Evaluation of the Juvenile Collection and Bypass Systems at Bonneville Dam – 1985

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COASTAL ZONE AND ESTUARINE STUDIES

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INTRODUCTION

The National Marine Fisheries Service (NMFS) under contract to the U.S. Army Corps of Engineers (CofE) began studies in 1983 to evaluate the fingerling collection and bypass system at the Bonneville Dam Second Powerhouse. These studies have concentrated primarily on improving the fish guiding efficiency (FGE) of the submersible traveling screens (STS). Studies in 1983, showed very low FGEs of less than 30% for the STS (Krcma et al. 1984). Vertical distribution tests conducted during the same period indicated two problem areas: (1) a large percentage of the juvenile salmonids were passing through the turbine intake below the STS and (2) avoidance and/or deflection was also occurring because FGE was approximately half of the theoretical potential FGE (based on vertical distribution tests). An extensive model study was then initiated to determine potential methods of increasing FGE.

Studies during the 1984 field season implemented several of the recommended modifications/additions to the STS and trashracks (Gessel et al. 1985). FGE, however, remained at an unacceptable level, plus fish condition deteriorated as indicated by increased descaling and mortality. Vertical distribution tests reinforced the indication of an avoidance/deflection problem since potential FGEs greater than 70% were indicated, but FGEs of only 30-50% were attained. Several possible reasons were suspected for the avoidance/deflection problem: (1) a flow restriction causing a "zone of resistance" that fish detect and avoid, (2) increasing velocity below the STS that attracts smolts, (3) a flow deflection that diverts a percentage of the intercepted fish below the STS, and (4) a combination of all three.

During the 1985 smolt migration, NMFS evaluated various methods intended to improve the fingerling collection and bypass system efficiency at the Bonneville Dam Second Powerhouse. Studies were also conducted to evaluate the fingerling bypass and sampling facilities at the First Powerhouse. Research for 1985 had the following primary objectives:

1. Evaluate modifications to improve FGE at the Second Powerhouse.

2. Continue monitoring the Second Powerhouse downstream migrant system (DSM) sampling facilities.

3. Evaluate the First Powerhouse juvenile bypass and sampling system.

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

5. Continue orifice passage efficiency (OPE) studies at the First Powerhouse.

6. Determine diel passage of juvenile migrants at the First Powerhouse.

7. Continue temporal smolt passage studies at Bonneville Dam.

This report provides pertinent findings of the research conducted in 1985.

OBJECTIVE I -- EVALUATION OF MODIFICATIONS TO IMPROVE FGE AT THE SECOND POWERHOUSE

Task 1 - STS FGE Tests

Methods and Procedures

FGE tests were conducted using the same procedures developed in previous years. A net frame attached to the traveling screen supported nets to collect unguided fish (Fig. 1). A standard replicate began by closing the orifice, lowering the STS and net frame into the intake, setting the STS at the

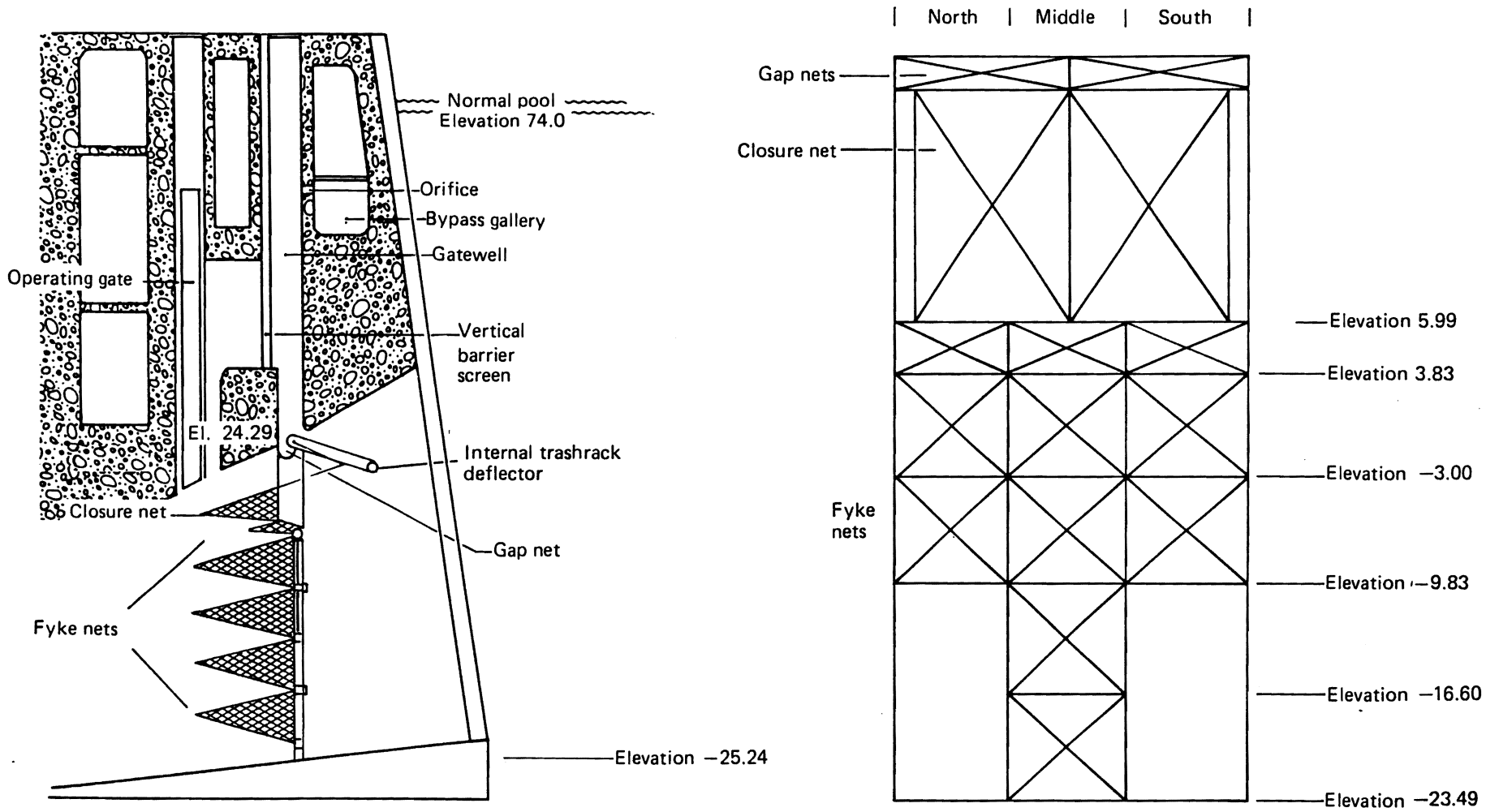

Figure 1.--Cross-section of the turbine intake with a traveling screen, internal trashrack deflecting and attached nets at Bonneville Dam Second Powerhouse; the net layout is also shown - 1985.

required operating angle, dipnetting the gatewell to remove all residual fish, and starting the turbine. 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 spring, FGE tests with yearling fish were conducted with a unit load of 18,000 cfs. During the summer tests with subyearlings, high forebay levels combined with low tailwater elevations reduced the unit discharge to 15,000 - 16,000 cfs.

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.

The 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

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

A minimum of three to five replicates of a specific test condition are usually required for statistical analysis. This replication was not always attained, nor necessary, because of the variety of possible test conditions, continued low FGE, and the relatively short time available for testing. Therefore, much of the effort was spent searching for solutions, often with very little replication. The data for these unreplicated tests are presented as possible trend indicators, not for statistical analysis. Each condition compared requires about 500 fish per replicate to be able to identify a difference of 10% or greater in FGE at an "alpha" = 0.05 level of significance with a power of tests of 1- "beta" = 0.80. In the repeated trials, the number of replicates is determined using the formulas in Appendix A as based on an FGE standard error of 0.0314.

Each test would be run until adequate numbers of guided fish for statistical analysis were collected in the gatewell. This would vary depending on FGE. If FGE was anticipated to be about 30%, then testing would stop after about 150 fish (of the target species) were guided into the gatewell. For 40% FGE, testing would stop when 200 fish were guided into the gatewell. For most tests in 1985, the target number was 200 guided fish.

One of the major problems observed in 1984 was a serious deflection under or avoidance of the STS. To determine if a flow restriction in the throat area was a cause of the avoidance/deflection, an STS was modified so it could be lowered an additional 2 to 4 feet into the turbine intake (Fig. 2). This enabled us to increase the throat opening and subsequently increase flow through this area. A false gap device was fabricated and available for testing if we needed to try and minimize escapement of fish through the enlarged gap that resulted when the STS was lowered. In addition, to reduce turbulence immediately downstream from the trashrack, three specially designed streamlined trashracks (Fig. 2) were positioned in the upper half of Intake

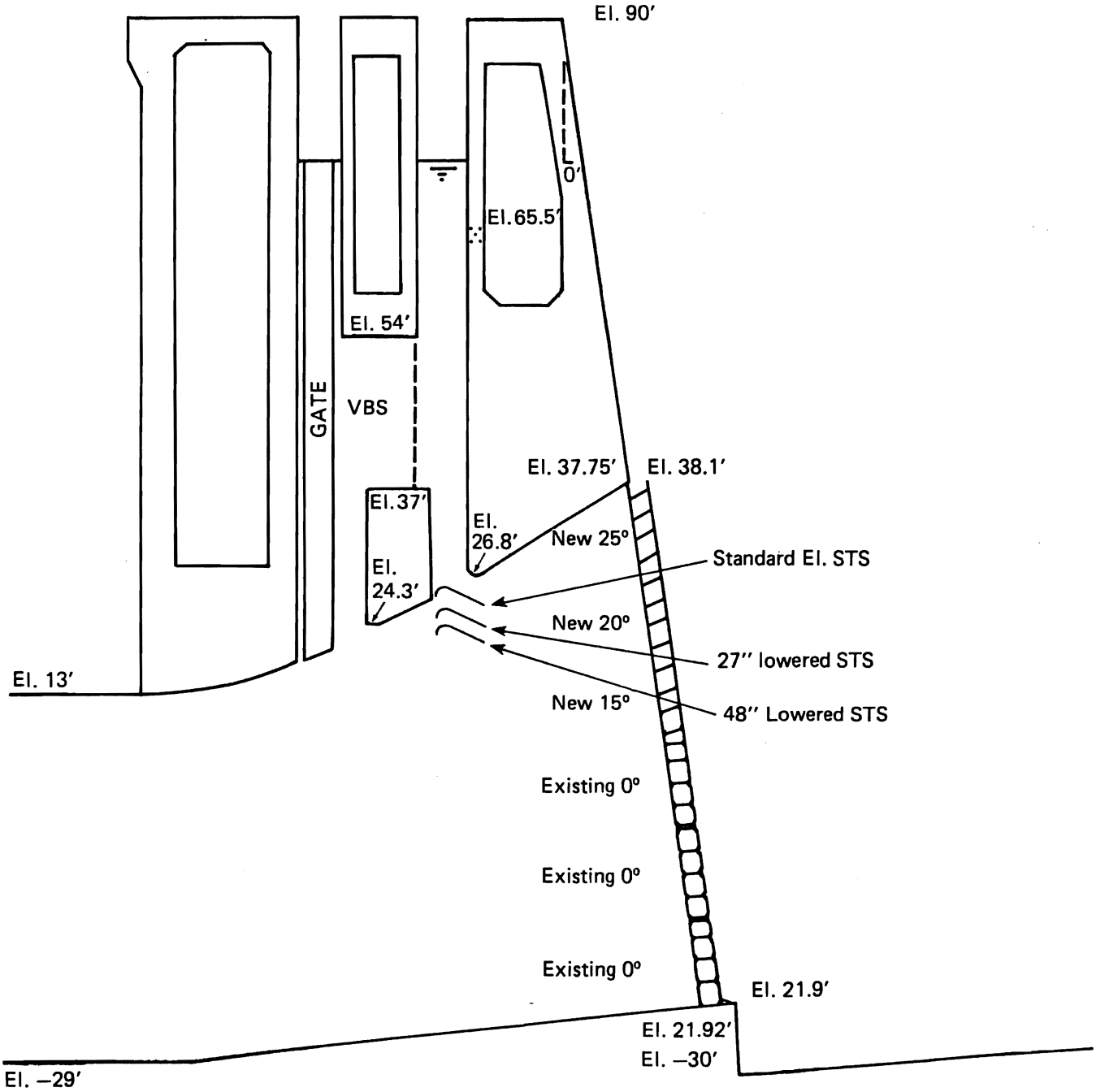

Figure 2.--Cross-sectional view of a turbine entrance showing the placement of the three streamlined trashracks, Bonneville Dam Second Powerhouse, 1985.

12B. To aid in defining the general areas of the avoidance/deflection, hydroacoustic gear monitored the movement of fish as they passed through the trashracks and approached the STS and throat area. Monitoring was also done immediately upstream from the trashracks as the fish approached the intakes.

Tests were also conducted during the 1985 field season using an internal trashrack deflector as an extension of the STS to try and prevent deflection. This deflector had a porosity of 50% as opposed to the 33% porosity of the deflectors used in FY84.

Most tests were conducted in Unit 12B where the streamlined trashracks were installed. FGE tests consisted of two phases. During the first phase (3 May to 6 June), the target species was yearling chinook salmon. The primary test emphasis was measuring benefits to FGE, if any, of a lowered STS, streamlined trashrack, and an internal trashrack deflector. The second phase (16 July to 1 August) used subyearling chinook salmon as the target species. This phase compared FGEs of a standard versus a lowered STS and streamlined versus normal trashracks. Tests were also conducted with a raised operating gate and with the false gap device used in conjunction with a lowered STS.

Initial research plans also included testing a bar screen guiding device (50% porosity) in lieu of the STS (33% porosity) and an external trashrack deflector. Neither of these items were tested in 1985; the first, because of an insufficient number of test days and the second, because it was not constructed.

Results

Table 1 lists the various conditions tested during each phase along with the corresponding FGE and descaling percentages. Figures 3 (yearlings) and 4 (subyearlings) show percentage FGE, gap loss, closure net catch, and fyke net

Table 1.—Traveling screen fish guiding efficiency (FGE) tests on yearling and subyearling chinook salmon and coho salmon at Bonneville Dam Second Powerhouse during the FY 85 field season.

Test no.	Gatewell	Date(s) of test(s)	STS Angle (Degree)	STS position	Stream-lined trashrack	Unit dis-charge (cfs)	Deflector and length	False gap device	Operating gap position	Yearling percentages		Subyearling percentages	
										FGE	Descaled	FGE	Descaled
1	12B	May 3-7	65	std.	Yes	18,000	No	No	Normal	33.4	6.3		
2	12B	May 8-10,18	65	-27"	Yes	18,000	No	No	Normal	41.1	6.5		
3	12B	May 11-13	65	-39"	Yes	18,000	No	No	Normal	39.3	7.9		
4	12B	May 14-17	65	-48"	Yes	18,000	No	No	Normal	28.6	9.3		
5	12B	May 22-24	54	-27"	Yes	18,000	No	No	Normal	42.4	8.0		
6	12B	May 25-26	54	-33"	Yes	18,000	No	No	Normal	41.9	10.0		
7	12B	May 28-29	65	-27"	Yes	18,000	Yes, Short	No	Normal	34.3	9.0		
8	12B	May 30	65	-33"	Yes	18,000	Yes, Short	No	Normal	32.4	10.2		
9	12B	May 31	65	-39"	Yes	18,000	Yes, Short	No	Normal	26.6	12.3		
10	12B	Jun 1-3	65	-48"	Yes	18,000	Yes, Short	No	Normal	34.9	12.0		
11[a/]	12B	Jun 4-6	65	-48"	Yes	18,000	Yes, Long	No	Normal	42.5	0.9		
12	12A	Jul 16-19	65	std.	No	16,000	No	No	Normal			9.9	4.6
13	12B	Jul 16-19	65	-27"	Yes	16,000	No	No	Normal			23.7	4.1
14	12A	Jul 20-23	65	-27"	No	16,000	No	No	Normal			15.5	4.9
15	12B	Jul 20-23	65	std.	Yes	16,000	No	No	Normal			13.6	2.3
16	12B	Jul 27-29	65	-27"	Yes	16,000	No	No	Up 26.5'			17.8	3.6
17	12B	Jul 30	65	-48"	Yes	16,000	No	Yes	Up 26.5'			18.0	4.5
18	12B	Jul 31	65	-48"	Yes	16,000	No	No	Normal			12.8	1.8
19	12B	Aug 1	54	-48"	Yes	16,000	No	No	Up 26.5'			21.7	0.9

a/ The predominant species for this test was coho salmon.

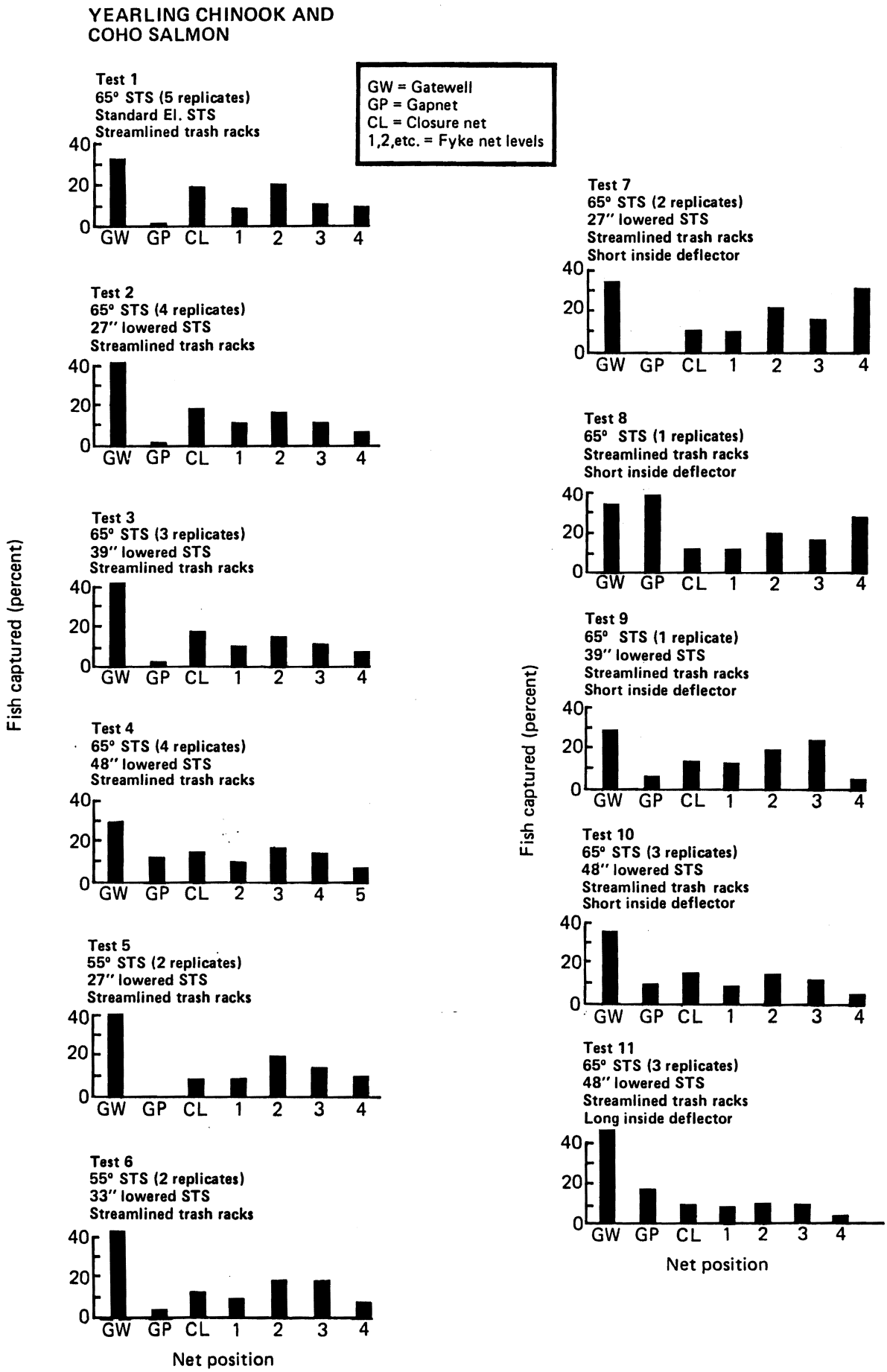

Figure 3.--Results of STS tests for yearling chinook and coho salmon showing FGE and percentage fish captured at various net levels, Bonneville Dam Second Powerhouse, 1985. Test numbers correspond to tests as listed in Table 1 (refer to this table for complete test details).

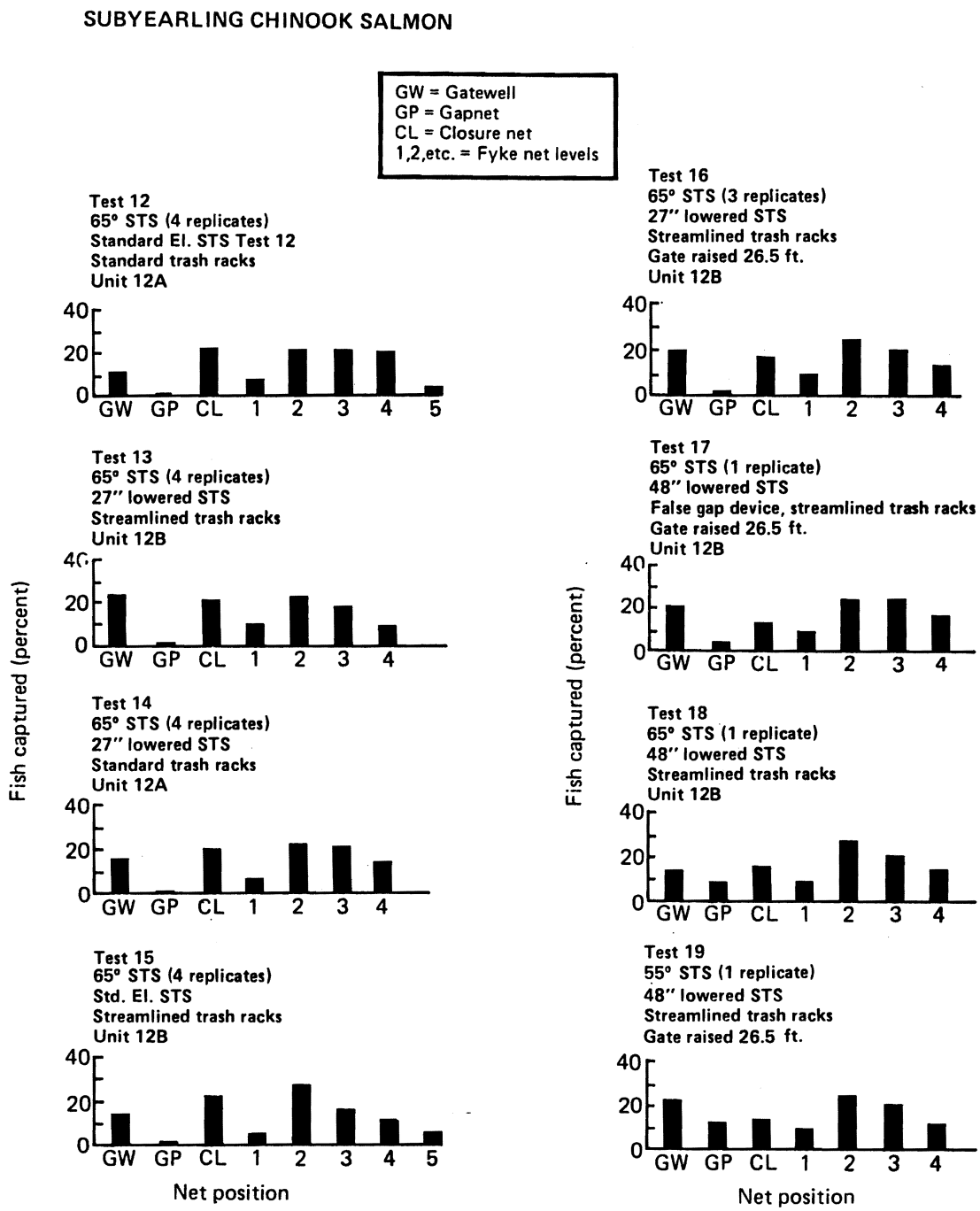

Figure 4.--Results of STS tests for subyearling chinook salmon showing FGE and percentage fish captured at the various net levels, Bonneville Dam Second Powerhouse, 1985. Test numbers correspond to tests as listed in Table 1 (refer to this table for complete test details).

catches at the various net levels for each test condition (a numerical listing of the target species for each individual test is shown in Appendix Table B1).

A primary goal of the 1985 FGE tests was to determine the general area where avoidance/deflection was occurring. Several observations from the 1985 tests indicate this probably occurs because of: (1) the restriction in the throat area of the STS and (2) turbulence and/or strong lateral flow upstream from the trashrack, which tends to push fish deeper in the intake below the area where they could be intercepted by an STS.

Total fish intercepted (TFI) (FGE plus percent gap net catch) data in Tests 1 through 6 (Table 2) indicate restriction in the throat area was part of the cause for low FGE at the Second Powerhouse. As shown in Table 2, there was significant increase in TFI when comparing lowered STS (Tests 2 through 6) to standard STS (Test 1) (see Figure 3 for FGE and percent gap net catch). This indicates that the increase in TFI resulted from either the increased throat opening or greater percentage of fish being intercepted by the lowered STS. The lack of a difference in TFI between the 27- or 48-inch lowered STS, though, would seem to rule against the latter.

Data from Tests 7 through 10 (Fig. 3) provide a strong indication that another major problem with FGE at the Second Powerhouse is that conditions upstream from the trashrack are causing many fish to be deeper in the intake and below the effective interception point of the STS. In this series of tests, an internal trashrack deflector was attached to the trashrack and positioned to overlap the leading edge of the STS. This addition should have intercepted and effectively guided the fish that were potentially guidable but were being diverted under the STS by flow deflection or were actually sounding to avoid the STS. The TFIs, however, with the STS lowered 27, 33, and 39 inches were only, 34, 33, and 32%, respectively (about the same as measured

Table 2.--G-statistic comparison of the total fish intercepted (TFI) and unguided yearling chinook salmon for a standard vs lowered STS, Bonneville Dam Second Powerhouse, 1985.

Item	Test 1[a/]	Test 2	Test 3	Test 4	Test 5	Test 6
STS position	Std.	-27"	-39"	-48"	-27"	-33"
Intercepted fish	821	730	539	1,150	316	381
Unguided fish	1,611	1,032	753	1,718	423	476
TFI (%)	33	41	41	41	42	45
G-test values		25.724*	22.886*	22.707*	19.645*	30.793*

a/ Test numbers correspond to those in Table 1.

