Evaluation of the Rehabilitated Juvenile Salmonid Collection and Passage System at John Day Dam—1986

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COASTAL ZONE AND ESTUARINE STUDIES

BREGE

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INTRODUCTION

Improvement of the juvenile salmonid collection and bypass system at John Day Dam on the Columbia River (River Kilometer 347) began in 1984 and continues to date. The fish collection portion of the system consists of submersible traveling screens (STS) installed in the gatewell slots to intercept fish passing into the power-generating turbines and guide the fish up into the gatewell slots (Fig. 1). The bypass system consists of 12-inch diameter orifices leading from the gatewells into the bypass gallery and a transportation channel to carry fish from the gallery to a release area approximately 0.25 mile downstream from the dam. A juvenile fish sampling and handling facility was constructed on the lower portion of the transportation channel for evaluation of fish after they had passed through the system.

In 1985, personnel of the National Marine Fisheries Service (NMFS), under contract to the COE, began a series of studies to evaluate the new fish passage system and sampling facilities (Krcma et al. 1986). In 1985, construction was completed in nine turbine units (1-9) out of the total of 16. The fish guiding efficiencies (FGE) of the STSs were estimated for all salmonid species and found to be acceptable (>70%) for yearling chinook salmon, *Oncorhynchus tshawytscha*, and steelhead, *Salmo gairdneri*, but disturbingly low (21%) for subyearling chinook salmon. In 1985, orifice passage efficiencies (OPE) for all juvenile salmonids were greater than 70%. However, with only nine units completed, orifice head was 5.8 ft, considerably higher than the 3.7 ft expected when all turbine units are connected to the new bypass. There is a distinct possibility that a decrease in head may result in decreased OPE. The fish sampling facilities located on the

