FGE tests, groups of marked (partial caudal clip) subyearling chinook salmon were used to determine dipnet efficiency. On four successive days, groups of approximately 100 marked fish were released into the gatewell after the turbine reached full load. The releases were made from a weighted

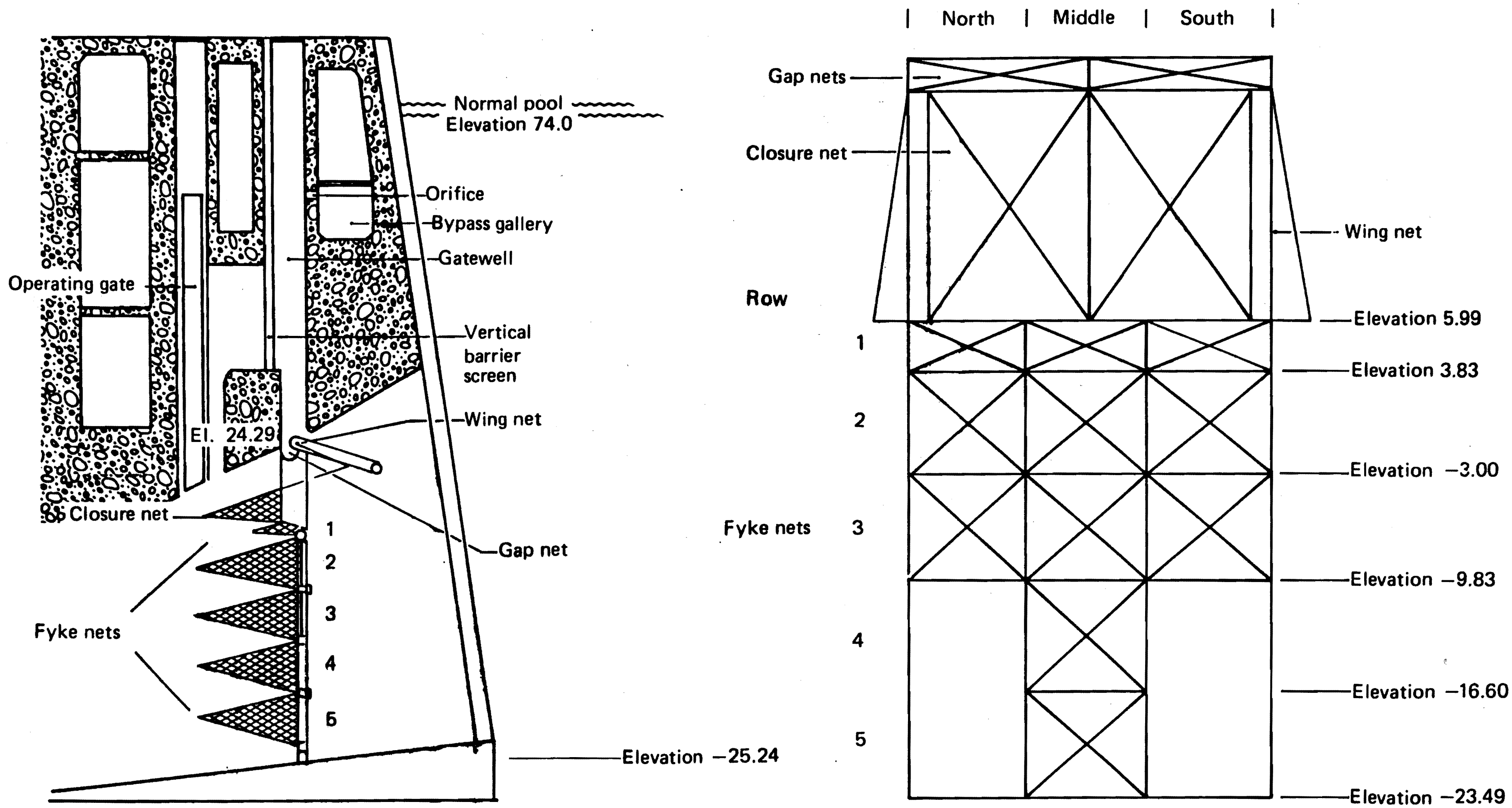


Figure 4.--Cross-section of the turbine intake with a traveling screen, net frame, and attached nets at Bonneville Dam Second Powerhouse and the net layout is also shown - 1984.

container approximately 10-15 feet below the surface. Recapture rates between 98 and 99% indicated dipnetting was very efficient.

Fish quality was monitored by examining fish captured in the gatewell for descaling. Descaling was determined by dividing the fish into five equal areas per side: if any two areas on a side were 50% or more descaled, the fish was classified as descaled. Target species for the FGE tests were yearling and subyearling chinook salmon: information on other species was collected as available.

FGE is the percentage of fish (by species) entering the turbine intake that are guided by the STS out of the intake and into the gatewell for a specific test condition. This is represented by the following formula:

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

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

For statistical evaluation, tests usually require three to five replicates (about 200 STS guided fish per replicate). However, due to the large number of test conditions and the relatively short time available for testing of individual species, many of the test conditions were not replicated. If the initial test results did not approach 70% FGE or the condition of the fish resulted in unacceptably high descaling or mortality, only one or two replicates were usually conducted. If statistical significance was desired, the following properties were used: (1) the specified statistical significance level, (2) the discrimination of the test, (3) the magnitude of the variability, and (4) the number of treatment or factor levels.

1/ Fyke net catches at levels with only a center net are expanded (x3).

The following formula for calculating confidence intervals for multinomial proportions was used to determine sample size per treatment:

C.I. = P ± (B x P x (1-P /N)*1/2

where P is the estimated probability for one of the treatment categories, B is the tabular value for the upper percentile of the chi-square distribution with one degree of freedom at the specified significance level for discrimination, and N is the total sample size.

The variables used to determine the number of replicates are related by the formula:

(H x S) / (N *1/2)

where H is an analysis of means factor and S is the estimated pooled standard deviation. The means factor is determined as a product of tabular values of the t-distribution at the specified statistical significance level and the number of replicates and sample size per replicate.

Results

A total of 21 test conditions consisting of 36 individual tests were conducted between 2 May and 6 August. Table 1 lists the test conditions and the corresponding FGE and descaling percentages (a numerical listing of the target species in these tests is shown in Appendix Table 1). Figures 5-8 are cross-sectional views of the intake showing the modifications/additions tested, corresponding FGE, and percentage of fish captured at the different net levels.

Prior to a discussion of these data, it is necessary to reiterate that primarily because FGE was poor in nearly every condition tested, very little replication occurred. With low FGE and the constraints of a relatively short field season, it was more important to test as many configurations as possible

Table 1.--Traveling screen fish guiding efficiency (FGE) tests on yearling and subyearling chinook salmon conducted in Unit 12 at Bonneville Second Powerhouse during the FY84 field season.

													Yearling		Sub-yearling	
Test no.	STS angle (°)	Date(s) of test(s)	Defl. &	angle (°)	Avg. unit disch. (kcfs)[a]	Louvered[b] trash-rack	Blocked[b] trash-rack	STS lowered (1 foot)	Turning vane	Forebay lights	Perforated plate in STS	Operating gate position	FGE (%)	Descaled (mortality)[c] (%)	FGE (%)	Descaled (mortality)[c] (%)
1	48	2 & 4 May[d]	Yes	48	18;14	2nd	6th	Yes	Yes	Yes	In	Normal	46	48 (10)	-	-
2	48	3 May	Yes	48	20	2nd	6th	Yes	Yes	No	In	Normal	27	46 (14)	-	-
3	48	5 & 6 May	Yes	48	13;13	2nd	6th	Yes	Yes	Yes	In	Normal	36	17	-	-
4	48	19 May	Yes	48	14	None	6th	No	No	No	In	Normal	44	32	-	-
5	48	20 May	Yes	48	15	None	6th	No	No	No	In	Normal	48	53	-	-
6	48	23 May	Yes	48	10	None	5 & 6	No	No	No	In	Normal	86	57	-	-
7	48	2 & 3 Jun	Yes	48	20;19	None	None	No	No	No	Out	Normal	26	61	20	62 (11)
8	48	31 Jul to 1 Aug	Yes	48	17;16	None	None	No	No	No	In	Up-38'	-	-	22	7
9	48	2 & 3 Aug	Yes	48	14;16	None	None	Yes	No	No	Out	Normal	-	-	29	9
10	48	6 Aug	Yes	48	15	None	None	Yes	No	No	Out	Up-38'	-	-	30	8
11	60	2 May	Yes	60	18	2nd	6th	Yes	Yes	Yes	In	Normal	34	57 (35)	-	-
12	60	3 May	Yes	60	20	2nd	6th	Yes	Yes	No	In	Normal	35	77 (41)	-	-
13	60	4 May	Yes	60	14	None	6th	Yes	Yes	Yes	In	Normal	41	57 (24)	-	-
14	60	5 & 6 May	Yes	60	13;13	None	6th	Yes	Yes	Yes	In	Normal	26	19	-	-
15	60	20 May	Yes	60	15	None	6th	Yes	Yes	Yes	In	Normal	37	53	-	-
16	60	23 May	Yes	60	10	None	5 & 6	No	No	No	In	Normal	36	65	-	-
17	60	2 & 3 Jun	Yes	60	20;19	None	None	No	No	No	In	Normal	32	33	22	43
18	60	16, 18, & 20 Jul	In stream		18;18;17	None	None	No	No	No	In	Up-23'	-	-	29	7
19	60	17, 19, 21, & 22 Jul	In stream		18;16;15	None	None	No	No	No	In	Normal	-	-	27	11
20[e]	60	23, 24 & 25 Jul	Yes	48	16;16;15	None	None	No	No	No	In	Up-23'	-	-	24	5
21[e]	60	26 & 27 Jul	Yes	48	17;17	None	None	No	No	No	Out	Normal	-	-	32	5

a/ KCFS = thousand cubic feet/sec.
b/ This powerhouse has six (6) trashrack sections stacked on top of each other that cover each turbine intake bay; louvered trashrack in the second means the second section from the top. Blocked trashrack in the sixth means the bottom section was blocked.
c/ Indicates the percentage mortality of the various test conditions; descaling percentage include these data.
d/ Each date represents one replicate (one date equals one replicate, two dates equals two replicates, etc.).
e/ These tests are not compatible with any of the other tests because the STS angle was incorrect in relation to the deflector.

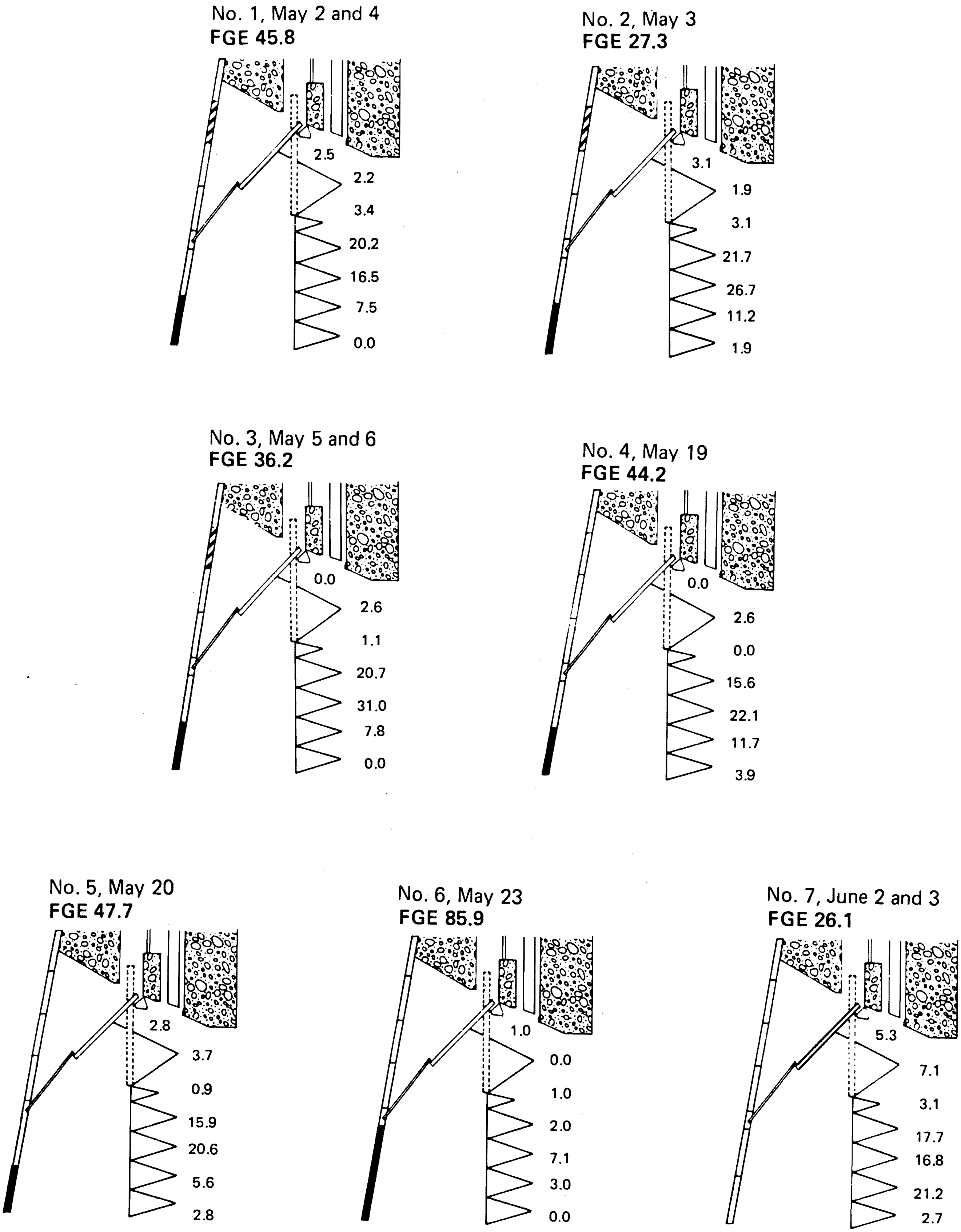


Figure 5.--Results of STS tests (48° angle) for yearling chinook salmon showing FGE and percentage fish captured at the various net levels, Bonneville Dam Second Powerhouse, 1984. Test numbers correspond to tests as listed in Table 1 (refer to this table for complete test details).

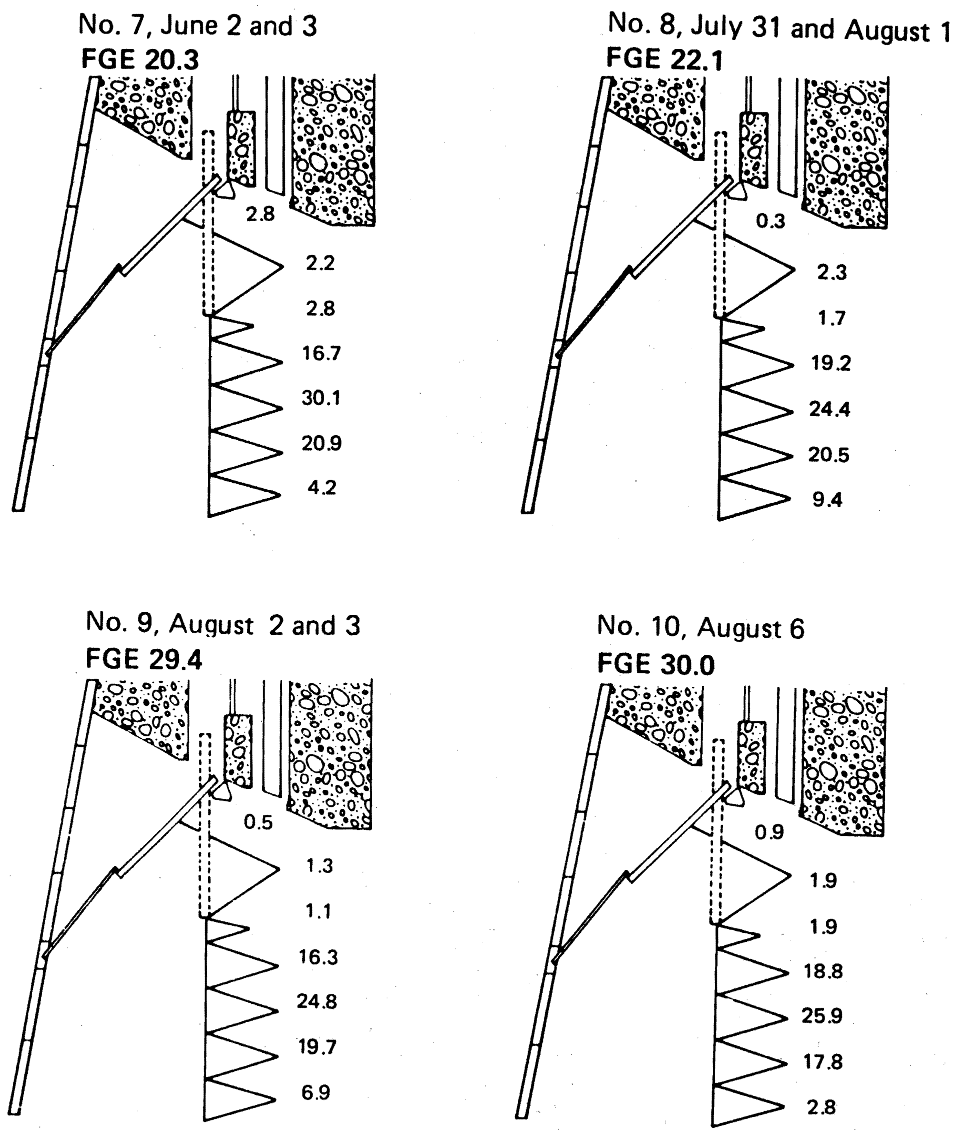


Figure 6.--Results of STS tests (48° angle) for subyearling chinook salmon showing FGE and percentage fish captured at the various net levels, Bonneville Dam Second Powerhouse, 1984. Test numbers correspond to tests as listed in Table 1 (refer to this table for complete test details).