* = $P < 0.01$.

with a standard STS in Test 1). In Test 10 (48-inch lowered STS), though, the TFI increased to 44%. This information suggests the following: (1) the added water flow, towards the throat area, that is produced by the deflector recreated the original restriction problem until the STS was lowered 48 inches and (2) the lack of a significant increase in TFI with a deflector (41 vs 44%) indicates there was not a large difference in the numbers of fish available for guidance by the STS between the two test conditions. Instead, what appears to be happening is that factors upstream from the trashrack (possibly turbulence and/or strong lateral flows across the powerhouse) are causing potentially guidable smolts to enter the intakes below the effective interception point of the guiding device. Data from hydroacoustic studies seems to substantiate this conclusion. [2]

Figure 5 is a bar graph showing FGE and gap net percentages and also gives an estimate of the potential FGE (based on vertical distribution tests) for each condition tested in Phase 1.[3] Dividing actual FGE by potential FGE gives an indication of the effectiveness of the various test conditions. This comparison indicates that, although several of the tests showed greater than 50% effectiveness, Tests 2, 5, and 6 (57, 56, and 56%, respectively) appeared to be the most effective.

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[2] Nagy, Bill and R.A. Magne; unpublished CofE Report. Hydroacoustic Study at the Bonneville Dam Second Powerhouse in 1985, August 1985.

[3] During previous FGE studies (Krcma et al. 1984; Gessel et al. 1985) the theoretical interception point of a standard elevation STS was estimated to be at the bottom of the second net on the vertical distribution net frame. Additional field and model studies indicate that this point is probably nearer the mid-line of the third net row. This revised estimate is used to determine potential FGE percentages for this report.

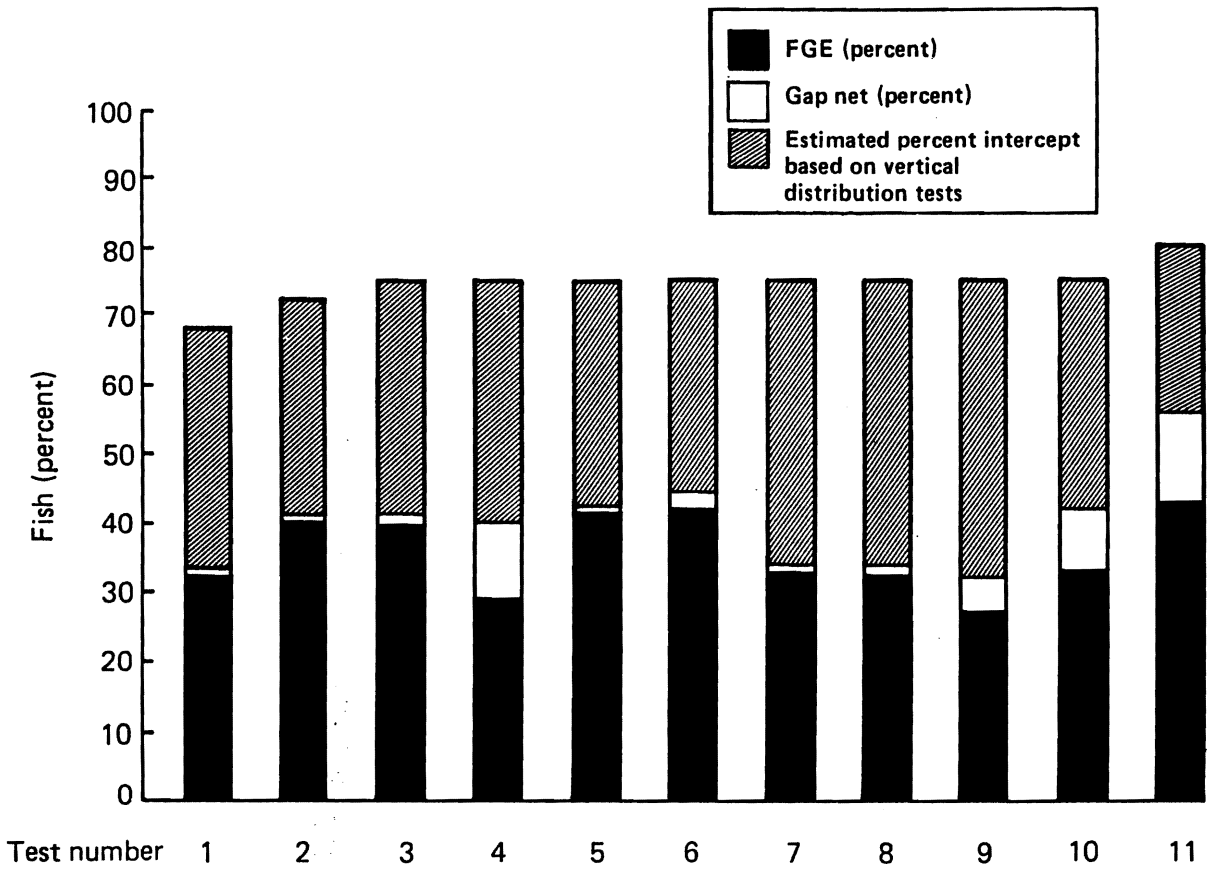


Figure 5.--Graph showing FGE and gap net percentages with an estimate of the potential FGE for tests conducted with yearling chinook salmon (except for Test 11-predominantly coho salmon) at Bonneville Dam Second Powerhouse, 1985. Test numbers correspond to those in Table 1.

Replicated test conditions were conducted during Phase 2 to determine the effectiveness of the streamlined trashracks and to determine the effect of raising the operating gate. Test 12, 13, 14, and 15 (Table 1, Fig. 4) compare the streamlined trashracks in Unit 12B to standard trashracks in Unit 12A. Because there was a limited number of test days available, we also included in these tests a comparison of a 27-inch lowered STS with and without the streamlined trashrack. In evaluating these tests, it was necessary to make the assumption that there was a minimal difference in fish passage between the two gatewells (results from the vertical distribution tests suggest this is a valid assumption). These tests indicated that whereas both the 27-inch lowered STS and the streamlined trashrack improved FGE, the combination of both (Test 13) gave the highest FGE (23.7%) for subyearling chinook salmon. Appendix Table B2 gives a description and analysis of these data.

Tests to determine the effect of raising the operating gate in conjunction with a lowered STS and streamlined trashracks (Test 16) did not indicate an improved FGE. The average FGE for the three replicates was only 18% (range: 13 to 25%).

None of the remaining conditions in Phase 2 were replicated, but a comparison of Tests 17 and 18 indicated the false gap device may effectively reduce gap loss by diverting these fish into the gatewell (Test 17 with false gap, FGE = 18% and gap net = 3%; Test 18 without false gap, FGE = 13% and gap net = 8%).

The much lower FGEs in all tests for subyearlings as compared to FGEs for yearling fish were not due to the lower unit discharge during Phase 2 testing (Table 1). With a lower unit discharge, approach velocities would be less, resulting in less deflection under the STS and, if anything, higher FGEs. Instead the low FGE was probably the result of deeper running fish because of near record high water temperatures in the river in July. The FGEs for

subyearlings were also much lower than expected at other projects on the lower Columbia River 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 (Fig. 6). All nets were 6.0 x 6.5 ft at the mouth and approximately 15 ft long. 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. Testing occurred from 2000 to 2400 h with the same turbine load as the FGE tests. 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 three to estimate the number of fish in that net level (Appendix Table B3 provides fyke net data that validate the assumption that the middle net collects approximately one-third of the fish for a given net level). The sum of these estimates plus the gatewell catch gives 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. A total of three tests (Unit 12A, yearlings, standard trashracks; Unit 12B, yearlings, streamlined trashracks; and Unit 12B, subyearlings,

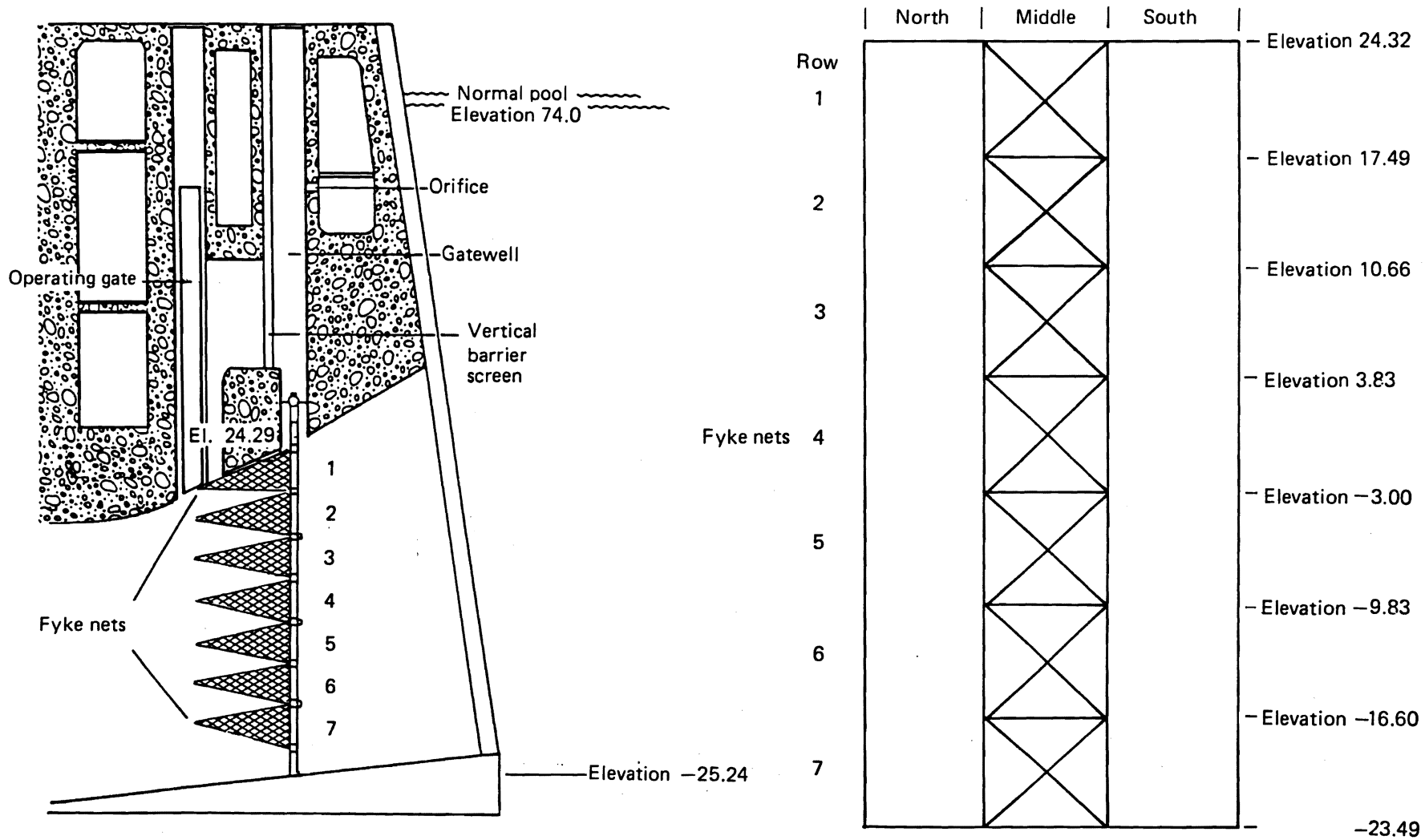


Figure 6.--Cross-section of the turbine intake at Bonneville Dam Second Powerhouse with vertical distribution frame and fyke nets, including a view showing the net layout, 1985.

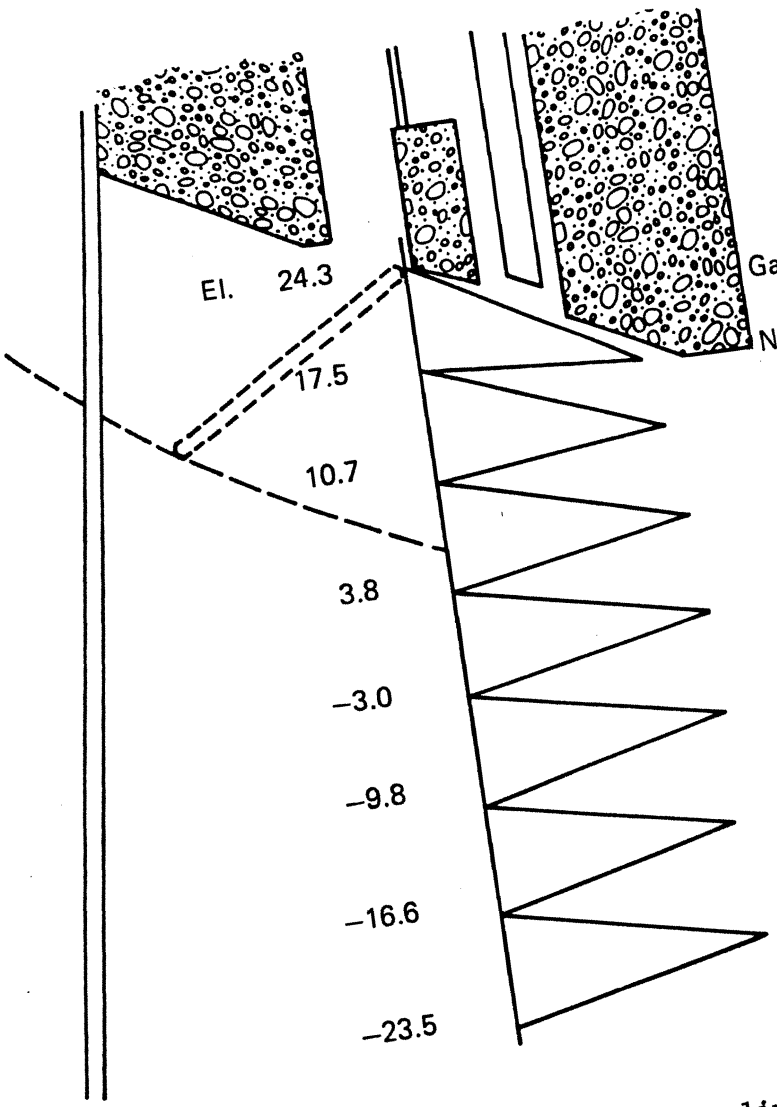
streamlined trashracks) each with three replicates were conducted. Data from these tests were used to determine the effectiveness of the FGE tests, and also as a possible indicator of any differences in vertical distribution between the two gatewells or between the two types of trashracks.

Results

Figure 7 shows the percentage of fish caught at the various net levels in Unit 12B (streamlined trashracks) for yearling and subyearling chinook salmon. Similar distribution was noted for tests in Unit 12A (standard trashracks). Additional details including data, number of fish per net, etc. for each test are contained in Appendix Table B4.

Approximately 69% of the yearling chinook salmon were captured in the gatewell and upper two and one-half fyke nets in 1985, as compared to 56% in 1983 (Krcma et al. 1984). This would seem to indicate that the fish were higher in the intake and more fish were available for interception by the STS. This higher distribution pattern possibly contributed to the increase in FGE from 19% in 1983 to 33% in 1985, since there was no measurable difference in vertical distribution related to the standard (12A) or streamlined (12B) trashracks. Another possible influencing factor was the fact that only Units 11, 12, and 18 were operating during 1985, compared to a more complete powerhouse operation during 1983.

In 1985, only 48% of the subyearling chinook salmon were captured in the gatewell and upper two and one-half nets; about the same as in 1983. A possible reason for the subyearlings not being higher in the intakes in 1985 like the yearlings could be the low river flows and correspondingly higher than normal water temperatures present during the 1985 tests.



	YEARLING CHINOOK DISTRIBUTION (percent)		SUBYEARLING CHINOOK DISTRIBUTION (percent)	
	Individual	Accumulated	Individual	Accumulated
Gatewell - 18	18	18	9	9
Net 1 - 26	44	44	14	23
2 - 19	63	63	18	41
3 - 12	75	75	14	55
4 - 10	85	85	16	71
5 - 8	93	93	14	85
6 - 5	98	98	10	95
7 - 2	100	100	4	99

Figure 7.--Vertical distribution of yearling and subyearling chinook salmon for Turbine Unit 12B (streamlined trashrack) Bonneville Dam Second Powerhouse, 1985.

OBJECTIVE II - CONTINUED MONITORING OF THE SECOND POWERHOUSE SAMPLING FACILITY

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 monitor smolt migrations passing this powerhouse. 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 juveniles by size, and four raceways to hold fish graded by the wet separator.

In our monitoring of the DSM sampling facility, we did the following: (1) enumerated fish collected by species, measured descaling, and recorded marks daily throughout the smolt migration; (2) evaluated improvements made to correct deficiencies in the DSM and made adjustments and recommendations as needed; and (3) compared the data collected at the Second Powerhouse with data collected at the First Powerhouse.

Task 1 - Smolt Indexing

Methods and Procedures

Fish passing through the Second Powerhouse bypass system were collected by the random sampler 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 fish were enumerated by species or race and examined for descaling and marks. The fish were classified as descaled using the same criteria mentioned under Objective I. 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

operated Monday through Friday, 24 h a day. Estimates of total weekly passage (by species) were determined by multiplying the catch per unit of effort times 10 [random sampler efficiency is 10% (McConnell and Muir 1982)] andexpanding to a 7-day week.

Results

Between 6 March and 27 November, the random sampler operated for 3,052 h for an average of about 87 h per week. During this time, a total of 26,993 juvenile salmonids were captured, of which 15,536 were examined for descaling and injury (Appendix Table B5). These numbers represent a passage rate for a lower level of powerhouse operation than in 1984, when usually three or four of the existing eight turbines were operated during the nightly peak periods of fish movement. In 1985, however, the nighttime operation was restricted to only the hours of FGE testing (3 May to 6 June and 16 July to 1 August), during which time no more than three units were operated. Because of these limited operations, measures of timing and/or peak migrations of smolts shown in Figure 8 may not be representative of the actual smolt migration. Figure 8 illustrates a weekly estimate of the number of fish by species that were bypassed at the Second Powerhouse from 6 March to 27 November, except 3 August - 2 September when no sampling was done because the observation room was flooded by a back-surge in the downwell. The CofE personnel were advised of this problem and visited the site, but could not determine a cause for the back-surge. Sampling was then continued for the remainder of the field season. (Note: The problem still exists; periodically, the downwell back-surges and floods the the observation room. This problem must be resolved prior to the 1986 field season.)

Periods of peak migration and the total estimated Second Powerhouse DSM passage by species (excluding August) were: (1) yearling chinook salmon - 17

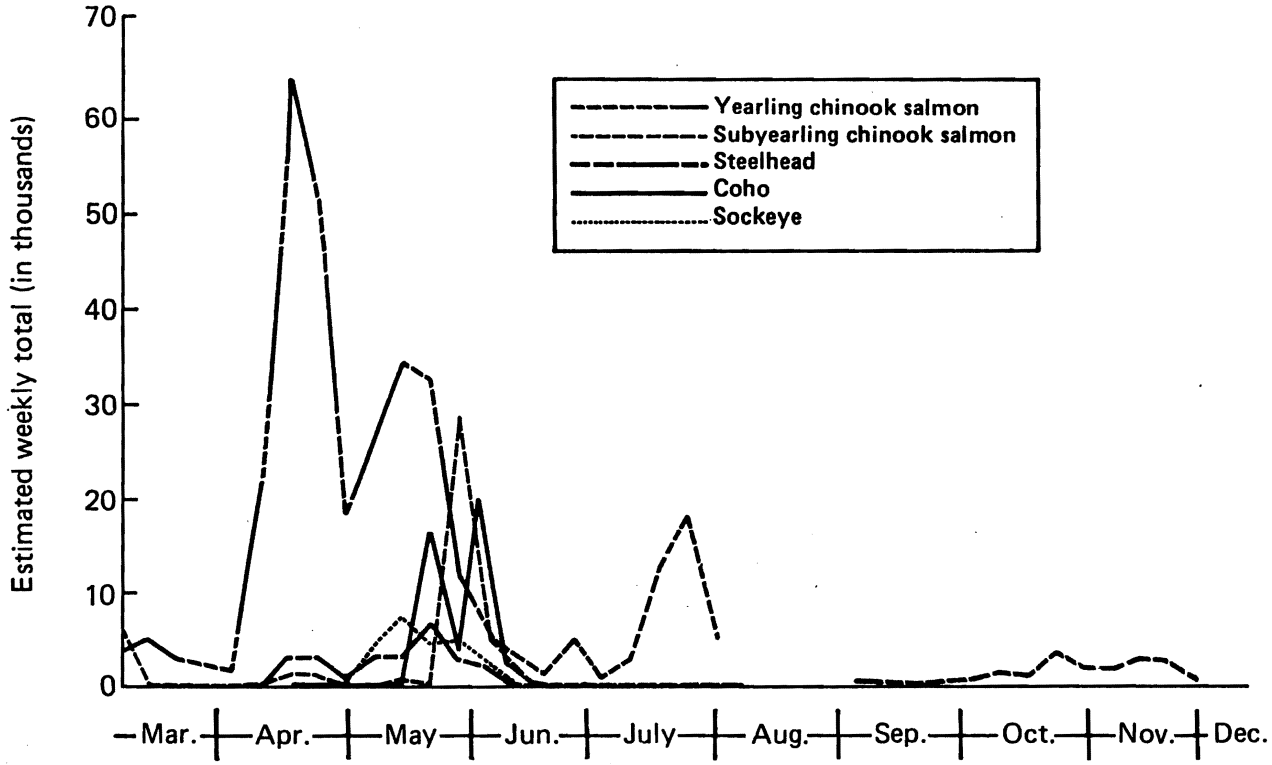


Figure 8.--Weekly estimated passage of salmonids at Bonneville Dam Second Powerhouse, 6 March to 26 November 1985.

April, 290,501; (2) subyearling chinook salmon - 29 May, 120,246; (3) steelhead - 22 May, 29,777; (4) coho salmon - 5 June, 48,289; and (5) sockeye salmon - 15 May, 28,644. Appendix Table B6 gives the weekly passage numbers for these fish. The number of smolts passing through the Second Powerhouse in 1985 was approximately one third of 1983 and 1984 passage; this was largely due to the limited turbine operation and the reduction in numbers of subyearling chinook and coho salmon released from local hatcheries during the sampling year.

The amount of descaling varied among species. Sockeye salmon had the highest descaling (20.7%) and subyearling chinook salmon had the lowest (1.1%). Yearling chinook salmon, coho salmon, and steelhead had descaling of 4.1, 1.8, and 3.0%, respectively. Compared to 1984 data (Gessel et al. 1985), descaling was lower for all species.

Mortality during 1985 was highest for sockeye salmon (6.1%) followed by subyearling chinook salmon (3.2%). Mortality for other species was low. In general, survival was improved over 1984 (Gessel et al. 1985), especially for sockeye salmon.

Task 2 - DSM Improvements

Improvements to the DSM at the Second Powerhouse made prior to the 1985 field season included the modification of the automatic water level controls and lowering the energy dissipator in the downwell in the observation room.

Modifications of the DSM water level controls did not adequately stabilize water levels in the dry (El. 65) and wet (El. 45) separators. For this reason, salmonids were graded for only a short time during 1985. For most of the year the grading bars were removed from the wet separator, and all salmonids were collected in one raceway.

Lowering the energy dissipator in the observation room visibly reduced the turbulence in the downwell and improved the drainage from the raceways. There were, however, some problems with the automatic water level control systems.

Task 3 - Powerhouse Collection Comparisons

Methods and Procedures

During the 1983 evaluation of the juvenile collection and bypass systems at Bonneville Dam (Krcma et al. 1984) major differences in species composition and size were found between salmonids collected at the First and Second Powerhouses. This was prior to the completion of the First Powerhouse collection system, therefore, data for the First Powerhouse was collected by dipnetting gatewells. During the 1985 evaluation, both collection systems were operating, so species composition and length frequencies were again compared.

Data on species composition and length frequencies were collected daily at each powerhouse and combined weekly for analysis. Comparisons of species composition were made using the G-statistic (Sokal and Rohlf 1981). Length frequencies were compared by using mean lengths plus or minus two times the standard errors.

Results

A relative comparison of the species compositions between the two powerhouses indicated the Second Powerhouse collected a higher proportion of yearling and subyearling chinook salmon and lower proportions of coho and sockeye salmon and steelhead during most weeks (Table 3). In contrast, in 1983, the Second Powerhouse collected a higher proportion of coho and sockeye salmon and a lower proportion of subyearling chinook salmon. Proportions of

Table 3.--G-Test comparisons of species compostion between the First and Second Powerhouse at Bonneville Dam in 1985.

	Yearling Chinook			Subyearling chinook			Steelhead			Coho			Sockeye		
	Percent capture			Percent capture			Percent capture			Percent capture			Percent capture		
Date	1 P.H.	2 P.H.	G	1 P.H.	2 P.H.	G	1 P.H.	2 P.H.	G	1 P.H.	2 P.H.	G	1 P.H.	2 P.H.	G
1-4 Apr	86.1	89.2	0.3	5.5	10.0	0.8	2.8	0.8	0.8	2.8	0.0	0.8	2.8	0.0	0.8
8-11 Apr	91.5	95.2	5.5*	4.2	2.8	1.5	3.2	2.0	1.5	0.7	0.0	3.2	0.4	0.0	0.9
15-18 Apr	93.2	92.4	1.2	0.3	2.5	47.9**	5.6	4.9	1.0	0.9	0.2	10.9**	0.0	0.0	0.0
22-25 Apr	84.2	90.4	54.5**	0.5	2.6	46.1**	9.8	6.4	24.2**	5.3	0.6	144.2**	0.1	0.0	2.2
29 Apr-2 May	80.2	89.7	67.9**	0.5	1.2	5.5*	12.0	5.8	45.1**	3.1	0.7	31.0**	4.2	2.6	6.5*
5-9 May	66.3	73.3	40.6**	2.1	0.5	33.0**	15.3	10.6	33.4**	3.6	1.5	28.6**	12.7	14.1	2.9
13-16 May	71.4	71.1	0.1	2.5	2.9	0.9	10.4	7.7	19.9**	4.0	2.0	28.9**	11.7	16.3	43.7**
20-23 May	49.4	52.4	12.5**	2.5	1.4	18.6**	9.5	11.4	12.8**	26.6	26.7	0.0	12.0	8.1	54.2**
28-30 May	46.3	23.1	454.8**	16.7	53.0	1270.5**	6.6	6.1	0.8	12.2	7.6	43.8**	18.2	10.2	100.1**
3-5 Jun	31.9	18.2	154.0**	2.9	12.9	285.3**	9.5	5.9	26.6**	38.0	53.7	159.3**	17.7	9.3	91.1**
11 Jun	15.0	31.5	20.5**	13.0	42.0	59.2**	8.6	1.8	11.3**	48.4	17.9	52.0**	15.0	6.8	8.4**
17-18 Jun	19.0	15.4	0.5	62.1	44.2	6.7**	1.6	1.9	0.0	12.7	38.5	21.4**	4.6	0.0	1.1

* = $P<0.05$
** = $P<0.01$

yearling chinook salmon and steelhead in each powerhouse remained the same. Based on chi-square and g-test comparisons, there were significant week to week differences in proportions between the two powerhouse for all species in both 1983 (Table 9, Krcma et al. 1984) and 1985 (Table 3).