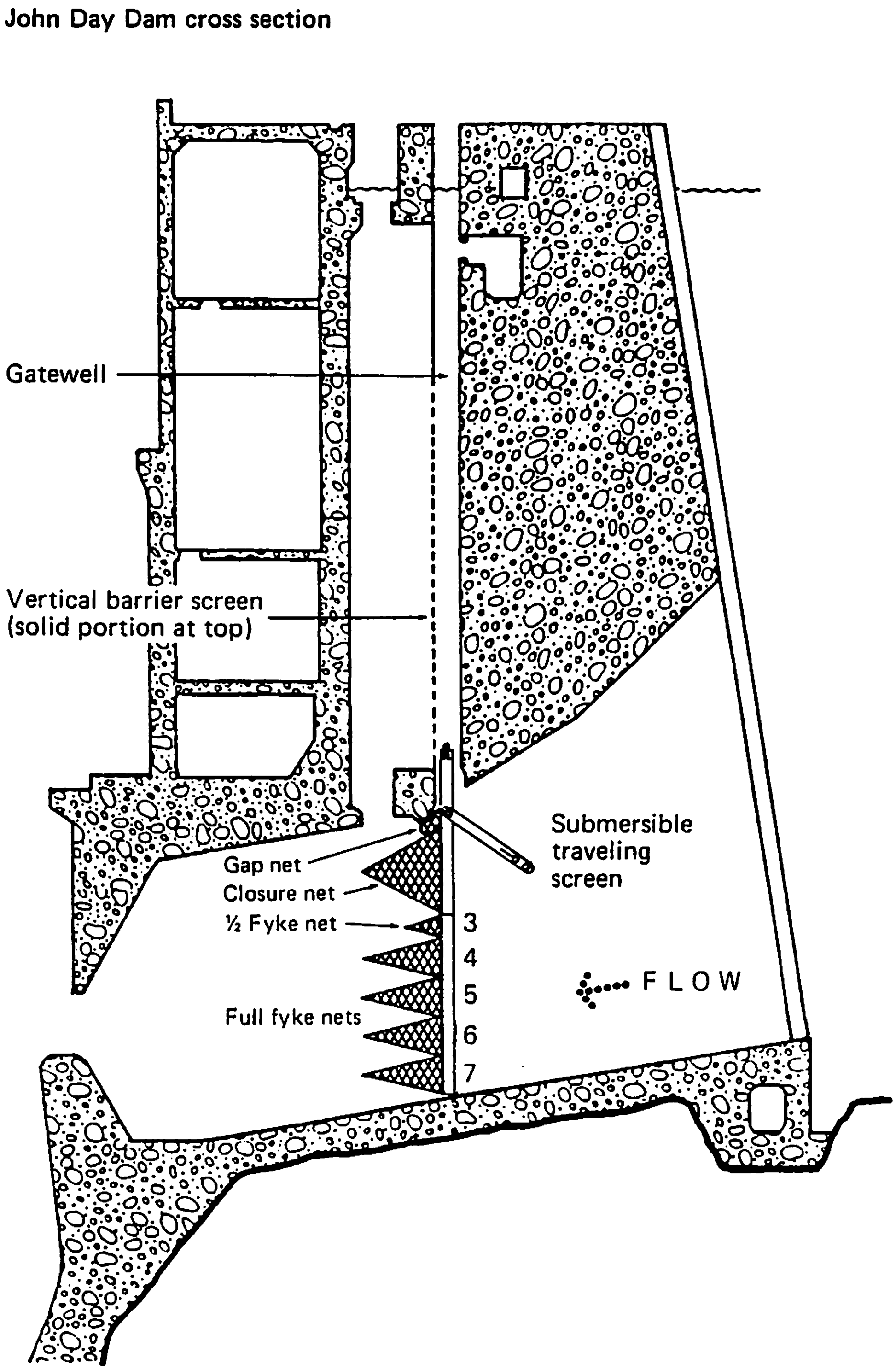

Figure 1.--Cross section of a typical turbine intake at John Day Dam showing STS and fyke nets.

transportation channel were incomplete in 1985, and only preliminary evaluations were possible.

Prior to the 1986 smolt migration, the collection and bypass system for Turbine Units 10, 11, and 12 was completed. This included installation of vertical barrier screens (VBS) and STSs and construction of 12-inch diameter orifices leading into an enlarged bypass gallery. Numerous modifications were also made to the fingerling sampler and fish handling facilites. With a completed bypass in 12 units, orifice head was reduced to about 4 ft--close to the normal operating head of 3.7 ft.

Research in 1986 had four objectives: (1) repeat the FGE studies for subyearling chinook salmon, (2) continue evaluation of the orifice passage system at a near-normal operating head of 4.0 ft, (3) determine the efficiency of the fish sampler, and (4) compare the descaling rates of juvenile salmonids captured in the fish sampler to the descaling rates of fish captured in gatewells.

MATERIALS AND METHODS

FGE Tests

FGE tests were conducted in Slot 6B with turbine loads of 135 megawatts (MW) and an STS angle of 54°--similar to conditions during 1985. A composite of nets attached to the STS was used to recover unguided fish (guided fish are recovered from the gatewell above the STS) (Fig. 2). The standard net configuration consisted of two gap nets attached near the top of the STS to capture fish that pass through the space between the top of the STS and the concrete beam that divides the operating gate slot and the bulkhead gate slot; two closure nets attached to the back of the STS, and five rows of fyke nets suspended on a net frame below the STS (Fig. 2). The top three rows of fyke

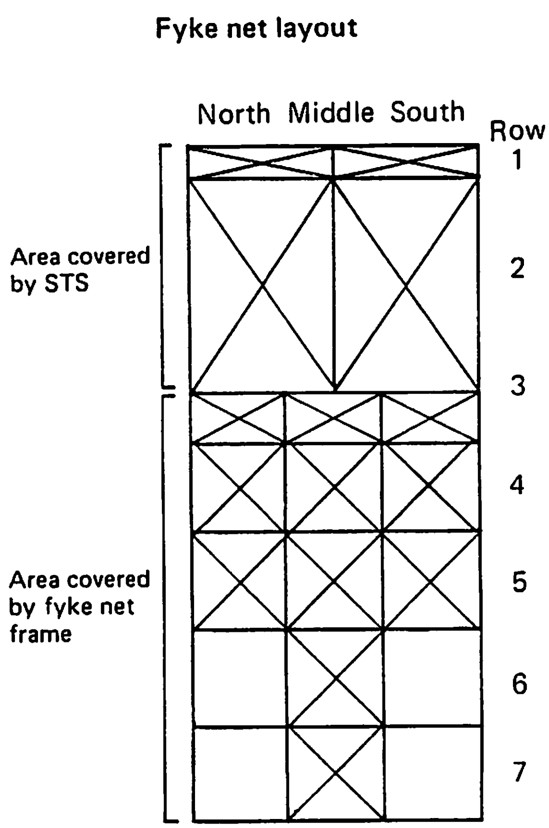

Figure 2.--Layout of fyke nets used to measure FGE at John Day Dam.

nets normally contained three nets, with each row extending completely across the intake; the bottom two rows contained only the center net. The fyke nets in the top row were 2.5 by 6.5 ft whereas the other fyke nets were 6.5 ft by 6.5 ft. During some tests (discussed below), side nets were removed from Rows 1, 2, and 3. This net configuration is referred to as "partial net coverage."