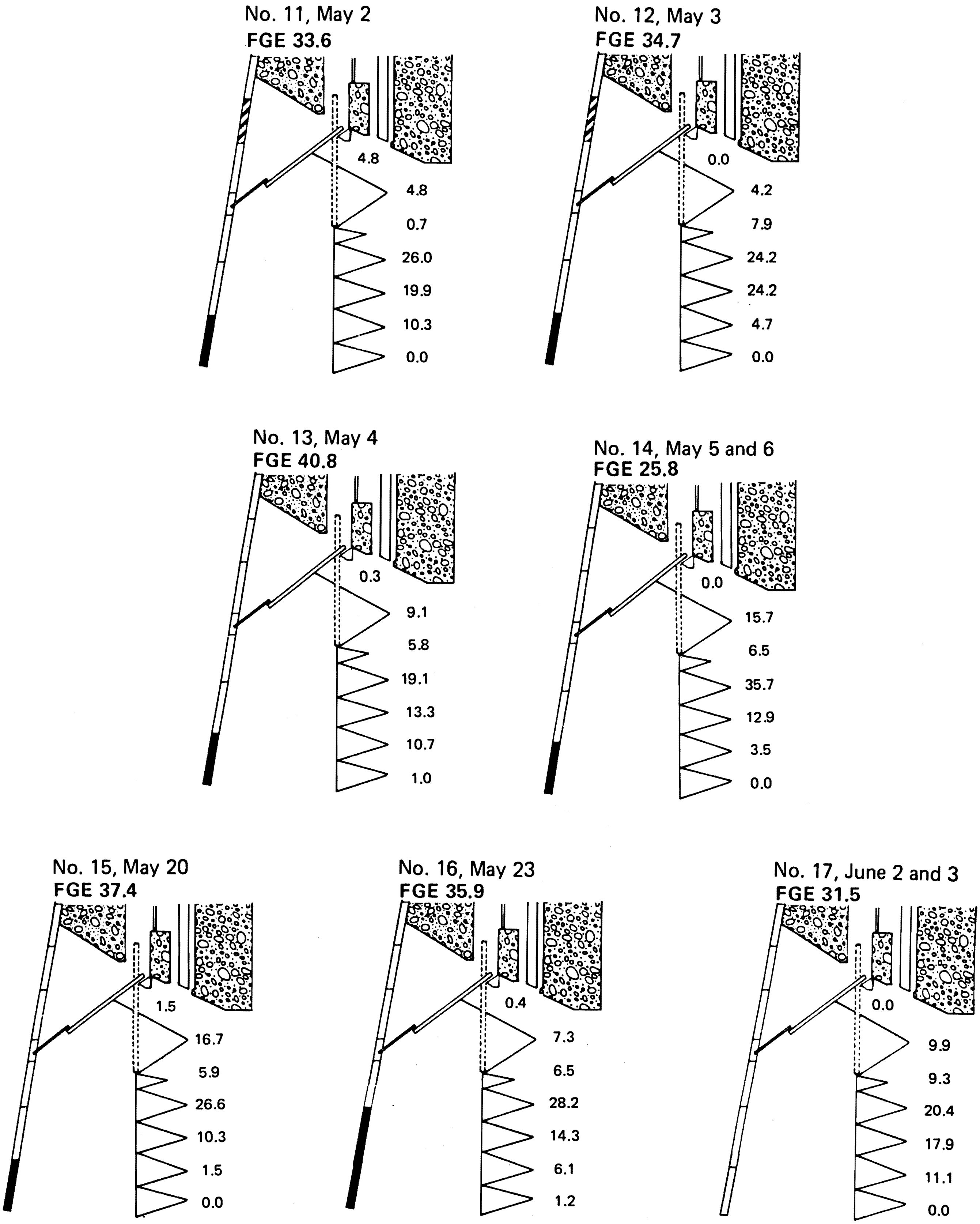


Figure 7.--Results of STS tests (60° angle) for yearling chinook salmon showing FGE and percentage fish captured at the various net levels, Bonneville Dam Second Powerhouse, 1984. Test numbers correspond to tests as listed in Table 1 (refer to this table for complete test details).

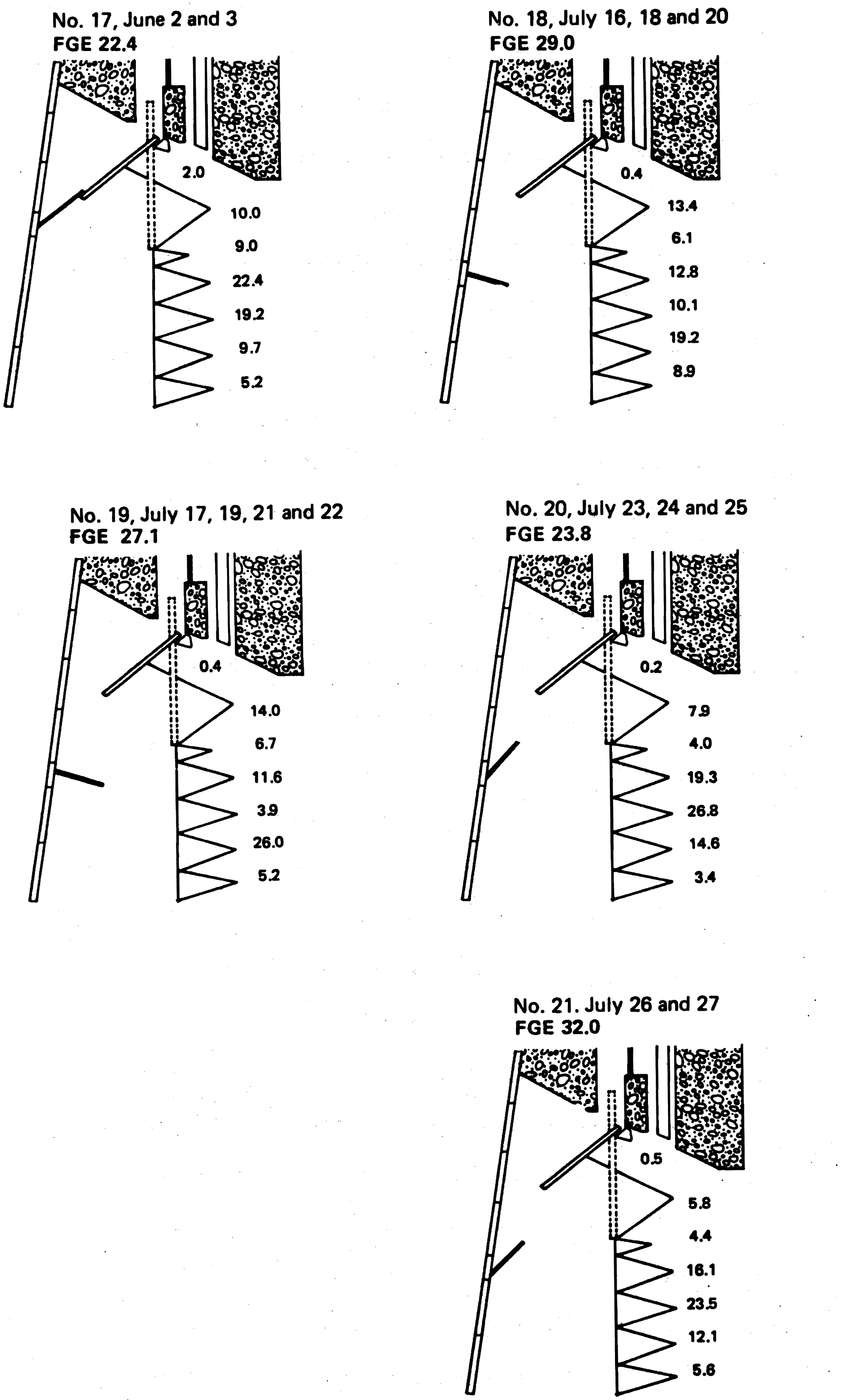


Figure 8.--Results of STS tests (60° angle) for subyearling chinook salmon showing FGE and percentage fish captured at the various net levels, Bonneville Dam Second Powerhouse, 1984. Test numbers correspond to tests as listed in Table 1 (refer to this table for complete test details).

to try and improve FGE rather than replicate conditions yielding poor FGE just to obtain sufficient data for statistical evaluation. With this perspective, the following is a discussion of the possible effects of the different modifications/additions on FGE and descaling:

Blocked Trashrack Sections - This condition was tested in conjunction with other modifications (deflector and/or louvered trashrack). In 11 of 12 tests, FGE did not exceed 50%. In Test 6, FGE was 86%. During this test, the two trashracks below the 48° deflector were blocked, thus forcing almost all the flow (and fish) into the area intercepted by the deflector and STS. Only a small area below the deflector remained unblocked; it consisted of a short section of trashrack (approximately 3 feet high) that supported the deflector. For this test, it was also necessary to operate the unit at a minimum load of approximately 35MW (about 10,000 cfs) for structural reasons and also to reduce velocity through the screen area as much as possible. Even with reduced velocity, descaling was extremely high--exceeding 50%.

Louvered Trashrack Section - Tests 11 and 13 indicate use of this modification may have actually decreased FGE (34% w/louver vs 41% w/o louver).

Lowering STS and Turning Vane - No independent comparison could be made of this modification. However, it would appear there was no benefit from a lowered STS. In tests where they were used, FGE still remained low and descaling high in addition to higher levels of mortality (Tests 1-3 and 9-15).

Trashrack Deflectors - This addition simulates an extension of the STS and should theoretically intercept significantly more fish. FGE test results indicated a slight increase for yearling chinook salmon (Test 17 - FGE 32%) when compared to 1983 data (FGE 19.3% $\pm$ 7.0). However, this is still only about one-half of what it should be based on vertical distribution data (see section on vertical distribution results). This condition also appeared to be more detrimental to fish as indicated by an increase in descaling.

Side Wings - A very small percentage (12/714 = 1.7%) of the total (guided plus unguided) fingerlings were captured in this area.

Raised Operating Gate - No major increase in FGE was noted when tested with subyearling chinook salmon. Two raised gate conditions were tested; one with and without perforated plate in the STS and the other with and without the deflector. For Tests 9 and 10 (no perforated plate), FGE for the normal gate vs raised gate was 29 vs 30%, and in Tests 18 and 19 (without deflector), it was 27 and 29%, respectively.

Removing Perforated Plate from Inside the STS - No appreciable benefit could be related to removal of the perforated plates (Tests 7, 9, and 10).

Reduced Turbine Load - Descaling appeared to be significantly decreased, but FGE was not enhanced (Tests 3 and 14). The reduced descaling rates, though, were still unacceptably high--17 and 19%, respectively.

Lighting of Forebay - No consistent pattern of improvement occurred with forebay lights. In Tests 1 and 2, forebay lights appeared to improve FGE (46 vs 27%), but in Tests 11 and 12, no benefit was noted (34 vs 35%). The highest FGE for any lighted forebay condition was 46%, well below an acceptable level of FGE.

In summary, in all but one test (everything completely blocked), FGE was not appreciably improved by the various modifications over that measured in 1983. In some instances, it appeared that some of the items tested were actually counter-productive, e.g., the tests with partially blocked trashracks and deflectors. Both of these additions theoretically should have increased FGE simply because they both reduced the unscreened area of the intake, thereby forcing more fish into the area that should be intercepted by the STS. However, both were counter-productive based on vertical distribution information which showed that the STS guided only 30 to 50% of the fish available for interception. Apparently, fish are avoiding or rejecting the STS (Krcma et al. 1984). Possible reasons for this rejection include: (1) there is a flow restriction that subsequently produces a "zone of resistance" that fish detect and avoid, (2) an increasing velocity beneath the STS that is attractive to smolts, (3) a flow deflection that diverts a percentage of the intercepted fish below the STS, or (4) a combination of all three. If this is true, then reducing the open area of the intake (by adding blocked trashracks and/or a deflector) quite possibly compounds these guidance problems and may even transfer the "zone of resistance" further upstream while simultaneously flows are increasing beneath the guiding device. Methods for testing these theories have been developed and will be conducted during the 1985 field season.

Task 2 - Vertical Distribution Tests

Methods and Procedures

Vertical distribution data were obtained by using a single column of fyke nets attached to a frame installed in the turbine intake. Figure 9 illustrates this frame with the number and position of each net. The lower nets (4-7) were about 6.0 x 6.5 ft at the mouth and approximately 15 ft long. The upper nets (1-3) were the same size but were divided in half in an attempt to more accurately define the distribution of the fish in the area intercepted by the STS or deflectors. The nets tapered to an 8-inch diameter metal ring to which a 3-ft long cod-end bag was attached. A standard replicate was conducted in the same manner as the FGE tests, i.e., closing the orifice, lowering the net frame, dipnetting the gatewell, etc. As in the FGE tests, the turbine was run only during the hours when tests were conducted.

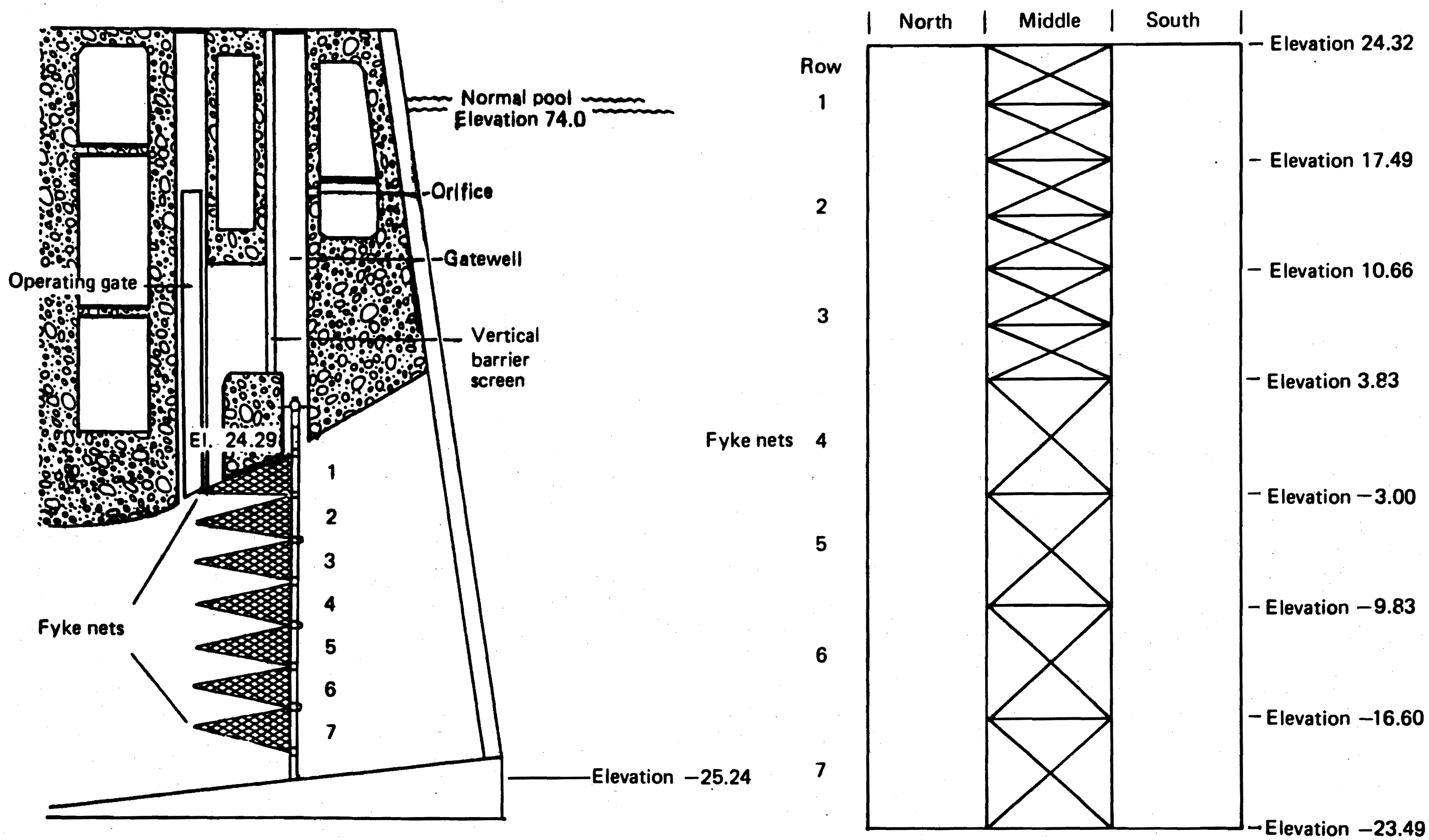


Figure 9.--Cross-section of the turbine intake at Bonneville Dam Second Powerhouse with vertical distribution frame and fyke nets, including a view showing the net layout, 1984.