In addition to the differences in species composition, there were also differences in length frequencies between the two collection systems, especially for subyearling chinook salmon (Table 4). As in 1983, fish collected at the First Powerhouse were generally longer (fork length) than the same species collected at the Second Powerhouse.

Variation in spill and power generation can influence the horizontal distribution of salmonids as they approach the dam by altering the amount of flow through either of the two powerhouses or over the spillway. Also, the previously noted limited turbine operation at the Second Powerhouse, could influence the data collected at this powerhouse.

Based on the above observations, it would appear that without additional powerhouse distribution studies, little potential exists for Bonneville Dam as a lower river index site. This could change in future years if the variances noted are minimized once FGE improves and there is full-time powerhouse operation at the Second Powerhouse.

OBJECTIVE III - EVALUATION OF THE FIRST POWERHOUSE JUVENILE BYPASS AND SAMPLING SYSTEM

Evaluation of the juvenile salmonid bypass and sampling facility (Fig. 9) at the First Powerhouse began in 1984. Tests were conducted to determine the utility and efficiency of the bypass system and sampling gear. Several problems were encountered and changes were made to resolve them prior to the

Table 4.--Mean fork length (mm) ($\bar{x}$) comparisons between salmonids collected at the First and Second Powerhouses at Bonneville Dam, 1985. S.E. = standard error, N = number of fish measured.

		Yearling chinook			Subyearling chinook			Steelhead			Coho			Sockeye		
Dates	P.H.	N	$\bar{X}$ (mm)	2 S.E.	N	$\bar{X}$ (mm)	2 S.E.	N	$\bar{X}$ (mm)	2 S.E.	N	$\bar{X}$ (mm)	2 S.E.	N	$\bar{X}$ (mm)	2 S.E.
4/8 - 4/11	1	97	179.1	7.2	-	-	-	5	202.0	26.0	-	-	-	-	-	-
	2	223	158.1	3.8*	-	-	-	23	206.8	13.0	-	-	-	-	-	-
4/15 - 4/19	1	503	155.8	2.0	5	73.0	24.6	161	191.7	4.6	24	149.5	7.4	-	-	-
	2	591	158.9	2.0	76	45.0	2.6*	140	192.8	5.4	8	149.5	4.6	-	-	-
4/22 - 4/25	1	416	156.4	2.0	7	63.4	12.8	114	180.6	5.4	32	148.6	5.6	-	-	-
	2	712	143.1	1.6*	76	46.1	2.8*	198	186.1	3.4	19	148.1	9.0	-	-	-
4/29 - 5/2	1	303	146.1	2.2	-	-	-	80	187.7	5.2	13	152.0	5.8	24	119.7	3.4
	2	626	142.4	1.6	-	-	-	71	193.5	7.0	8	145.1	10.8	31	118.1	3.0
5/8 - 5/9	1	203	145.2	2.4	-	-	-	129	186.8	5.2	36	150.3	5.0	93	114.0	1.6
	2	224	143.2	2.2	-	-	-	130	191.9	4.6	21	156.3	6.2	145	114.8	1.4
5/13 - 5/15	1	303	143.0	2.2	64	88.3	2.6	219	195.3	3.8	231	154.9	2.0	257	107.2	1.2
	2	421	140.5	1.6	14	69.5	11.2*	133	201.8	5.6	58	160.4	4.2	182	112.0	1.4*
5/20 - 5/23	1	301	148.2	2.0	47	92.0	3.4	266	188.8	2.6	304	157.6	1.4	246	105.3	0.8
	2	339	143.4	1.6*	19	82.0	9.4	263	196.7	3.6*	299	157.6	1.2	179	107.5	1.2*
5/28 - 5/30	1	297	147.2	2.0	198	79.1	1.4	96	188.3	5.2	247	159.1	1.6	234	118.0	1.4
	2	309	142.9	1.6*	313	76.3	1.0*	137	195.6	4.4	175	158.0	2.0	219	114.7	1.4*
6/3 - 6/5	1	360	137.3	1.8	142	94.2	1.6	214	194.0	3.6	309	149.9	1.4	307	117.5	1.2
	2	283	140.6	2.0	229	85.8	1.8*	106	198.9	4.8	378	145.3	1.2*	164	116.2	1.6
6/11 - 6/12	1	59	149.4	3.4	100	105.9	2.4	-	-	-	100	141.7	2.2	84	121.9	2.2
	2	37	149.8	5.6	81	102.6	2.6	-	-	-	29	147.7	6.0	10	116.0	6.0
6/17 - 6/18	1	149	149.0	2.4	295	110.0	1.2	-	-	-	198	146.9	2.4	-	-	-
	2	9	143.1	6.8	50	99.9	5.4*	-	-	-	26	144.3	6.4	-	-	-

Table 4.--Continued.

		Yearling chinook			Subyearling chinook			Steelhead			Coho			Sockeye		
Dates	P.H.	N	$\overline{X}$ (mm)	2 S.E.	N	$\overline{X}$ (mm)	2 S.E.	N	$\overline{X}$ (mm)	2 S.E.	N	$\overline{X}$ (mm)	2 S.E.	N	$\overline{X}$ (mm)	2 S.E.
6/24 - 6/27	1	-	-	-	399	109.2	1.0	-	-	-	-	-	-	-	-	-
	2	-	-	-	274	103.1	1.2*	-	-	-	-	-	-	-	-	-
7/1 - 7/3	1	-	-	-	357	112.1	1.6	-	-	-	-	-	-	-	-	-
	2	-	-	-	70	99.0	3.0*	-	-	-	-	-	-	-	-	-
7/8 - 7/9	1	-	-	-	243	112.1	1.8	-	-	-	-	-	-	-	-	-
	2	-	-	-	96	101.6	2.6*	-	-	-	-	-	-	-	-	-
7/15 - 7/17	1	-	-	-	286	118.8	1.6	-	-	-	-	-	-	-	-	-
	2	-	-	-	199	108.3	1.8*	-	-	-	-	-	-	-	-	-
7/23 - 7/24	1	-	-	-	321	114.0	1.2	-	-	-	-	-	-	-	-	-
	2	-	-	-	213	108.3	1.4*	-	-	-	-	-	-	-	-	-
7/30 - 8/1	1	-	-	-	88	107.7	2.8	-	-	-	-	-	-	-	-	-
	2	-	-	-	103	104.9	1.8	-	-	-	-	-	-	-	-	-

* = $P<0.05$

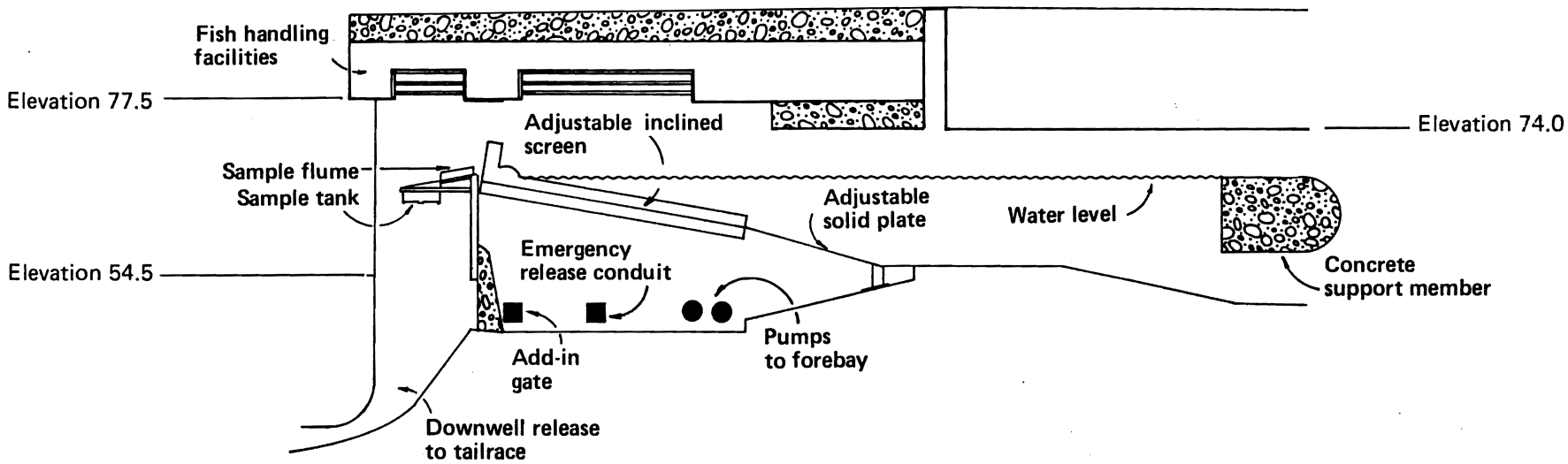


Figure 9.--Cross-section of the juvenile bypass (downstream end) system at Bonneville Dam First Powerhouse, 1985. The inclined screen, emergency relief conduit, add-in gate, and pumps are all designed to operate under automatic control.

1985 field season. Testing continued during the 1985 smolt migration to: (1) determine the effectiveness of these changes and recommend additional modifications if necessary and (2) evaluate the sampler efficiency for the two modes of operation-- free-flowing (all the water going to the tailrace) and pump-back (excess water pumped back to the forebay).

Task 1 - Modifications to Sample Gear

During the 1984 studies, considerable difficulty was experienced handling the sample tank and flume, specifically during placement into the fishing position and transferring the catch to a holding tank. Prior to the 1985 field season, guides were installed on the sample tank (Fig. 10) in an attempt to keep it from wracking as it was raised or lowered. Also, the sample tank floor was sloped to facilitate unloading. These modifications improved operations in 1985, but additional changes are needed. The two electric hoists used to raise and lower the sample tank continue to create problems of wracking. A four-point hoist mechanism is needed to eliminate this problem. A new hoist arrangement could add approximately 12 inches in height to the sample tank, which would help reduce the turbulent water conditions that presently develop in the sub-sample tank. The sample tank floor also needs to be both sloped and tapered to the outlet to prevent fish from accumulating in the corners during transfer to the handling facility.

Task 2 - Sampler Efficiency

Tests to evaluate sampler efficiency in 1985 were to be conducted under the two modes of bypass operation (free-flowing and pump-back). However, no sampling was done in the pump-back mode for two reasons: (1)

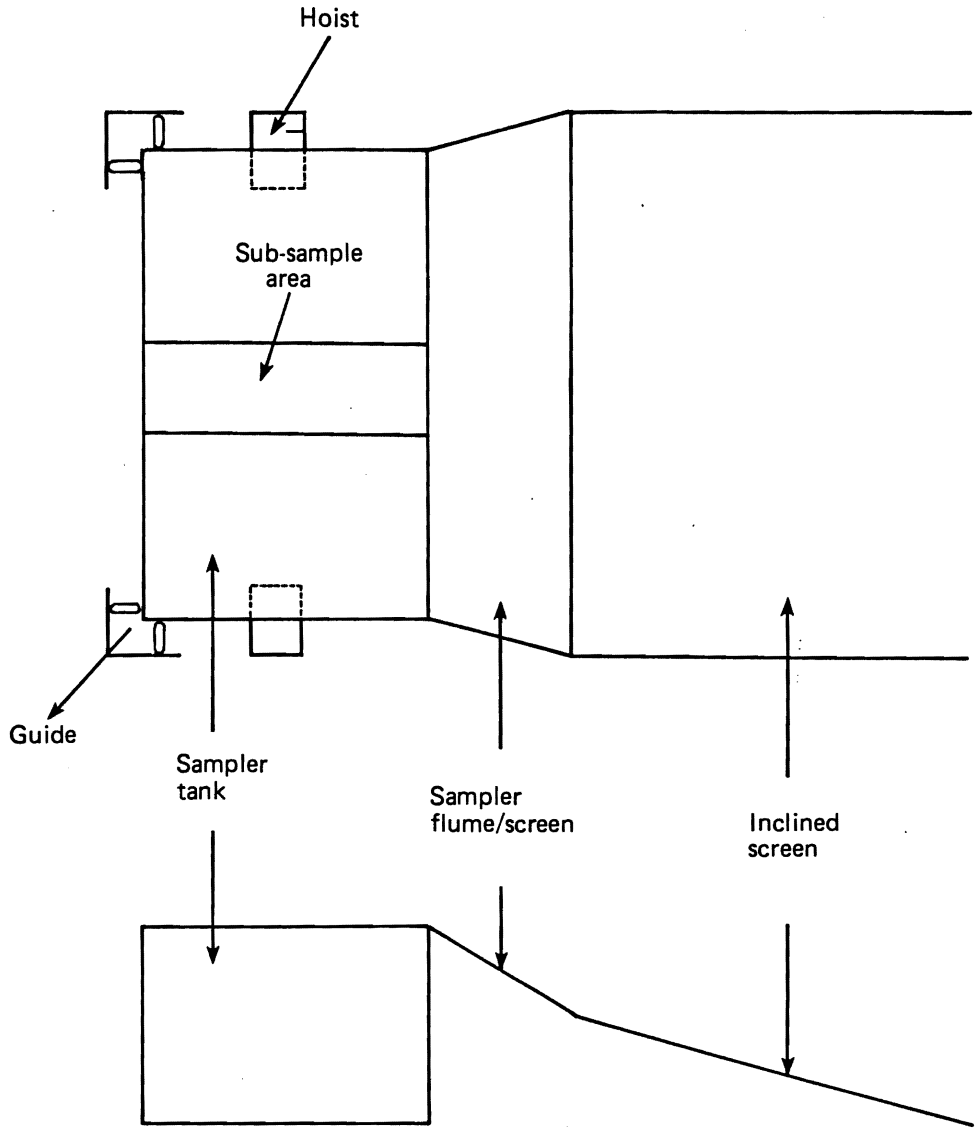


Figure 10.--Overhead (top) and side view of the fish collection site in the juvenile bypass channel at Bonneville Dam First Powerhouse, 1985.

vibration/cavitation problems developed when the pumps were test operated by CofE personnel and (2) the automatic water level control system for the DSM was not completely functional. Therefore, all sampling in 1985 was conducted with these controls set for manual adjustment.

Methods and Procedures

During the 1984 field season, evaluation of sampler efficiency was attempted with marked fish releases at various points in the bypass channel. This method was not successful because the sampler could not be operated for long enough intervals to ensure that all marked fish had exited the system prior to ending the sample. Modifications made in 1985 allowed a different technique and enabled us to use natural migrants in place of marked fish to evaluate sampler efficiency. A small compartment was built within the sample tank, and the sample flume was widened to fish the entire width of the bypass channel (Fig. 10). These changes allowed sampling that gave a sub-sample within the total sample. The sampler could be fished for a selected interval, and the two groups compared for consistency.

Two sampling regimes were used to collect fish passage data during 1985. The first, or intermittent method, consisted of collecting several 20-minute samples each week throughout the field season (31 March - 16 November). During sampling, only the main sample tank was used to collect the fish. These individual samples could then be expanded into hourly passage estimates for each species or race collected. For example, if 100 steelhead were collected in a 20-minute sample, then the total steelhead passage for that hour would be 100 x 3 = 300 steelhead. Generally, samples were taken twice a day (mid-morning, 1000 h and mid-day, 1400 h) 3 days a week. During some weeks, mechanical problems with the sampler or other equipment failures did not allow 3 days of sampling.

The second sampling regime, or intensive sampling method, consisted of sampling every hour during a 24-h period. We attempted to sample for 20 minutes each hour, but large numbers of migrants often made it necessary to shorten the sample intervals. Intensive sampling occurred from 8 to 23 May and collected passage data for yearling chinook, coho, and sockeye salmon and steelhead. Subyearling chinook salmon data were collected from 22 to 25 July. In these samples, both the sub-sampler and sample tank were used to collect fish. The sub-sampler was placed in the center of the channel for each sample and intercepted approximately 17% of the total channel width (sub-sampler is 16 inches wide; channel width is 96 inches). Theoretically, if the smolts were randomly distributed across the width of the channel, approximately 17% would be collected by the sub-sampler.

Determining sub-sampler consistency was done by computing the average collection percentage for each group of fish and comparing it to the theoretical 17%. Only individual samples with >100 fish of the target species were used to compute these averages.

The intensive sampling data were also used to determine average hourly passage percentages for each species or race for a standard 24-h period, beginning at 0000 and ending at 2400 h. Confidence Intervals (CI) at the 95% level for the hourly percentages were defined using the formula:

$$P \pm t\left(1-\frac{\alpha}{2},\ K-1\right) \frac{S}{\sqrt{K}}$$

Where: K = number of replicates
S = standard deviation among replicates

The hourly percentages in conjunction with the individual samples collected throughout the field season were then used to estimate weekly passage for

all salmonids. The formula for computing a weekly passage estimate for one species from one sample period is:

$$P = \left(\frac{A \times B}{C} \right) \div D, \quad R = P \times 7$$

Where:

A	=	number of target fish in a given sample
B	=	60 (number of minutes in 1 hour)
C	=	number of minutes in the given sample interval
D	=	average hourly passage percentage for the target species
P	=	estimated 24-h passage
R	=	estimated weekly passage

For example: if 125 steelhead were captured during a 5-minute sample collected at 0600 h, when 3.1% of the steelhead passage occurs, then the estimated weekly passage for this species would be:

$$\left(\frac{125 \times 60}{5} \right) \div 0.031 = 48{,}387 = \text{24-h passage}$$

$$\times 7 = 338{,}709 \text{ estimated weekly passage}$$

Generally, only samples collected during hours with CIs of $\pm$ 1% were used to estimate weekly passage for each species or race. All individual samples, collected during a given week, that met this CI criteria were expanded and averaged to yield a mean passage/day estimate which was multiplied by seven to give a mean passage/week total. During weeks when less than two samples were collected that met the CI criteria, all the samples, regardless of their time of collection were expanded and averaged to obtain the weekly passage estimate.

Results

Table 5, gives the average collection data by species for the sub-sampler. The target of 17% collection was not achieved for any species, and there was considerable variation between species. Either the fish were not

Table 5.--Summary of sub-sampler collection data for the two intensive sampling periods conducted at Bonneville Dam First Powerhouse juvenile collection facility, 1985, (refer to Appendix Tables B7 and B8 for individual sample details).

Species	Subyearlings	Yearlings	Steelhead	Coho	Sockeye
# of samples[a]	116	182	17	40	15
# fish collected in sub-sample	9,383	6,981	314	873	998
# fish collected in sample tank	29,044	37,943	2,494	5,682	3,740
Totals	38,427	44,924	2,808	6,555	4,738
% fish collected in sub-sample	24.4	15.5	11.2	13.3	21.1

[a] Only samples that collected over 100 fish of any species were used to determine the average percent collected by the sub-sampler.

randomly distributed across the channel, or they were able to avoid the sampling equipment--some smolts (particularly larger ones) were observed actively swimming away from the sample area.

Figures 11-15 are graphs showing the hourly passage percentages for the migrants during the intensive sampling periods with 95% CIs for each data point. Table 6 provides the actual percentages depicted by these graphs, and Table 7 gives an estimate of salmonid passage through the First Powerhouse DSM based on these hourly percentage rates. Appendix Tables B7 and B8 give the data for the individual samples collected.

The intermittent sampling periods (mid-morning and mid-day) selected to monitor fish passage throughout the field season were generally insufficient to provide meaningful estimates of daily and weekly passage because of wide CIs about the hourly estimates during peak migration periods at night. However, during the intensive sampling period (8-23 May) a sufficient number of samples was collected to allow relatively good passage estimates for yearling chinook, coho, and sockeye salmon and steelhead. Most data collected for subyearling chinook salmon occurred during hours with fairly wide CIs and consequently give a relatively poor passage estimate for these fish.

The variability in the sub-sampler collection percentages indicates some sampling problems may exist. The possibility of a sampling bias occurring with the different species must be addressed. If a bias exists, it must be eliminated or measured so that the appropriate adjustments can be made with the collection data. Also, the differences in passage rates and timing for the various species indicate the number of samples taken must be increased so that representative samples for all species are collected throughout the migration period. Of special concern is the wide CIs observed during peak migration periods at night for yearling fish. These have to be reduced before meaningful estimates of total passage can be made.

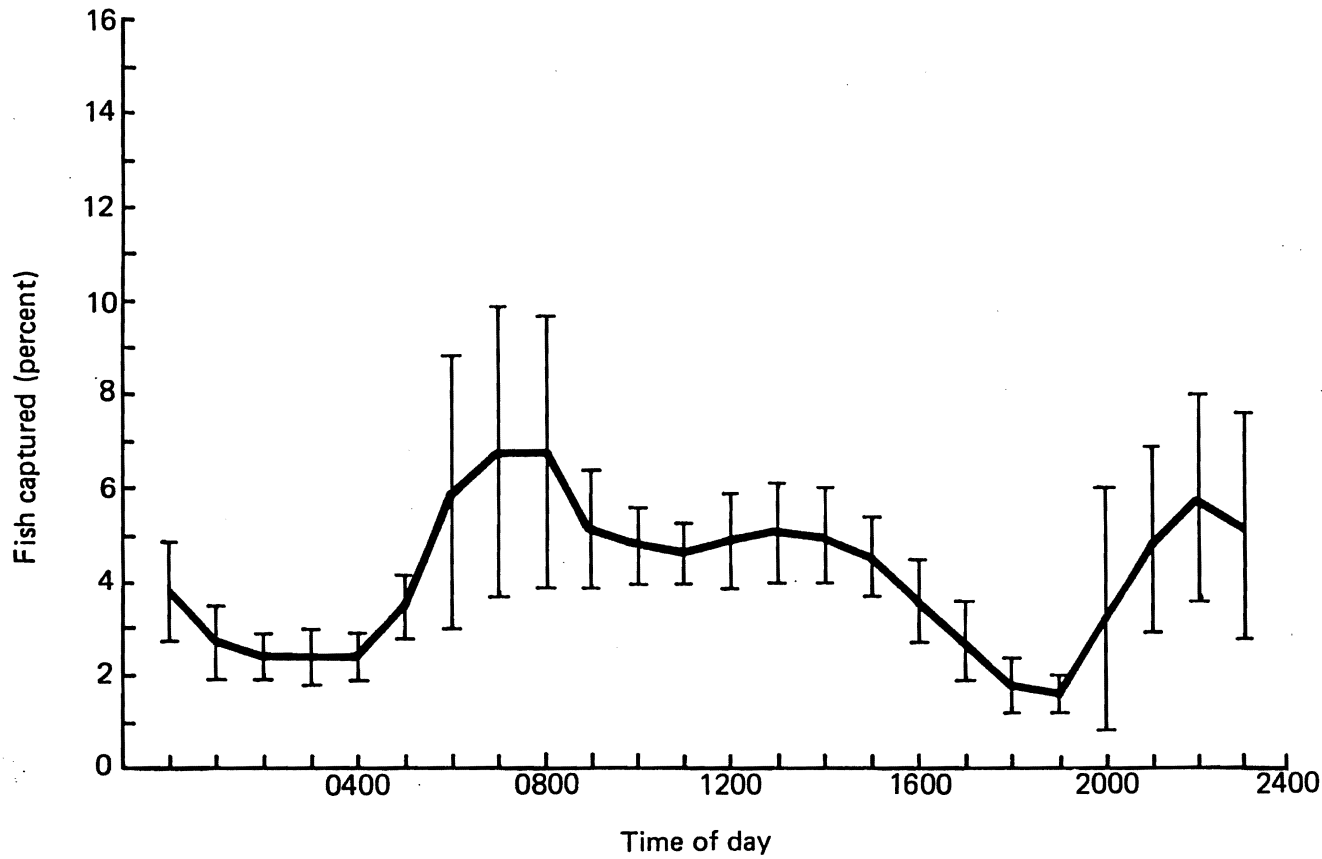


Figure 11.--Graph depicting the hourly passage for juvenile yearling chinook salmon with 95% C.I. for each data point at Bonneville First Powerhouse DSM, 1985.

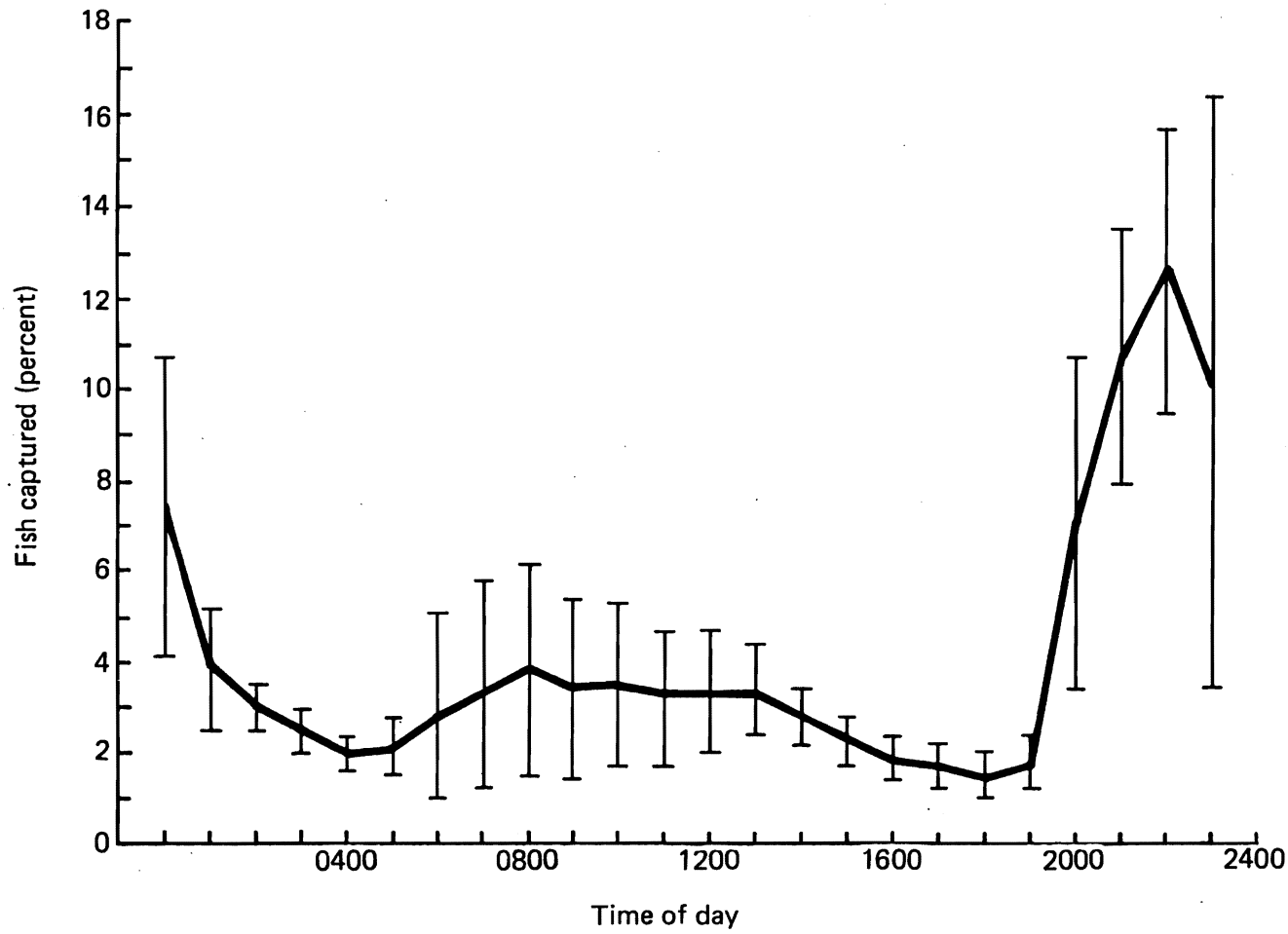


Figure 12.--Graph depicting the hourly passage for steelhead with 95% C.I. for each data point at Bonneville Dam First Powerhouse DSM, 1985.