The following sequence of events was typical for conducting an FGE test:

1. The STS with attached fyke net frames was lowered into position with the gantry crane (turbine off).

2. The bypass orifice was closed, and all fish were removed from the gatewell using a dipbasket (Swan et al. 1979).

3. The unit was brought to full power-generating capacity (135MW).

4. The number of fish entering the unit was monitored by periodic dipnetting of guided fish from the gatewell.

5. The test was terminated when adequate numbers of fish for statistical needs were collected.

6. The turbine was shut down, and all remaining fish were dipped from the gatewell.

7. The STS with attached nets was brought to deck level, and the fish were removed for identification and enumeration.

The methods for determining FGE were similar to those used in previous FGE experiments (Swan et al. 1983). Gatewell dipnet catches provide the number of guided fish; catches from the gap, closure, and fyke nets provide data for estimating the number of unguided fish. FGE was calculated as gatewell catch divided by the total number of fish passing through the intake during the test period:

$$\text{FGE \%} = \frac{\text{Gatewell catch}}{\text{Gatewell catch + adj. total net catch}} \times 100$$

where:

adjusted total net catch = total catch by net row adjusted for any missing nets.

The effects of the STS on fish condition were determined from descaling information. Descaling was determined by visually dividing each side of the fish into five equal areas; if any two areas on a side were 50% or more descaled, the fish was classified as descaled.

Sample Size

Prior to the testing season, NMFS and COE personnel met to discuss guidelines for the numbers of fish required for statisical validation of FGE tests at all dams using various net configurations and guidance values. For FGE tests with the standard net configuration and FGE >60%, the desired sample was 200 fish, including gatewell fish. If FGE was less than 60%, side nets could be removed and the desired sample was 250 fish.

Statistical Comparisons

For most statistical tests involving FGE percentages, the data were transformed using the angular (arcsine) transformation (Sokal and Rohlf 1981).

Prior to the testing period, a statistical evaluation of the assumption that the middle fyke nets catch 1/3 of the total fish passing through the intake was performed using data from past years collected at various dams where the standard net configuration was used (n=227 samples). No evidence was found to reject the 1/3 assumption (Ossiander[1/]). In 1986,

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1/ Memo 10 March 1986, F. Ossiander to Teri Barila, COE. "Comparisons of center and side net catches from FGE and vertical distribution tests."

this assumption was evaluated further by rotating between standard and partial net coverage at John Day Dam (Appendix Table A1).

Estimates of FGE obtained using standard and partial net configuations were compared using two methods: (1) a single sample t-statistic was used to test the hypothesis that there was 0% difference in FGE (no transformation) in paired tests using different net configurations on consecutive days, and (2) a binomial proportion analysis (Snedecor and Cochran 1967) was used to test the hypothesis that the middle nets captured 1/3 of the total fish at Levels 1-3 during tests where the standard net configuration was used.

One-way analysis of variance was used to test the seasonal variability of FGEs. For this analysis, FGEs (transformed) were grouped into three periods: Period 1, 17-26 June; Period 2, 14-17 July; and Period 3, 21-24 July.

OPE Tests

The design of the new bypass gallery precludes the installation of the orifice trap normally used for OPE evaluation. The new gallery, which is totally enclosed, is 8 ft wide and varies in height from 17 ft at Unit 1 to 4 ft at Unit 16. Without the option of an orifice trap to provide absolute numbers of fish leaving the gatewell, it was necessary to use an indirect method to estimate OPE (Krcma et al. 1986). Daily OPE estimates were based on the catches of juvenile salmonids (volitional migrants) from two adjacent slots (B and C).[2/] The orifice leading to the bypass was open in one slot and closed in the other. The open and closed positions of the orifices in the two

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2/ Gatewell slots, three per turbine unit, are designated A,B, and C in a north to south direction (left to right facing upstream) across the dam--this is opposite the designations used at most other dams.

slots were alternated daily to follow a cross-over statistical design (Cochran and Cox 1957). The orifice in the A Slot was closed throughout the test series, and fish were removed daily to provide an estimate of the proportional catch between the A and B or C Slots, whichever had the closed orifice. The mean catch ratios, A:B and A:C, were used to estimate a catch ratio for B:C, though the B and C Slots were never closed on the same day.