Testing occurred from 2000 to 2400 h under full turbine load, 70 ± 5 MW (approximately 20,000 cfs). At the end of each test, individual net catches were identified and enumerated by species. Vertical distribution was based on an estimate of the total number of fish entering the intake. Since the single column of fyke nets fished the middle third of the intake, each net catch was multiplied by a factor of three to estimate the number of fish in that net level. The sum of these estimates plus the gatewell catch provided an estimate of the total number of fish entering the intakes during the test. The percentage of fish for each net level (vertical distribution) was determined by dividing the computed figure for each net level by the total intake estimate. Half net data from the top rows were combined for comparison to 1983 data. Vertical distribution testing was done with various combinations of intake conditions. All but two of the conditions tested in 1984 were replicated a minimum of three times.

Results

Twenty-one vertical distribution tests were conducted from 5 May through 20 June. Tests were conducted in Units 12A, 12B, and 15B. Vertical distribution was measured for five different intake conditions: (1) one louvered and one blocked trashrack, (2) 48° deflector with one louvered and one blocked trashrack, (3) 48° deflector only, and (4) 60° deflector only, and (5) intake with no modifications (net frame only). Tables 2 and 3 summarize the results of these tests for yearling chinook and coho salmon and subyearling chinook salmon. Additional details including date, number of fish per net, etc., for each test are contained in Appendix Tables 2 and 3.

These tests indicate that the deflectors and partially blocked trashracks, in conjunction with the STS should be capable of intercepting and

Table 2.--Percentage of yearling chinook salmon and coho salmon in gatewells and fyke nets during vertical distribution tests conducted at Bonneville Dam Second Powerhouse in 1983 and 1984.

		1984 Tests								1983 Tests	
		Test 1 (12B),[a] yearling chinook, louvered rack (2nd), blocked rack (6th) (3)[b]		Test 2 (12B), yearling chinook, 48° deflector, louvered rack (2nd), blocked rack (6th) (2)		Test 3 (12B). yearling coho, 48° deflector (3)		Test 4 (12A), yearling chinook, 60° deflector, blocked rack (6th) (2)		(11B 14B, 15B), yearling chinook net frame only (12)	
Location	Approximate distance from intake ceiling (feet)	Individual (%)	Cumulative (%)	Individual (%)	Cumulative (%)	Individual (%)	Cumulative (%)	Individual (%)	Cumulative (%)	Individual (%)	Cumulative (%)
Gatewell		8.8		17.6		17.9		23.6		12.1	
Net 1	6.5	32.1	40.9	48.3	65.9	31.9	49.9	34.1	57.7	20.0	32.2
Net 2[c]	13.0	23.9	64.8	14.8	80.7	24.7	74.5	12.2	69.9	15.7	47.9
Net 3[d]	19.5	12.2	77.0	5.1	85.8	1.6	76.1	8.3	78.1	13.4	61.3
Net 4[e]	26.0	9.1	86.1	4.0	89.8	6.1	82.2	14.7	92.8	13.4	74.7
Net 5	32.5	3.5	89.6	5.7	95.5	8.1	90.3	4.7	97.5	12.3	87.0
Net 6	39.0	4.3	93.9	4.0	99.5	7.3	97.6	2.5	100.0	9.8	96.8
Net 7	45.5	6.0	100.0	0.6	100.0	2.4	100.0	0.0	-	3.1	100.0

a/ ( ) gatewell.
b/ Number of replicates.
c/ Level that could theoretically be intercepted by the STS at the 48° angle.
d/ Level that could theoretically be intercepted by the STS at the 60° angle and a trashrack deflector.
e/ Level that could theoretically be intercepted by the STS at the 48° angle and a trashrack deflector.

Table 3.--Percentage of sub-yearling chinook salmon in gatewells and fyke nets during vertical distribution test conducted at Bonneville Dam Second Powerhouse in 1983 and 1984.

		1984 Tests						1983 Tests	
		Test 1 (12B),[a] 48° deflector (7)[b]		Test 2 (12B), net frame only (3)		Test 3 (15B), net frame only (3)		(11C, 12B), net frame only (15)	
Location	Approximate distance from intake ceiling (feet)	Individual (%)	Cumulative (%)	Individual (%)	Cumulative (%)	Individual (%)	Cumulative (%)	Individual (%)	Cumulative (%)
Gatewell		10.1		9.6		13.7		11.3	
Net 1	6.5	29.0	39.2	21.0	30.6	20.0	33.7	15.0	26.3
Net 2[c]	13.0	17.6	56.8	15.1	45.6	16.6	50.3	15.9	42.2
Net 3[d]	19.5	11.8	68.6	12.4	58.1	17.4	67.7	20.4	62.6
Net 4[e]	26.0	7.6	76.2	8.5	66.6	12.2	79.9	13.2	75.8
Net 5	32.5	8.2	84.4	6.6	73.2	7.8	87.7	11.4	87.2
Net 6	39.0	11.6	96.0	17.0	90.2	8.7	96.4	8.2	95.4
Net 7	45.5	4.0	100.0	9.8	100.0	3.5	100.0	4.5	100.0

a/ ( ) gatewell.
b/ Number of replicates.
c/ Level that could theoretically be intercepted by the STS at the 48° angle.
d/ Level that could theoretically be intercepted by the STS at the 60° angle and a trashrack deflector.
e/ Level that could theoretically be intercepted by the STS at the 48° angle and a trashrack deflector.

guiding over 70% of the subyearling chinook salmon and 80% of the yearling fish. However, FGE for similar test configurations ranged between 20 and 30% for subyearlings and 26 to 41% for yearling fish.

It was difficult to say if vertical distribution for fingerling salmonids was significantly different between gatewells because intake conditions were not the same for many of the tests in 1984. However, the differences were relatively minor and in no circumstances could they be construed as being capable for significantly improving FGE.

OBJECTIVE II - CONTINUED MONITORING OF THE SECOND POWERHOUSE DSM AND SMOLT INDEXING FACILITIES

The random sampler in the Second Powerhouse provides the means to examine the condition of salmonids passing through the downstream migrant bypass system (DSM) and to index smolt migrations passing Bonneville Dam. The DSM consists of a smolt sampler designed to randomly collect a portion of the juvenile migrants passing through the DSM, a dry separator for removing adult fish and debris, a wet separator in the migrant observation room for separating juvenile migrants by size, and four raceways to hold fish graded by the wet separator.

The 1984 evaluation of the DSM and indexing system had the following primary research objectives: (1) enumerate fish collected by species, measure descaling, and record marks daily throughout the 1984 juvenile salmonid outmigration; (2) improve the size grading capability of the wet separator; (3) evaluate a modified sampling system for taking sample sizes of less than 10%; and (4) monitor DSM operation to determine if recommended improvements to correct deficiencies identified during the past 2 years are satisfactory.

Task 1 - Smolt Indexing

Methods and Procedures

Fish passing through the Second Powerhouse bypass system that were collected by the random sampler were used as an index of the smolt migration and examined to monitor their quality. At least twice a day fish were crowded to the downstream end of the raceways and dipnetted into an anesthetic bath (MS 222). The anesthetized fish were enumerated by species or race and examined for descaling and marks. Descaling was determined by dividing the fish into five equal areas per side; if any two areas on a side were 50% or more descaled, the fish was classified as descaled. Using this criteria, fish classified as descaled are considered to have a poor chance of survival. When large numbers of fish were captured, subsamples of 200 fish per species or race were examined and the remainder enumerated and released. During most weeks, the random sampler was operated Monday through Friday, 24 h a day. Estimates of total weekly passage (by species) were determined by expanding the catch per unit effort from Appendix Table 4 x 10 (random sampler efficiency is 10%).

Results

Between 23 April and 4 October, the random sampler operated for 2,153 h for an average of about 90 h per week. During this time, a total of 80,379 juvenile salmonids were captured, of which 36,099 were examined for descaling and injury (Appendix Table 4). These numbers represent a passage rate for a restricted powerhouse operating level. Usually only three or four of the existing eight turbines at the Second Powerhouse were running during peak periods of fish movement. This limitation was implemented by the CofE to provide added protection for salmonid smolts at this powerhouse until better passage conditions are developed. Figure 10 illustrates a weekly estimate of

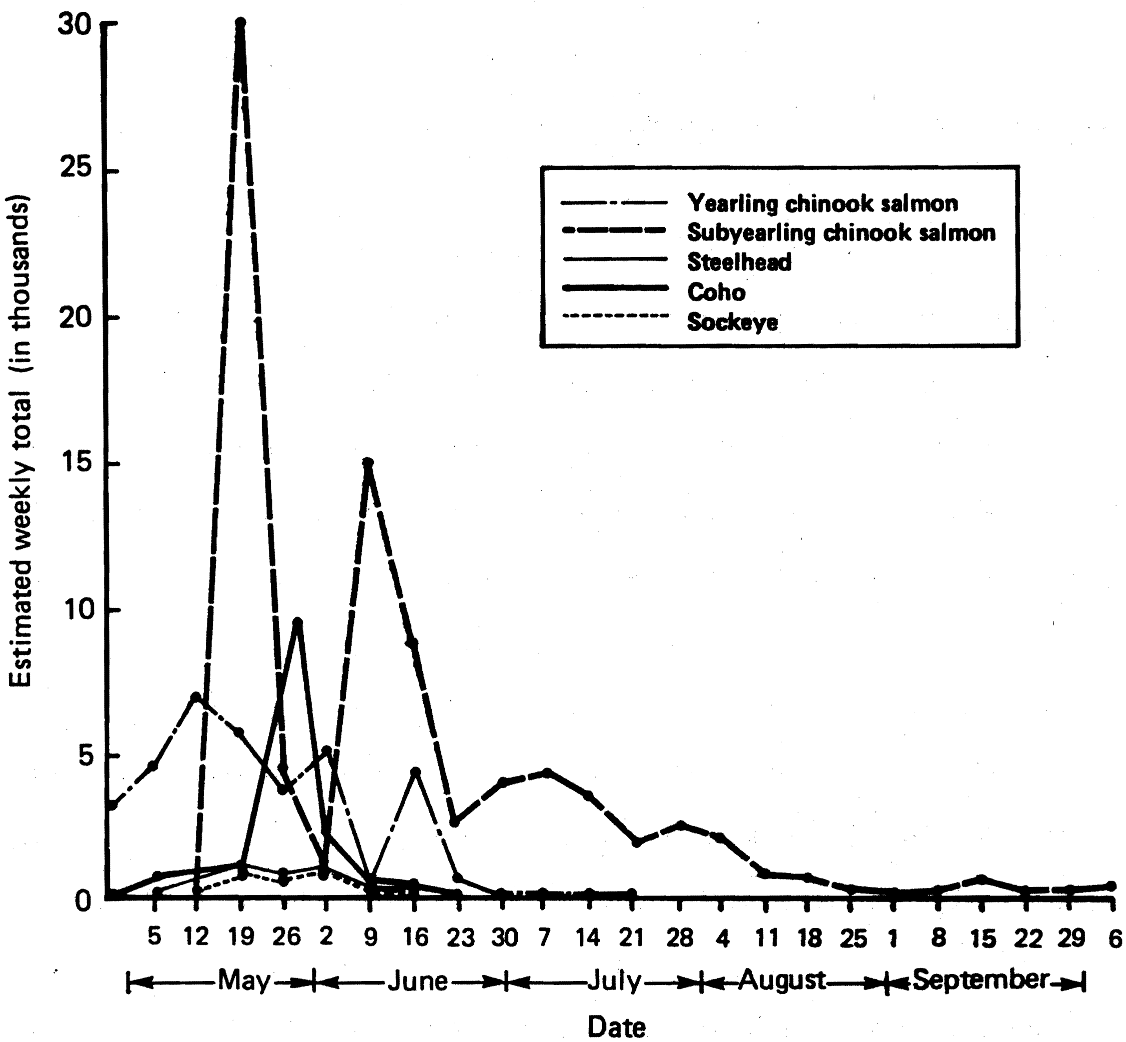


Figure 10.--Weekly estimated passage of salmonids at Bonneville Dam Second Powerhouse, 23 April to 6 October 1984.

the number of fish by species that were bypassed at the Second Powerhouse during the period 23 April to 4 October. Periods of peak migration and the total estimated Second Powerhouse DSM passage by species were: (1) yearling chinook salmon 7 May - 312,750; (2) subyearling chinook salmon 14 May - 853,520; (3) steelhead 14 May - 46,580; (4) coho salmon 21 May - 209,460; and (5) sockeye salmon 14 May - 34,990.

The amount of descaling varied among species. Sockeye salmon had the highest descaling rate (28.3%) and coho salmon the lowest (1.9%). Yearling chinook salmon, subyearling chinook salmon, and steelhead had descaling rates of 9.6, 3.2, and 5.9%, respectively. Compared to 1983 data (Krcma et al. 1984), these descaling rates are higher for yearling chinook salmon, subyearling chinook salmon, and sockeye salmon, but lower for coho salmon and steelhead.

Mortality rates during 1984 were highest for sockeye salmon (23.5%) followed by subyearling chinook salmon (4.5%). Mortality rates for other species were low. Of particular concern was the increased mortality and descaling rates for subyearling chinook salmon at both the First and Second Powerhouses in 1984. At the Second Powerhouse, the subyearling chinook salmon mortality rate was nearly four times greater and the descaling rate three times greater than in 1983 (Krcma et al. 1984). To determine where this injury and descaling was occurring, releases of marked subyearling chinook salmon (three replicates, approximately 600 fish per replicate) were made on 3 June into Gatewell 17A at the Second Powerhouse. The resulting combined mortality and descaling rate was less than 0.2%. These data indicated that the injury and descaling were occurring before the fish entered the gatewell. A possible explanation of this mortality is the quality of fish passing through the dam. Bonneville Dam is the first hydroelectric project encountered by subyearling chinook salmon released from several local hatcheries. The majority of the subyearling chinook salmon examined at the Second Powerhouse were from these releases. Of 16,833 subyearling chinook salmon captured at the Second Powerhouse from a Spring Creek National Fish Hatchery (NFH) release of subyearling chinook salmon in May, 6.1% suffered mortalities and 5.2% were descaled. Mortality and descaling rates in the DSM returned to a more acceptable level after these hatchery releases passed Bonneville Dam.

A total of 4,248 adipose fin clipped and/or branded salmonids were captured at the Second Powerhouse in 1984--4,036 adipose clips and 212 nitrogen freeze brands (Table 4). Individual brand information is available to interested agencies (c/o William Muir, P.O. Box 67, North Bonneville, WA 98639).

Sampling at the Second Powerhouse indexing facilities was discontinued on 4 October because of problems with the mesh on the inclined screen in the DSM. Because of the small numbers of salmonids passing through the Second Powerhouse at this time of year, repair of the inclined screen was postponed and fish were bypassed through the emergency relief conduit. Monitoring of the smolt migration was continued by dipnetting gatewells until 1 December when the STS were removed for annual maintenance requirements (Appendix Table 5).

Task 2 - Wet Separator Evaluation

Methods and Procedures

The wet separator in the Second Powerhouse consists of three grading compartments and an overflow area. In the first, second, and third

Table 4.--Numbers of marked salmonids captured at the Second Powerhouse indexing facility at Bonneville Dam in 1984.

Mark	Yearling chinook	Subyearling chinook	Steelhead	Coho	Sockeye
Adipose clips	1,372	431	823	1,409	1
Brands	178	1	22	0	11

compartments there are 3/8- 3/4-, and 1 1/2-inch spacing between the grading bars, respectively. Each compartment empties into a separate raceway with the overflow diverted into a fourth raceway.

In 1983, the separator only successfully graded 54% of the fish. We felt that fluctuating water levels, mostly at night, caused the poor separation. During 1984, 4 weeks of data were recorded for both day and night operation to determine the impact of fluctuations in water levels in the DSM. During the day when NMFS personnel were in the vicinity of the wet separator, water levels were kept at or near the optimum level for separation. During the night, water levels in the wet separator were raised to reduce the threat of stranding caused by fluctuating water levels in the DSM. Species composition and length frequencies were recorded for each raceway and combined weekly for analysis.

Results

For the 4-week test in 1984, an average of 71.6% of the subyearling chinook salmon were separated by the 3/8-inch grader during the day, 41.3% during the night, and 58.0% combined (Table 5). The range was 67.8-77.6% for daytime separation and 32.9-47.5% for nighttime separation. Separation of other species was also improved with the better water level controls in daytime hours. If accurate separation is required, the data strongly support the need for accurate water level control.

Several factors affected the separation data collected during 1984. First, although water levels in the separator were lowered and monitored during the day, there was still some fluctuation. In general, water level control was much improved over 1983, but could still be improved. Second, to avoid a buildup of fish in the dry separator in the DSM, it was drained each

Table 5.--Species composition with mean fork length comparison for each raceway (grader size) in the Observation Room of the Second Powerhouse at Bonneville Dam, 7 May to 1 June 1984. SE = standard error.