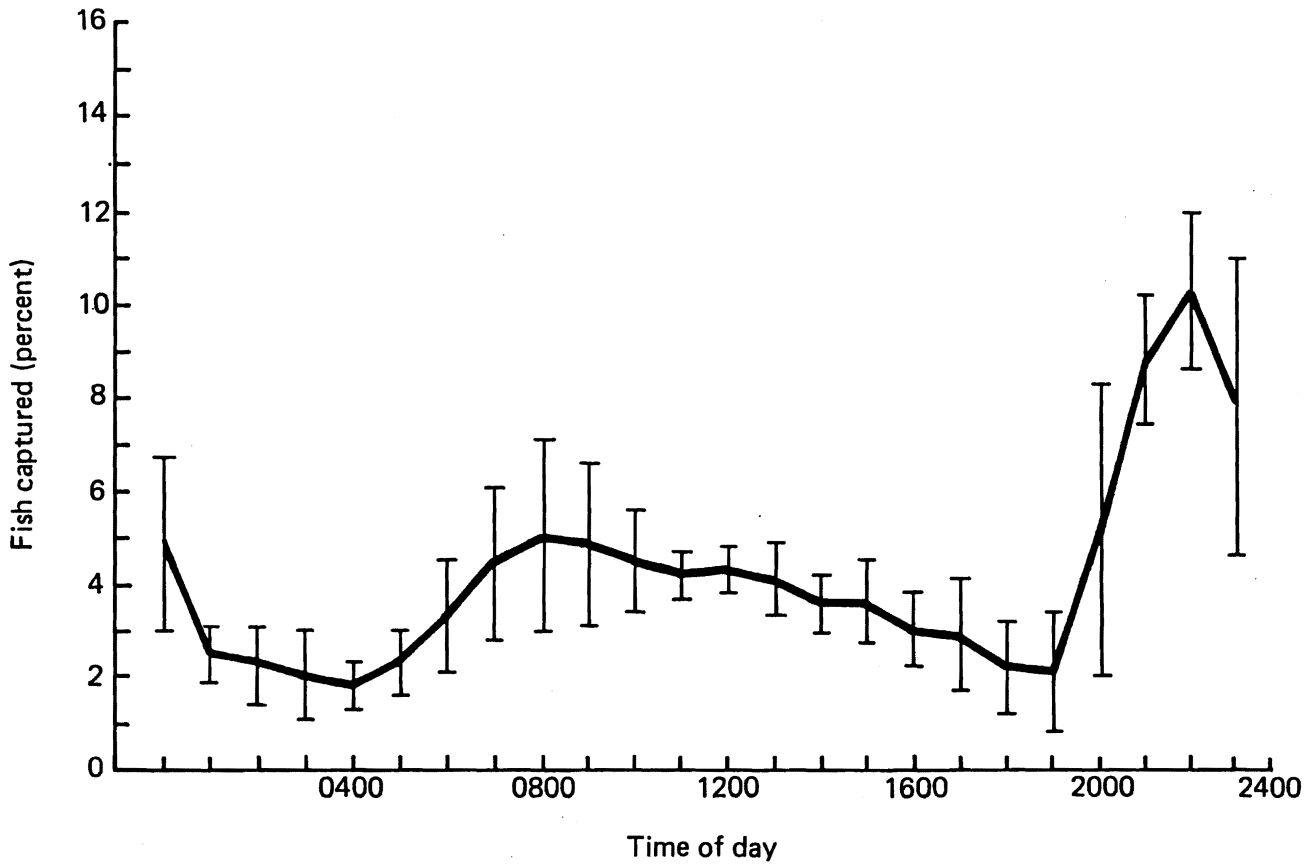


Figure 13.--Graph depicting the hourly passage for coho salmon with 95% C.I. for each data point at Bonneville Dam First Powerhouse DSM, 1985.

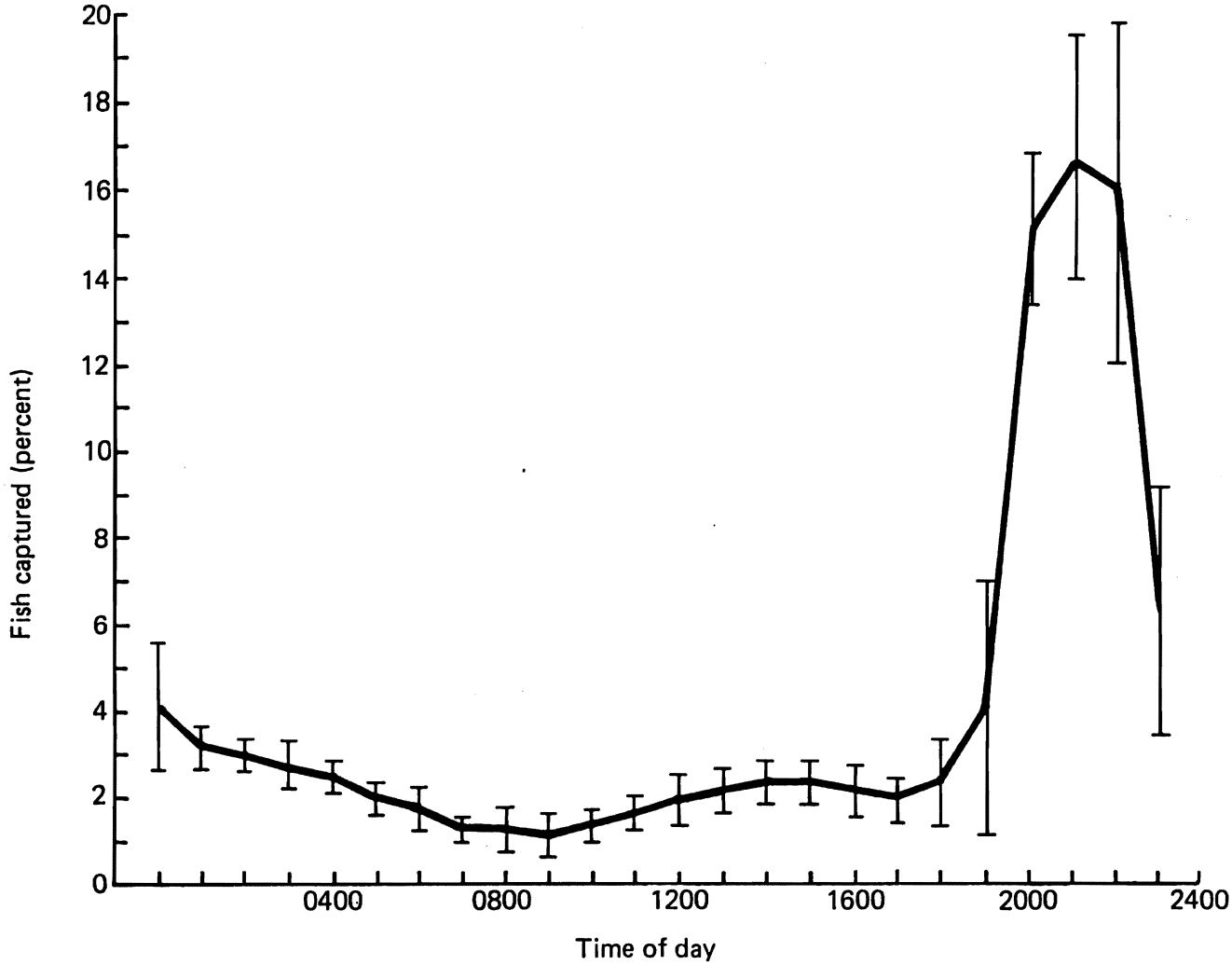


Figure 14.--Graph depicting the hourly passage for sockeye salmon with 95% C.I. for each data point at Bonneville Dam First Powerhouse DSM, 1985.

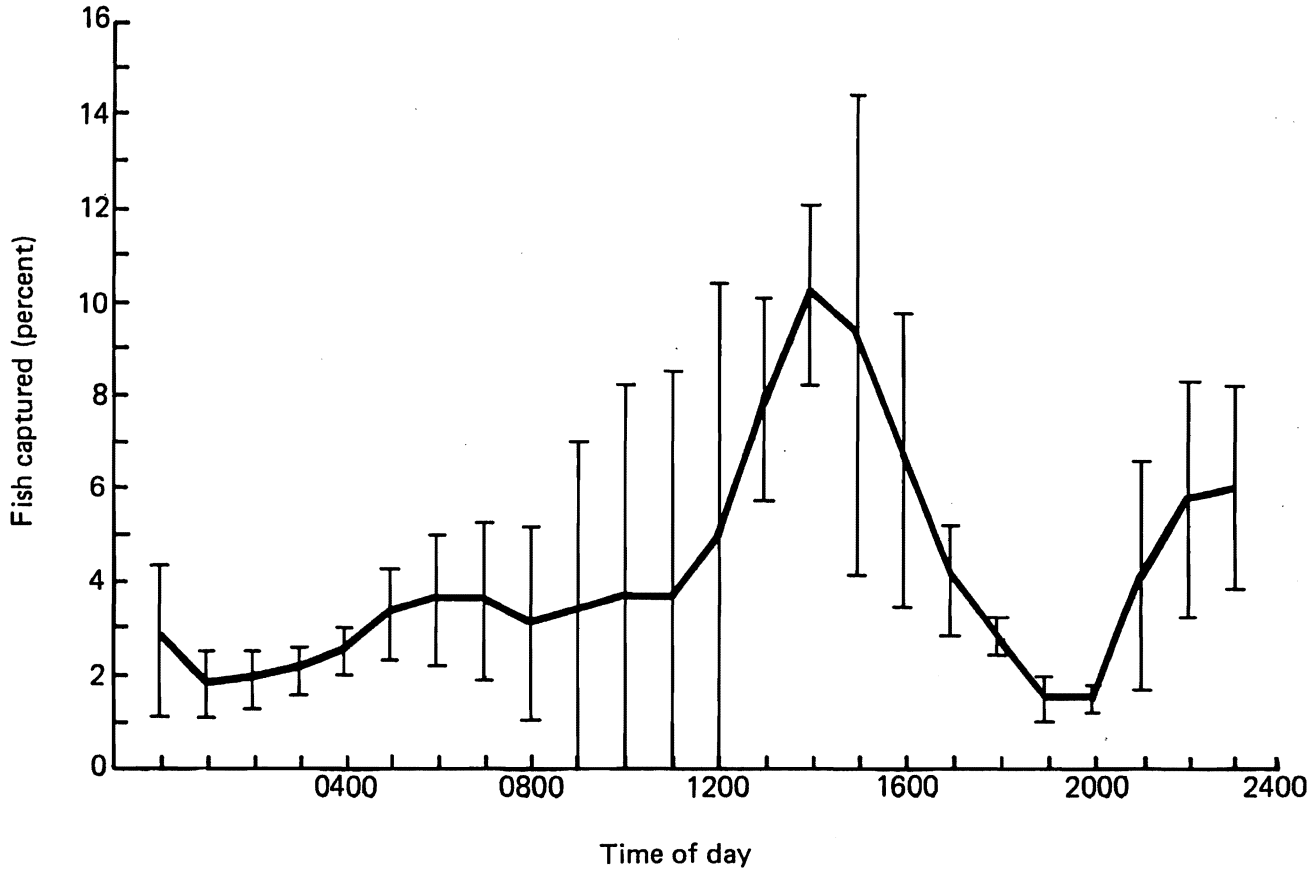


Figure 15.-- Graph depicting the hourly passage for subyearling chinook salmon with 95% C.I. for each data point at Bonneville Dam First Powerhouse DSM, 1985.

Table 6.--Average hourly passage percentages for salmonids collected during intensive sampling periods at Bonneville Dam First Powerhouse collection facility, 1985 (based on seven replicates except for subyearling chinook salmon which had only four replicates).

Time	Subyearling chinook	Yearling chinook	Steelhead	Coho	Sockeye
0000	2.8	3.8	7.4	4.9	4.1
0100	1.8	2.7	3.9	2.5	3.2
0200	1.9	2.4	3.0	2.3	3.0
0300	2.1	2.4	2.5	2.0	2.7
0400	2.5	2.5	2.0	1.8	2.5
0500	3.3	3.5	2.1	2.3	2.0
0600	3.6	5.9	3.1	3.3	1.8
0700	3.6	6.8	3.5	4.5	1.3
0800	3.1	6.8	3.8	5.1	1.3
0900	3.4	5.1	3.4	4.9	1.2
1000	3.7	4.8	3.5	4.5	1.5
1100	3.7	4.6	3.3	4.2	1.7
1200	5.0	4.9	3.3	4.3	2.0
1300	7.9	5.2	3.3	4.1	2.3
1400	10.2	5.0	2.8	3.6	2.4
1500	9.3	4.6	2.3	3.6	2.4
1600	6.6	3.6	1.8	3.0	2.2
1700	4.1	2.7	1.7	2.9	2.0
1800	2.8	1.8	1.4	2.2	2.4
1900	1.5	1.6	1.7	2.1	4.1
2000	1.5	3.4	7.1	5.2	15.1
2100	4.2	4.9	10.7	8.8	16.8
2200	5.8	5.8	12.6	10.3	16.0
2300	6.0	5.2	9.9	7.8	6.3

Table 7.--Estimated salmonid passage through the first powerhouse DSM at Bonneville Dam during 1985. n = number of samples used in estimate, * = less than two samples met the CI criteria, therefore, all samples were used to determine the weekly passage estimate.

	Subyearling chinook		Yearling chinook		Steelhead		Coho		Sockeye		All species
Date	n	Estimated passage	n	Estimated passage	n	Estimated passage	n	Estimated passage	n	Estimated passage	Estimated passage
31 Mar-06 Apr	2*	42	2*	3,416	2*	49	2*	98	2*	28	3,633
07-13 Apr	10*	231	9	4,816	4	77	10*	78	10	28	5,180
14-20 Apr	8*	182	3	30,401	5	4,844	6	1,358	8	35	36,820
21-27 Apr	15*	602	9	90,874	7	23,163	4	4,900	11	266	119,805
28 Apr-04 May	9	1,792	15	63,966	12	12,768	13	1,771	20	7,119	87,416
05-11 May	20	12,498	28	107,116	31	20,804	27	6,797	51	20,867	168,082
12-18 May	21	18,370	26	108,948	28	21,301	24	8,190	43	29,762	186,571
19-25 May	40	15,052	44	139,545	50	29,146	45	79,352	77	32,725	295,820
26 May-01 Jun	22	62,720	36	123,011	27	27,811	26	31,269	42	99,015	343,826
02-08 Jun	13*	7,147	9	104,524	9	49,210	10	241,304	13	134,001	536,186
09-15 Jun	7*	10,017	5	16,017	5	5,145	6	21,028	7	13,062	65,269
16-22 Jun	14*	131,733	8	15,582	5	2,065	7	10,171	14	10,780	170,331
23-29 Jun	12*	258,370	9	4,060	12*	679	5	6,335	12	3,871	273,315
30 Jun-07 Jul[a/]	9*	217,910	3	3,066	9*	539	9*	3,885	9	882	226,282
07-13 Jul	4*	70,763	3	5,187	4	189	4	8,813	4	2,863	87,815
14-20 Jul	3*	1,586,263	2	54,074	-	-	2	15,232	3	9,772	1,665,342
21-27 Jul	40	787,916	9	16,197	3	8,819	46	16,718	31	10,418	840,068
28 Jul-03 Aug	5*	6,356	-	-	5*	115	-	-	-	-	6,471
04-10 Aug	2*	22,337	-	-	-	-	2*	385	2	210	22,932
11-17 Aug	2*	4,168	-	-	-	-	2*	511	-	-	4,679
18-24 Aug	3*	4,627	-	-	-	-	-	-	-	-	4,627
25-31 Aug	3*	5,376	-	-	-	-	-	-	-	-	5,376
01-07 Sep	3*	5,215	-	-	-	-	-	-	-	-	5,215
09-14 Sep	8	18,697	-	-	-	-	-	-	-	-	18,697
15-21 Sep	3*	931	-	-	-	-	3	231	-	-	1,162
22-28 Sep	4*	644	-	-	-	-	4	42	-	-	686
29 Sep-05 Oct	6*	1,218	-	-	-	-	-	-	-	-	2,218
06-12 Oct	6*	5,859	-	-	-	-	3	56	-	-	5,915
13-19 Oct	8	9,576	-	-	-	-	-	-	-	-	9,576
20-16 Oct	3*	2,079	-	-	-	-	-	-	-	-	2,079
27 Oct-02 Nov	6*	2,457	-	-	3	182	3	196	-	-	2,835
03-09 Nov	3*	10,430	-	-	-	-	-	-	-	-	10,430
10-16 Nov	6*	10,220	-	-	-	-	3	644	-	-	10,864
Total		3,291,798		890,800		206,906		459,364		375,704	5,224,572

a/ End of spill at Bonneville 7/4.

OBJECTIVE IV - FISH QUALITY AND STRESS AT THE FIRST POWERHOUSE

Methods and Procedures

Delayed mortality was used as the primary indicator of relative stress for yearling chinook salmon collected at the fish collection facility and Gatewell 10A at the First Powerhouse and the DSM at the Second Powerhouse. Also, descaling and delayed mortality tests were conducted for subyearling chinook salmon collected from gatewells at the First Powerhouse equipped with either a standard or a balanced flow vertical barrier screen (SVBS or BFVBS).

Three to four replicate samples of yearling chinook salmon were collected at each sample point at various times during the outmigration. Smolt samples were taken from the sample tank (First Powerhouse) or the raceway (Second Powerhouse). Smolts were collected from Gatewell 10A with a standard gatewell dipnet; samples were then taken with a small dipnet equipped with a sanctuary bag to allow water-to-water transfer. Fish were then transferred in 30-gallon plastic containers to net-pens in a raceway at the Second Powerhouse observation room. These raceways had a continuous supply of river water. Delayed mortality tests were 5 days in duration, with daily mortality checks. Live fish were checked for descaling after termination of the test. The G-statistic was used to test for significant differences in mortality and descaling (Sokal and Rohlf 1981).

Results

Delayed mortality tests were conducted between 29 April and 22 May for yearling chinook salmon. Delayed mortality was significantly higher for yearling chinook salmon collected from the First Powerhouse DSM than from Gatewell 10A, 1.7 vs 0.3% (Table 8). Differences between the Second

Table 8.--Descaling and delayed mortality comparisons for yearling chinook salmon captured in Gatewell 10A, the First Powerhouse DSM, and the Second Powerhouse DSM, Bonneville Dam, 1985. All delayed mortality tests were 5 days in duration.

	Descaling						Delayed Mortality					
	1st PH	GW 10A	1st PH	DSM	2nd PH	DSM	1st PH	10A	1st PH	DSM	2nd PH	DSM
Date	Sample size	% des.	Sample size	% des.	Sample size	% des.	Sample size	% mort.	Sample size	% mort.	Sample size	% mort.
29 Apr	194	0.5	204	3.9	251	4.4	194	0.0	204	1.5	251	0.8
2 May	75	1.3	157	7.6	206	3.4	76	1.3	160	1.9	207	0.5
10 May	102	4.9	108	2.8	127	3.1	102	0.0	111	2.7	129	1.6
22 May			215	8.8	207	11.1			215	1.4	207	1.9
TOTALS	371	1.9	684	6.1	791	5.7	372	0.3	690	1.7	794	1.1

G-values
10A vs 1st PH 11.3**
10A vs 2nd PH 9.9**
1st PH vs 2nd PH 0.1

G-values
10A vs 1st PH 5.4**
10A vs 2nd PH 2.7
1st PH vs 2nd PH 1.0

** = $P < 0.01$

Powerhouse DSM and Gatewell 10A were not significant (1.1 vs 0.3%) nor were there significant differences between the two collection facilities (1.1 vs 1.7%). The descaling rates for yearling chinook salmon used in these tests were significantly higher for both collection facilities than for fish collected from Gatewell 10A (Table 8). There was little difference in descaling rates between the two collection facilities. Comparison of delayed mortality and descaling for yearling chinook salmon (Fig. 16) indicates a close relationship exists between the two --areas with higher descaling had correspondingly higher delayed mortality.

Descaling rates for subyearling chinook salmon indicate little difference between fish collected from gatewells equipped with the SVBS or BFVBS (1.5 vs 0.8%), respectively. Delayed mortality tests with subyearling chinook salmon were inconclusive due to high water temperatures (>70° F.) during their migration. Very little mortality occurred during the first 48-h period for either group. Mortality generally increased with the length of the test and was probably stress related.

OBJECTIVE V - ORIFICE PASSAGE EFFICIENCY TESTS AT THE FIRST POWERHOUSE

Orifice passage efficiency tests (OPE) were to be conducted at both powerhouses during the 1985 field season, but no tests were conducted at the Second Powerhouse because of continued low FGEs and solving the FGE problems took priority over OPE tests. Tests were, however, conducted at the First Powerhouse to complete the studies began in 1984. Tests in 1985 compared: (1) SVBS and BFVBS, (2) the addition of solid closure plates to the upper panel sections of both types of barrier screens, and (3) 12- and 14-inch diameter orifices.

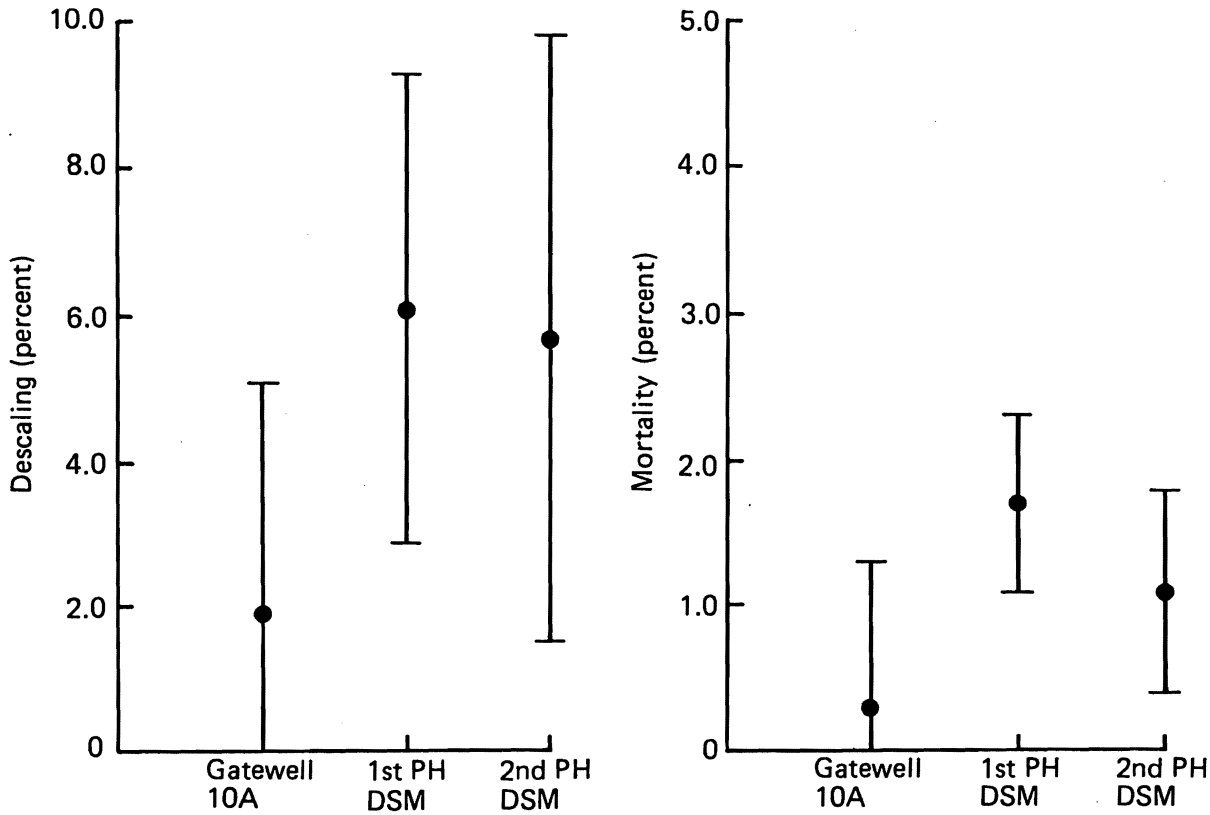


Figure 16.--Comparison of descaling and delayed mortality tests conducted with yearling chinook salmon collected from various points at Bonneville Dam in 1985. The bars show the 95% C.I. for each test.

Methods and Procedures

An adjustable inclined plane trap attached to the orifice in Gatewell 9C was used to capture the fish as they exited the gatewell. Because there was room for only one trap, tests were run consecutively rather rather than as the more desirable paired replicates. All tests were 24 h in duration, beginning and ending during periods of low fish movement (typically 1000 - 1400 h). Target species were yearling and subyearling chinook salmon, with data gathered on other species as available. OPE was determined by a direct comparison of the number of fish that were collected in the orifice trap with the number of fish that remained in the gatewell after 24 h of orifice operation. A minimum of three replicates with at least 200 fish of the target species were required for statistical analysis utilizing the G-statistic (Sokal and Rohlf 1981). An OPE approaching 75% in a 24-h period was considered acceptable.

A typical test sequence involved the following steps: (1) dipnet the gatewell to remove all residual fish and open the orifice to begin the test, (2) at set intervals (usually each hour) adjust (if needed) the head on the orifice to maintain a 2.5-foot head (this was done by raising or lowering the adjustable inclined plane), (3) remove and count all fish that collected in the trap, and (4) end the test by closing the orifice and dipnetting the gatewell to capture all remaining fish.

Results

A total of 9 test conditions with 28 individual replicates were conducted from 22 April to 1 August. Appendix Table B9 gives the collection data for these replicates. Test results for yearling chinook salmon (Table 9) indicate that the present orifice (14-inch) with a minimum orifice head of 2.5 feet and a SVBS is adequate for achieving acceptable OPE. The BFVBS did not show any improvement in OPE over a SVBS for tests with 14-inch diameter orifices.

Table 9.--Orifice passage efficiency (OPE) test data and G-test values for tests conducted at Bonneville Dam First Powerhouse, 1985. All tests were 24 h in duration with approximately 2.6 feet of head on the orifice. Only individual replicates with 200 fish of a given species or race were used for statistical evaluation.