A typical test series began about 0800 h (time of minimal fish passage) when all fish were removed from the three gatewells using a dipbasket (Swan et al. 1979) and the turbines were started. After 24 h, the open orifice was closed and all fish were dipped from each of the three gatewell slots and counted by species. Then, the test was repeated with the positions of the orifices (open or closed) reversed in the B and C Slots.

OPE was measured daily in Units 10 and 11 to provide a comparison between two types of vertical barrier screens (VBS). Both VBSs consisted of 10 panels; the top two panels had solid backing plates, and the bottom seven panels had perforated backing plates of the balanced flow design (Fig. 3). The VBSs in the two units differed in the area of the third panel; Unit 11 (control) had a solid backing plate whereas in Unit 10 (test), one-third of the panel, in the area adjacent to the orifice opening, was of the balanced flow design. Turbines in both units were controlled so the daily variation in loading required by power demand was the same.

The crossover statistical design eliminated possible slot effects (within unit) from the analysis by averaging OPEs between B and C Slots every 2 days. Therefore, an adjustment factor, required by the indirect method used in 1985, was not needed to compensate for potential differences in total numbers of fish passing into the various slots. In 1986, the formula used for calculating daily OPE was as follows:

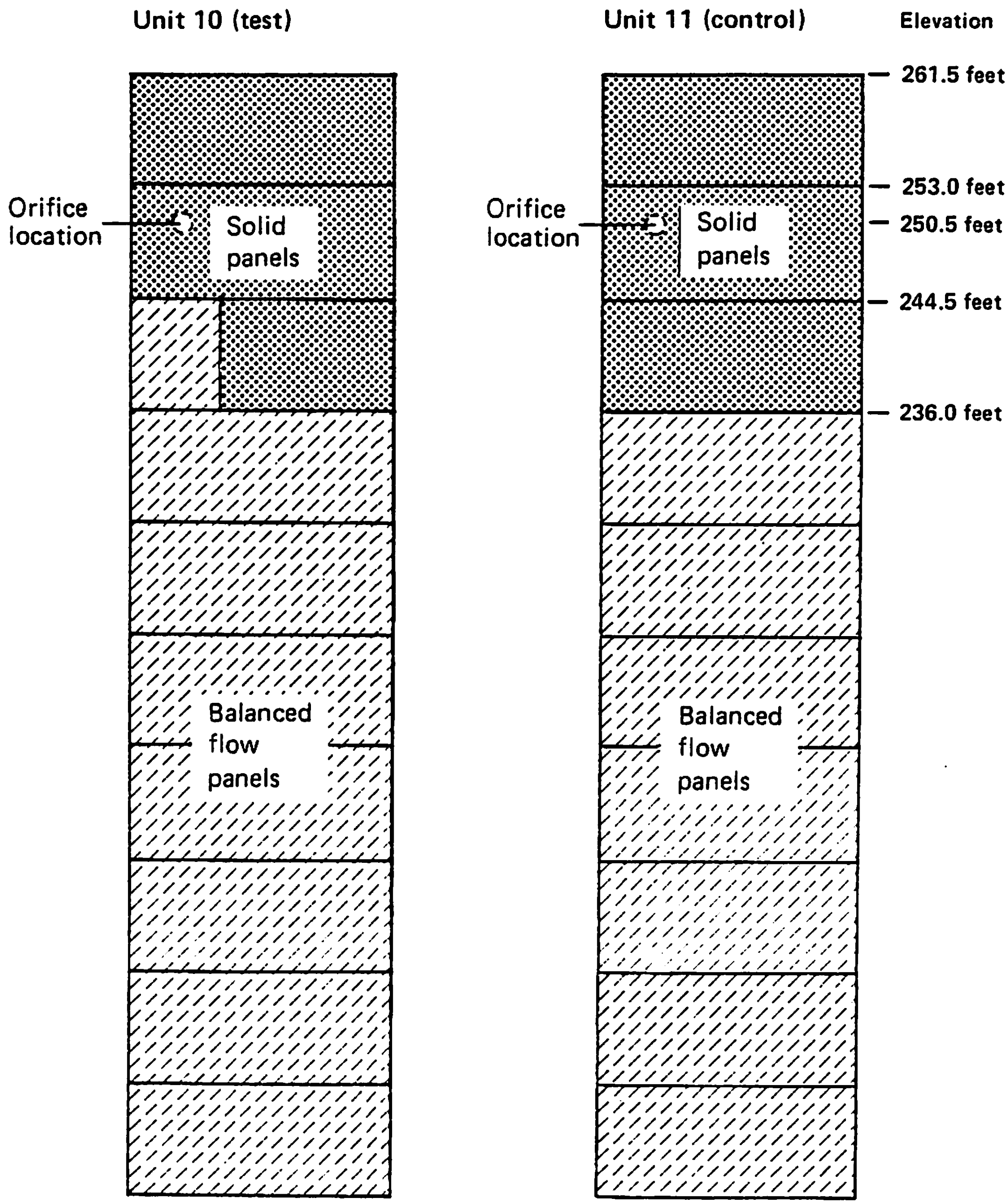

Figure 3.--Layout of vertical barrier screen panels for VBS tests at John Day Dam, 1986.

$$OPE_i = 100 - [(O_i / C_i) \times 100]$$

where:

OPE_i = orifice passage efficiency (%) for fish species i

O_i = total number of fish species i dipped from the slot with the open orifice

C_i = total number of fish species i dipped from the slot with the closed orifice.

The overall difference in OPE (D_i) between Units 10 and 11 was calculated as follows:

$$D_i = (OPE1_{10} - OPE1_{11}) + (OPE2_{10} - OPE2_{11})/2$$

where:

D_i = 2-day average difference between Units 10 and 11 in daily OPEs