Grader size	Yearling chinook			Subyearling chinook			Steelhead			Coho			Sockeye		
	Percent capture	Mean fork length (mm)	SE	Percent capture	Mean fork length (mm)	SE	Percent capture	Mean fork length (mm)	SE	Percent capture	Mean fork length (mm)	SE	Percent capture	Mean fork length (mm)	SE
							Daytime operation								
3/8"	26.1	131.5	0.8*	71.6	90.8	0.7	2.4	159.0	10.2*	14.3	136.5	2.1*	43.2	101.5	1.7*
3/4"	37.2	142.9	0.9*	13.9	90.2	0.9	24.9	186.0	4.8*	48.8	140.3	1.1*	32.3	106.8	3.1*
1-1/2"	36.7	145.0	1.1*	14.5	89.3	0.8	72.7	206.2	3.3*	36.9	144.6	1.4*	24.5	103.4	2.7
							Nighttime operation								
3/8"	14.5	132.1	0.9*	41.3	90.1	0.6	1.3	162.5	11.0*	5.2	136.5	1.3*	35.3	102.1	1.6
3/4"	27.4	143.7	0.8*	11.3	90.9	0.8	12.7	188.6	4.2*	54.7	143.9	0.7*	9.1	103.3	2.8*
1-1/2"	51.2	145.6	0.8*	36.1	91.1	0.6	68.7	205.3	2.4*	29.0	146.5	0.8*	24.5	97.6	1.6*
+Overflow	6.9	137.6	1.5	11.3	78.6	1.5	17.3	186.1	4.6	11.1	144.8	1.2	31.1	101.3	1.8

* = P<0.05.

+ = No statistical comparison.

morning. Wet separator water levels were adjusted during this operation to keep from stranding fish. Third, although data were recorded separately for day and night, fish still held up in the wet separator from one time period to another. If hold up in the dry and wet separators were reduced or eliminated and water level fluctuations controlled in the DSM, species separation could be improved.

Task 3 - Modified Sampling System

Because of mechanical problems associated with raising and lowering the random sampler, tests for taking samples of less than 10% were cancelled.

Task 4 - DSM Improvements Evaluation

None of the improvements recommended were completed, thus no evaluation was conducted.

Task 5 - Sampling During Releases of Lower River Hatchery Fish

Large numbers of salmonids can often be expected to enter the bypass system soon after local hatchery releases. To avoid handling large numbers of these production releases, while retaining the ability to sample other salmonids, a compartment bypass method was tested. To use this method, the outlet pipe from the desired compartment of the wet separator was connected directly to the raceway overflow. Fish then bypass the raceway and go directly from the wet separator into the downwell and return to the river. Wet separator evaluation data from Table 5 were then used to estimate numbers of fish utilizing the bypassed compartment (i.e., if the 3/8-inch grader compartment was bypassed, then numbers of subyearling chinook salmon collected in the other three compartments divided by 0.299 would provide the estimate of numbers of bypassed subyearlings, etc.).

A 5 June release of 6.9 million subyearling chinook salmon from Little White Salmon NFH was chosen to test the compartment bypass method. On 5 June, this compartment was connected to the raceway overflow, and water levels were monitored continually for the next 3 days. During this period, a total of 3,633 salmonids (all species) were sampled. Had fish not been bypassed, we estimated a total of 9,957 would have been sampled. Thus, we were able to significantly reduce the numbers of sampled fish while still providing accurate estimates of passage.

OBJECTIVE III - EVALUATION OF THE FIRST POWERHOUSE SMOLT INDEXING FACILITIES

The juvenile bypass system at the First Powerhouse was completed during 1984, and began operating on 17 April. The basic design includes features in common with other bypass systems. Submersible traveling screens guide fish into the upstream gatewells. Vertical barrier screens prevent guided fish from re-entering the turbine intake via the downstream gatewell. Fish exit the gatewells through orifices and enter a transportation channel that terminates in an outfall conduit with a submerged discharge in the tailrace.

Features of the system unique to the First Powerhouse include: (1) 14-inch diameter orifices (equipped for timed, automatic back-flushing for debris removal) that operate at a minimum head of about 2.5 feet and with a submerged discharge; (2) a non-sloping transportation channel confined to the existing ice and trash sluiceway, so that flow may run either north to the 24-inch diameter outfall conduit (normal operation) or south into the ice and trash sluiceway; (3) the manual installation of a fish collection tank and flume for sampling of fish (Fig. 11); (4) the ability to either discharge excess water, dissipated through the adjustable inclined screen, to the tailrace through a

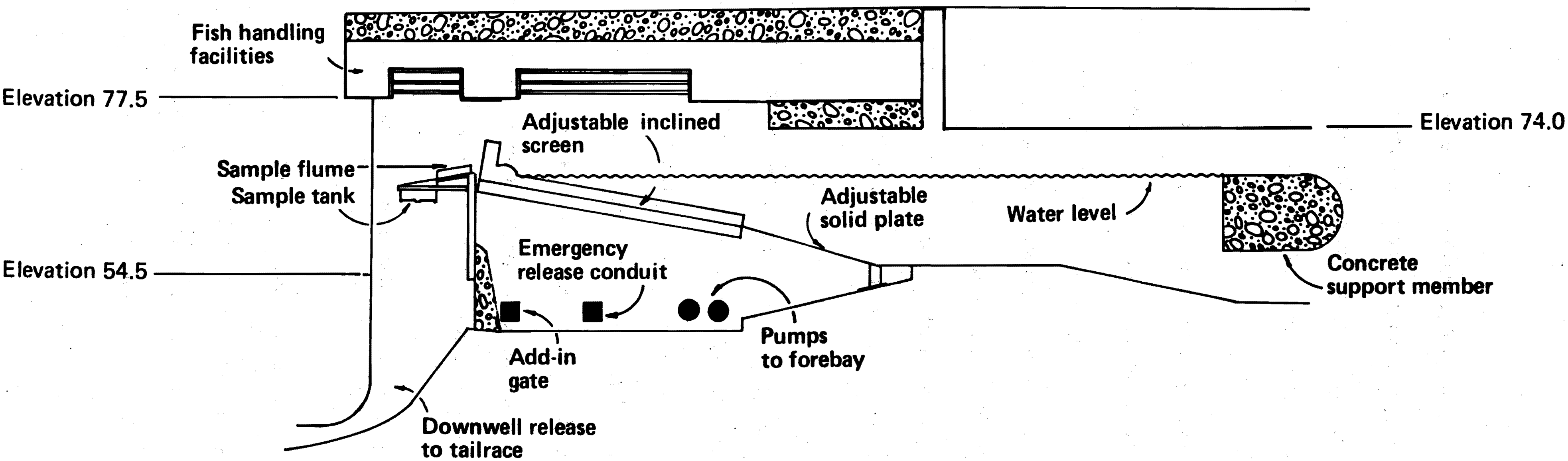


Figure 11.--Cross-section of the juvenile bypass (downstream end) system at Bonneville Dam First Powerhouse, 1984.

48-inch diameter emergency relief conduit or pump excess water back into the forebay (as a water/energy conservation method); and (5) an add-in gate designed to automatically adjust as the forebay fluctuates to maintain a constant water level in the transportation channel, on the inclined screen, and in the emergency relief conduit.

The primary objectives of the evaluation of the smolt indexing facilities were to determine the utility and efficiency of the sampling equipment.

Accomplishment of the objectives was hindered by repeated mechanical failures of the inclined screen trash sweep and by malfunction of the automatic water level controls. These problems usually required reversal of the transportation channel flow to the south (away from the sampling facilities). Downtime for sampling purposes totaled 49 days from 17 April to 10 June (Appendix Table 6). More reliable operation was achieved from 10 June until 21 October when the inclined screen trash sweep failed again, and bypass flow was directed to the south where it remained until the end of the season. Appendix Table 7 is a summary of the smolts captured with the sampling equipment from 30 April to 20 September. From 26 September until 1 December monitoring of the smolt migration was done by dipnetting gatewells (Appendix Table 8). When monitoring was discontinued, fewer than 10 fish per day were estimated entering Gatewell 10A with an STS.

Task 1 - Utility of Sampling Equipment

Methods and Procedures

Sampling equipment included a sample tank, sample flume, dump chute, holding tank, anesthetic trough, and recovery tanks. The sampling procedure began by lowering the sample tank and flume onto a support arm over the downwell (Fig. 11). The sample flume was then tipped to bridge the gap between the sample tank and crest of the inclined screen. After fishing for the desired time, the sample flume was removed from the flow and the sample tank raised. Fish were transferred to the holding tank (through the dump chute), anesthetized, examined, allowed to recover, and released.

Results

Considerable difficulty was experienced handling the sample tank and flume, specifically during placement into the fishing position and transferring the catch to the holding tank. These and other deficiencies were addressed and are listed under General Recommendations. Modifications are underway and should be implemented before the 1985 field season.

Task 2 - Efficiency of Sampling Equipment

Methods and Procedures

The sample flume intercepts approximately 25% of the flow width at the inclined screen crest. If the smolts are randomly distributed across the channel, then fishing for 20 minutes each hour should result in a sampling efficiency of approximately 8%. To measure this and provide information on descaling (see Objective IV), groups of marked subyearling chinook salmon were released at several points within the bypass system.

Results

The marked fish releases provided some information concerning sampler efficiency, but were inadequate for complete evaluation. An average of 10% of the marked fish released into Gatewell 1A were recovered by the sampler (244/2451, range 6.2 - 12.7%) for three replicates (Table 6). The major problem was that the sampler could not be fished on a continuous basis. This problem was addressed, and an improved technique will be tried during the 1985 field season.

Table 6.--Summary of recaptures and descaling for various groups of marked subyearling chinook salmon released in the Bonneville Dam First Powerhouse DSM, 1984.

Release location	Replicate number 1st	2nd	3rd	Total	Percent descaled
Gate slot 1A					
Number released	863	896	692	2,451	
Number recaptured	87	114	43	244	
Percent recaptured	10.1	12.7	6.2	10.0	0.0
Upper transportation channel					
Number released	856	843	898	2,597	
Number recaptured	64	274	181	519	
Percent recaptured	7.5	32.5	20.6	20.0	0.0
Lower transportation channel[a/]					
Number released	844	840	856	2,540	
Number recaptured	351	401	483	1,235	
Percent recaptured	41.6	47.7	56.4	48.6	0.2
Lower transportation channel[b/]					
Number released	887	916	894	2,697	
Number recaptured	360	452	465	1,277	
Percent recaptured	40.6	49.3	52.0	47.3	0.2

a/ Upstream of concrete support member.

b/ Downstream of concrete support member.

OBJECTIVE IV - MONITOR FISH QUALITY AND STRESS ON FINGERLINGS IN THE BYPASS AND INDEXING FACILITIES AT THE FIRST POWERHOUSE

Task 1 - Fish Quality

Methods and Procedures

Groups of freeze branded and partial caudal clipped subyearling chinook salmon (tule stock, Spring Creek NFH) were used to determine if fish quality was adversely impacted by the First Powerhouse bypass system. Fish were transported to Bonneville Dam, held for 2 days, marked, and allowed to recover for 4 days before release. Release locations included: (1) Gatewell 1A, (2) upper transportation channel, and (3) two places in the lower transportation channel; one upstream and one downstream from the concrete support member that obstructs a portion of the lower channel (Fig. 11). Releases began on 25 June, and each was replicated three times on successive days. Sampling was done for 20 minutes each hour from first release until catches indicated the marked fish were clear of the system. All marked fish recovered during the tests were examined for descaling. Standard descaling criteria were used to determine fish quality (see Objective II).

Results

Table 6 is a summary of the recapture and descaling data from the marked fish releases. Only four subyearlings (0.1%) out of a total recapture of 3,275 were classified as descaled. It should be noted that these marked fish were not in a smolting condition, consequently, they may have been less susceptible to descaling than natural migrants. During a period when a direct comparison between DSM descaling and gatewell descaling (fish that had not passed through the system) could be made on subyearling chinook salmon, descaling was 3.5 and 1.0%, respectively, indicating a slight amount of descaling might be attributable to the DSM. Further evaluation will be conducted during the 1985 field season.

Task 2 - Stress Tests

Methods and Procedures

Seawater challenge was used to measure stress on yearling chinook salmon at the First Powerhouse. These tests were to be conducted for two purposes: (1) to measure stress at various points within the DSM (continual mechanical breakdowns precluded these tests) and (2) to measure stress in gatewells equipped with either a standard or a balanced flow vertical barrier screen (SVBS or BFVBS). The BFVBS is designed to evenly distribute the flows through the barrier screens, thereby alleviating any turbulent (potentially stressful) areas that may be present when using the SVBS.

Samples of yearling chinook salmon were collected during three periods of the smolt migration (early season - 15 and 16 May; mid-season - 22, 23, and 24 May; and late season - 30 and 31 May and 1 June). Smolts were collected from the gatewells with a standard dipnet. Samples were then taken with a small dipnet equipped with a sanctuary bag. Fish were transferred using water to water techniques into 10-gallon aquariums. Fish were held in the dark, in an artificial seawater environment during testing. Water temperature was maintained at ambient river temperature by using an external water bath circulating system.

Mortality in seawater challenge tests was used as an indicator of stress. At the termination of each test, counts of live and dead fish were used to form contingency tables. The G-statistic as described by Sokal and Rohlf (1981) was used to test for significance at the df = 0.05 levels. Data were also collected on individual length, descaling, injuries, and disease symptoms.

Results

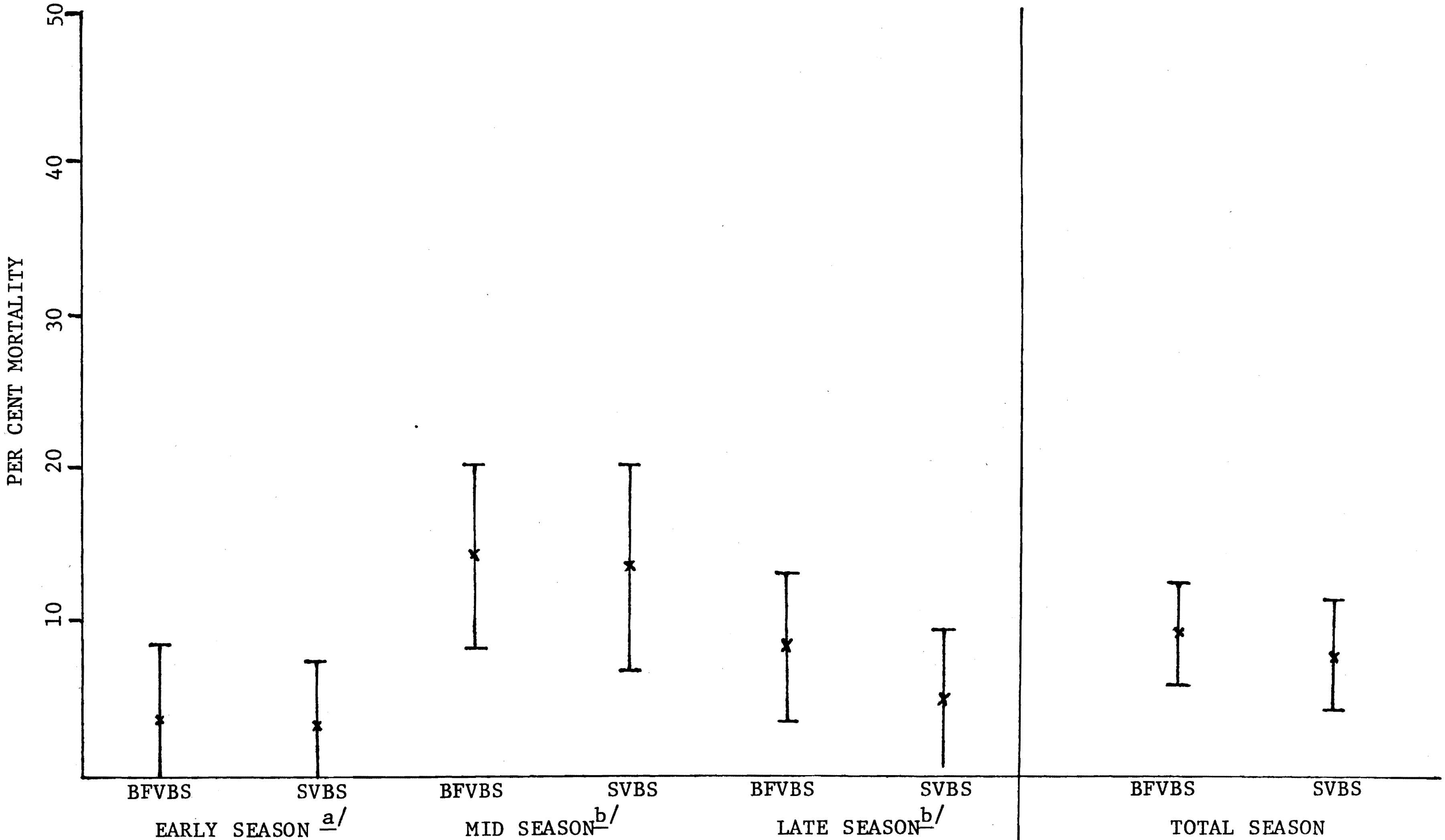
No significant difference in stress was determined between fish collected from gatewells equipped with either the SVBS or BFVBS ($P = 0.55$, $df = 1$) (Fig. 12). Data for the individual replicates are given in Appendix Tables 9-11.