Test condition			Yearling chinook			Steelhead			Coho			Sockeye		
Orifice size	Screen type	Closure plate	# of rep.	% OPE	G-test value	# of rep.	% OPE	G-test value	# of rep.	% OPE	G-test value	# of rep.	% OPE	G-test value
14"	BFVBS	w/ cp	5	80.3	5.3*									
14"	BFVBS	w/o cp	5	82.4										
14"	SVBS	w/ cp	4	92.9	18.4**	3	96.1	1.3	3	95.0	13.5**	3	93.6	13.2**
14"	SVBS	w/o cp	3	95.2		3	96.8		3	92.4		3	96.5	
14"	BFVBS	w/cp	5	80.3	293.2**									
14"	SVBS	w/cp	4	92.9										
14"	BFVBS	w/cp	5	82.4	296.7**									
14"	SVBS	w/o cp	3	95.2										

* = $P < 0.05$
** = $P < 0.01$

Also, the addition of closure plates to the top sections of the barrier screens did not significantly improve OPE. The data also indicate the 14-inch orifice system is adequate for other yearling species. However, acceptable levels of OPE were also measured for the 12-inch diameter orifices in 1984 (Gessel et al. 1985).

OPE for subyearling chinook salmon varied considerably between replicates late in the season similar to 1984 (Gessel et al. 1985). Tests conducted in May resulted in very high OPE (> 85%), whereas tests conducted during July and August gave much lower results. However, OPEs for three of four replicates of a test with a 12-inch orifice during this later part of the season were > 75%, but the range for the four replicates was 39 to 85% with a weighted average of 64%.

OBJECTIVE VI - DIEL PASSAGE AT THE FIRST POWERHOUSE

Methods and Procedures

To monitor diel fish movement, gatewells at the First Powerhouse were sampled every 2 h for a 24-h period using a standard gatewell dipnet. Prior to each test, the gatewell was dipnetted to remove all residual fish and the orifice closed. After collection, the fish were anesthetized, enumerated by species or race, allowed to recover in fresh water, and released. Only species represented by at least 200 fish per test were included in the analysis.

Results

Diel fish passage sampling was conducted from 25 April to 12 June. The results are shown graphically in Figures 17-21. Peak fish movements for all

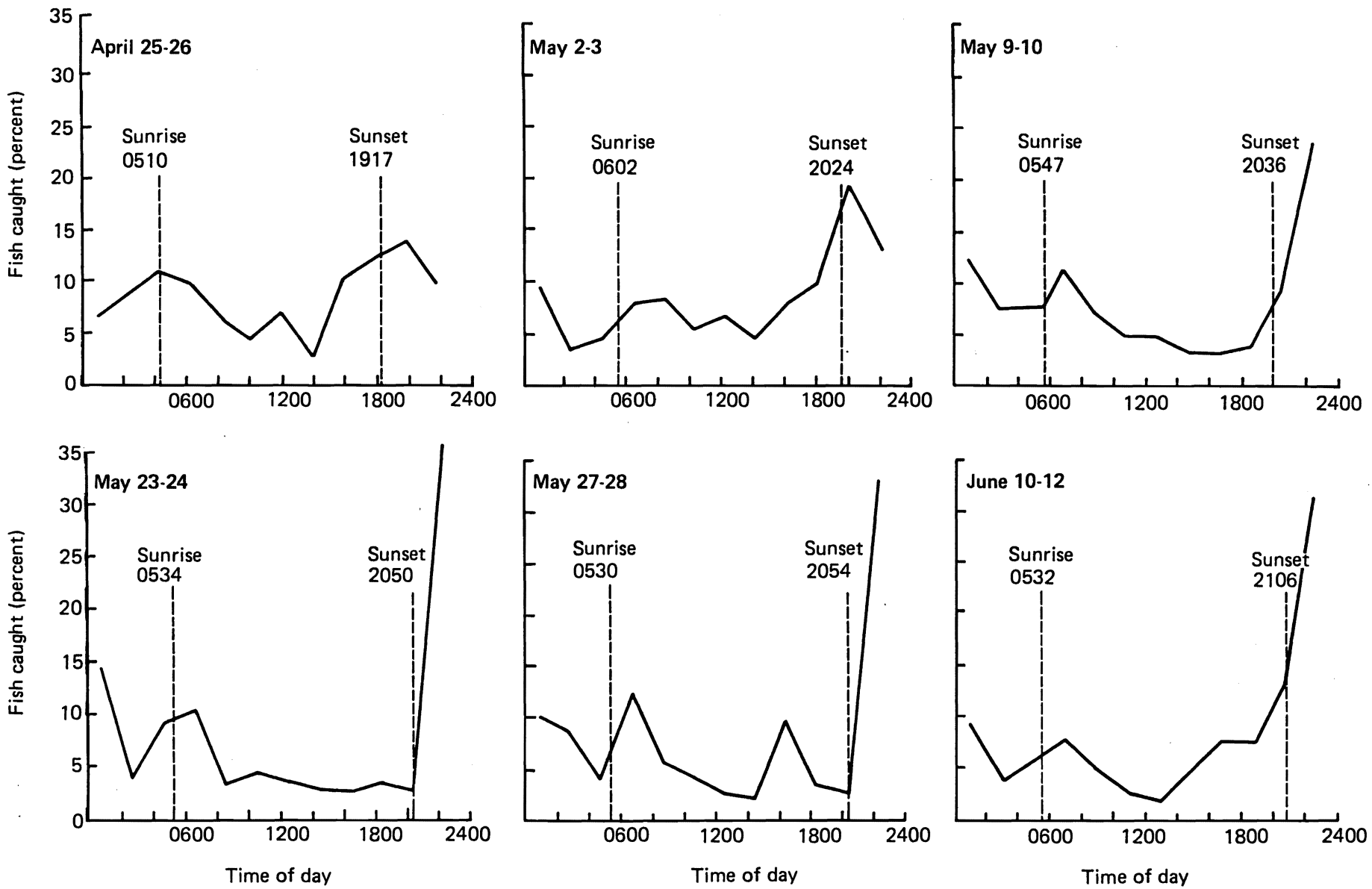


Figure 17.--Graphs showing diel passage of salmonids (all species), dipnetted from a gatewell at Bonneville Dam First Powerhouse, 1985.

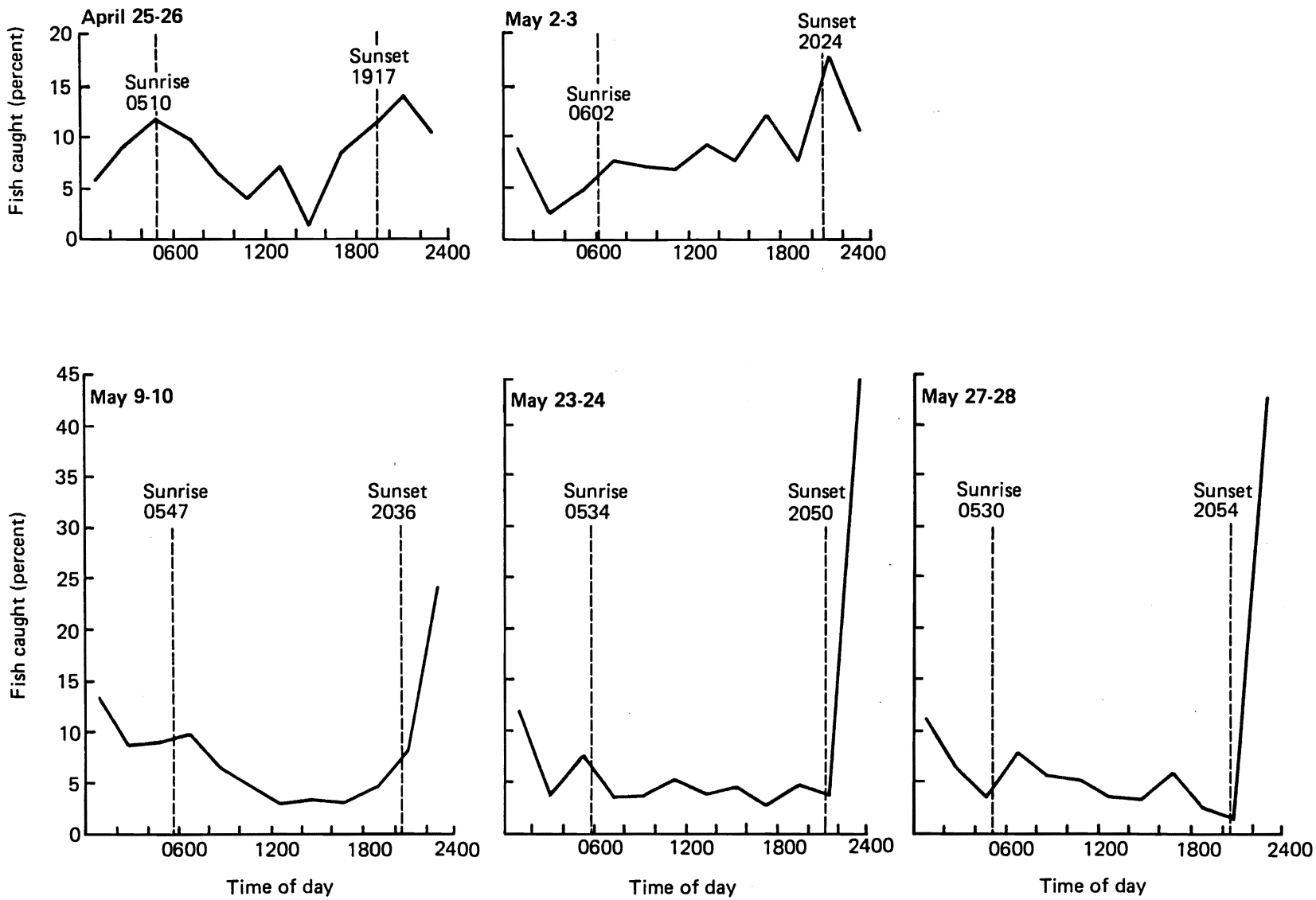


Figure 18.--Graphs showing diel passage of yearling chinook salmon, dipnetted from a gatewell at Bonneville Dam First Powerhouse, 1985.

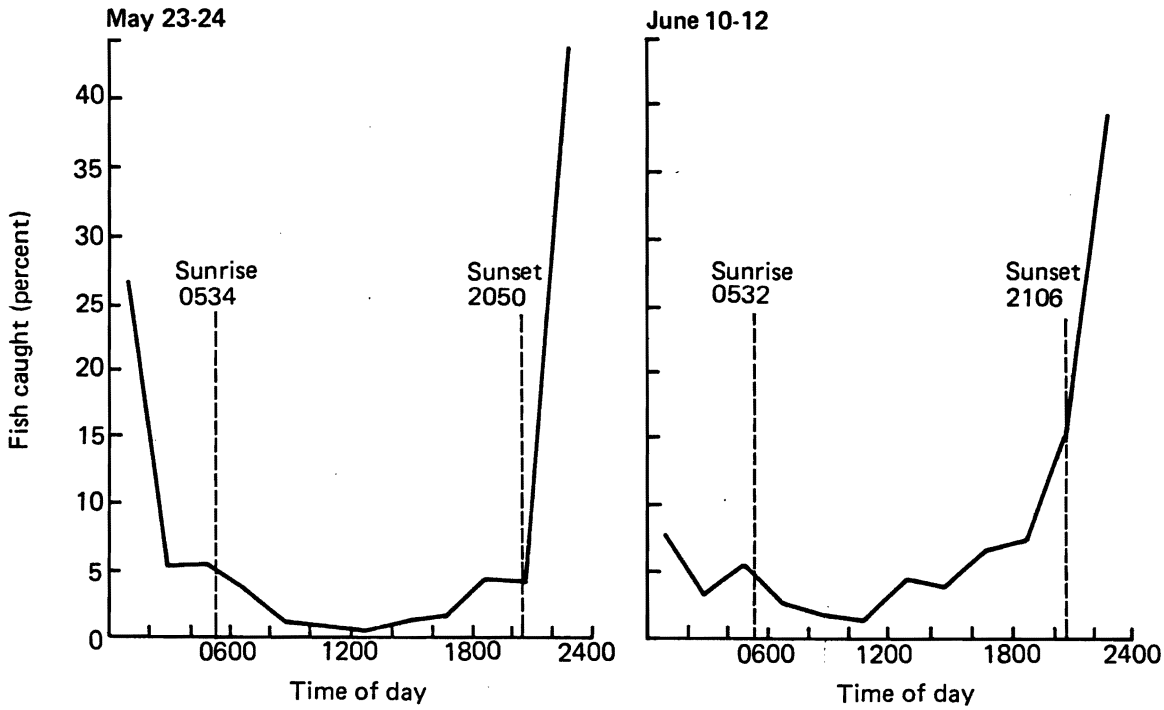


Figure 19.--Graphs showing diel passage of sockeye salmon, dipnetted from a gatewell at Bonneville Dam First Powerhouse, 1985.

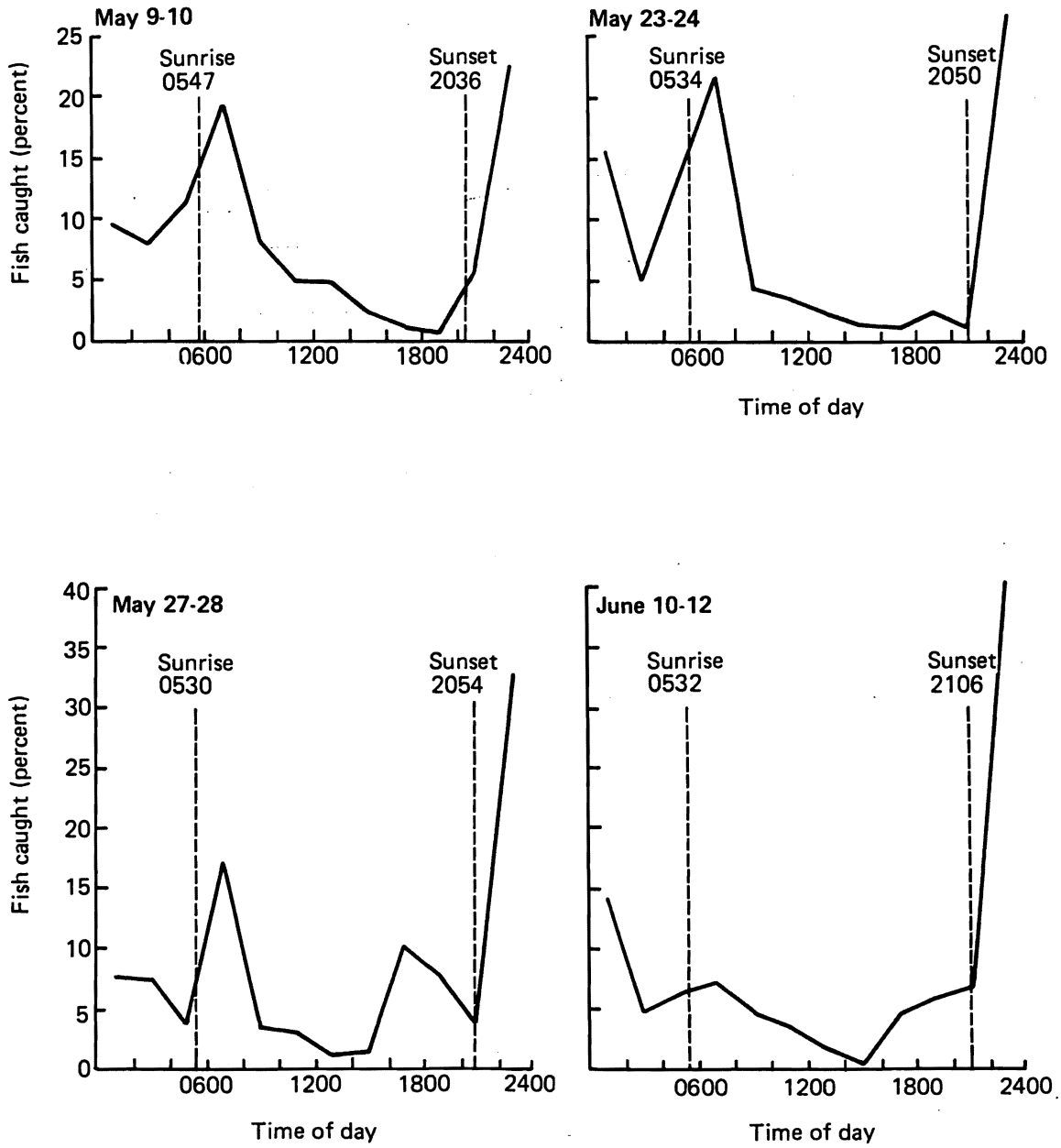


Figure 20.--Graphs showing diel passage of steelhead, dipnetted from a gatewell at Bonneville Dam First Powerhouse, 1985.

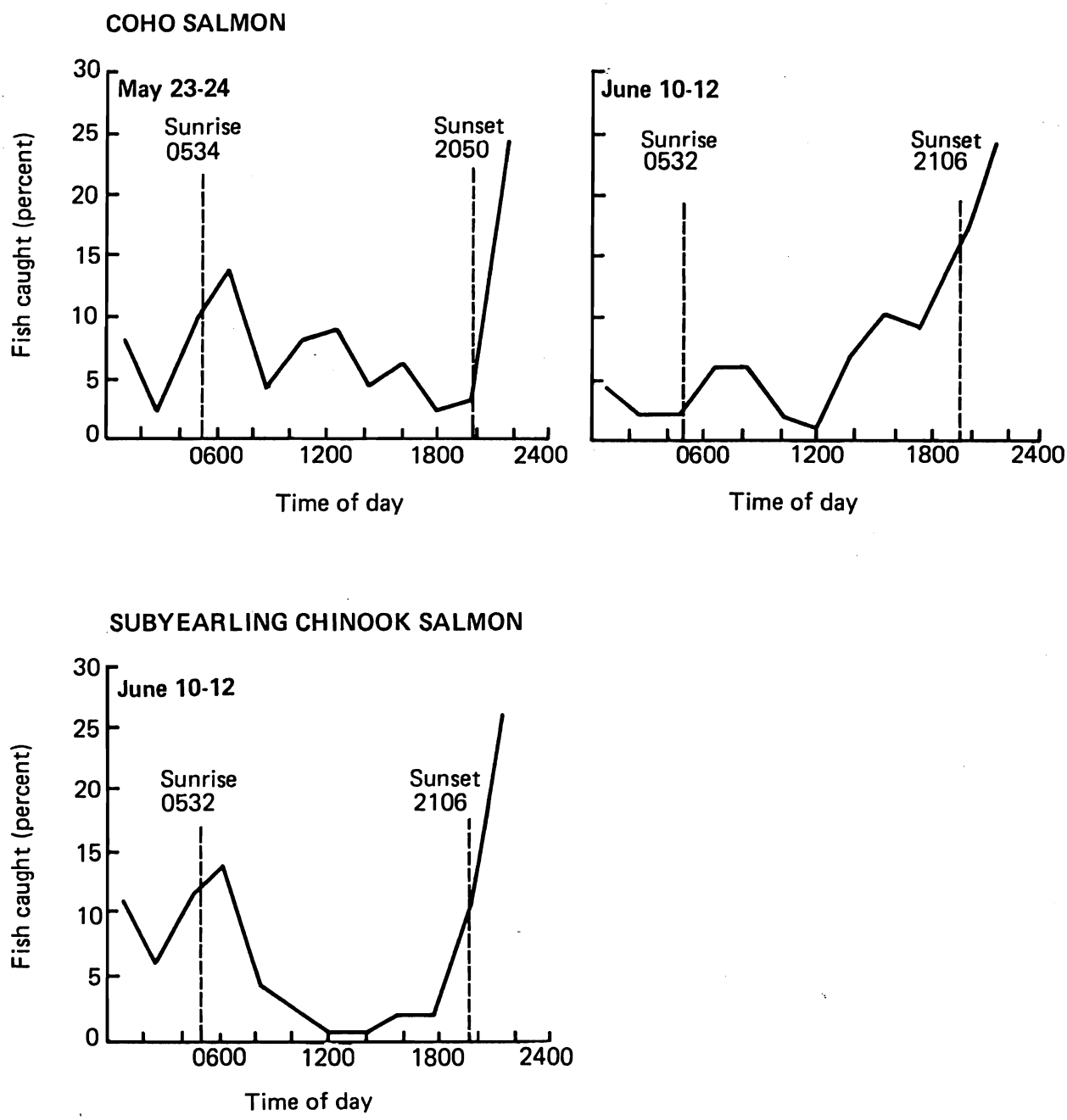


Figure 21.--Graphs showing diel passage of subyearling chinook salmon and coho salmon and coho salmon, dipnetted from a gatewell at Bonneville Dam First Powerhouse, 1985.

species combined were shortly after dawn and dusk, with the evening peak being typically much higher (Fig. 17). The size of these peaks changed over the course of the season, with an even more pronounced evening peak later in the year.

Yearling chinook salmon and steelhead (Figs. 18 and 19) generally followed these same patterns; sockeye salmon had the lowest daytime passage overall (Fig. 20) and coho the highest (Fig. 21). Local hatchery releases of large numbers of coho salmon may have influenced their diel pattern of movement. The diel passage of subyearling chinook salmon was similar to other species (Fig. 21); however, sufficient numbers for analysis were only captured during one sampling period (10 to 12 June). Because of relatively low numbers of sockeye, coho, and subyearling chinook salmon available during these tests, no significant conclusions should be made on their diel passage in 1985.

OBJECTIVE VII - TEMPORAL DISTRIBUTION

The optimum operation of the fingerling bypass facilities at Bonneville Dam requires a certain amount of downtime for necessary maintenance and repair. At the present time, all such activities are scheduled between 15 December and 1 March each year. The extensive repair and maintenance of the STS and other parts of the bypass systems has made it difficult to complete all the required work during this limited time. These impacts also affect other projects operations by restricting scheduling flexibility.

Such difficulties could be resolved if certain maintenance and repair activities could be scheduled outside the time period presently allotted. The

objective of this portion of the Bonneville Dam bypass studies was to define the temporal smolt passage distribution to ensure that rescheduled activities would not significantly impact smolt passage.

Methods and Procedures

The DSM sampler systems at both powerhouses were normally operated from about mid-April to mid-August to determine their affect on fish quality, develop sampler protocol and efficiency, obtain species information, etc. The temporal studies required increasing this operating period by beginning the weekly sampling about mid-March and continuing through mid-December.

The temporal distribution of the migration is represented in terms of a monthly percentage of the estimated DSM passage for both powerhouses. An accurate measure of temporal passage depends upon a reliable estimate of the number of fish passing through each powerhouse and/or over the spill. This can only be accomplished by a mark and release project designed to determine the proportion of smolts that pass each powerhouse under varying spill and powerhouse operating modes. This has not yet been achieved.

Estimates of the number of fish (by species) that passed through the individual powerhouse collection systems on a weekly basis, however, were made (see Objectives II and III, this report). This information was used as a relative indicator of smolt passage for making a gross determination of percent smolt passage on a monthly basis.

Results

Normal downstream smolt migration by Bonneville Dam generally begins in April, however, upstream hatchery releases of pre-smolts can occur in February or March. During 1985, salmonid fingerlings migrated at various levels of magnitude throughout the temporal study period.

Table 10 shows monthly estimated passage rates compiled from the data reported in Appendix Table B6 and Table 9. Passage rates were highest during May, June, and July; approximately 90% of the annual smolt migration occurred during these 3 months. September through November was the period of lowest passage and accounted for 1.5% of the estimated annual bypass total, about 90,000 fish (27,500; 25,200; and 37,300 fish per month, respectively).

Subyearling chinook salmon was the predominant (95%) species during the September to November period, with 80% passage through the First Powerhouse DSM and 20% through the Second Powerhouse DSM. As noted previously, the First Powerhouse estimates are not very exact due to design and operational deficiencies that are still being worked on. This problem becomes even more magnified for periods of low fish numbers. However, we feel the Second Powerhouse sampler is accurate and provides a more consistent measure of fingerling passage through the DSM. The sudden drop off in numbers, as shown in Table 10 for the Second Powerhouse, during late summer may have been atypical due to the higher than normal water temperatures in 1985. This may have caused fish to hold up and could have contributed to a larger number than normal migrating in late October and November as water temperatures began to drop.

Even with the noted sampling problems, it appears that over 98% of the outmigration has passed Bonneville Dam by the end of August. However, if the problems with the First Powerhouse sampler can be resolved, it would probably be advisable to continue the temporal studies through 1986, so a more accurate evaluation can be made for both powerhouses.

able 10.—Monthly estimates by species showing percentage passage rates for each Powerhouse each month during the temporal sampling period March through November 1985.

Month and Powerhouse	Species: Subyearling Chinook	Species: Yearling Chinook	Species: Steelhead	Species: Coho	Species: Sockeye	Monthly totals: Total PH I	Monthly totals: Total PH II	Monthly totals: Combined total	Monthly percentages[a/]: % PH I	Monthly percentages[a/]: % PH II	Monthly percentages[a/]: % Combined total
March											
PH I	b/	b/	b/	b/	b/						
PH II	7,180	15,034	17	0	17		22,248			4.3	
								22,248			0.4
April											
PH I	1,057	129,507	28,133	6,434	357	165,488			3.2		
PH II	4,083	140,072	7,534	485	18		152,192			29.4	
								317,680			5.5
May											
PH I	47,712	419,575	84,109	96,110	90,473	737,889			14.1		
PH II	2,688	112,614	15,945	18,306	18,596		168,149			32.5	
								906,038			15.8
June											
PH I	469,987	263,194	84,910	310,107	260,729	1,388,927			26.6		
PH II	46,426	22,313	6,093	28,415	9,959		113,206			21.9	
								1,502,133			26.2
July											
PH I	2,662,852	78,524	9,547	44,648	23,935	2,819,506			54.0		
PH II	42,041	468	18	863	18		43,408			8.3	
								2,862,914			50.0
August											
PH I	42,864	0	115	896	210	44,085			0.8		
PH II	b/	b/	b/	b/	b/	b/					
								44,085			0.8
September											
PH I	25,487	0	0	273	0	25,760			0.4		
PH II	1,697	0	0	0	0		1,697			.3	
								27,457			0.5
October											
PH I	18,732	0	0	56	0	18,788			0.3		
PH II	6,249	0	18	127	18		6,412			1.2	
								25,200			0.4
November											
PH I	23,107	0	182	840	0	24,129			0.5		
PH II	9,882	0	152	93	18		10,145			2.0	
								37,274			0.6
Species Totals											
PH I	3,291,798	890,800	206,906	459,364	375,704	5,224,572					
PH II	120,246	290,501	29,777	48,289	28,644	517,457					
PH I + PH II	3,412,044	1,181,301	236,683	507,653	404,348	5,742,029					
Species Percentage											
PH I	63.0	17.0	4.0	8.8	7.2						
PH II	23.2	56.1	0.6	9.3	5.5						
PH I + PH II	59.4	20.6	4.1	8.8	7.0						

a/ No adjustments made for periods of no data.

b/ No data.

CONCLUSIONS

1. Lowering the STS to reduce the flow restriction at the throat opening significantly increased FGE from 33 to about 42%; still far below the acceptable (> 70%) FGE.

2. Streamlined trashracks in conjunction with a 27-inch lowered STS gave the highest FGE for both yearling and subyearling chinook salmon, 42 and 24%, respectively.