$OPE1_{10}$ and $OPE1_{11}$ = OPEs in Units 10 and 11 on first paired day

$OPE2_{10}$ and $OPE2_{11}$ = OPEs in Units 10 and 11 on second paired day

The null hypothesis that both styles of VBSs performed equally was tested by using Student's t-test according to the following formula:

$$t = \Sigma\bar{D}/SD$$

where:

t = calculated t-value

$\Sigma\bar{D}$ = summation of the average 2-day OPE differences between Units 10 and 11 (see Di above).

SD = standard deviation with (n-1) weighting

There were 12 (n) paired days of testing for yearling chinook salmon, sockeye salmon, and steelhead and 7 paired days for subyearling chinook salmon.

A paired t-test was used to compare OPEs for all species, within units, on consecutive days.

Fish Sampler Evaluation

The juvenile salmonid sampler (Fig. 4) was operated for various 24-h periods during the smolt migration. Juvenile salmonids dipped from gatewells in Units 10 and 11 (OPE studies) were marked and released into various parts of the bypass system for recapture and evaluation at the fish sampler. Fish captured for marking were anesthetized, freeze branded, caudal clipped, and held for 48 h in tanks of circulating river water. Marked fish were released into the gatewells of Units 10 and 11 in lots of about 600-1,000 fish. The number of gatewell released fish remaining in the gatewell the following day were subtracted from the total release number when calculating sampler efficiency (percent recovery of marked fish). Additional marked fish releases (1,000-fish lots) were made directly into the bypass conduit at the air vent located at Unit 1 and through the manhole opening approximately 100 ft upstream from the sampler. Numbers of marked fish recovered and descaling and mortality of unmarked fish in the sampler were recorded hourly.

A comparison of the percentage of descaled fish was made from fish dipnetted from gatewells of Units 10 and 11 and from fish collected with the sampler. If there was no increase in descaling at the sampler, we assumed the fish were being safely passed through the system.