OBJECTIVE V - MONITOR ORIFICE PASSAGE EFFICIENCY AT BOTH POWERHOUSES

Orifice passage efficiency (OPE) tests were to be conducted at both powerhouses during the 1984 field season. Tests were not conducted at the Second Powerhouse because the orifice trap is located in Unit 12B, and FGE tests took priority. Tests were, however, conducted at the First Powerhouse to compare OPE for 12- and 14-inch diameter orifices, SVBS and BFVBS, and for three different types of lights; standard quartz, high pressure sodium, and metal halide.

Methods and Procedures

OPE tests were conducted from 14 May to 25 August. Fish passing through the orifice of Gatewell 9C were captured by means of an inclined plane trap installed in the ice and trash sluiceway. Because there was room for only one trap, tests had to be run consecutively rather than as the more desirable paired replicate. Target species were yearling and subyearling chinook salmon. Tests comparing 12- and 14-inch diameter orifices were conducted in May when yearling fish dominated the catch. The remaining tests were conducted in June and July when mostly subyearling chinook salmon were present. All tests were 24 h in duration, beginning and ending during periods



	EARLY SEASON a/	MID SEASON b/	LATE SEASON b/	TOTAL SEASON
G-Test Results	0.0749 df=1, P=0.78	0.1065 df=1, P=0.74	1.2257 df=1, P=0.27	0.3604 df=1, P=0.55

a/ Two days of replicates, total of 6 tests.
b/ Three days of replicates, total of 9 tests.

Figure 12.--Seawater challenge stress tests conducted with yearling chinook salmon collected from gate slots equipped with balance flow (BFVBS) or standard (SVBS) vertical barrier screens, Bonneville Dam First Powerhouse, 1984. The bars show the 90% confidence intervals for each test condition.

of low fish movement (typically 1000-1400 h). OPE was determined by direct comparison of the number of fish in the trap to the number that were collected from the gatewell by dipnetting at the end of each test. A minimum of three replicates with at least 200 fish of the target species was required for statistical analysis utilizing the G-statistic (Sokal and Rohlf 1981). An OPE approaching 75% in a 24-h period was considered acceptable.

Results

Table 7 summarizes the data for the OPE tests. Data for individual replicates that meet the minimum number requirement were lumped for analysis. Appendix Table 12 gives the collection data for the individual replicates. No significant difference (G = 2.89, df-1, P = 0.09) was found in OPE for yearling chinook salmon when comparing the 14- and 12-inch diameter orifices (70.0 and 73.1%).

Periodical bypass channel reversals occurred due to breakdowns in the DSM which limited the amount of OPE testing that could be accomplished. Therefore, only the 12-inch + diameter orifice was used for tests comparing BFVBS and SVBS. These tests were conducted later in the season when only subyearling chinook salmon were available. The results indicated the OPE appeared to be slightly better with a BFVBS than with a SVBS. Average OPE for 16 tests was 85 vs 79%. These differences, however, were not statistically significant because of variability in OPE among replicates for both barrier screen conditions. These variabilities may have resulted from changes in the behavioral response of different races of fish collected during the 2 months of testing; time lapses between replicates were as much as 7 days (Table 7). In addition, tests with a SVBS were run 1 month earlier (4 June to 10 July) than those with a BFVBS (17 July to 1 August). Tests in 1985 have been

Table 7.--Summary of the OPE data collected at Bonneville Dam First Powerhouse, 1984.

Yearling Chinook Salmon

14-inch orifice				12-inch orifice			
Date	Trap catch (no.)	Total catch (no.)	OPE (%)	Date	Trap catch (no.)	Total catch (no.)	OPE (%)
14 May	175	282	62.1	29 May	181	253	71.5
15 May	370	564	65.6	30 May	214	298	71.8
21 May	441	613	71.9	31 May	171	223	76.7
22 May	502	679	73.9				
23 May	394	551	71.5				
Total	1,882	2,689	70.0		556	774	73.1

Subyearling Chinook Salmon

SVBS				BFVBS			
Date	Trap catch (no.)	Total catch (no.)	OPE (%)	Date	Trap catch (no.)	Total catch (no.)	OPE (%)
4 Jun	200	337	59.3	17 Jul	226	373	60.6
11 Jun	270	419	64.4	18 Jul	208	304	68.4
12 Jun	253	306	82.7	19 Jul	201	336	59.8
13 Jun	224	340	65.9	23 Jul	1,731	1,873	92.4
14 Jun	291	374	77.8	30 Jul	525	555	94.6
1 Jul	671	734	91.4	1 Aug	374	405	92.3
2 Jul	582	615	94.6				
5 Jul	691	989	69.9				
9 Jul	419	466	89.9				
10 Jul	273	345	79.1				
Total	3,874	4,925	78.7		3,265	3,846	84.9

designed to obtain more accurate comparisons of OPE by having to minimize potential bias in results from extended testing.

GENERAL CONCLUSIONS

1. Modifications of the trashrack and STS improved FGE over 1983, but not enough to be acceptable (only 20-40% for most tests). Descaling was higher than desired.

2. The low FGE measured indicates a major problem of deflection or rejection because vertical distribution tests indicated the STS in conjunction with a trashrack deflector should be capable of intercepting and guiding at least 70% of the fish.

3. Descaling of sockeye, yearling chinook, and subyearling chinook salmon in the DSM of the Second Powerhouse in 1984 was higher than in 1983; descaling of coho salmon and steelhead was lower. Sockeye salmon had the highest descaling and mortality.

4. Separating juvenile salmonids by size with the wet separator in the DSM at the Second Powerhouse can be accomplished if water levels can be controlled.

5. The wet separator compartment bypass method tested allows sampling during local hatchery releases without handling an excessive number of fish.

6. Mechanical breakdowns prevented a complete evaluation of the First Powerhouse smolt bypass and indexing facilities.

7. No significant difference in stress was found between groups of yearling chinook salmon collected from gatewells equipped with either a SVBS or a BFVBS.

8. No significant difference in OPE was found between 12- and 14-inch diameter orifices for yearling chinook salmon. OPE for subyearling chinook salmon was not significantly higher in gatewells equipped with a BFVBS.

GENERAL RECOMMENDATIONS

The following list of recommendations were developed at the end of the 1984 operating season. Since then, some of the modifications have been completed and others are in the process and should be finished in time for the 1985 season.

Second Powerhouse

1. Continue FGE testing to determine the cause of the deflection, rejection, or avoidance and determine where it is occurring.

2. Defer OPE testing until satisfactory FGE is achieved.

3. Repair or modify the automatic water level controls to eliminate fluctuations in the water level of the wet and dry separators in the DSM.

4. Modify random sampler in the DSM to allow it to be inserted or removed from the flow automatically. This would allow sampling of less than 10% of the fish from the DSM when desired.

5. Brace tracks of the random sampler to keep them from separating.

6. Complete installation of the spray bar system located between the random sampler and the dry separator.

7. Provide additional auxillary water to supply both the dry separator hopper and the adult/trash bypass channel. Volume through the present auxillary supply varies with forebay level resulting in fluctuations at the and dry separators. Additional auxilliary water should be provided from the

nearby upstream migrant transportation channel--a source not subject to forebay fluctuations.

8. Modify the dry separator hopper to allow operation at variable, stable water levels. The modified hopper must have overflow capacity to handle inflow from a plugged random sampler to eliminate flooding beneath the dry separtor.

9. Weld or caulk the leaks in the dry separator hopper to reduce flooding problems.

10. Modify trash sweep on the dry separator for automatic, timed operation.

11. Install an 8-inch long clear section of pipe directly below the dry separator that can be lighted. This may help reduce fish hold up in the dry separator hopper.

12. Install a removable "hatch" in the dry separator to provide an access for releasing water balloons into the pipe connecting the two separators. This is done whenever the sampler is shut down to force fish out of the pipeline.

13. Cut down the weir between the energy dissipator and the downwell to elevation 44.0 so the water surface in the downwell can be maintained at this elevation. This will improve the drainage from the raceways for fish removal and reduce turbulence in the downwell. Also, lowering the weir would provide a greater range in which the automatic control system could operate and subsequently aid in maintaining the proper water levels.

First Powerhouse

1. Automatic water level controls in the DSM need to be operational for the 1985 field season in both pump-back and free-flowing modes.

2. Repair the inclined screen mesh and the trash sweep for 1985 testing.

3. Modify the sample tank, dump chute, sample flume, and hoist mechanisms of the indexing facilities so complete evaluation of the utility and efficiency of the sampling equipment can be accomplished.

4. Measure fish quality and stress on smolts collected at the indexing facilities.

5. Repeat OPE tests for yearling and subyearling chinook salmon comparing the 12- and 14-inch diameter orifices, BFVBS vs SVBS, and different types of lights. Reduce test duration and days between replicates to minimize potential bias in results from extended testing.

ACKNOWLEDGMENTS

Individual responsibilities for conducting research and writing reports were divided among the junior authors as follows:

OBJECTIVE I - Evaluation of modifications/additions to STS and trashracks at the Second Powerhouse -- Michael H. Gessel and Bruce H. Monk.

OBJECTIVE II - Continued monitoring of the Second Powerhouse DSM and smolt indexing facilities - William D. Muir.

OBJECTIVE III - Evaluation of the First Powerhouse smolt indexing facilities - Lyle G. Gilbreath.

OBJECTIVE IV - Monitor fish quality and stress on fingerlings in the bypass and indexing facilities at the First Powerhouse - C. Scott McCutcheon and Lyle G. Gilbreath.

OBJECTIVE V - Monitor orifice passage efficiency at both powerhouses - Lyle G. Gilbreath.

We would all like to express our appreciation to Bonneville Dam Project Engineer Mr. Gail Gardner and his Superintendent of Maintenance Mr. Quinn O'Brien for their grateful cooperation. We would also like to thank the members of their staffs, without whose assistance this study would not have been possible.

LITERATURE CITED

Krcma, R. F., M. H. Gessel, W. D. Muir, C. S. McCutcheon, L. G. Gilbreath, and B.H. Monk.
1984. Evaluation of the juvenile collection and bypass system at Bonneville Dam -- 1983. U.S. Dep. Commer, Natl. Oceanic Atmos. Admin, Natl. Mar. Fish. Ser., Norhtwest and Alaska Fish. Cent., 56 p. plus Appendix. Report to U.S. Army Corps of Engineers, (Contract DACW57-83-F-0315).

Sokal, R. R., and F. J. Rohlf.
1981. Biometry, 2nd Edition. W.H. Freeman. San Francisco, California, U.S.A.

Appendix Table 1.--Numbers of fish collected in the individual replicates of STS FGE tests at Bonneville Dam Second Powerhouse, 1984 (tests conducted in July and August captured only subyearling chinook salmon).

Date and (test number)[a]

	2 May (1)					2 May (11)					3 May (2)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell		52					49	12				44	22		
Gap Net		2					7				1	5			4
Closure Net	1	2	2				7					3			
1st Level		5				3	1					5			
2nd Level		17	4	2		1	38	4			2	35	4		2
3rd Level	1	26	4	1	1	10	29	5			8	43	7		1
4th Level[b]	6	12	3		3		15				12	18			
5th Level[b]												3			3
Totals	8	116	13	3	4	14	146	21			23	156	33		10

	3 May (12)					4 May (1)					4 May (13)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell		66	24				95	49				126	66		
Gap Net							6	1				1			
Closure Net		8	10				5					28	22		
1st Level	2	15	2				6	2			1	18	8		3
2nd Level	4	46	10		5	4	48	13		2	6	59	26		3
3rd Level	7	46	4		2	4	27	6			6	41	15		
4th Level[b]		9				3	12	3		3	6	33	3		
5th Level[b]												3			
Totals	13	190	50		7	11	199	74		5	19	309	140		6

	5 May (3)					5 May (14)					6 May (3)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell		33	19				44	19				51	17		7
Gap Net			1												
Closure Net		3					28	4		2	1	3	3		
1st Level	1					2	13	2			1	3			
2nd Level		13	10		5	3	49	9		5	2	35	3		4
3rd Level	3	28	7		3	3	18	10			4	44	9		2
4th Level[b]		3					9	3			3	15			
5th Level[b]															
Totals	4	80	37		8	8	161	47		7	11	151	32		13

Appendix Table 1.--cont.

	6 May (14)					19 May (4)					20 May (5)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell		68	18		5	3	34	6				51	9	17	3
Gap Net						5					1	3	1[c]		
Closure Net		40	8		2	2	2					4		2[c]	
1st Level		15	2		3							1		1[c]	
2nd Level	1	106	22		11	9	12	1		1	8	17		8[c]	4
3rd Level	2	38	4		2	25	17			1	11	22	5	7[c]	1
4th Level[b]		6	3			18	9			9	6	6	6		
5th Level[b]							3					3			3
Totals	3	273	57		23	62	77	7		11	26	107	21	35	11

	20 May (15)					23 May (6)					23 May (16)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	5	76	26	20	5	1	85	30	36	2	2	88	44	34	
Gap Net		3	2	1[c]			1	2				1			1
Closure Net		34	6	10[c]	6				1[c]			18	10	12[c]	
1st Level	1	12	2	4[c]	1		1			1		16	3	5[c]	
2nd Level	8	54	7	13[c]	5		2	1	1[c]		2	69	7	24[c]	1
3rd Level	8	21	1	6[c]			7	1	3[c]	1	3	35	4	13[c]	2
4th Level[b]	3	3	9	3[c]			3				3	15	9	6[c]	
5th Level[b]	3											3			
Totals	28	203	53	57	17	1	99	34	41	4	10	245	77	94	4

	2 Jun (7)					2 Jun (17)					3 Jun (7)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	23	43	23		7	31	30	27		13	50	16	12		18
Gap Net	4	4			3	4		1		4	6	8	3		10
Closure Net	2	6				8	12	6		6	6	10			4
1st Level	1	1	1			6	7	5		2	9	6	1		4
2nd Level	11	18	9		11	17	16	6		4	49	22	6		20
3rd Level	9	24	3		6	7	10	2		2	99	14	3		40
4th Level[b]	6	6	3		3	6	15			9	69	42	3		15
5th Level[b]						18				3	15	6			3
Totals	56	102	39		30	97	90	47		43	303	124	28		111

Appendix Table 1.--cont.

	3 Jun (17)					16 Jul (18)					17 Jul (19)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	59	21	10		19	71					103				
Gap Net	4		1		1	1					3				
Closure Net	32	4	1		16	26					58				
1st Level	30	8			4	11					32				
2nd Level	73	17	3		21	15					57				
3rd Level	70	19	9		29	12					36				
4th Level[b]	33	3			12	39					120				
5th Level[b]	3				12	6					21				
Totals	304	72	24		114	181					430				

	19 Jul (19)					20 Jul (18)					21 Jul (19)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	310					117					147				
Gap Net	5					1					1				
Closure Net	156					48					74				
1st Level	73					22					23				
2nd Level	117					69					51				
3rd Level	96					45					33				
4th Level[b]	228					69					105				
5th Level[b]	48					54					27				
Totals	1,033					425					461				

	22 Jul (19)					23 Jul (20)					24 Jul (20)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	110					132					66				
Gap Net	1					1									
Closure Net	58					60					16				
1st Level	41					24					12				
2nd Level	63					141					24				
3rd Level	54					207					48				
4th Level[b]	189					123					12				
5th Level[b]	33					21					6				
Totals	549					709					184				

Appendix Table 1.--cont.

Location	25 Jul (20) SC	YC	ST	CO	SO	26 Jul (21) SC	YC	ST	CO	SO	27 Jul (21) SC	YC	ST	CO	SO
Gatewell	121					103					206				
Gap Net	2					1					4				
Closure Net	30					20					36				
1st Level	17					15					28				
2nd Level	93					72					84				
3rd Level	104					69					158				
4th Level[b/]	60					45					72				
5th Level[b/]	18					12					42				
Totals	445					337					630				

Location	31 Jul (8) SC	YC	ST	CO	SO	1 Aug (8) SC	YC	ST	CO	SO	2 Aug (9) SC	YC	ST	CO	SO
Gatewell	111					142					165				
Gap Net	3					1					3				
Closure Net	18					8					8				
1st Level	9					11					8				
2nd Level	93					126					96				
3rd Level	134					145					166				
4th Level[b/]	144					90					135				
5th Level[b/]	54					54					45				
Totals	566					577					626				

Location	3 Aug (9) SC	YC	ST	CO	SO	6 Aug (10) SC	YC	ST	CO	SO
Gatewell	116					96				
Gap Net	2					3				
Closure Net	4					6				
1st Level	3					6				
2nd Level	60					60				
3rd Level	71					83				
4th Level[b/]	54					57				
5th Level[b/]	21					9				
Totals	331					320				

a/ Test numbers correspond to the numbers in Tables 5-8 in the text.
b/ Numbers of fish captured at these levels have been expanded (x3).
c/ Due to severe net multilation, positive coho salmon identification was not possible, therefore, the net catches of coho salmon in these tests are estimates based on gatewell catch ratios.

SC-Subyearling chinook; YC-Yearling chinook; ST-Steelhead; CO-Coho; SO-Sockeye

Appendix Table 2.--Collection data for yearling chinook and coho salmon for the individual replicates of vertical distribution tests at Bonneville Dam Second Powerhouse, 1984.