3. Factors upstream from the trashracks are causing the fingerlings to enter the intakes too deep for the STS to achieve acceptable FGE.

4. Descaling and mortality at the Second Powerhouse DSM were lower than in 1984 for all species.

5. Modifications of the DSM water level controls at the Second Powerhouse did not adequately stabilize water levels.

6. Lowering the energy dissipator in the observation room reduced turbulence in the downwell and improved drainage from the raceways.

7. The automatic water level controls at the First Powerhouse are not completely functional.

8. Additional modifications are required to the sampling equipment to achieve more efficient and accurate sampling at the First Powerhouse.

9. Under existing operating conditions, there is little potential for use of Bonneville Dam as a lower river index site.

10. Stress, indicated by delayed mortality, is higher for yearling chinook salmon collected in the DSM than for those collected from a gatewell at the First Powerhouse.

11. Descaling is higher for yearling chinook salmon collected at either DSM when compared to those captured from a gatewell at the First Powerhouse.

12. There is a close relationship between descaling and delayed mortality for yearling chinook salmon.

13. Descaling rates for subyearling chinook salmon appear to be the same for fish captured in gatewells equipped with either an SVBS or a BFVBS.

14. The present orifice/SVBS system at the First Powerhouse provides adequate OPE for yearling and subyearling chinook salmon when the orifice is operated with approximately 2.5 feet of head.

15. Diel passage for juvenile salmonids at the First Powerhouse peaks at dawn and dusk, with the evening peak typically higher.

16. Of the portion of juvenile salmonids that pass Bonneville Dam through the DSMs at the two powerhouses throughout the sampling period, approximately 90% pass from May to July and approximately 1.5% from September to November.

RECOMMENDATIONS

First Powerhouse

1. Continue evaluation of the modifications at the fish collection site in the DSM.

2. Continue temporal studies to determine smolt passage at Bonneville Dam.

Second Powerhouse

1. Continue FGE studies to improve FGE through the use of a lower STS, more porous guiding device(s), and improved flow conditions near the intakes.

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

3. Determine the cause of the back-surge in the downwell and the subsequent flooding in the observation room and resolve the problem.

4. Modify the random sampler in the DSM to allow it to be inserted or removed from the flow automatically.

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Appendix A

Sample sizes needed for comparative trials

APPENDIX A

Sample Sizes Needed for Comparative Trials

In these experiments we are mainly concerned with comparing different treatment groups to determine the best condition. In some cases a comparison is made against a standard value or an estimate of an average value is desired. In the design of these studies, it is necessary to determine the sample sizes required to assure acceptable results.

Typically, the information needed to determine sample sizes and number of replicates required is the experimental error variance, s^2; the size of the effect to be detected, δ ; the number of means being compared, k; and the α and β levels (the probability of a Type I error, α , and the probability of a Type II error, β) desired from the statistical test. It is usual to specify α , β and δ to satisfy research objectives. For the studies considered here we use $\alpha = 0.05$, $\beta = 0.20$ and $\delta = 0.10$. We estimate a value for the standard error, s, based on compilation of data from past fish guidance efficiency (FGE) studies. From these data we obtained a value of 0.0314 for chinook salmon and a value of 0.0272 for steelhead. Limited data from other species show slightly lower standard errors. We have used the value obtained from chinook salmon in our sample size computations.

The data are collected in the form of fish counts and will often be used directly in contingency table analysis. For this analysis, sample size formulas will be used which apply to categorical data. In some tests, the FGE is expressed as a percentage and an average value is also estimated. Standard randomized block procedures apply to these situations.

In these studies we are dealing with research on fish in their natural environment. It is not anticipated that our experiments will contain the

uniformity of laboratory studies. When conditions provide the opportunity, we plan additional repeated measurements as assurance against the lack of uniformity in field conditions. These may not be stipulated by a formal experimental design. They have several uses in subsequent data analysis. Replicated measurements should steadily decrease the error associated with the comparisons among treatment groups, and they can also be used to make an assessment of measurement accuracy, e.g., the closeness among comparable measurements (Tsao and Wright 1983). This assessment is especially useful to identify problem areas in the data collection system which may require special investigation. For a more lucid and comprehensive discussion see Cochran and Cox (1957) and Mosteller and Tukey (1977).

In these experiments, we compare experimental units by means of a test of significance. We will be attempting to establish that one procedure is superior or different than another by at least some stated amount. Consequently, the experiments must be large enough to reasonably ensure that if the true difference is equal to or greater than the specified amount, we have a high probability of detecting it, or obtaining a statistically significant result. The procedures used as follows provide an approximation that is adequate for design purposes. The notation for the formulas is given below.

1. Two group comparison case: This case is concerned with determining whether one condition is better than another condition (a one-way comparison), or with determining whether two conditions differ (a two-way comparison). The formula used is:

$$NT = (ZA + ZB)^2 \;/\; 2\,(\arcsin\sqrt{P1} - \arcsin\sqrt{P2})^2.$$

This formula is given by Paulson and Wallis (1947), it is also used by Cochran and Cox (1957), sample size graphs calculated by Feigl (1978) and

Lemeshow et al. (1981) showed that it provided the closest approximation to an exact method when the underlying proportions are small. This formula may be expressed in different forms, depending on the definition of ZA and ZB. We follow the form used by Feigl. The formula applies to categorical data.

2. More than two groups or multinomial case: The procedures used for obtaining confidence intervals and sample sizes follow methods given by Angers (1984), Bailey (1980), Goodman (1965), and Miller (1966). The formula used is:

$$NM = [(B)\ (P_i\ (1-P_i)]\ /\ D^2.$$

3. For determining the number of replicates, the procedures follow those given in Steel and Torrie (1960), Cochran and Cox (1957), and Diamond (1981).

The formula used is:

$$R \geq 2\ (T_1 + T_2)^2\ (S^2)\ /\ D^2.$$

This formula is an approximation which depends on how well S^2 estimates the experimental error. Successive approximations must be used since the number of degrees of freedom associated with T_1 and T_2 depends upon R.

The following notation is used in the samples size formulas:

NT - sample size in the two group comparison.

ZA - standardized normal deviate exceeded with probability A. Where A is $1 - \alpha/2$ for the two-sided case and A is $1 - \alpha$ for the one-sided case.

ZB - standardized normal deviate exceeded with probability B. Where B is $1 - \beta$, for the one-sided case. This corresponds to the probability of obtaining a significant result. Note that ZB - -ZB' where B' equals β . Hence, (ZA + ZB) could be written as (ZA - ZB') without altering the value of NT.

P1 - proportion in the control group.

P2 - proportion in the test group.

NM - smallest sample size such that the statistical precision levels for the multinomial parameters, P_i are simultaneously satisfied.

B - tabular value for the upper percentile of the chi-squared distribution at the $1-\alpha/k$ statistical precision level with one degree of freedom. Where k is the number of proportions being compared.

P_i - expected proportion in each multinomial category, $i = 1, 2, \ldots, k$.

D - level of difference it is desirable to be able to detect, this can be different for each treatment (or multinomial) category.

R - the number of replicates per treatment.

T_1 - t-distribution value associated with type I error,

T_2 - t-distribution value associated with type II error; T_2 is the tabulated t for probability 2(1-Q) where Q is the power of the test, $1-\beta$.

S_2 - estimated experimental error, this is usually obtained from previous experiments.

The degrees of freedom for T_1 and T_2 are the product (L-1) (R-1), where L is the number of treatment groups, and R the number of replicates. Successive approximations are involved in the calculations for parts (2) and (3) since the number of degrees of freedom assoicated with tabulated probability distribution values depends on sample size.

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Appendix B

Catch data for fish guiding efficiency, vertical distribution, First and Second Powerhouse smolt sampling facilities, and orifice passage efficiency

Appendix Table B1.--Numbers of fish collected in the individual replicates of STS FGE tests at Bonneville Dam Second Powerhouse, 1985 (tests conducted in July and August captured only subyearling chinook salmon).

	Date and (test number)[a]														
	3 May (1)					4 May (1)					5 May (1)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell		174	17		15		186	20		18		149	11		6
Gap Net		2	1										1		
Closure Net		97	9		10		85	13		21		58	3		4
1st Level		34			1		37	5		4		38	3		6
2nd Level	1	98	3		1		113	15		18		69	2		7
3rd Level	1	57	6		1		49	13		20		36	3		6
4th Level[b]	1	57	3				33	9		9		12	3		3
5th Level[b]	2	9					6			6		3			3
Totals	5	528	39		28		509	74		96		365	26		35

	6 May (1)					7 May (1)					8 May (2)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell		85	24		15		219	119		63		129	37		102
Gap Net		2	1				4			4					
Closure Net		35	9		13		158	53		46		48	21		93
1st Level		22	4		5		63	15		16		29	13		46
2nd Level		50	15		12		160	53		45		44	7		65
3rd Level		36	9		12		88	46		29		22	6		46
4th Level[b]		15	3		12		78	3		24		21			33
5th Level[b]							15			12		3			
Totals		245	65		69		785	289		296		84	385		

	9 May (2)					10 May (2)					11 May (3)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell		201	30		58	2	158	31		82		133	33		71
Gap Net		2										2			9
Closure Net	1	77	13		41	1	68	12		46	3	63	16		60
1st Level		38	6		16	1	30	8		26	1	32	15		36
2nd Level	1	85	9		30	2	62	10		39	2	60	11		55
3rd Level	2	51	11		37	1	43	5		30		28	17		27
4th Level[b]		24			36		27	3		9	3	24	6		18
5th Level[b]		3			3		6								
Totals	4	481	69		221	7	394	69		232	9	342	98		276

Appendix Table B1.--Cont.

Location	Date and (test number)[a]														
	12 May (3)					13 May (3)					14 May (4)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	3	221	35		46	8	154	38		78		175	28		84
Gap Net	4	18	4		4		11			14		72	10		52
Closure Net		93	12		38	4	56	15		46	1	94	18		89
1st Level	1	39	8		15	1	45	4		33		57	12		57
2nd Level		64	18		38	1	51	9		55	1	92	17		110
3rd Level		63	9		29	1	51	11		37	3	94	20		110
4th Level[b]		33			12		36			18	3	39			39
5th Level[b]		15													
Totals	9	546	86		192	15	404	77		281	8	623	105		521

	15 May (4)					16 May (4)					17 May (4)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	5	252	46		52	8	166	19		24	2	226	69		40
Gap Net		86	2		33	5	67			8	1	106	10		29
Closure Net	2	126	16		73	4	61	9		18	1	145	43		50
1st Level	1	99	9		39	3	36			5	1	78	28		26
2nd Level	1	154	9		62	4	69	6		20	1	138	41		59
3rd Level	2	125	11		52	6	56	6		15	1	117	38		56
4th Level[b]	3	45	3		12		33			9		57	6		12
5th Level[b]															
Totals	14	887	96		323	30	488	40		99	7	867	235		272

	18 May (2)					22 May (5)					24 May (5)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	5	237	30		77	3	194	63	38	51	7	119	67	26	43
Gap Net	1	3					3		1	1					3
Closure Net	1	103	21		65	2	33	18	6	26		33	14	13	26
1st Level	2	62	10		22	5	36	22	5	23	2	26	22	2	28
2nd Level	4	76	23		70	5	68	30	8	67	6	73	38	8	64
3rd Level	3	68	20		71	4	53	32	8	57	6	47	35	4	64
4th Level[b]		42	3		21	6	30	12		27	9	24	9		27
5th Level[b]															
Totals	16	591	107		326	25	417	177	66	252	30	322	185	53	255

Appendix Table B1.--Cont.

Location	25 May (6) SC	YC	ST	CO	SO	26 May (6) SC	YC	ST	CO	SO	28 May (7) SC	YC	ST	CO	SO
Gatewell	14	240	50	35	40	53	119	67		39	111	108	33	9	23
Gap Net	4	16	4	3	4	9	6			7	11				1
Closure Net	6	46	10	3	23	23	36	14		27	35	38	19	4	15
1st Level	11	33	18	4	20	11	28	24		23	20	30	18	2	12
2nd Level	25	79	15	3	55	63	59	17		55	33	59	20	3	35
3rd Level	36	82	15	6	45	50	59	32		82	37	31	17		34
4th Level[b]	33	30	9	6	21	36	24	3		45	21	24	6	3	15
5th Level[b]															
Totals	129	526	121	60	208	244	331	157		268	268	290	113	21	135

	29 May (7) SC	YC	ST	CO	SO	30 May (8) SC	YC	ST	CO	SO	31 May (9) SC	YC	ST	CO	SO
Gatewell	40	91	44	14	21	30	88	34	12	18	17	73	30	5	20
Gap Net	4				2	4	4	1		3	11	15	2		3
Closure Net	15	20	18	2	20	14	30	28	1	14	8	32	28		36
1st Level	14	26	11	3	15	5	27	19	1	13	4	29	20		16
2nd Level	18	62	24	3	46	13	45	39	2	34	21	47	17	1	48
3rd Level	28	58	20	2	41	22	42	22	1	42	4	62	23	3	50
4th Level[b]	3	33	12		18	9	36	9		21	3	12			15
5th Level[b]															
Totals	122	290	129	24	163	98	272	152	17	145	68	274	120	9	188

	1 June (10) SC	YC	ST	CO	SO	2 June (10) SC	YC	ST	CO	SO	3 June (10) SC	YC	ST	CO	SO
Gatewell	13	90	25	6	24	25	80	29		11	12	48	18		14
Gap Net	7	18	6		12	7	23	4		3	5	17	1		5
Closure Net	7	31	12		20	10	39	34		12	14	22	6		10
1st Level	3	18	10	3	14	5	17	10		10	2	17	6		5
2nd Level	9	33	18	1	21	19	45	17		26	8	16	5		4
3rd Level	10	26	10		21	10	40	18		23	8	11	3		11
4th Level[b]		15	3		9	6	9			3	3	6	3		3
5th Level[b]															
Totals	49	235	82	10	121	82	253	112		88	52	137	42		52

Appendix Table B1.—Cont.

Location	Date and (test number)[a]														
	4 June (11)					5 June (11)					6 June (11)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	21	151	24	123	9	31	125	18	88	10	56	48	18	34	1
Gap Net	3	52	1	47	2	11	33	5	26	1	23	20	1	14	2
Closure Net	15	42	22	29	9	13	24	6	18	4	20	8	7	7	
1st Level	7	35	7	19	5	8	18	5	9	4	10	16	1	8	2
2nd Level	8	50	14	27	14	11	23	11	13	12	25	19	10	8	1
3rd Level	17	35	25	23	12	5	25	8	18	8	20	12	1	5	
4th Level[b]	3	15		9	9		9			3	12	3			
5th Level[b]															
Totals	74	380	96	277	60	79	257	53	172	43	166	126	38	76	6

	16 July (12)					16 July (13)					17 July (12)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	95					261					99				
Gap Net	2					8					1				
Closure Net	240					242					224				
1st Level	57					90					105[b]				
2nd Level	249					240					264[b]				
3rd Level	288					207					240[b]				
4th Level[b]	315					105					192[b]				
5th Level[b]	69										57[b]				
Totals	1315					1153					1182				

	17 July (13)					18 July (12)					18 July (13)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	168					83					232				
Gap Net	4										7				
Closure Net	150					104					176				
1st Level[b]	99					27					57				
2nd Level[b]	273					87					123				
3rd Level[b]	213					90					84				
4th Level[b]	141					69					39				
5th Level[b]						18									
Totals	1048					478					718				

Appendix Table B1.—Cont.

	Date and (test number)[a]														
	19 July (12)					19 July (13)					20 July (14)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	74					216					216				
Gap Net	6					6					4				
Closure Net	166					188					308				
1st Level[b]	30					90					99				
2nd Level[b]	114					138					270				
3rd Level[b]	105					114					201				
4th Level[b]	51					36					198				
5th Level[b]	15														
Totals	561					788					1356				

	20 July (15)					21 July (14)					21 July (15)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	195					173					141				
Gap Net	5					3					10				
Closure Net	378					202					274				
1st Level[b]	81					87					108				
2nd Level[b]	459					202					354				
3rd Level[b]	189					246					204				
4th Level[b]	156					165					126				
5th Level[b]	51										42				
Totals	1514					1098					1259				

	22 July (14)					22 July (15)					23 July (14)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
atewell	126					164					92				
ap Net	7					2					3				
losure Net	144					222					104				
st Level	57					18					48				
nd Level	192					258					159				
rd Level	171					174					174				
th Level[b]	102					120					87				
th Level[b]						24									
Totals	799					982					667				

Appendix Table B1.—Cont.

	Date and (test number)[a]														
	23 July (15)					27 July (16)					28 July (16)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	101					78					209				
Gap Net	3					5					12				
Closure Net	104					114					224				
1st Level	33					36					135				
2nd Level	120					162					291				
3rd Level	111					123					261				
4th Level[b]	126					102					150				
5th Level[b]	54														
Totals	652					620					1282				

	29 July (16)					30 July (17)					31 July (18)				
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	179					157					57				
Gap Net	18					22					36				
Closure Net	106					106					64				
1st Level	51					66					33				
2nd Level	168					198					117				
3rd Level	114					201					81				
4th Level[b]	75					120					57				
5th Level[b]															
Totals	711					870					445				

	1 August (19)														
	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	214														
Gap Net	97														
Closure Net	118														
1st Level	69														
2nd Level	222														
3rd Level	177														
4th Level[b]	90														
5th Level[b]															
Totals	987														

[a] Test numbers ocrrespond to those in Table 1, this report.

[b] Only the middle net was fished at these levels.

Appendix Table B2.--Bonneville Dam Second Powerhouse STS and streamlined trash racks comparison tests, July 1985.

BASIC TEST CONFIGURATION

Test #	Unit	STS Elevation	Trashrack	Symbols
1	12A	Standard (S)	Standard (S)	S&S
1	12B	Lowered (L)	Streamlined (M)	L&M
2	12A	Lowered (L)	Standard (S)	L&S
2	12B	Standard (S)	Streamlined (M)	S&M

ACTUAL TEST DATA

TESTS #1 12A S&S

Replicate	Gatewell	Nets	Total	FGE
1	95	220	1315	0.072
2	99	1083	1182	0.084
3	83	395	478	0.174
4	74	487	561	0.132
Totals/averages	351	2185	3536	0.099

TEST #1 12B L&M

Replicate	Gatewell	Nets	Total	FGE
1	261	892	1153	0.226
2	168	880	1048	0.160
3	232	486	718	0.323
4	216	572	788	0.274
Totals/average	877	2830	3707	0.237

Appendix Table B2.--Continued.

TEST #2 12A L&S

Replicate	Gatewell	Nets	Total	FGE
1	216	1140	1356	0.159
2	173	925	1098	0.158
3	126	673	799	0.158
4	92	575	667	0.138
Totals/average	607	3313	3920	0.155

TEST #2 12B S&M

Replicate	Gatewell	Nets	Total	FGE
1	195	1319	1514	0.129
2	141	1118	1259	0.112
3	164	818	982	0.167
4	101	551	652	0.155
Totals/average	601	3806	4407	0.136

DATA ANALYSIS

The following comparisons should show whether or not the Lowered (L) condition for the STS is effective for all trashrack conditions:

L&M vs S&M
L&S vs S&S

For which we have,

L&M vs S&M : 0.237 vs 0.136
L&S vs S&S : 0.155 vs 0.099

These comparisons show that the lowered (L) STS condition is more effective for all trashrack conditions, but it is much more so with the streamlined trashracks.

Appendix Table B2.--Continued.

The following comparisons show whether or not the streamlined (M) trashrack condition is effective for both STS elevations.

L&M vs L&S
S&M vs S&S

For which we have,

L&M vs L&S	:	0.237 vs 0.155
S&M vs S&S	:	0.136 vs 0.099

These comparisons show that the streamlined trashrack condition (M) is much better with the lowered (L) STS, but it is almost the same or slightly worse for the Standard (S) STS.

The main effects studied by these tests were run in tandem. We can only access the relative improvement of a combination of conditions. Let P_1 be the proportion of fish quiding under one condition and P_2 the proportion guiding under the other condition. Let R denote the proportion of fish failing to guide under one condition which would guide under the other condition. Then, if we arbitrairily take P_2 to be the best condition

$$P_2 = P_1 + R\,(1-P_1).$$

This expresses the guidance under one condition as being a sum of the guidance under the other condition plus an added guidance which applies to those fish that fail to guide under the other condition.

The solution for R is,

$$R = \frac{P_2 - P_1}{1 - P_1}$$

which is a measure of the relative difference between the conditions.

Appendix Table B2.--Continued.

Because sample proportions p_1 and p_2 are estimates of the population proportions P_1 and P_2 an estimate of the relative difference, R_1, would be,

$$r = \frac{p_2 - p_1}{1 - p_1}$$

The standard error of this estimate is approximately;

$$\text{s.e. } (r) = \frac{1}{1-p_1} \sqrt{\frac{p_2(1-p_2)}{n_2} + (1-r)^2 \frac{p_1(1-p_1)}{n_1}}$$

n_1 and n_2 represent the total populations for the different test conditions.

Using these data, estimates of R can be made for the following cases:

I Lowered & Streamlined vs Standard & Standard

L&M vs S&M

$$r_1 = \frac{0.237 - 0.136}{1 - 0.136} = 0.117$$

The lowered and streamline condition results in a 11.7% improvement over the standard and streamlined condition.

Calculation of the s.e. for this comparison is:

$$\text{s.e. } (r) = \frac{1}{1 - 0.136} \sqrt{\frac{0.237\ (1-0.237)}{3707} + (1-0.117)^2 \frac{0.136\ (1-0.136)}{4407}}$$

s.e. (r) = 0.902

Appendix Table B2.--Continued.

II Lowered & Streamlined vs Standard and Standard

L&S vs S&S

$$r_2 = \frac{0.155 - 0.099}{1 - 0.099} = 0.062$$

The lowered and standard condition has a relative efficiency of 6.2% over the standard and standard condition.

$$s.e. = \frac{1}{1 - 0.099} \sqrt{\frac{0.155\ (1-0.155)}{3920} (1-0.062)^2 \frac{0.099\ (1-0.099)}{3536}}$$

$$s.e. = 0.977$$

III Lowered and Streamlined vs Lowered and Standard

L&M vs L&S

$$r_3 = \frac{0.237 - 0.155}{1 - 0.155} = 0.097$$

The lowered and streamlined condition has a relative efficiency of 9.7% over the lowered and standard condition

$$s.e. = \frac{1}{1 - 0.155} \sqrt{\frac{0.237(1-0.237)}{3707} + (1 - 0.097)^2 \frac{0.155(1-0.155)}{3920}}$$

$$s.e. = 0.965$$

Appendix Table B2.--Continued.

IV Standard and Streamlined vs Standard and Standard

S&M vs S&S

$$r_4 = \frac{0.136 - 0.099}{1 - 0.099} = 0.041$$

The standard and streamlined condition has a relative efficiency of 4.1% with respect to the standard and standard condition.

$$s.e. = \frac{1}{1 - 0.138} \sqrt{\frac{0.136\ (1-0.136)}{4407} (1 - 0.041)^2 \frac{0.099\ (1-0.099)}{2536}}$$

s.e. = 1.021

In conclusion, the best condition would be the lowered STS and the streamlined trashrack.

L&M	vs	S&M	-	11.7%
L&S	vs	S&S	-	6.2%
L&M	vs	L&S	-	9.7%
S&M	vs	S&S	-	4.1%

Appendix Table B3.--Net catch data showing the numbers of yearling chinook salmon captured at various net levels during vertical distribution and STS FGE tests at Bonneville Dam second powerhouse during the 1983, 1984, and 1985 field seasons.

1983			1984			1985		
Date	Middle net	Outside nets	Date	Middle net	Outside nets	Date	Middle net	Outside nets
April 21	55	147	May 04	40	56	May 19	102	229
22	70	99	05	21	59	20	79	198
23	58	110	06	49	106	21	96	174
24	27	47				Totals	277	601 = 31.5%
25	10	20	Totals	110	221 = 33.2%	April 23	116	230
May 04	33	99				24	136	262
05	48	108	May 04	26	52	25	126	248
06	57	161	05	13	27	Totals	378	740 = 33.8%
07	24	49	06	26	54	May 03	67	122
24	51	106				04	76	123
25	118	294	Totals	65	133 = 32.8%	05	40	113
26	29	54				06	42	66
			May 19	8	21	07	90	221
Totals	580	1,294 = 30.9%	20	11	29	Totals	315	645 = 32.8%
						May 08	42	53
May 09	46	92	Totals	19	50 = 27.5%	09	59	115
10	63	152				10	47	88
11	116	263	May 20	32	53 = 37.6%	18	77	129
12	150	292				Totals	225	385 = 36.9%
13	10	32						
16	79	195				May 11	44	76
17	38	59				12	54	112
18	122	303				13	58	89
19	49	108				Totals	156	277 = 36.0%
						May 14	71	172
Totals	673	1,496 = 31.0%				15	128	250
						16	50	111
						17	115	213

Appendix Table B4.--Collection data of yearling and subyearling chinook salmon for the individual replicates of vertical distribution tests at Bonneville Dam Second Powerhouse, 1985.

	Test number and gatewell ( ), species, and condition tested														
	Test 1 Gatewell 12A - yearling chinook standard trashrack					Test 2 Gatewell 12B - yearling chinook streamlined trashracks					Test 3 Gatewell 12B - subyearling chinook streamlined trashracks				
Date	16 May	17 May	18 May	Total	%	19 May	20 May	21 May	Total	%	24 July	25 July	26 July	Total	%
Gatewell	106	137	94	337	17.6	272	231	228	731	18.5	103	89	55	247	9.1
1st Level a/	165	228	126	519	27.1	388	347	302	1037	26.2	141	168	81	390	14.3
2nd Level a/	111	156	111	378	19.7	303	204	237	744	18.8	195	174	126	495	18.2
3rd Level a/	18	105	78	201	10.5	198	126	156	480	12.1	162	138	81	381	14.0
4th Level a/	39	84	45	168	8.8	183	108	96	387	9.8	180	159	96	435	16.0
5th Level a/	42	87	36	165	8.6	135	57	108	300	7.6	183	81	105	369	13.6
6th Level a/	15	75	36	126	6.6	81	66	69	216	5.5	126	81	78	285	10.5
7th Level a/	3	6	15	24	1.3	36	9	21	66	1.7	42	48	30	120	4.4
Totals	499	878	541	1,918		1,596	1,148	1,217	3,961		1,132	938	652	2,722	

Appendix Table B5.--Weekly and cumulative totals of fish captured by the random sampler in the Second Powerhouse DSM at Bonneville Dam, 1985.