	Test number and gatewell ( ), species, and condition tested																	
	Test 1 (12B), Yearling chinook salmon, louvered rack (2nd), blocked rack (6th)					Test 2 (12B), Yearling chinook salmon, 48° deflector, louvered rack (2nd), blocked rack (6th)				Test 3 (12B), Yearling coho salmon, 48° deflector					Test 4 (12A), Yearling chinook salmon, 60° deflector, blocked rack (6th)			
Location	8 May	9 May	10 May	Total	%	11 May	12 May	Total	%	11 Jun	12 Jun	13 Jun	Total	%	11 May	12 May	Total	%
Gatewell	22	31	8	61	8.8	46	47	93	17.6	18	81	34	133	17.9	86	111	197	23.6
1st level																		
Upper net	42	45	27	114	16.5	81	63	144	27.3	36	48	12	96	12.9	84	81	165	19.7
Lower net	39	57	12	108	15.6	42	69	1	21.0	21	102	18	141	19.0	60	60	120	14.4
2nd level																		
Upper net	48	27	6	81	11.7	15	36	51	9.7	27	51	24	102	13.7	21	36	57	6.8
Lower net	36	36	12	84	12.2	21	6	27	5.1	18	51	12	81	10.9	18	27	45	5.4
3rd level																		
Upper net	15	21	18	54	7.8	3	9	12	2.3	0	6	0	6	0.8	9	27	36	4.3
Lower net	3	21	6	30	4.3	6	9	15	2.8	3	3	0	6	0.8	3	30	33	3.9
4th level	21	18	24	63	9.1	9	12	21	4.0	15	27	3	45	6.1	51	72	123	14.7
5th level	6	12	6	24	3.5	18	12	30	5.7	33	24	3	60	8.1	12	27	39	4.7
6th level	6	15	9	30	4.3	12	9	21	4.0	30	9	15	54	7.3	6	15	21	2.5
7th level	15	24	3	42	6.1	0	3	3	0.6	6	6	6	18	2.4	0	0	0	0.0
Totals	253	307	131	691		253	275	528		207	408	127	742		350	486	836	

Appendix Table 3.--Collection data of subyearling chinook salmon for the individual replicates of vertical distribution tests at Bonneville Dam Second Powerhouse, 1984.

	Test number and gatewell ( ), species, and condition tested																	
	Test 1 (12B), Subyearling chinook salmon, 48° deflector									Test 2 (12B), Subyearling chinook salmon, net-frame only					Test 3 (15B), Subyearling chinook salmon, net-frame only				
Date	4 Jun	5 Jun	9 Jun	10 Jun	11 Jun	12 Jun	13 Jun	Total	%	18 Jun	19 Jun	20 Jun	Total	%	12 Jun	13 Jun	14 Jun	Total	%
Gatewell	14	17	19	24	27	25	26	152	10.1	11	16	17	44	9.6	18	16	13	47	13.7
1st level																			
Upper net	18	21	42	42	27	30	24	204	13.6	24	21	15	60	13.1	9	9	12	30	8.7
Lower net	24	24	27	42	24	45	45	231	15.4	9	21	6	36	7.9	12	21	6	39	11.3
2nd Level																			
Upper net	15	15	36	24	18	12	18	138	9.2	12	18	9	39	8.5	0	18	15	33	9.6
Lower net	15	12	12	21	15	33	18	126	8.4	12	15	3	30	6.6	0	18	6	24	7.0
3rd Level																			
Upper net	21	6	30	21	9	9	9	105	7.0	6	15	9	30	6.6	6	18	15	39	11.3
Lower net	3	9	24	15	6	6	9	72	4.8	9	9	9	27	5.9	3	12	6	21	6.1
4th Level	12	15	24	24	18	12	9	114	7.6	15	9	15	39	8.5	9	27	6	42	12.2
5th Level	15	12	39	36	9	6	6	123	8.2	12	12	6	30	6.6	6	15	6	27	7.8
6th Level	12	12	57	30	30	21	12	174	11.6	27	24	27	78	17.0	0	12	18	30	8.7
7th Level	12	3	6	15	9	9	6	60	4.0	18	21	6	45	9.8	0	6	6	12	3.5
Totals	161	146	316	294	192	208	182	1,499		155	181	122	458		63	172	109	344	

Appendix Table 4.--Weekly and cumulative totals of fish captured by the random sampler in the Second Powerhouse at Bonneville Dam in 1984.

	Weekly Totals								Cumulative Totals						
	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Date	Hours fished	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	1.839	389	189	186	11	2,614	April	99.0	1,839	389	189	186	11	2,614	99.0
No. examined	1,313	358	180	166	11	2,028	23		1,313	358	180	166	11	2,028	
No. descaled	84	3	7	4	1	99	April		84	3	7	4	1	99	
No. mortalities	35	9	0	1	0	45	27		35	9	0	1	0	45	
% descaled	6.4	0.8	3.9	2.4	9.1	4.9			6.4	0.8	3.9	2.4	9.1	4.9	
% mortality	1.9	2.3	0.0	0.5	0.0	1.7			1.9	2.3	0.0	0.5	0.0	1.7	
No. captured	2,476	95	250	525	35	3,381	April	91.0	4,315	484	439	711	46	5,995	190.0
No. examined	2,116	91	250	520	34	3,011	30		3,429	449	430	686	45	5,039	
No. descaled	117	0	10	5	4	136	May		201	3	17	9	5	235	
No. mortalities	48	4	0	5	1	58	4		83	13	0	6	1	103	
% descaled	5.5	0.0	4.0	1.0	11.8	4.5			5.9	0.7	4.0	1.3	11.1	4.7	
% mortality	1.9	4.2	0.0	1.0	2.9	1.7			1.9	2.7	0.0	0.8	2.2	1.7	
No. captured	4,037	96	393	470	167	5,163	May	96.0	8,352	580	832	1,181	213	11,158	286.0
No. examined	1,667	77	371	431	148	2,694	7		5,096	526	801	1,117	193	7,733	
No. descaled	131	1	17	6	41	196			332	4	34	15	46	431	
No. mortalities	97	4	2	2	13	118	May		180	17	2	8	14	221	
% descaled	7.9	1.3	4.6	1.4	27.7	7.3	11		6.5	0.8	4.2	1.3	23.8	5.6	
% mortality	2.4	4.2	0.5	0.4	7.8	2.3			2.2	2.9	0.2	0.7	6.6	2.0	
No. captured	3,286	16,833	585	622	584	21,910	May	94.0	11,638	17,413	1,417	1,803	797	33,068	380.0
No. examined	1,662	1,572	569	609	475	4,887	14		6,758	2,098	1,370	1,726	668	12,620	
No. descaled	186	82	32	9	106	415	May		518	86	66	24	152	846	
No. mortalities	65	1,020	5	4	106	1,200	18		245	1,037	7	12	120	1,421	
% descaled	11.2	5.2	5.6	1.5	22.3	8.5			7.7	4.1	4.8	1.4	22.8	6.7	
% mortality	2.0	6.1	0.9	0.6	18.2	5.5			2.1	6.0	0.5	0.7	15.1	4.3	

Appendix Table 4.--Continued

	Weekly Totals								Cumulative Totals						
	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Date	Hours fished	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	2,182	2,564	421	5,232	365	10,764	May	96.0	13,820	19,977	1,838	7,035	1,162	43,832	476.0
No. examined	991	1,246	400	1,581	240	4,458	21		7,749	3,344	1,770	3,307	908	17,078	
No. descaled	114	28	32	19	71	264	May		632	114	98	43	223	1,110	
No. mortalities	75	162	7	28	124	396	25		320	1,199	14	40	244	1,817	
% descaled	11.5	2.2	8.0	1.2	29.6	5.9			8.2	3.4	5.5	1.3	24.6	6.5	
% mortality	3.4	6.3	1.7	0.5	34.0	3.7			2.3	6.0	0.8	0.6	21.0	4.1	
No. captured	2,231	471	321	1,007	361	4,391	May	71.0	16,051	20,448	2,159	8,042	1,523	48,223	547.0
No. examined	813	443	318	990	243	2,807	29		8,562	3,787	2,088	4,297	1,151	19,885	
No. descaled	110	13	22	28	63	236	June		742	127	120	71	286	1,346	
No. mortalities	55	28	3	17	118	221	1		375	1,227	17	57	362	2,038	
% descaled	13.5	2.9	6.9	2.8	25.9	8.4			8.7	3.4	5.7	1.7	24.8	6.8	
% mortality	2.5	5.9	0.9	1.7	32.7	5.0			2.3	6.0	0.8	0.7	23.8	4.2	
No. captured	436	9,847	218	602	130	11,233[a]	June	110.0	16,487	30,295	2,377	8,644	1,653	59,456	657.0
No. examined	341	1,850	210	540	77	3,018	3		8,903	5,637	2,298	4,837	1,228	22,903	
No. descaled	88	69	9	21	39	226	June		830	196	129	92	325	1,572	
No. mortalities	20	484	4	12	24	544	8		395	1,711	21	69	386	2,582	
% descaled	25.8	3.7	4.3	3.9	50.6	7.5			9.3	3.5	5.6	1.9	26.5	6.9	
% mortality	4.6	4.9	1.8	2.0	18.5	4.8			2.4	5.6	0.9	0.8	23.4	4.3	
No. captured	237	4,889	133	2,584	104	7,947	June	96.0	16,724	35,184	2,510	11,228	1,757	67,403	753.0
No. examined	231	1,614	131	1,145	64	3,185	11		9,134	7,251	2,429	5,982	1,292	26,088	
No. descaled	34	17	12	17	26	106	June		864	213	141	109	351	1,678	
No. mortalities	6	195	2	13	40	256	15		401	1,906	23	82	426	2,838	
% descaled	14.7	1.1	9.2	1.5	40.6	3.3			9.5	2.9	5.8	1.8	27.2	6.4	
% mortality	2.5	4.0	1.5	0.5	38.5	3.2			2.4	5.4	0.9	0.7	24.2	4.2	

[a] Totals for this week are estimated because the compartment bypass test occurred at this time.

Appendix Table 4.--Continued.

	Weekly Totals								Cumulative Totals						
	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Date	Hours fished	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	42	1,431	32	383	48	1,936	June	94.0	16,766	36,615	2,542	11,611	1,805	69,339	847.0
No. examined	41	1,268	32	382	39	1,762	18		9,175	8,519	2,461	6,364	1,331	27,850	
No. descaled	13	60	3	10	21	107	June		877	273	144	119	372	1,785	
No. mortalities	1	51	0	1	9	62	22		402	1,957	23	83	435	2,900	
% descaled	31.7	4.7	9.4	2.6	53.8	6.1			9.6	3.2	5.9	1.9	27.9	6.4	
% mortality	2.4	3.6	0.0	0.3	18.8	3.2			2.4	5.3	0.9	0.7	24.1	4.2	
No. captured	61	1,662	4	11	27	1,765	June	70.0	16,827	38,277	2,546	11,622	1,832	71,104	917.0
No. examined	56	981	4	11	24	1,076	27		9,231	9,500	2,465	6,375	1,355	28,926	
No. descaled	8	47	0	0	11	66	June		885	320	144	119	383	1,851	
No. mortalities	1	38	0	0	1	40	29		403	1,995	23	83	436	2,940	
% descaled	14.3	4.8	0.0	0.0	45.8	6.1			9.6	3.4	5.8	1.9	28.3	6.4	
% mortality	1.6	2.3	0.0	0.0	3.7	2.3			2.4	5.3	0.9	0.7	23.8	4.1	
No. captured	58	1,537	1	3	13	1,612	July	60.0	16,885	39,814	2,547	11,625	1,845	72,716	977.0
No. examined	48	905	1	3	11	968	2		9,279	10,405	2,466	6,378	1,366	29,894	
No. descaled	5	54	0	0	3	62	July		890	374	144	119	386	1,913	
No. mortalities	0	20	0	0	0	20	6		403	2,015	23	83	436	2,960	
% descaled	10.4	6.0	0.0	0.0	27.3	6.4			9.6	3.6	5.8	1.9	28.3	6.4	
% mortality	0.0	1.3	0.0	0.0	0.0	1.2			2.4	5.1	0.9	0.7	23.6	4.1	
No. captured	26	2,074	---	12	6	2,118	July	99.0	16,911	41,888	2,547	11,637	1,851	74,834	1,076.0
No. examined	26	1,410	---	12	6	1,454	9		9,305	11,815	2,466	6,390	1,372	31,348	
No. descaled	5	41	---	0	3	49	July		895	415	144	119	389	1,962	
No. mortalities	0	40	---	0	0	40	13		403	2,055	23	83	436	3,000	
% descaled	19.2	2.9	---	0.0	50.0	3.4			9.6	3.5	5.8	1.9	28.4	6.3	
% mortality	0.0	1.9	---	0.0	0.0	1.9			2.4	4.9	0.9	0.7	23.6	4.0	

Appendix Table 4.--Continued.

	Weekly Totals								Cumulative Totals						
	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Date	Hours fished	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	11	621	1	---	1	634	July	53.0	16,922	42,509	2,548	11,637	1,852	75,468	1,129.0
No. examined	11	611	1	---	1	624	16		9,316	12,426	2,467	6,390	1,373	31,972	
No. descaled	0	15	1	---	0	16	July		895	430	145	119	389	1,978	
No. mortalities	0	10	0	---	0	10	19		403	2,065	23	83	436	3,010	
% descaled	0.0	2.5	100.0	---	0.0	2.6			9.6	3.5	5.9	1.9	28.3	6.2	
% mortality	0.0	1.6	0.0	---	0.0	1.6			2.4	4.9	0.9	0.7	23.5	4.0	
No. captured	2	1,321	2	2	---	1,327	July	90.0	16,924	43,830	2,550	11,639	1,852	76,795	1,219.0
No. examined	1	1,233	2	2	---	1,238	23		9,317	13,659	2,469	6,392	1,373	33,210	
No. descaled	0	43	0	0	---	43	July		895	473	145	119	389	2,021	
No. mortalities	1	16	0	0	---	17	27		404	2,081	23	83	436	3,027	
% descaled	0.0	3.5	0.0	0.0	---	3.5			9.6	3.5	5.9	1.9	28.3	6.1	
% mortality	50.0	1.2	0.0	0.0	---	1.3			2.4	4.7	0.9	0.7	23.5	3.9	
No. captured	---	1,308	---	1	---	1,309	July	104.0	16,924	45,138	2,550	11,640	1,852	78,104	1,323.0
No. examined	---	781	---	0	---	781	30		9,317	14,440	2,469	6,392	1,373	33,991	
No. descaled	---	14	---	0	---	14	Aug		895	487	145	119	389	2,035	
No. mortalities	---	11	---	1	---	12	3		404	2,092	23	84	436	3,039	
% descaled	---	1.8	---	0.0	---	1.8			9.6	3.4	5.9	1.9	28.3	6.0	
% mortality	---	0.8	---	100.0	---	0.9			2.4	4.6	0.9	0.7	23.5	3.9	
No. captured	---	783	---	---	---	783	Aug	99.0	16,924	45,921	2,550	11,640	1,852	78,887	1,422.0
No. examined	---	703	---	---	---	703	6		9,317	15,143	2,469	6,392	1,373	34,694	
No. descaled	---	9	---	---	---	9	Aug		895	496	145	119	389	2,044	
No. mortalities	---	3	---	---	---	3	10		404	2,095	23	84	436	3,042	
% descaled	---	1.3	---	---	---	1.3			9.6	3.3	5.9	1.9	28.3	5.9	
%mortality	---	0.4	---	---	---	0.4			2.4	4.6	0.9	0.7	23.5	3.9	

Appendix Table 4.--Continued.

	WEEKLY TOTALS								CUMULATIVE TOTALS						
	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Date	Hours fished	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	---	374	---	---	---	374	Aug	99.0	16,924	46,295	2,550	11,640	1,852	79,261	1,521.0
No. examined	---	367	---	---	---	367	13		9,317	15,510	2,469	6,392	1,373	35,061	
No. descaled	---	7	---	---	---	7	Aug		895	503	145	119	389	2,051	
No. mortalities	---	7	---	---	---	7	17		404	2,102	23	84	436	3,049	
% descaled	---	1.9	---	---	---	1.9			9.6	3.2	5.9	1.9	28.3	5.8	
% mortality	---	1.9	---	---	---	1.9			2.4	4.5	0.9	0.7	23.5	3.8	
No. captured	---	181	---	---	---	181	Aug	103.0	16,924	46,476	2,550	11,640	1,852	79,442	1,624.0
No. examined	---	180	---	---	---	180	20		9,317	15,690	2,469	6,392	1,373	35,241	
No. descaled	---	3	---	---	---	3	Aug		895	506	145	119	389	2,054	
No. mortalities	---	1	---	---	---	1	24		404	2,103	23	84	436	3,050	
% descaled	---	1.7	---	---	---	1.7			9.6	3.2	5.9	1.9	28.3	5.8	
% mortality	---	0.6	---	---	---	0.6			2.4	4.5	0.9	0.7	23.5	3.8	
No. captured	---	124	---	---	2	126	Aug	98.0	16,924	46,600	2,550	11,640	1,854	79,568	1,722.0
No. examined	---	121	---	---	2	123	26		9,317	15,811	2,469	6,392	1,375	35,364	
No. descaled	---	2	---	---	0	2	Aug		895	508	145	119	389	2,056	
No. mortalities	---	3	---	---	0	3	29		404	2,106	23	84	436	3,053	
% descaled	---	1.6	---	---	0.0	1.6			9.6	3.2	5.9	1.9	28.3	5.8	
% mortality	---	2.4	---	---	0.0	2.4			2.4	4.5	0.9	0.7	23.5	3.8	
No. captured	---	101	---	---	1	102	Sep	81.0	16,924	46,701	2,550	11,640	1,855	79,670	1,803.0
No. examined	---	37	---	---	0	37	2		9,317	15,848	2,469	6,392	1,375	35,401	
No. descaled	---	2	---	---	0	2	Sep		895	510	145	119	389	2,058	
No. mortalities	---	1	---	---	0	1	5		404	2,107	23	84	436	3,054	
% descaled	---	5.4	---	---	0.0	5.4			9.6	3.2	5.9	1.9	28.3	5.8	
% mortality	---	1.0	---	---	0.0	1.0			2.4	4.5	0.9	0.7	23.5	3.8	

Appendix Table 4.--Continued.

	WEEKLY TOTALS								CUMULATIVE TOTALS						
	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Date	Hours fished	Yearling chinook	Subyearling chinook	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	---	278	---	---	---	278	Sep	77.0	16,924	46,979	2,550	11,640	1,855	79,948	1,888.0
No. examined	---	274	---	---	---	274	9		9,317	16,122	2,469	6,392	1,375	35,675	
No. descaled	---	7	---	---	---	7	Sep		895	517	145	119	389	2,065	
No. mortalities	---	4	---	---	---	4	12		404	2,111	23	84	436	3,058	
% descaled	---	2.6	---	---	---	2.6			9.6	3.2	5.9	1.9	28.3	5.8	
% mortality	---	1.4	---	---	---	1.4			2.4	4.5	0.9	0.7	23.5	3.8	
No. captured	---	145	---	1	---	146	Sep	102.0	16,924	47,124	2,550	11,641	1,855	80,094	1982.0
No. examined	---	141	---	1	---	142	16		9,317	16,263	2,469	6,393	1,375	35,817	
No. descaled	---	9	---	0	---	9	Sep		895	526	145	119	389	2,074	
No. mortalities	---	4	---	0	---	4	19		404	2,115	23	84	436	3,062	
% descaled	---	6.4	---	0.0	---	6.3			9.6	3.2	5.9	1.9	28.3	5.8	
% mortality	---	2.8	---	0.0	---	2.7			2.4	4.5	0.9	0.7	23.5	3.8	
No. Captured	---	170	1	---	---	171	Sep	123.0	16,924	47,294	2,551	11,641	1,855	80,265	2,105.0
No. Examined	---	168	1	---	---	169	23		9,317	16,431	2,470	6,393	1,375	35,986	
No. Descaled	---	4	0	---	---	4	Sep		895	530	145	119	389	2,078	
No. Mortalities	---	2	0	---	---	2	28		404	2,117	23	84	436	3,064	
% Descaled	---	2.4	0.0	---	---	2.4			9.6	3.2	5.9	1.9	28.3	5.8	
% Mortality	---	1.2	0.0	---	---	1.2			2.4	4.5	0.9	0.7	23.5	3.8	
No. Captured	---	114	---	---	---	114	Oct	48.0	16,924	47,408	2,551	11,641	1,855	80,379	2,153.0
No. Exaained	---	113	---	---	---	113	2		9,317	16,544	2,470	6,393	1,375	36,099	
No. Descaled	---	0	---	---	---	0	Oct		895	530	145	119	389	2,078	
No. Mortalities	---	1	---	---	---	1	4		404	2,118	23	84	436	3,065	
% Descaled	---	0.0	---	---	---	0.0			9.6	3.2	5.9	1.9	28.3	5.8	
% Mortality	---	0.9	---	---	---	0.9			2.4	4.5	0.9	0.7	23.5	3.8	

Appendix Table 5.--Gatewell catches by dipnetting of juvenile salmonids at the Bonneville Dam Second Powerhouse during October-December 1984. (A continuation of the temporal studies when failure of the inclined screen prevented routine sampling.)

		Gatewell 11C[a]		
Week	Sample dates	Catch	Accumulation time	Catch 24h
21-27 Oct	26 Oct	142	48h	
Week total		142	48h	71
28 Oct- 3 Jan	1 Nov	58	24h	
	2 Nov	77	24h	
Week total		135	48h	68
4-10 Nov	7 Nov	66	24h	
	8 Nov	84	24h	
	8 Nov	52	24h	
Week total		202	72h	67
11-17 Nov	15 Nov	78	48h	
Week total		78	48h	39
18-24 Nov	21 Nov	59	48h	
Week total		59	48h	30
25 Nov-1 Dec	30 Nov	60	48h	
Week total		60	48h	30

[a] Sampling in gatewell 11c was terminated with the removal of the screen during the week of 2-8 December.

Appendix Table 6.--Operation of the Bonneville Dam First Powerhouse bypass system during 1984.

Dates	Bypass direction[a] North	South	Comment
17-19 Apr	X		Initial operation with bypass north.
20 Apr-8 May		X	Flow was reversed on 4/20 to investigate impingement of fish on the inclined screen. North bypass was attempted during this time but could not be sustained due to four instances of trash sweep failure.
9 May-10 Jun		X	Trash sweep modified. Air jet debris removal system installed.
11-14 Jun	X		Air system tested. Modified trash sweep functions without breakage.
15-20 Jun		X	Flow reversed to south to dewater screen for completion of contract work.
21 Jun-24 Jul	X		CofE testing pumps and working to resolve automatic control problems.
25-27 Jul		X	Flow reversed to south to dewater screen. Seal plate had loosened, allowing debris to enter beneath the screen and plug add-in water gratings.
28 Jul-10 Aug	X		
11 Aug	X		Trash sweep breaks, but is repaired without flow reversal.
12 Aug-20 Sep	X		
21 Sep		X	Trash sweep breaks. Both carrier bars and one chain are lost down outfall conduit. Bypass will be to the south for the balance of the 1984 outmigration.

[a] North bypass via the 24-inch outfall conduit terminating in the powerhouse tailrace. South bypass via the ice and trash sluiceway.

Appendix Table 7.--Daily catches and descaling data for juvenile salmonids captured at Bonneville Dam First Powerhouse indexing facilities, 1984.

Date	Sample Time	Subyearling chinook Catch #	Subyearling chinook % Descaled	Yearling chinook Catch #	Yearling chinook % Descaled	Steelhead Catch #	Steelhead % Descaled	Coho Catch #	Coho % Descaled	Sockeye Catch #	Sockeye % Descaled
4/30	1330-1350	6	0	113	19	14	14	0	-	0	-
5/1	1542-1554	2	0	156	9	41	15	2	0	0	-
5/8	1018-1048	3		121		17		2		51	
	1300-1314	1		116		21		0		32	
		4	0	237	14	38	8	2	0	83	4
6/13	0835-0905	203		31		15		2		62	
	1325-1350	52		15		11		1		18	
		255	0	46	7	26	8	3	33	80	1
6/14	0837-0914	263		12		13		1		41	
	1328-1358	151		15		13		1		53	
		414	4	27	4	26	0	2	50	94	0
6/15	0838-0908	85		6		1		0		27	
	0945-1000	38		3		0		0		8	
		123	2	9	0	1	0	0	-	35	0
7/2	1352-1422	495	26	27	7	3	1/	3	1/	1	1/
7/3	1242-1302	28		3		0		0		0	
	1318-1338	75		8		0		0		1	1/
		103	34	11	9	0	-	0	-	1	

1/ No descaling sample.
2/ Total catch not enumerated-descaling sample only.

Appendix Table 7.--(Continued)

Date	Sample Time	Subyearling chinook Catch #	Subyearling chinook % Descaled	Yearling chinook Catch #	Yearling chinook % Descaled	Steelhead Catch #	Steelhead % Descaled	Coho Catch #	Coho % Descaled	Sockeye Catch #	Sockeye # Descaled
7/6	1308-1338	2/	28	2/		2/	-	2/	-	2/	-
7/9	0940-1000	49		5		1		0		1	
	1458-1518	156		2		0		0		0	
		205	6	7	0	1		0		1	
7/10	1328-1358	155		4		0		1		0	
	1424-1445	183		4		0		3		1	
		338	4	8	25	0		4		1	
7/11	1343-1405	157		1		0		1		0	
	1545-1555	42		0		0		0		0	
		199	5	1		0		1		0	
7/12	1000-1020	27		0		0		0		0	
	1040-1125	212		1		0		1		1	
	1342-1427	178		0		0		1		0	
		417	4	1	0	0		2	0	1	0
7/18	1112-1132	28		6		0		0		0	
	1500-1532	26		0		0		0		0	
		54	13	6	0	0		0		0	

1/ No descaling sample.
2/ Total catch not enumerated-descaling sample only.

Appendix Table 7.--(Continued)

Date	Sample Time	Subyearling chinook Catch #	Subyearling chinook % Descaled	Yearling chinook Catch #	Yearling chinook % Descaled	Steelhead Catch #	Steelhead % Descaled	Coho Catch #	Coho % Descaled	Steelhead Catch #	Steelhead # Descaled
7/19	1120-1140	67		1		0		0		0	
	1330-1350	46		4		0		1		0	
	1415-1435	26		1		0		1		0	
	1455-1520	28		1		0		0		1	
	1840-1900	29		0		0		0		0	
	1920-1940	15		1		0		0		0	
	2020-2040	10		0		0		0		0	
		221	14	8	25	0		2		1	
7/20	1100-1120	108		1		0		1		0	
	1300-1320	87		1		0		0		0	
	1400-1420	73		3		0		0		0	
	1500-1520	142		3		0		1		0	
		410	11	8	38	0		2	50	0	
7/30	1335-1400	131	4	0		0		0		0	
8/1	0830-0850	27		0		0		0		0	
	1300-1320	137		0		0		0		0	
		164	2	0		0		0		0	
8/2	0920-0940	65	3	0		0		0		0	
8/3	0830-0850	101	3	0		0		0		0	

1/ No descaling sample.
2/ Total catch not enumerated-descaling sample only.

Appendix Table 7.--(Continued)

Date	Sample Time	Subyearling chinook Catch #	Subyearling chinook % Descaled	Yearling chinook Catch #	Yearling chinook % Descaled	Steelhead Catch #	Steelhead % Descaled	Coho Catch #	Coho % Descaled	Sockeye Catch #	Sockeye # Descaled
8/6	0832-0852	10									
	0930-0950	17									
	1030-1050	45									
	1130-1150	31									
	1230-1250	18									
	1330-1350	30									
	1430-1450	106									
	1530-1550	214									
		471	4								
8/8	0830-0850	38									
	0930-0950	39									
	1030-1050	11									
	1100-1120	62									
	1130-1150	26									
	1230-1250	10									
	1300-1320	45									
	1330-1350	89									
	1430-1450	82									
	1455-1515	60									
	1530-1550	9									
		471	4								

1/ No descaling sample.
2/ Total catch not enumerated-descaling sample only.

Appendix Table 7.--(Continued)

Date	Sample Time	Subyearling chinook Catch #	Subyearling chinook # Descaled	Yearling chinook Catch #	Yearling chinook % Descaled	Steelhead Catch #	Steelhead % Descaled	Coho Catch #	Coho % Descaled	Sockeye Catch #	Sockeye # Descaled
8/9	0845-0900	13									
	1055-1010	0									
	1120-1135	1									
	1300-1315	2									
	1320-1337	0									
	1345-1400	0									
	1405-1420	0									
	1530-1550	72									
		88	1								
8/10	0930-0945	3									
	1000-1015	0									
	1025-1040	14									
	1045-1100	48									
	1115-1130	17									
	1140-1155	15									
	1225-1240	10									
	1250-1305	11									
	1320-1335	38									
	1345-1400	1									
	1415-1430	56									
	1445-1500	15									
	1515-1530	7									
		235	9								

1/ No descaling sample.
2/ Total catch not enumerated-descaling sample only.

Appendix Table 7.--(Continued)

		Subyearling chinook		Yearling chinook		Steelhead		Coho		Sockeye	
Date	Sample Time	Catch #	# Descaled	Catch #	% Descaled	Catch %	% Descaled	Catch #	% Descaled	Catch #	# Descaled
8/14	0840-0900	30									
	1000-1020	25									
	1100-1120	43									
	1150-1210	38									
	1330-1350	25									
	1500-1520	71									
	1545-1605	43									
		275	9								
8/15	0855-0910	4									
	0930-0945	3									
	1000-1015	13									
	1030-1045	28									
	1100-1115	8									
	1130-1145	5									
	1300-1315	13									
	1330-1345	5									
	1355-1410	29									
	1511-1526	10									
	1545-1600	37									
		155	6								
8/20	1430-1450	2	1/								
	1520-1540	3	1/								
		5									

1/ No descaling sample.
2/ Total catch not enumerated-descaling sample only.

Appendix Table 8.--Gatewell catches by dipnetting of juvenile salmonids at the Bonneville Dam First Powerhouse during the period 26 August through 1 December 1984. (A continuation of the temporal studies after failure of the inclined screen trash sweep prevented routine sampling).

		Gatewell 9C[a/]			Gatewell 10A[b/]		
Week	Sample dates	Catch	Accumulation time	Catch 24h	Catch	Accumulation time	Catch 24h
26 Aug - 1 Sep	27 Aug	156	24h				
	28 Aug	123	24h				
Week total		279	48h	140			
2-8 Sep	5 Sep	28	24h				
	6 Sep	71	24h				
Week total		99	48h	50			
9-15 Sep	12 Sep	84	24h				
	13 Sep	38	24h				
	14 Sep	56	24h				
Week total		178	72h	59			
16-22 Sep	19 Sep	11	24h				
	20 Sep	4	24h				
Week total		15	48h	8			
23-29 Sep	28 Sep	28	24h				
Week total		28	24h	28			
30 Sep- 6 Oct	1 Oct	40	72h				
Week total		40	72h	13			
7-13 Oct	9 Oct	26	96h				
	12 Oct	43	72h				
Week total		69	168h	10			

Appendix Table 8.--cont.

Week	Sample dates	Gatewell 9C[a] Catch	Gatewell 9C[a] Accumulation time	Gatewell 9C[a] Catch 24h	Gatewell 10A[b] Catch	Gatewell 10A[b] Accumulation time	Gatewell 10A[b] Catch 24h
14-20 Oct		No sample[a]					
21-27 Oct	24 Oct	53	120h				
	26 Oct				67	48h	
Week total		53	120h	11	67	48h	34
28 Oct- 3 Nov	29 Oct	39	72h		114	72h	
	31 Oct	80	48h		83	48h	
	2 Nov	58	48h		98	48h	
Week total		177	168h	25	295	168h	42
4-10 Nov	6 Nov				42	24h	
	7 Nov	20	24h		69	24h	
	8 Nov	16	24h		67	24h	
	9 Nov	8	24h				
Week total		44	72h	15	178	72h	59
11-17 Nov	15 Nov	No sample[c]			14	48h	
Week total					14	48h	7
18-24 Nov	21 Nov	No sample[c]			22	48h	
Week total					22	48h	11
25 Nov - 1 Dec	30 Nov	No sample[c]			14	48h	
Week total					14	48h	7

[a] Screen was removed from 9C the week of 14-20 October. Sampling in 9C after 20 October was with no screen in place.

[b] Screen was removed for the year during the week of 2-8 December.

[c] Gatewell 9C was used exclusively for debris detector testing from the week of 11-17 November on.

Appendix Table 9.--Early Season seawater challenge test data for yearling chinook salmon collected from gatewells with standard (SVBS) or balanced flow vertical barrier screens (BFVBS) at Bonneville Dam First Powerhouse, 1984. Data includes test numbers, descaling, total biomass, and average length of live and dead fish by sample area and replicate after 24 h exposure to 30 ppt artificial seawater (includes data for coho, sockeye, and steelhead which were unintentially sampled with chinook salmon in some tests).

		DEAD FISH															LIVE FISH															
		Number nondescaled					Number descaled					Average fork length mm					Number nondescaled					Number descaled					Average fork length mm					[a] Total biomass
Test	Date	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	(gm)
																	Test Condition - 10A Early Season (BFVBS)															
1/1	15 May	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	28	1	8	2	2	4	0	0	0	0	134.7	94.0	176.8	135.5	112.0	1250.0
1/2	15 May	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	20	1	2	3	1	2	0	2	0	0	131.0	92.0	191.3	135.7	114.0	-
1/3	15 May	1	-	1	0	-	1	-	0	0	-	126.5	-	150.0	-	-	12	-	13	3	-	4	-	0	0	-	137.3	-	172.2	129.3	-	1092.8
1/4																																
2/1	16 May	0	-	0	0	-	0	-	0	0	-	-	-	-	-	-	18	-	3	2	-	5	-	0	0	-	132.7	-	159.0	142.0	-	750.0
2/2	16 May	0	1	0	-	-	1	0	0	-	-	124.0	96.0	-	-	-	21	0	1	-	-	6	0	0	-	-	132.5	-	136.0	-	-	756.6
2/3	16 May	2	0	0	0	0	0	0	0	0	0	120.0	-	-	-	-	17	3	9	2	2	7	0	1	0	0	140.0	98.3	168.0	151.0	98.0	1260.1
3/1																																
3/2																																
3/3																																
Totals or averages		3	1	1	0	0	2	0	0	0	0	123.5	96.0	150.0	-	-	116	5	36	12	5	28	0	3	0	0	134.7	94.8	167.2	138.7	108.0	1021.9
																	Test Condition - 9C Early Season (SVBS)															
1/1	15 May	3	-	0	0	-	0	-	0	0	-	129.0	-	-	-	-	25	-	4	1	-	3	-	0	0	-	137.9	-	185.5	138.0	-	1065.3
1/2	15 May	0	-	0	0	1	0	0	0	0	0	-	-	-	-	80.0	12	-	8	2	5	1	-	0	0	1	135.4	-	172.0	151.0	96.6	780.9
1/3	15 May	1	-	0	0	0	1	-	-	-	-	127.0	-	-	-	93.0	33	-	6	2	3	5	-	0	0	0	136.1	-	181.3	139.5	116.0	1397.4
1/4																																
1/5																																
1/6																																
2/1	16 May	0	0	0	-	1	0	0	0	-	0	-	-	-	-	87.0	16	0	2	-	2	5	1	0	-	0	133.9	97.0	182.0	-	106.5	707.1
2/2	16 May	1	-	0	-	1	0	-	0	-	0	112.0	-	-	-	88.0	20	-	7	-	4	2	-	0	-	0	129.6	-	174.1	-	94.5	877.5
2/3	16 May	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	20	1	7	0	3	4	0	0	1	1	130.5	98.0	172.1	144.0	99.8	950.0
3/1																																
3/2																																
3/3																																
Totals or averages		5	0	0	0	3	1	0	0	0	0	122.7	-	-	-	87.0	126	1	34	5	17	20	1	0	1	2	133.9	97.5	177.8	143.1	102.7	963.0

[a] Biomass includes incidental catches of other species.