	WEEKLY TOTALS								CUMULATIVE TOTALS						
	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	1985 date	Hours fished	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	121	188	-	-	-	309	March		121	188	-	-	-	309	
No. examined	120	154	-	-	-	274	6		120	154	-	-	-	274	
No. descaled	1	0	-	-	-	1		51	1	0	-	-	-	1	51
No. mortalities	1	34	-	-	-	35	March		1	34	-	-	-	35	
% descaled	0.8	0.0	-	-	-	0.4	8		0.8	0.0	-	-	-	0.4	
% mortality	0.8	18.1	-	-	-	11.3			0.8	18.1	-	-	-	11.3	
No. captured	289	39	-	-	-	328	March		410	227	-	-	-	637	
No. examined	289	30	-	-	-	319	11		409	184	-	-	-	593	
No. descaled	4	0	-	-	-	4		96	5	0	-	-	-	5	147
No. mortalities	0	9	-	-	-	9	March		1	43	-	-	-	44	
% descaled	1.4	0.0	-	-	-	1.3	15		1.2	0.0	-	-	-	0.8	
% mortality	0.0	23.1	-	-	-	2.7			0.2	18.9	-	-	-	6.9	
No. captured	195	8	1	-	1	205	March		605	235	1	-	1	842	
No. examined	194	5	1	-	1	201	18		603	189	1	-	1	794	
No. descaled	3	0	0	-	0	3		98	8	0	0	-	0	8	245
No. mortalities	1	3	0	-	0	4	March		2	46	0	-	0	48	
% descaled	1.5	0.0	0.0	-	0.0	1.5	22		1.3	0.0	0.0	-	0.0	1.0	
% mortality	0.5	37.5	0.0	-	0.0	2.0			0.3	19.6	0.0	-	0.0	5.7	
No. captured	152	10	-	-	-	162	March		757	245	1	-	1	1,004	
No. examined	151	10	-	-	-	161	25		754	199	1	-	1	955	
No. descaled	0	0	-	-	-	0		96	8	0	0	-	0	8	341
No. mortalities	1	0	-	-	-	1	March		3	46	0	-	0	49	
% descaled	0.0	0.0	-	-	-	0.0	29		1.1	0.0	0.0	-	0.0	0.8	
% mortality	0.7	0.0	-	-	-	0.6			0.4	18.8	0.0	-	0.0	4.9	
No. captured	116	13	1	-	-	130	April		873	258	2	-	1	1,134	
No. examined	115	13	1	-	-	129	1		869	212	2	-	1	1,084	
No. descaled	3	0	0	-	-	3		96	11	0	0	-	0	11	437
No. mortalities	1	0	0	-	-	1	April		4	46	0	-	0	50	
% descaled	2.6	0.0	0.0	-	-	2.3	5		1.3	0.0	0.0	-	0.0	1.0	
% mortality	0.9	0.0	0.0	-	-	0.8			0.5	17.8	0.0	-	0.0	4.4	

Appendix Table B5.--cont.

	WEEKLY TOTALS								CUMULATIVE TOTALS						
	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	1985 date	Hours fished	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	1,121	33	23	-	-	1,177	April		1,994	291	25	-	1	2,311	
No. examined	549	29	23	-	-	601	8		1,418	241	25	-	1	1,685	
No. descaled	7	0	0	-	-	7		84	18	0	0	-	0	18	521
No. mortalities	4	4	0	-	-	8	April		8	50	0	-	0	58	
% descaled	1.3	0.0	0.0	-	-	1.2	12		1.3	0.0	0.0	-	0.0	1.1	
% mortality	0.4	12.1	0.0	-	-	0.7			0.4	17.2	0.0	-	0.0	2.5	
No. captured	2,661[a/]	71	142	7	-	2,881	April		4,655	362	167	7	1	5,192	
No. examined	1,122	69	142	7	-	1,340	15		2,540	310	167	7	1	3,025	
No. descaled	6	0	2	0	-	8		69	24	0	2	0	0	26	590
No. mortalities	15	2	0	0	-	17	April		23	52	0	0	0	75	
% descaled	0.5	0.0	1.4	0.0	-	0.6	19		0.9	0.0	1.2	0.0	0.0	0.9	
% mortality	0.6	2.8	0.0	0.0	-	0.6			0.5	14.4	0.0	0.0	0.0	1.4	
No. captured	2,912	84	206	18	1	3,221	April		7,567	446	373	25	2	8,413	
No. examined	693	83	201	18	1	996	22		3,233	393	368	25	2	4,021	
No. descaled	17	0	3	0	0	20		96	41	0	5	0	0	46	686
No. mortalities	43	1	5	0	0	48	April		66	53	5	0	0	124	
% descaled	2.5	0.0	1.5	0.0	0.0	2.0	26		1.3	0.0	1.4	0.0	0.0	1.1	
% mortality	1.5	1.2	2.4	0.0	0.0	1.5			0.9	11.9	1.3	0.0	0.0	1.5	
No. captured	1,085	14	70	8	32	1,209	April		8,652	460	443	33	34	9,622	
No. examined	699	14	70	8	32	823	29		3,932	407	438	33	34	4,844	
No. descaled	6	0	1	0	2	9		96	47	0	6	0	2	55	782
No. mortalities	14	0	0	0	0	14	May		80	53	5	0	0	138	
% descaled	0.9	0.0	1.4	0.0	6.3	1.1	3		1.2	0.0	1.4	0.0	5.9	1.1	
% mortality	1.3	0.0	0.0	0.0	0.0	1.2			0.9	11.5	1.1	0.0	0.0	1.4	
No. captured	1,479	10	215	31	284	2,019	May		10,131	470	658	64	318	11,641	
No. examined	752	8	198	26	196	1,180	6		4,684	415	636	59	230	6,024	
No. descaled	33	0	4	1	40	78		95	80	0	10	1	42	133	877
No. mortalities	8	0	1	0	18	27	May		88	53	6	0	18	165	
% descaled	4.4	0.0	2.0	3.8	20.4	6.6	10		1.7	0.0	1.6	1.7	18.3	2.2	
% mortality	0.5	0.0	0.5	0.0	6.3	1.3			0.9	11.3	0.9	0.0	5.7	1.4	

Appendix Table B5.--cont.

	WEEKLY TOTALS								CUMULATIVE TOTALS						
	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	1985 date	Hours fished	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	1,921	77	209	55	441	2,703	May		12,052	547	867	119	759	14,344	
No. examined	340	9	68	36	82	535	13		5,024	424	704	95	312	6,559	
No. descaled	22	0	3	0	9	34		93	102	0	13	1	51	167	970
No. mortalities	94	1	18	2	24	139	May		182	54	24	2	42	304	
% descaled	6.5	0.0	4.4	0.0	11.0	6.1	17		2.0	0.0	1.8	1.1	16.3	2.5	
% mortality	4.9	1.3	8.6	3.6	5.4	5.1			1.5	9.9	2.8	1.7	5.5	2.1	
No. captured	1,911	51	417	972	294	3,645	May		13,963	598	1,284	1,091	1,053	17,989	
No. examined	800	47	414	770	269	2,300	20		5,824	471	1,118	865	581	8,859	
No. descaled	68	0	15	17	55	155		98	170	0	28	18	106	322	1,068
No. mortalities	16	4	3	1	25	49	May		198	58	27	3	67	353	
% descaled	8.5	0.0	3.6	2.2	20.4	6.7	24		2.9	0.0	2.5	2.1	18.2	3.6	
% mortality	0.8	7.8	0.7	0.1	8.5	1.3			1.4	9.7	2.1	0.3	6.4	2.0	
No. captured	537	1,229	141	177	236	2,320	May		14,500	1,827	1,425	1,268	1,289	20,309	
No. examined	500	548	138	176	223	1,585	28		6,324	1,019	1,256	1,041	804	10,444	
No. descaled	53	2	6	4	40	105		71	223	2	34	22	146	427	1,139
No. mortalities	5	22	3	1	13	44	May		203	80	30	4	80	397	
% descaled	10.6	0.4	4.3	2.3	17.9	6.6	31		3.5	0.2	2.7	2.1	18.2	4.1	
% mortality	0.9	1.8	2.1	0.6	5.5	1.9			1.4	4.4	2.1	0.3	6.2	2.0	
No. captured	376	351	140	1,164	190	2,221	June		14,876	2,178	1,565	2,432	1,479	22,530	
No. examined	331	349	139	454	183	1,456	3		6,655	1,368	1,395	1,495	987	11,900	
No. descaled	52	9	8	4	57	130		96	275	11	42	26	203	557	1,235
No. mortalities	4	2	1	3	7	17	June		207	82	31	7	87	414	
% descaled	15.7	2.6	5.8	0.9	31.1	8.9	7		4.1	0.8	3.0	1.7	20.6	4.7	
% mortality	1.1	0.6	0.7	0.3	3.7	0.8			1.4	3.8	2.0	0.3	5.9	1.8	
No. captured	153	216	16	173	52	610	June		15,029	2,394	1,581	2,605	1,531	23,140	
No. examined	148	215	14	172	45	594	10		6,803	1,583	1,409	1,667	1,032	12,494	
No. descaled	5	4	0	5	13	27		95	280	15	42	31	216	584	1,330
No. mortalities	5	1	2	1	7	16	June		212	83	33	8	94	430	
% descaled	3.4	1.9	0.0	2.9	28.9	4.5	14		4.1	0.9	3.0	1.9	20.9	4.7	
% mortality	3.3	0.4	12.5	0.6	13.5	2.6			1.4	3.5	2.1	0.3	6.1	1.9	

	WEEKLY TOTALS								CUMULATIVE TOTALS						
	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	1985 date	Hours fished	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	16	101	1	37	4	159	June		15,045	2,495	1,582	2,642	1,535	23,299	
No. examined	16	98	1	37	4	156	17		6,819	1,681	1,410	1,704	1,036	12,650	
No. descaled	1	2	0	0	0	3		96	281	17	42	31	216	587	1,426
No. mortalities	0	3	0	0	0	3	June		212	86	33	3	94	433	
% descaled	6.3	2.0	0.0	0.0	0.0	1.9	21		4.1	1.0	3.0	1.8	20.8	4.6	
% mortality	0.0	3.0	0.0	0.0	0.0	1.9			1.4	3.4	2.1	0.3	6.1	1.9	
No. captured	1	318	-	8	3	330	June		15,046	2,813	1,582	2,650	1,538	23,629	
No. examined	1	316	-	8	3	328	24		6,820	1,997	1,410	1,712	1,039	12,978	
No. descaled	0	0	-	0	0	0		96	281	17	42	31	216	587	1,522
No. mortalities	0	2	-	0	0	2	June		212	88	33	8	94	435	
% descaled	0.0	0.0	-	0.0	0.0	0.0	28		4.1	0.9	3.0	1.8	20.8	4.5	
% mortality	0.0	0.6	-	0.0	0.0	0.6			1.4	3.1	2.1	0.3	6.1	1.8	
No. captured	-	71	-	1	-	72	July		15,046	2,884	1,582	2,651	1,538	23,701	
No. examined	-	70	-	1	-	71	1		6,820	2,067	1,410	1,713	1,039	13,049	
No. descaled	-	1	-	0	-	1		96	281	18	42	31	216	588	1,618
No. mortalities	-	1	-	0	-	1	July		212	89	33	8	94	436	
% descaled	-	1.4	-	0.0	-	1.4	5		4.1	0.9	3.0	1.8	20.8	4.5	
% mortality	-	1.4	-	0.0	-	1.4			1.4	3.1	2.1	0.3	6.1	1.8	
No. captured	-	201	1	13	-	215	July		15,046	3,085	1,583	2,664	1,538	23,916	
No. examined	-	190	1	13	-	204	8		6,820	2,257	1,411	1,726	1,039	13,253	
No. descaled	-	2	0	0	-	2		96	281	20	42	31	216	590	1,714
No. mortalities	-	11	0	0	-	11	July		212	100	33	8	94	447	
% descaled	-	1.1	0.0	0.0	-	1.0	12		4.1	0.9	3.0	1.8	20.8	4.5	
% mortality	-	5.5	0.0	0.0	-	5.1			1.4	3.2	2.1	0.3	6.1	1.9	
No. captured	16	748	-	15	1	780	July		15,062	3,833	1,583	2,679	1,539	24,696	
No. examined	16	712	-	15	1	744	15		6,836	2,969	1,411	1,741	1,040	13,997	
No. descaled	0	0	-	0	0	0		96	281	20	42	31	216	590	1,810
No. mortalities	0	36	-	0	0	36	July		212	136	33	8	94	483	
% descaled	0.0	0.0	-	0.0	0.0	0.0	19		4.1	0.7	3.0	1.8	20.8	4.2	
% mortality	0.0	4.8	-	0.0	0.0	4.6			1.4	3.5	2.1	0.3	6.1	2.0	

Appendix Table B5.--cont.

	WEEKLY TOTALS								CUMULATIVE TOTALS						
	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	1985 date	Hours fished	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	11	1,069	-	10	-	1,090	July		15,073	4,902	1,583	2,689	1,539	25,786	
No. examined	11	400	-	9	-	420	22		6,847	3,369	1,411	1,750	1,040	14,417	
No. descaled	1	5	-	0	-	6		98	282	25	42	31	216	576	1,908
No. mortalities	0	36	-	1	-	37	July		12	172	33	9	94	520	
% descaled	9.1	1.3	-	0.0	-	1.4	26		4.1	0.7	3.0	1.8	20.8	4.1	
% mortality	0.0	3.4	-	10.0	-	3.4			1.4	3.5	2.1	0.3	6.1	2.0	
No. captured	-	356	-	11	-	367	July		15,073	5,258	1,583	2,700	1,539	26,153	
No. examined	-	277	-	11	-	288	29		6,847	3,646	1,411	1,761	1,040	14,705	
No. descaled	-	8	-	0	-	8		101	282	33	42	31	216	604	2,009
No. mortalities	-	16	-	0	-	16	Aug.		212	188	33	9	94	536	
% descaled	-	2.9	-	0.0	-	2.8	2		4.1	0.9	3.0	1.8	20.8	4.1	
% mortality	-	4.5	-	0.0	-	4.4			1.4	3.6	2.1	0.3	6.1	2.0	
No. captured	-	27	-	-	-	27	Sept.		15,073	5,285	1,583	2,700	1,539	26,180	
No. examined	-	25	-	-	-	25	3		6,847	3,671	1,411	1,761	1,040	14,730	
No. descaled	-	1	-	-	-	1		72	282	34	42	31	216	605	2,081
No. mortalities	-	2	-	-	-	2	Sept.		212	190	33	9	94	538	
% descaled	-	4.0	-	-	-	4.0	6		4.1	0.9	3.0	1.8	20.8	4.1	
% mortality	-	7.4	-	-	-	7.4			1.4	3.6	2.1	0.3	6.1	2.1	
No. captured	-	27	-	-	-	27	Sept.		15,073	5,312	1,583	2,700	1,539	26,207	
No. examined	-	26	-	-	-	26	9		6,847	3,697	1,411	1,761	1,040	14,756	
No. descaled	-	0	-	-	-	0		96	282	34	42	31	216	605	2,177
No. mortalities	-	1	-	-	-	1	Sept.		212	191	33	9	94	539	
% descaled	-	0.0	-	-	-	0.0	13		4.1	0.9	3.0	1.8	20.8	4.1	
% mortality	-	3.7	-	-	-	3.7			1.4	3.6	2.1	0.3	6.1	2.1	
No. captured	-	14	-	-	-	14	Sept.		15,073	5,326	1,583	2,700	1,539	26,221	
No. examined	-	13	-	-	-	13	16		6,847	3,710	1,411	1,761	1,040	14,769	
No. descaled	-	0	-	-	-	0		96	282	34	42	31	216	605	2,273
No. mortalities	-	1	-	-	-	1	Sept.		212	192	33	9	94	540	
% descaled	-	0.0	-	-	-	0.0	20		4.1	0.9	3.0	1.8	20.8	4.1	
% mortality	-	7.1	-	-	-	7.1			1.4	3.6	2.1	0.3	6.1	2.1	

	WEEKLY TOTALS								CUMULATIVE TOTALS						
	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	1985 date	Hours fished	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	-	20	-	-	-	20	Sept.		15,073	5,346	1,583	2,700	1,539	26,241	
No. examined	-	20	-	-	-	20	23		6,847	3,730	1,411	1,761	1,040	14,789	
No. descaled	-	1	-	-	-	1		96	282	35	42	31	216	606	2,369
No. mortalities	-	0	-	-	-	0	Sept.		212	192	33	9	94	540	
% descaled	-	5.0	-	-	-	5.0	27		4.1	0.9	3.0	1.8	20.8	4.1	
% mortality	-	0.0	-	-	-	0.0			1.4	3.6	2.1	0.3	6.1	2.1	
No. captured	-	22	-	1	-	23	Sept.		15,073	5,368	1,583	2,701	1,539	26,264	
No. examined	-	22	-	1	-	23	30		6,847	3,752	1,411	1,762	1,040	14,812	
No. descaled	-	1	-	0	-	1		79	282	36	42	31	216	607	2,448
No. mortalities	-	0	-	0	-	0	Oct.		212	192	33	9	94	540	
% descaled	-	4.5	-	0.0	-	4.3	4		4.1	1.0	3.0	1.8	20.8	4.1	
% mortality	-	0.0	-	0.0	-	0.0			1.4	3.6	2.1	0.3	6.1	2.1	
No. captured	-	78	1	1	-	80	Oct.		15,073	5,446	1,584	2,702	1,539	26,344	
No. examined	-	77	1	1	-	79	7		6,847	3,829	1,412	1,763	1,040	14,891	
No. descaled	-	2	0	0	-	2		96	282	38	42	31	216	609	2,544
No. mortalities	-	1	0	0	-	1	Oct.		212	193	33	9	94	541	
% descaled	-	2.6	0.0	0.0	-	2.5	11		4.1	1.0	3.0	1.8	20.8	4.1	
% mortality	-	1.3	0.0	0.0	-	1.3			1.3	3.5	2.1	0.3	6.1	2.1	
No. captured	-	40	-	1	-	41	Oct.		15,073	5,486	1,584	2,703	1,539	26,385	
No. examined	-	38	-	1	-	39	15		6,847	3,867	1,412	1,764	1,040	14,930	
No. descaled	-	1	-	0	-	1		72	282	39	42	31	216	610	2,616
No. mortalities	-	2	-	0	-	2	Oct.		212	195	33	9	94	543	
% descaled	-	2.6	-	0.0	-	2.1	18		4.1	1.0	3.0	1.8	20.8	4.1	
% mortality	-	5.0	-	0.0	-	4.9			1.4	3.6	2.1	0.3	6.1	2.1	
No. captured	-	199	-	4	1	204	Oct.		15,073	5,685	1,584	2,707	1,540	26,589	
No. examined	-	197	-	4	1	202	21		6,847	4,064	1,412	1,768	1,041	15,132	
No. descaled	-	5	-	0	0	5		96	282	44	42	31	216	615	2,712
No. mortalities	-	2	-	0	0	2	Oct.		212	197	33	9	94	545	
% descaled	-	2.5	-	0.0	0.0	2.5	25		4.1	1.1	3.0	1.8	20.7	4.1	
% mortality	-	1.0	-	0.0	0.0	1.0			1.4	3.5	2.1	0.3	6.1	2.0	

Appendix Table B5.--cont.

	WEEKLY TOTALS								CUMULATIVE TOTALS						
	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	1985 date	Hours fished	"1" chin.	"0" chin.	Sthd.	Coho	Sock.	Total	Hours fished
No. captured	-	108	2	-	-	110	Oct.		15,073	5,793	1,586	2,707	1,540	26,699	
No. examined	-	108	2	-	-	110	28		6,847	4,172	1,414	1,768	1,041	15,242	
No. descaled	-	4	0	-	-	4		96	282	48	42	31	216	619	2,808
No. mortalities	-	0	0	-	-	0	Nov.		212	197	33	9	94	545	
% descaled	-	3.7	0.0	-	-	3.6	1		4.1	1.2	3.0	1.8	20.7	4.1	
% mortality	-	0.0	0.0	-	-	0.0			1.4	3.4	2.1	0.3	6.1	2.0	
No. captured	-	102	1	-	1	104	Nov.		15,073	5,895	1,587	2,707	1,541	26,803	
No. examined	-	102	1	-	1	104	4		6,847	4,274	1,415	1,768	1,042	15,346	
No. descaled	-	2	0	-	0	2		96	282	50	42	31	216	621	2,904
No. mortalities	-	0	0	-	0	0	Nov.		212	197	33	9	94	545	
% descaled	-	2.0	0.0	-	0.0	1.9	8		4.1	1.2	3.0	1.8	20.7	4.0	
% mortality	-	0.0	0.0	-	0.0	0.0			1.4	3.3	2.1	0.3	6.1	2.0	
No. captured	-	124	-	4	-	128	Nov.		15,073	6,019	1,587	2,711	1,541	26,931	
No. examined	-	124	-	4	-	128	12		6,847	4,398	1,415	1,772	1,042	15,474	
No. descaled	-	1	-	0	-	1		72	282	51	42	31	216	622	2,976
No. mortalities	-	0	-	0	-	0	Nov.		212	197	33	9	94	545	
% descaled	-	0.8	-	0.0	-	0.8	15		4.1	1.2	3.0	1.8	20.7	4.0	
% mortality	-	0.0	-	0.0	-	0.0			1.4	3.3	2.1	0.3	6.1	2.0	
No. captured	-	42	1	-	-	43	Nov.		15,073	6,061	1,588	2,711	1,541	26,974	
No. examined	-	42	1	-	-	43	18		6,847	4,440	1,416	1,772	1,042	15,517	
No. descaled	-	0	0	-	-	0		26	282	51	42	31	216	622	3,002
No. mortalities	-	0	0	-	-	0	Nov.		212	197	33	9	94	545	
% descaled	-	0.0	0.0	-	-	0.0	19		4.1	1.1	3.0	1.8	20.7	4.0	
% mortality	-	0.0	0.0	-	-	0.0			1.4	3.3	2.1	0.3	6.1	2.0	
No. captured	-	18	1	-	-	19	Nov.		15,073	6,079	1,589	2,711	1,541	26,993	
No. examined	-	18	1	-	-	19	25		6,847	4,458	1,417	1,772	1,042	15,536	
No. descaled	-	0	0	-	-	0		50	282	51	42	31	216	622	3,052
No. mortalities	-	0	0	-	-	0	Nov.		212	197	33	9	94	545	
% descaled	-	0.0	0.0	-	-	0.0	27		4.1	1.1	3.0	1.8	20.7	4.0	
% mortality	-	0.0	0.0	-	-	0.0			1.4	3.2	2.1	0.3	6.1	2.0	

a/ Sampler removed to avoid large spring chinook salmon hatchery release.

Appendix Table B6.--Total salmonid passage estimates at Bonneville Dam Second Powerhouse DSM, 1985.

Week	Yearling chinook salmon	Subyearling chinook salmon	Steelhead	Coho salmon	Sockeye salmon	Total all species
March 6	3981	6185	0	0	0	10166
March 13	5058	683	0	0	0	5741
March 20	3335	137	17	0	17	3506
March 27	2660	175	0	0	0	2835
April 3	2030	228	18	0	0	2276
April 10	22420	660	460	0	0	23540
April 17	64662	1725	3451	170	0	70008
April 24	50960	1470	3605	315	18	56368
May 1	18988	245	1225	140	560	21158
May 8	26178	177	3806	549	5027	35737
May 15	34770	1394	3783	996	7982	48925
May 22	32678	872	7131	16621	5027	62329
May 29	12727	29127	3342	4195	5593	54984
June 5	6580	6143	2450	20370	3325	38868
June 12	2708	3823	283	3062	920	10796
June 19	280	1768	18	648	70	2784
June 26	18	5565	0	140	51	5774
July 3	0	1243	0	18	0	1261
July 10	0	3518	18	228	0	3764
July 17	280	13090	0	263	18	13651
July 24	188	18280	0	171	0	18639
July 31	0	5910	0	183	0	6093
August[a]						
Sept 4	0	629	0	0	0	629
Sept 11		473	0	0	0	473
Sept 18	0	245	0	0	0	245
Sept 25	0	350	0	0	0	350
Oct 2	0	469	0	21	0	490
Oct 9	0	1365	18	18	0	1401
Oct 16	0	932	0	18	0	950
Oct 23	0	3483	0	70	18	3571
Oct 30	0	1890	35	0	0	1925
Nov 6	0	1785	18	0	18	1821
Nov 13	0	2889	0	93	0	2982
Nov 19	0	2713	65	0	0	2778
Nov 26	0	605	34	0	0	639
Totals	290,501	120,246	29,777	48,289	28,644	517,457

[a] No samples were taken during month of August.

Appendix Table B7.—Sampling data collected during the first intensive sampling period at Bonneville Dam First Powerhouse DSM, 1985. Fish/minute data for hours when no sample was taken were determined by averaging the preceding and succeeding hours. Estimated fish passage for each sample was computed by averaging the fish/minute figures in blocks of three and multiplying this average by 60.

Date 8 May 1985		Yearling Chinook				Steelhead				Coho				Sockeye			
Sample hour	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage
2300				12.9				11.4				1.3				1.5	
0000	20	31	188	9.4	628	12	107	5.4	398	1	6	0.3	38	6	40	2.0	96
0100	20	29	182	9.1	556	6	61	3.1	234	1	5	0.3	26	6	26	1.3	82
0200	12	22	111	9.3	500	8	38	3.2	128	0	8	0.7	32	0	10	0.8	68
0300	20	27	131	6.6	492	3	20	0.1	98	1	12	0.6	34	2	25	1.3	58
0400	20	33	173	8.7	498	4	31	1.6	62	0	8	0.4	22	5	15	0.8	72
0500	20	16	192	9.6	500	1	27	1.4	70	0	1	0.1	18	2	30	1.5	60
0600	38	48	255	6.7	468	2	20	0.5	50	1	14	0.4	16	7	27	0.7	58
0700				7.1	424			0.6	36			0.3	16			0.7	40
0800	20	8	148	7.4	494	0	14	0.7	42	0	2	0.1	14	1	11	0.6	48
0900	20	0	203	10.2	578	0	15	0.8	46	0	6	0.3	12	0	22	1.1	48
1000	20	23	225	11.3	624	1	16	0.8	44	1	3	0.2	18	3	14	0.7	56
1100	20	12	183	9.7	668	1	11	0.6	50	2	8	0.4	30	1	20	1.0	58
1200	20	45	248	12.4	634	0	22	1.1	72	0	18	0.9	40	5	23	1.2	72
1300	20	44	192	9.6	626	1	37	1.9	78	1	14	0.7	44	10	28	1.4	80
1400	20	26	186	9.3	542	0	17	0.9	70	0	11	0.6	30	3	28	1.4	74
1500	20	28	164	8.2	476	1	13	0.7	54	0	4	0.2	30	6	17	0.9	74
1600	20	20	125	6.3	390	2	22	1.1	40	2	14	0.7	30	5	27	1.4	66
1700	20	20	99	5.0	286	1	3	0.2	30	1	12	0.6	34	5	19	1.0	78
1800	20	9	60	3.0	282	0	3	0.2	40	2	8	0.4	28	2	29	1.5	112
1900	20	22	121	6.1	304	3	32	1.6	52	2	11	0.6	24	16	61	3.1	172
2000	20	13	82	4.1	954	2	17	0.8	492	1	3	0.2	86	13	79	4.0	516
2100	10	74	375	37.5	970	24	222	22.2	506	9	35	3.5	96	29	187	18.7	498
2200	20	23	138	6.9	1114	2	46	2.3	584	5	22	1.1	112	12	43	2.2	470
2300	20	43	225	11.3	580	11	93	4.7	186	3	19	1.0	52	9	51	2.6	124
0000				10.8				2.3				0.5				1.4	
24-hour total					13,588				3,462				882				3,080

Appendix Table B7.—Continued.