YC - Yearling chinook, SC - Subyearling chinook, ST - Steelhead, CO - Coho, SO - Sockeye.

Appendix Table 10.--Mid-season seawater challenge test data for yearling chinook salmon collected from gatewells with standard (SVBS) or balanced flow vertical barrier screens (BFVBS) at Bonneville Dam First Powerhouse, 1984. Data includes test numbers, descaling, total biomass, and average length of live and dead fish by sample area and replicate after 24 h exposure to 32 ppt artificial seawater (includes data for coho, sockeye, and steelhead which were unintentially sampled with chinook salmon in some tests).

		DEAD FISH															LIVE FISH															
		Number nondescaled					Number descaled					Average fork length mm					Number nondescaled					Number descaled					Average fork length mm					a/ Total biomass
Test	Date	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	(gm)
																	Test Condition - 10A Mid-Season (BFVBS)															
1/1	22 May	4	3	0	0	-	1	0	0	0	-	134.4	83.3	-	-	-	17	0	3	3	-	4	0	1	0	-	131.7	-	156.3	134.0	-	899.5
1/2	22 May	3	3	1	0	1	0	0	0	0	0	123.7	78.3	173.0	-	88.0	7	0	1	6	0	4	0	3	1	0	137.5	-	185.3	142.9	-	865.5
1/3	22 May	2	3	1	1	2	1	0	0	0	0	124.7	84.3	191.0	120.0	91.5	12	0	1	7	0	2	0	0	0	0	141.9	-	163.0	143.9	-	876.0
1/4																																
2/1	23 May	2	-	0	0	-	0	-	0	0	-	144.0	-	-	-	-	9	-	2	8	-	2	-	3	0	-	138.5	-	181.8	139.5	-	856.0
2/2	23 May	0	1	0	0	0	1	0	0	0	0	132.0	104.0	-	-	-	13	2	5	4	1	0	0	0	1	0	140.7	87.5	180.2	139.6	100.0	807.5
2/3	23 May	1	0	0	0	-	0	0	0	0	-	120.0	-	-	-	-	13	1	4	3	-	2	0	0	0	-	135.3	80.0	186.0	145.7	-	696.0
3/1	24 May	1	2	0	0	1	0	0	0	0	0	114.0	92.0	-	-	83.0	12	3	1	12	1	3	0	0	0	0	139.7	94.7	195.0	138.7	100.0	911.5
3/2	24 May	3	1	0	0	1	1	1	0	0	0	122.5	100.0	-	-	85.0	9	2	8	26	0	2	0	0	1	0	142.5	95.5	177.3	144.4	-	1651.0
3/3	24 May	0	1	0	0	0	1	0	0	0	0	132.0	88.0	-	-	-	7	0	7	10	1	4	0	0	0	1	137.5	-	163.1	142.0	94.5	926.5
Totals or averages		16	14	2	1	5	5	1	0	0	0	127.5	90.0	182.0	120.0	86.9	99	8	32	79	3	23	0	7	3	1	138.4	89.4	176.4	141.2	98.2	943.3
																	Test Condition - 9C Mid-Season (SVBS)															
1/1	22 May	4	7	0	0	1	0	0	1	0	0	131.0	91.9	178.0	-	102.0	10	0	1	8	1	2	0	1	0	0	137.7	-	167.0	145.5	93.0	909.0
1/2	22 May	4	1	0	2	-	0	0	0	0	-	129.0	80.0	-	145.7	-	10	0	2	7	-	2	0	1	0	-	138.5	-	164.7	143.6	-	962.0
1/3	22 May	2	4	1	0	-	1	0	0	0	-	149.0	84.5	187.0	-	-	16	0	4	3	-	2	0	0	0	-	136.4	-	158.3	132.0	-	896.0
1/4																																
1/5																																
1/6																																
2/1	23 May	1	0	0	0	3	1	0	0	0	0	130.0	91.0	-	-	-	16	3	2	2	1	3	0	1	1	0	144.3	99.0	176.3	136.3	97.0	915.0
2/2	23 May	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	8	2	6	3	1	6	0	0	0	0	139.4	95.5	162.0	146.7	96.0	750.0
2/3	23 May	1	0	0	0	1	0	0	0	0	0	117.0	-	-	-	84.0	15	4	2	8	2	2	0	0	0	0	138.0	92.5	174.0	143.9	96.0	874.3
3/1	24 May	2	2	1	2	1	0	0	0	0	1	131.5	89.0	171.0	130.0	103.5	16	0	5	19	1	3	0	0	1	0	135.6	-	186.2	139.7	95.0	1440.0
3/2	24 May	2	2	0	0	1	1	0	0	0	0	111.3	85.5	-	-	91.0	9	4	3	13	2	1	0	0	0	0	131.8	95.3	168.7	136.1	95.5	846.0
3/3	24 May	2	1	0	0	1	0	0	0	0	0	141.5	82.0	-	-	91.0	14	5	4	26	1	1	0	0	2	1	135.7	89.0	186.0	138.3	96.0	1490.0
Totals or averages		18	17	2	4	8	3	0	1	0	1	130.0	86.3	178.7	137.9	94.3	114	18	29	89	9	22	0	3	4	1	137.5	94.3	171.5	140.2	95.5	1009.1

a/ Biomass includes incidental catches of other species.

YC - Yearling chinook, SC - Subyearling chinook, ST - Steelhead, CO - Coho, SO - Sockeye

Appendix Table 11.--Late season seawater challenge test data for yearling chinook salmon collected from gatewells with standard (SVBS) or balanced flow vertical barrier screens (BFVBS) at Bonneville Dam First Powerhouse, 1984. Data includes test numbers, descaling, total biomass, and average length of live and dead fish by sample area and replicate after 24 h exposure to 32 ppt artificial seawater (includes data for coho, sockeye, and steelhead which were unintentially sampled with chinook salmon in some tests).

		DEAD FISH Number nondescaled					DEAD FISH Number descaled					DEAD FISH Average fork length mm					LIVE FISH Number nondescaled					LIVE FISH Number descaled					LIVE FISH Average fork length mm					a/ Total biomass
Test	Date	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	YC	SC	ST	CO	SO	(gm)
Test Condition - 10A Late Season (BFVBS)																																
1/1	30 May	1	0	0	0	1	1	0	0	0	0	123.0	-	-	-	96.0	13	1	4	6	0	3	0	0	0	0	132.6	95.0	165.3	140.8	-	774.5
1/2	30 May	1	0	0	0	0	0	0	0	0	0	123.0	-	-	-	-	14	3	3	4	0	1	0	0	0	1	138.0	97.0	157.3	146.3	119.0	693.0
1/3	30 May	1	-	0	0	1	0	-	0	0	0	131.0	-	-	-	88.0	15	-	3	2	0	3	-	0	0	0	132.6	-	162.0	141.5	-	700.6
1/4																																
2/1	31 May	3	2	0	0	0	1	0	0	0	0	117.3	80.5	-	-	-	15	2	1	5	1	1	0	0	0	0	140.8	93.5	150.0	140.6	95.0	706.5
2/2	31 May	1	0	0	0	0	0	0	0	0	0	142.0	-	-	-	-	13	4	4	8	1	3	1	0	1	0	132.3	96.6	163.5	145.7	109.0	926.2
2/3	31 May	2	0	0	0	2	1	1	0	0	0	123.7	100.0	-	-	89.5	26	6	5	7	1	4	0	0	1	1	137.8	100.0	170.2	139.5	106.0	1415.5
3/1	1 Jun	1	1	1	0	0	0	1	0	0	0	136.0	104.5	158.0	-	-	26	5	1	5	1	4	0	0	0	0	134.1	100.2	174.0	150.2	96.0	1070.8
3/2	1 Jun	1	1	0	0	1	2	0	0	0	0	140.0	67.0	-	-	89.0	17	8	2	10	1	2	0	0	0	0	133.0	102.5	160.5	140.1	99.0	1085.5
3/3	1 Jun	0	1	0	0	0	0	1	0	0	0	-	94.0	-	-	-	13	3	1	9	1	3	0	0	0	0	138.5	95.0	168.0	139.1	97.0	821.0
Totals or averages		11	5	1	0	5	5	3	0	0	0	129.5	89.2	158.0	-	90.6	152	32	24	56	6	24	1	0	2	2	135.5	97.5	163.4	142.6	103.0	910.4
Test Condition - 9C Late Season (SVBS)																																
1/1	30 May	1	-	0	0	0	0	-	0	0	1	115.0	-	-	-	106.0	12	-	2	2	0	3	-	0	0	0	139.5	-	165.0	141.0	-	628.0
1/2	30 May	0	-	0	0	0	0	-	0	0	0	-	-	-	-	-	14	-	2	3	1	4	-	0	0	0	145.8	-	183.5	150.0	115.0	775.0
1/3	30 May	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	12	3	3	2	2	1	0	0	0	0	141.7	93.0	176.0	135.5	93.0	625.0
1/4																																
1/5																																
1/6																																
2/1	31 May	0	0	0	0	1	0	0	0	0	0	-	-	-	-	80.0	17	10	2	4	3	3	1	0	0	0	131.2	97.2	177.5	131.8	103.3	781.7
2/2	31 May	3	1	0	0	1	1	0	0	0	0	127.0	94.0	-	-	112.0	16	4	2	5	3	3	0	1	0	0	138.9	99.0	172.7	145.6	96.3	927.0
2/3	31 May	0	3	0	0	1	0	0	0	0	0	-	88.3	-	-	90.0	13	4	2	9	1	2	0	0	0	0	135.7	97.5	175.0	139.6	95.0	777.2
3/1	1 Jun	0	1	0	0	0	1	1	0	0	0	129.0	90.0	-	-	-	11	6	2	2	3	3	0	0	0	0	134.0	99.3	171.0	126.0	105.0	592.0
3/2	1 Jun	1	0	0	0	0	0	1	0	1	0	127.0	95.0	-	131.0	-	10	4	3	2	1	0	0	1	1	0	137.9	100.8	171.8	137.7	96.0	627.4
3/3	1 Jun	1	1	0	0	1	0	2	0	0	0	113.0	93.7	-	-	85.0	16	9	4	6	4	3	0	0	0	0	134.8	98.8	158.0	140.5	97.5	935.0
Totals or averages		6	6	0	0	4	2	4	0	1	1	122.2	92.0	-	131.0	94.6	121	40	22	35	18	22	1	2	1	0	137.7	97.9	172.3	138.4	100.1	740.9

a/ Biomass includes incidental catches of other species.

YC - Yearling chinook, SC - Subyearling chinook, ST - Steelhead, CO - Coho, SO - Sockeye.

Appendix Table 12.--Orifice passage efficiency (OPE) tests conducted at Bonneville Dam First Powerhouse, 1984. All tests were 24 h in duration with approximately 2.5 feet of head on the orifice. Individual replicates <200 fish of a given species or race were not used for statistical evaluation.

Date	Yearling Chinook			Subyearling Chinook			Steelhead			Coho			Sockeye		
	Trap catch	Total catch	% OPE	Trap catch	Total catch	% OPE	Trap catch	Total catch	% OPE	Trap catch	Total catch	% OPE	Trap catch	Total catch	% OPE
TEST I.--14" Diameter Orifice, SVBS, Quartz Light															
14-15 May	175	282	62.1	7	10	70.0	60	106	56.6	15	39	38.5	29	40	72.5
15-16 May	370	564	65.6	9	11	81.8	118	209	56.4	69	96	71.9	66	79	83.5
21-22 May	441	613	71.9	106	166	63.8	316	468	67.5	109	139	78.4	558	663	84.2
22-23 May	502	679	73.9	62	86	72.1	600	795	75.5	85	118	72.0	388	421	92.2
23-24 May	394	551	71.5	72	100	72.0	437	577	75.7	96	119	80.7	635	749	84.8
Totals	1,882	2,689	70.0	256	373	68.6	1,531	2,155	71.0	374	511	73.2	1,676	1,952	85.9
TEST II.--12" Diameter Orifice, SVBS, Quartz Light															
29-30 May	181	253	71.5	23	28	82.1	115	161	71.4	32	40	80.0	89	99	89.9
30-31 May	214	298	71.8	24	55	43.6	66	98	67.3	19	31	61.3	112	133	84.2
31 May-1 Jun	171	223	76.7	65	90	72.2	87	124	70.2	19	28	67.8	64	78	82.1
4-5 Jun	41	51	80.4	200	337	59.3	44	73	60.3	5	8	62.5	13	16	81.3
11-12 Jun	33	48	68.7	270	419	64.4	29	39	74.3	9	13	69.2	404	473	85.4
12-13 Jun	15	19	78.9	253	306	82.7	19	22	86.4	4	6	66.7	232	260	89.2
13-14 Jun	33	39	84.6	224	340	65.9	24	32	75.0	6	10	60.0	94	97	96.9
14-15 Jun	32	40	80.0	291	374	77.8	26	37	70.3	8	10	80.0	103	129	79.8
1-2 Jul	18	21	85.7	671	734	91.4	3	4	75.0	4	4	100.0	1	1	100.0
2-3 Jul	11	13	84.6	582	615	94.6	2	2	100.0	0	1	0.0	2	2	100.0
5-6 Jul	19	37	51.4	691	989	69.9	4	5	80.0	0	1	0.0	1	2	50.0
9-10 Jul	10	10	100.0	419	466	89.9	0	0	0.0	1	2	50.0	0	0	0.0
10-11 Jul	8	9	88.9	273	345	79.1	2	2	100.0	0	0	0.0	0	0	0.0
Totals	786	1,061	74.1	3,986	5,098	78.2	421	599	70.3	107	154	69.5	1,115	1,290	86.4

Appendix Table 12.--Continued

	Yearling Chinook			Subyearling Chinook			Steelhead			Coho			Sockeye		
Date	Trap catch	Total catch	% OPE	Trap catch	Total catch	% OPE	Trap catch	Total catch	% OPE	Trap catch	Total catch	% OPE	Trap catch	Total catch	% OPE
TEST III.--12" Diameter Orifice, BFVBS, Quartz Light															
17-18 Jul	1	1	100.0	226	373	60.6	0	0	-	0	0	-	0	0	-
18-19 Jul	0	0	-	208	304	68.4	0	0	-	0	0	-	0	0	-
19-20 Jul	0	0	-	201	336	59.8	0	0	-	0	0	-	0	0	-
23-24 Jul	2	2	100.0	1,731	1,873	92.4	0	0	-	0	0	-	0	0	-
30-31 Jul	0	0	-	525	555	94.6	2	2	100.0	0	0	-	0	0	-
1-2 Aug	0	0	-	374	405	92.3	0	0	-	0	0	-	0	0	-
Totals	3	3	100.0	3,265	3,846	84.9	2	2	100.0	0	0	-	0	0	-
TEST IV.--12" Diameter Orifice, BFVBS, High Presure Solium Light															
13-14 Aug	0	0	-	148	262	56.5	0	0	-	0	0	-	0	0	-
14-15 Aug	0	0	-	201	250	80.4	0	0	-	0	0	-	0	0	-
15-16 Aug	0	0	-	123	135	91.1	0	0	-	0	0	-	0	0	-
16-17 Aug	0	0	-	65	178	36.5	0	0	-	0	0	-	0	0	-
20-21 Aug	0	0	-	64	65	98.5	0	0	-	0	0	-	0	0	-
Totals	0	0	-	601	890	67.5	0	0	-	0	0	-	0	0	-
TEST V.--12" Diameter Orifice, BFVBS, Metal Halide Light															
21-22 Aug	0	0	-	185	278	66.5	0	0	-	0	0	-	0	0	-
22-23 Aug	0	0	-	47	121	38.8	0	0	-	0	0	-	0	0	-
23-24 Aug	0	0	-	68	158	43.0	0	0	-	0	0	-	0	0	-
24-25 Aug	0	0	-	82	84	97.6	0	0	-	0	0	-	0	0	-
Totals	0	0	-	382	641	59.6	0	0	-	0	0	-	0	0	-