Date 9 May 1985		Yearling Chinook				Steelhead				Coho				Sockeye			
Sample hour	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage
2300				11.3				4.7				1.0				2.6	
0000	20	49	216	10.8	580	3	46	2.3	184	1	9	0.5	38	6	28	1.4	114
0100	20	22	138	6.9	476	3	43	2.2	112	2	7	0.4	24	5	33	1.7	94
0200	20	28	121	6.1	360	6	22	1.1	90	1	5	0.3	16	7	32	1.6	98
0300	30	29	151	5.0	356	6	35	1.2	64	1	3	0.1	14	5	47	1.6	90
0400	30	48	202	6.7	338	2	26	0.9	54	1	10	0.3	10	10	38	1.3	76
0500	30	30	157	5.2	400	3	19	0.6	38	1	4	0.1	10	7	27	0.9	54
0600	25	40	202	8.1	386	2	10	0.4	28	0	3	0.1	10	2	12	0.5	34
0700	20	24	120	6.0	480	2	7	0.4	30	0	5	0.3	24	1	5	0.3	24
0800	20	20	197	9.9	478	0	13	0.7	48	1	15	0.8	28	1	8	0.4	20
0900	20	23	160	8.0	524	1	26	1.3	58	2	6	0.3	28	1	6	0.3	24
1000	20	19	166	8.3	606	2	18	0.9	108	0	6	0.3	32	4	9	0.5	28
1100	20	19	279	14.0	614	1	64	3.2	112	3	20	1.0	32	1	11	0.6	42
1200	20	17	168	8.4	690	0	30	1.5	138	0	6	0.3	34	0	19	1.0	46
1300	20	29	242	12.1	724	0	24	2.2	134	0	7	0.4	26	0	14	0.7	76
1400	20	40	314	15.7	696	4	59	3.0	114	1	12	0.6	30	11	41	2.1	80
1500	20	25	139	7.0	670	0	9	0.5	76	2	10	0.5	42	5	24	1.2	84
1600	20	25	216	10.8	442	3	25	1.3	40	3	19	1.0	38	5	18	0.9	66
1700	20	13	86	4.3	370	0	3	0.2	40	1	8	0.4	42	5	23	1.2	68
1800	20	6	67	3.4	216	1	9	0.5	22	0	13	0.7	34	5	25	1.3	96
1900	20	11	61	3.1	276	1	7	0.4	70	1	11	0.6	38	4	46	2.3	290
2000	20	36	145	7.3	1022	6	51	2.6	346	3	12	0.6	70	44	217	10.9	428
2100	10	87	407	40.7	1268	17	143	14.3	470	6	23	2.3	80	15	82	8.2	448
2200	10	38	154	15.4	1412	12	66	6.6	536	2	11	1.1	82	12	33	3.3	304
2300	15	33	218	14.5	804	8	89	5.9	294	1	10	0.7	36	5	56	3.7	202
0000				10.3				2.2				0.0				3.1	
24-hour total					14,190				3,206				818				2,886

Appendix Table B7.—Continued.

Date 13 May 1985		Yearling Chinook				Steelhead				Coho				Sockeye			
Sample hour	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage
2300				42.4				19.3				5.6				7.8	
0000	20	12	71	3.6	1072	0	19	1.0	442	2	4	0.2	124	6	34	1.7	228
0100	20	44	152	7.6	392	4	35	1.8	80	1	7	0.4	20	7	38	1.9	108
0200	20	51	168	8.4	428	4	23	1.2	76	0	8	0.4	18	2	36	1.8	106
0300	20	19	108	5.4	398	3	15	0.8	54	0	2	0.1	10	3	31	1.6	92
0400	20	26	121	6.1	426	2	13	0.7	46	0	0	0.0	16	5	23	1.2	92
0500	20	39	196	9.8	626	1	16	0.8	74	2	13	0.7	32	6	35	1.8	74
0600	20	43	307	15.4	912	4	43	2.2	86	2	18	0.9	48	3	13	0.7	70
0700	20	88	407	20.4	1146	0	26	1.3	152	0	16	0.8	64	4	19	1.0	48
0800	20	123	430	21.5	1336	11	81	4.1	182	7	30	1.5	70	3	14	0.7	56
0900	20	58	497	24.9	1280	18	73	3.7	250	3	24	1.2	82	4	22	1.1	54
1000	20	63	352	17.6	1114	10	93	4.7	224	4	27	1.4	64	3	17	0.9	54
1100	20	12	264	13.2	1054	0	55	2.8	220	1	11	0.6	56	0	14	0.7	60
1200				21.9	1314			3.5	190			0.8	46			1.4	82
1300	12	34	367	30.6	1382	2	38	3.2	146	2	11	0.9	52	0	24	2.0	90
1400	20	65	331	16.6	1188	0	12	0.6	90	4	17	0.9	44	4	21	1.1	96
1500	20	66	244	12.2	856	2	14	0.7	54	1	8	0.4	50	10	33	1.7	98
1600	20	73	279	14.0	606	7	28	1.4	64	3	23	1.2	42	11	42	2.1	102
1700	20	11	82	4.1	398	2	21	1.1	56	1	9	0.5	38	5	26	1.3	86
1800	20	5	35	1.8	286	0	5	0.3	70	0	3	0.2	30	5	18	0.9	100
1900	20	42	167	8.4	364	3	41	2.1	86	2	16	0.8	38	12	56	2.8	162
2000	20	46	159	8.0	652	6	38	1.9	198	5	17	0.9	74	22	87	4.4	334
2100	20	65	323	16.2	714	13	118	5.9	250	6	39	2.0	98	28	189	9.5	328
2200	20	27	230	11.5	864	10	94	4.7	272	2	39	2.0	106	3	50	2.5	306
2300	20	60	310	15.5	740	8	60	3.0	206	1	25	1.3	78	7	66	3.3	172
0000				10.0				2.6				0.6				2.8	
24-hour total					19,548				3,568				1,300				2,998

Appendix Table B7.—Continued.

Date 14 May 1985		Yearling Chinook				Steelhead				Coho				Sockeye			
Sample hour	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage
2300				15.5				3.0				1.3				3.3	
0000	20	43	200	10.0	682	9	51	2.6	138	1	11	0.6	44	12	56	2.8	190
0100	20	31	172	8.6	530	8	26	1.3	128	1	5	0.3	24	8	67	3.4	162
0200	20	40	158	7.9	468	4	50	2.5	106	0	6	0.3	22	8	38	1.9	144
0300	20	28	138	6.9	446	3	29	1.5	98	3	10	0.5	20	8	37	1.9	108
0400	20	23	149	7.5	550	2	17	0.9	86	1	4	0.2	26	3	32	1.6	114
0500	20	36	261	13.1	892	5	38	1.9	110	1	12	0.6	40	2	43	2.2	108
0600	20	50	479	24.0	1180	3	53	2.7	122	0	23	1.2	42	2	32	1.6	100
0700	20	100	438	21.9	1490	2	29	1.5	134	0	5	0.3	44	8	23	1.2	72
0800	20	122	572	28.6	1568	6	50	2.5	188	2	13	0.7	48	0	16	0.8	64
0900	20	112	557	27.9	1508	10	107	5.4	196	6	28	1.4	56	6	23	1.2	62
1000	20	50	377	18.9	1314	6	37	1.9	208	2	13	0.7	58	5	22	1.1	70
1100	20	43	377	18.9	1168	5	61	3.1	156	0	16	0.8	50	3	23	1.2	68
1200				20.6	1234			2.8	166			1.0	58			1.1	66
1300	20	86	444	22.2	1284	10	48	2.4	146	4	21	1.1	64	10	20	1.0	64
1400	20	57	427	21.4	1180	4	42	2.1	112	2	22	1.1	56	7	22	1.1	82
1500	20	42	307	15.4	980	0	21	1.1	86	1	12	0.6	52	5	39	2.0	88
1600	20	55	244	12.2	686	2	22	1.1	62	2	17	0.9	38	5	26	1.3	106
1700	20	13	133	6.7	440	2	17	0.9	60	0	8	0.4	42	2	40	2.0	106
1800	20	8	62	3.1	236	0	19	1.0	48	1	16	0.8	26	8	40	2.0	108
1900	20	4	39	2.0	270	1	9	0.5	46	0	2	0.1	24	4	28	1.4	120
2000	20	11	67	3.7	568	0	16	0.8	220	1	5	0.3	82	12	52	2.6	714
2100	20	89	459	23.0	758	26	194	9.7	272	17	73	3.7	106	134	633	31.7	772
2200	15	27	173	11.5	872	5	47	3.1	340	7	20	1.3	130	6	65	4.3	794
2300	15	45	136	9.1	510	7	63	4.2	156	3	22	1.5	64	6	55	3.7	202
0000				4.9				0.5				0.4				2.1	
24-hour total					20,814				3,384				1,216				4,484

Appendix Table B7.—Continued.

Date 21 May 1985		Yearling Chinook				Steelhead				Coho				Sockeye			
Sample hour	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage
2300				22.2				12.8				23.3				5.1	
0000	20	38	263	13.2	866	9	89	12.8	404	34	214	10.7	822	8	60	3.0	210
0100	20	46	157	7.9	598	9	58	2.9	202	25	142	7.1	584	8	48	2.4	178
0200	20	33	176	8.8	478	6	53	2.7	166	31	228	11.4	504	3	69	3.5	176
0300	20	31	144	7.2	448	4	33	2.7	138	23	133	6.7	480	12	57	2.9	186
0400	20	15	127	6.4	420	1	30	1.5	110	18	117	5.9	376	4	37	2.9	156
0500	20	24	147	7.4	936	2	25	1.3	130	18	123	6.2	498	6	39	2.0	128
0600	20	126	659	33.0	1596	7	73	3.7	164	49	256	12.8	710	3	29	1.5	92
0700	15	31	591	39.4	1844	3	48	3.2	176	28	248	16.5	944	1	17	1.1	68
0800	10	15	198	19.8	1542	0	19	1.9	162	25	179	17.9	1054	1	8	0.8	54
0900	10	5	179	17.9	1076	3	30	3.0	160	17	183	18.3	1012	2	8	0.8	54
1000	10	18	161	16.1	956	1	31	3.1	150	22	144	14.4	918	1	11	1.1	64
1100	10	9	138	13.8	918	1	14	1.4	130	16	132	13.2	822	3	13	1.3	80
1200				16.0	960			2.0	118			13.5	810			1.6	96
1300	10	19	182	18.2	982	3	25	2.5	148	16	138	13.8	768	6	19	1.9	116
1400	10	24	149	14.9	960	2	29	2.9	134	12	111	11.1	666	2	23	2.3	108
1500	10	17	149	14.9	818	1	13	1.3	120	4	84	8.4	520	4	12	1.2	98
1600				11.1	664			1.8	106			6.5	388			1.4	82
1700	20	9	144	7.2	454	3	43	2.2	98	8	89	4.5	312	9	29	1.5	74
1800	20	10	87	4.4	294	1	17	0.9	78	11	92	4.6	244	0	15	0.8	80
1900	20	6	62	3.1	200	2	15	0.8	58	4	61	3.1	204	6	34	1.7	118
2000	20	11	49	2.5	324	3	24	1.2	180	4	49	2.5	272	9	68	3.4	874
2100	5	12	53	10.6	974	3	35	7.0	440	7	40	8.0	1078	46	193	38.6	988
2200	5	33	178	35.6	1204	7	69	13.8	544	34	217	43.4	1328	8	37	7.4	964
2300	5	16	70	14.0	1192	4	32	6.4	474	10	75	15.0	1352	0	11	2.2	252
0000				10.0				3.5				9.2				3.0	
24-hour total					20,704				4,590				16.666				5,296

Appendix Table B7.—Continued.

Date 22 May 1985		Yearling Chinook				Steelhead				Coho				Sockeye			
Sample hour	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage
2300				14.0				6.4				15.0				2.2	
0000	20	34	199	10.0	586	5	70	3.5	228	24	184	9.2	534	8	60	3.0	148
0100	20	11	106	5.3	494	7	29	1.5	142	5	49	2.5	302	0	43	2.2	154
0200	20	30	187	9.4	544	6	42	2.1	110	7	67	3.4	196	14	50	2.5	138
0300	20	38	249	12.5	602	4	38	1.9	98	10	78	3.9	188	2	44	2.2	124
0400	20	33	163	8.2	568	5	17	0.9	78	7	41	2.1	182	1	29	1.5	102
0500	20	15	154	7.7	692	0	21	1.1	84	12	61	3.1	224	4	28	1.4	68
0600	20	29	374	18.7	3020	2	43	2.2	304	11	119	6.0	668	0	10	0.5	88
0700	10	38	1246	124.6	3196	3	119	11.9	320	29	243	24.3	1034	4	25	2.5	66
0800	10	10	165	16.5	3168	2	19	1.9	314	14	214	21.4	1230	0	3	0.3	68
0900				17.3	1038			1.9	114			15.8	946			0.6	34
1000	10	6	181	18.1	994	1	19	1.9	98	8	101	10.1	732	0	8	0.8	80
1100	10	6	143	14.3	924	0	11	1.1	86	8	107	10.7	618	1	26	2.6	108
1200				13.8	828			1.3	78			10.1	606			2.0	118
1300	10	20	133	13.3	820	0	15	1.5	72	10	95	9.5	564	3	13	1.3	114
1400	10	14	139	13.9	880	1	8	0.8	74	11	86	8.6	496	2	24	2.4	110
1500				16.8	1008			1.4	84			6.7	404			1.8	106
1600	15	28	295	19.7	964	3	30	2.0	80	3	73	4.9	296	2	16	1.1	78
1700	20	32	234	11.7	858	2	11	0.6	74	6	63	3.2	220	8	20	1.0	56
1800	20	30	229	11.5	502	1	22	1.1	38	7	58	2.9	140	0	14	0.7	54
1900	20	6	38	1.9	302	0	3	0.2	40	6	17	0.9	92	2	20	1.0	74
2000	20	5	33	1.7	232	1	14	0.7	194	0	16	0.8	258	10	39	2.0	684
2100	20	19	159	8.0	754	21	175	8.8	390	31	224	11.2	1452	107	623	31.2	824
2200	5	23	140	28.0	960	6	50	10.0	480	35	303	60.6	1824	4	40	8.0	824
2300	5	8	59	12.0	1016	2	26	5.2	362	15	97	19.4	1662	1	10	2.0	236
0000				10.8				2.9				3.1				1.8	
24-hour total					24,950				3,942				14,868				4,456

Appendix Table B7.—Continued.

Date 23 May 1985		Yearling chinook				Steelhead				Coho				Sockeye			
Sample hour	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage
2300				10.0				3.5				9.2				3.0	
0000	20	35	215	10.8	538	4	57	2.9	164	5	61	3.1	370	9	35	1.8	142
0100	20	36	121	6.1	466	4	35	1.8	130	19	123	6.2	250	8	46	2.3	126
0200	20	23	127	6.4	424	1	35	1.8	134	9	64	3.2	274	6	43	2.2	136
0300	20	23	173	8.7	424	4	62	3.1	126	4	85	4.3	208	4	45	2.3	116
0400	20	29	140	7.0	464	0	27	1.4	112	3	57	2.9	214	2	25	1.3	100
0500	20	17	150	7.5	720	4	22	1.1	70	13	69	3.5	254	7	27	1.4	74
0600	20	41	430	21.5	1176	0	20	1.0	94	11	126	6.3	406	2	19	1.0	58
0700	10	21	298	29.8	1510	2	26	2.6	104	17	105	10.5	550	1	5	0.5	42
0800				24.2	1450			1.6	94			10.7	642			0.6	34
0900	10	14	185	18.5	1150	2	5	0.5	80	12	109	10.9	582	2	6	0.6	42
1000	10	5	148	14.8	958	0	19	1.9	80	5	75	7.5	548	1	9	0.9	54
1100	10	6	146	14.6	964	1	16	1.6	100	10	90	9.0	440	3	12	1.2	62
1200	10	17	188	18.8	1000	1	15	1.5	96	4	55	5.5	394	1	10	1.0	68
1300	10	14	166	16.6	1268	0	17	1.7	148	2	52	5.2	304	3	12	1.2	80
1400	10	41	280	28.0	1458	3	42	4.2	158	4	45	4.5	274	0	18	1.8	98
1500	10	27	283	28.3	1556	0	20	2.0	146	2	40	4.0	242	1	19	1.9	106
1600	15	24	323	21.5	1356	1	17	1.1	92	2	54	3.6	214	3	24	1.6	98
1700				18.0	1078			1.5	110			3.1	184			1.4	82
1800	15	18	216	14.4	732	5	43	2.9	104	4	37	2.5	134	4	16	1.1	64
1900	20	13	83	4.2	422	1	16	0.8	92	1	21	1.1	90	1	14	0.7	62
2000	20	7	50	2.5	268	2	17	0.9	176	1	18	0.9	194	5	26	1.3	834
2100	10	23	67	6.7	932	10	71	7.1	524	13	77	7.7	844	74	397	39.7	1116
2200	5	27	187	37.4	1072	9	91	18.2	612	19	168	33.6	1044	4	74	14.8	1166
2300	15	25	143	9.5	2500	8	79	5.3	1184	15	164	10.9	1376	2	57	3.8	706
0000				78.1				35.7				24.3				16.7	
24-hour total					23,904				4,370				10,032				5,466

Appendix Table B8.—Sampling data collected during the second intensive sampling period at Bonneville Dam First Powerhouse DSM, 1985. Fish/minute data for hours when no sample was taken were determined by averaging the preceding and succeeding hours. Estimated fish passage for each sample was computed by averaging fish/minute figures in blocks of three and multiplying this average by 60.

	Subyearling chinook					Subyearling chinook				
Date 22 July 1985						Date 23 July 1985				
Sample hour	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage
2300				66.8					118.0	
0000	10	84	363	36.3	1640	7	83	295	42.1	4174
0100	7	76	320	45.7	2474	7	99	340	48.6	2614
0200	7	71	292	41.7	2366	7	77	280	40.0	2722
0300	10	72	309	30.9	2578	10	135	475	47.5	3062
0400	7	107	394	56.3	3292	7	151	459	65.5	3118
0500	5	94	387	77.4	4011	8	86	342	42.8	4662
0600				73.1	4386	3	66	374	124.7	4338
0700	5	122	344	68.8	4248	5	42	247	49.4	3842
0800	5	126	364	72.8	6652	15	35	270	18.0	2048
0900	5	241	955	191.0	9320	12	89	420	35.0	3268
1000	5	423	1011	202.2	9650	5	115	522	110.4	6358
1100	1.5	48	134	89.3	8822	2	56	345	172.5	7752
1200	2.5	118	374	149.6	10068	3	77	314	104.7	10474
1300	2	225	529	264.5	12596	2	117	493	246.5	10844
1400	3	135	647	215.7	12374	1	55	191	191.0	11690
1500	2	78	277	138.5	9104	2	71	294	147.0	8550
1600	4	143	404	101.0	7060	2	26	179	89.5	5926
1700	2	105	227	113.5	4798	5	52	299	59.8	4436
1800	9	68	229	25.4	3518	4	70	290	72.5	3120
1900	6	63	222	37.0	1530	13	52	308	23.7	2142
2000	20	91	282	14.1	1858	20	41	217	10.9	1794
2100	5	84	209	41.8	3678	11	172	606	55.1	4180
2200	2	78	256	128.0	5756	2	81	286	143.0	6222
2300	2	66	236	118.0	5762	2	57	226	113.0	7680
0000				42.1					72.1	
24-hour total					137,541					125,016

Appendix Table B8.—Continued.

Date 24 July 1985		Subyearling chinook				Date 25 July 1985	Subyearling chinook			
Sample hour	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage	Sample length (Min.)	No. fish sub-sample	Total number sample fish	No. fish/ minute	Estimated fish passage
2300				113.0					126.0	
0000				72.1	4323	10	59	463	46.3	4100
0100	7	68	218	31.1	1554	7	44	229	32.7	2282
0200	7	—	145	20.7	1772	10	99	351	35.1	2682
0300	10	75	368	36.8	2366	3	41	199	66.3	2916
0400	6	72	365	60.8	2928	5	63	222	44.4	3526
0500	5	53	244	48.8	3542	5	76	328	65.6	4860
0600	4	41	270	67.5	3682	3	111	399	133.0	5872
0700	4	31	271	67.8	3906	3	41	285	95.0	6348
0800	5	55	300	60.0	3460	5	65	447	89.4	4142
0900	5	30	226	45.2	2540	6	17	136	22.7	2762
1000	5	44	109	21.8	1478	10	50	260	26.0	1894
1100	17	20	117	6.9	872	4	19	184	46.0	1868
1200	15	45	224	14.9	1512	8	16	171	21.4	3538
1300	13	160	700	53.8	9954	4	95	438	109.5	7432
1400	1	174	429	429.0	15316	1.5	75	361	240.7	12884
1500	1	133	283	283.0	17550	1	61	294	294.0	12614
1600	2	87	331	165.5	10980	3	78	288	96.0	10094
1700	2	57	201	100.5	6760	1.5	25	172	114.7	5052
1800	3	60	216	72.0	3936	7	81	293	41.9	3550
1900	9	71	219	24.3	2208	11	43	230	20.9	1640
2000	20	64	282	14.1	2028	13	43	250	19.2	2182
2100	8	117	504	63.0	8062	10	160	690	69.0	5424
2200	1	70	326	326.0	10300	2	85	366	183.0	7360
2300	3	73	378	126.0	9966	2	43	232	116.0	7612
0000				46.3					81.6	
24-hour total					130,995					122,634

Appendix Table B9.--Orifice passage efficiency (OPE) tests conducted at Bonneville Dam First Powerhouse, 1985. All tests were 24 h in duration with approximately 2.6 feet of head on the orifice. Individual replicates <200 fish of a given species or race were not used for statistical evaluation.

	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 I.--14" diameter orifice, BFVBS, w/o closure plates															
22-23 Apr.	645	780	82.7	8	8	100.0	84	121	69.4	71	72	98.6	0	0	-
24-25 Apr.	789	948	83.2	13	13	100.0	105	161	65.2	35	38	92.1	0	0	-
29-30 Apr.	493	632	78.0	8	8	100.0	160	192	83.3	26	29	89.7	11	12	91.7
2-3 May	479	643	74.5	8	15	53.3	183	218	83.9	21	24	87.5	72	77	93.5
5-6 May	506	530	95.5	12	14	85.7	226	252	89.7	49	49	100.0	47	57	82.5
Totals	2,912	3,533	82.4	49	58	84.5	758	944	80.3	202	212	95.3	130	146	89.0
Test II.--14" diameter orifice, BFBVS, w/closure plates															
21-22 Apr.	559	874	64.0	3	3	100.0	64	83	77.1	29	34	85.3	1	1	100.0
23-24 Apr.	641	784	81.8	6	6	100.0	118	160	73.8	35	35	100.0	0	0	-
28-29 Apr.	571	674	84.7	11	11	100.0	161	207	77.8	28	30	93.3	21	23	91.3
30 Apr.-1 May	592	657	90.1	8	8	100.0	166	223	74.4	40	42	95.2	18	20	90.0
1-2 May	430	490	87.8	16	16	100.0	112	145	77.2	25	26	96.2	47	49	95.9
Totals	2,793	3,479	80.3	44	44	100.0	621	818	75.9	157	167	94.0	87	93	93.5
Test III.--14" diameter orifice, BFVBS, w/o closure plates, orifice light off															
6-7 May	456	539	84.6	16	16	100.0	321	342	93.9	34	42	81.0	81	83	97.6
Totals	456	539	84.6	16	16	100.0	321	342	93.9	34	42	81.0	81	83	97.6
Test IV.--14" diameter orifice, BFVBS, w/o closure plates, orifice light on															
7-8 May	532	624	85.3	24	25	96.0	331	350	94.6	28	35	80.0	85	97	87.6
12-13 May	824	964	85.5	47	53	88.7	373	399	93.5	55	60	91.7	219	239	91.6
Totals	1,356	1,588	85.4	71	78	91.0	704	749	94.0	83	95	87.4	304	336	90.5

Appendix Table B9.--Cont.

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 V.--14" diameter orifice, SVBS, w/o closure plates															
20-21 May	1,252	1,330	94.1	87	89	97.8	827	850	97.3	1,247	1,388	89.8	374	399	93.7
28-29 May	1,163	1,195	97.3	225	239	94.1	643	666	96.5	436	446	97.8	508	518	98.1
30-31 May	787	839	93.8	123	130	94.6	445	463	96.1	319	332	96.1	421	433	97.2
Totals	3,202	3,364	95.2	435	458	95.0	1,915	1,979	96.8	2,002	2,166	92.4	1,303	1,350	96.5
Test VI.--14" diameter orifice, SVBS, w/closure plates															
19-20 May	1,438	1,561	92.1	58	63	92.1	997	1,046	95.3	710	747	95.0	363	397	91.4
21-22 May	1,584	1,697	93.3	74	85	87.1	950	986	96.3	1,082	1,148	94.3	413	430	96.0
29-30 May	1,176	1,227	95.8	150	173	86.7	417	427	97.7	597	619	96.4	688	737	93.4
31 May-1 Jun	275	330	83.3	108	122	88.5	119	127	93.7	78	80	97.5	109	109	100.0
Totals	4,473	4,815	92.9	390	443	88.0	2,483	2,586	96.0	2,467	2,594	95.1	1,573	1,673	94.0
Test VII.--14" diameter orifice, SVBS, w/closure plates, orifice lights off															
21-22 Jul	7	7	100.0	1,444	2,080	69.4	0	0	-	26	35	74.3	7	7	100.0
22-23 Jul	0	0	-	3,965	5,362	73.9	0	0	-	1	11	9.1	0	1	0.0
Totals	7	7	100.00	5,409	7,442	72.7	0	0	-	27	46	58.7	7	8	87.5
Test VIII.--14" diameter orifice, SVBS, w/closure plates, orifice lights on															
23-24 Jul	0	0	-	2,719	3,714	73.2	0	0	-	0	10	0.0	0	0	-
24-25 Jul	0	0	-	2,123	3,567	59.5	0	0	-	0	16	0.0	0	1	0.0
Totals	0	0	-	4,842	7,281	66.5	0	0	-	0	26	0.0	0	1	0.0
Test IX.--12" diameter orifice, SVBS, w/closure plates															
28-29 Jul	0	0	-	153	390	39.2	0	0	-	0	0	-	0	0	-
29-30 Jul	0	0	-	219	268	81.7	1	1	100.0	8	9	88.9	3	3	100.0
30-31 Jul	0	0	-	137	174	78.7	0	0	-	0	0	-	0	0	-
31 Jul-1 Aug	0	0	-	110	130	84.6	0	0	-	0	0	-	0	0	-
Totals	0	0	-	619	962	64.3	1	1	100.0	8	9	88.9	3	3	100.0