RESULTS AND DISCUSSION

FGE Tests

Standard Versus Partial Net Configuration

The mean difference of -6.2% in paired tests comparing FGE obtained from standard and partial net configurations was not significant ($t=1.97$, $df=7$)

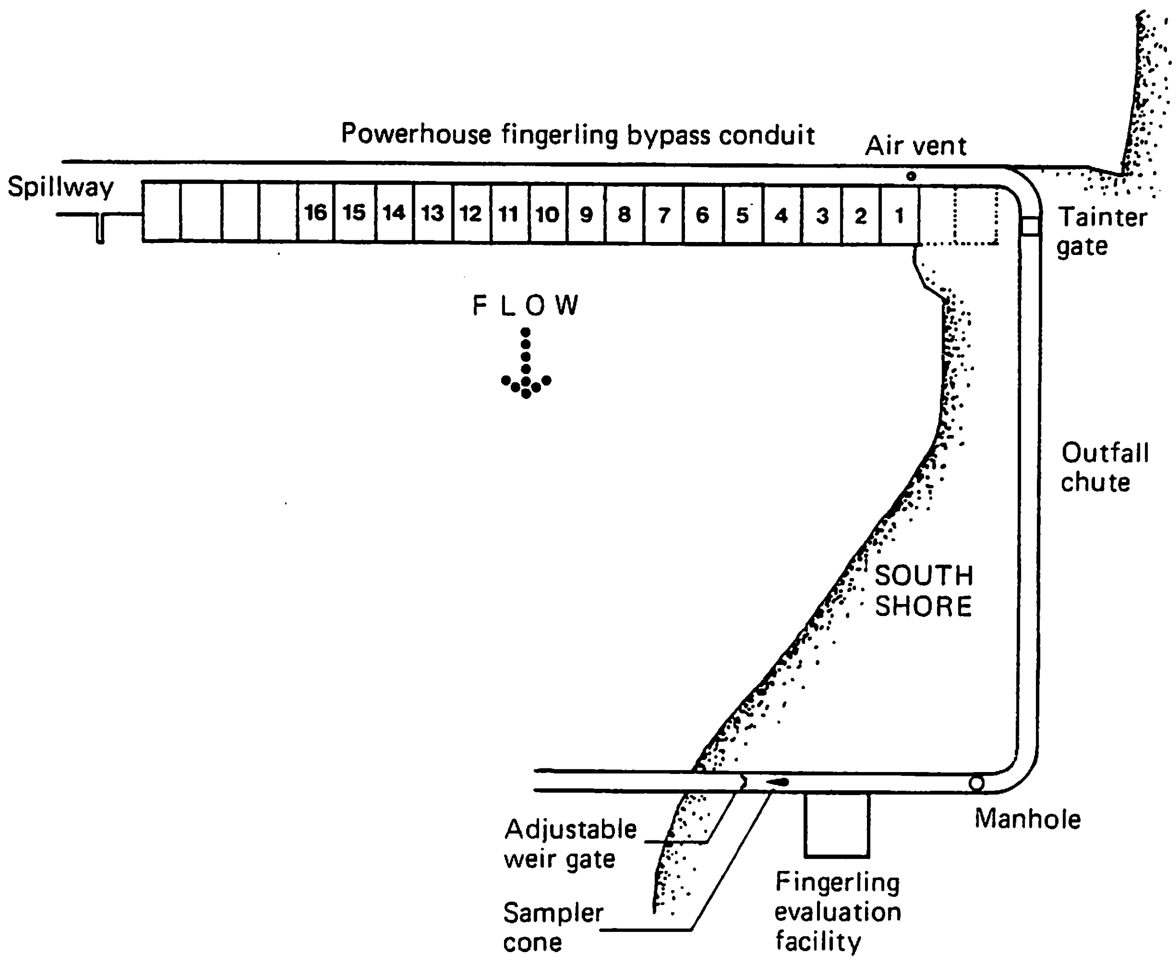

Figure 4.--Schematic of new fingerling bypass at John Day Dam.

(Table 1). Using the standard net configuration, the middle nets, overall, caught 32.5% of the total catch; only two of the seven tests indicated that the catch ratio was other than the expected 33% (Table 2). Consequently, for all subsequent analyses, data from all tests were treated equally regardless of net configuration.

Temporal Changes in FGE

Data for subyearling chinook salmon from the three test periods showed significant differences (P>0.05) in FGEs; means for the three test periods were 34.2, 46.4, and 24.6%, respectively (Tables 3-5).

Overall FGE averaged 35% for the three periods tested, considerably higher than the 21% observed in 1985 but still well below the interim target level of 70%. The 1985 results, however, were obtained in one short time period (15 to 17 July). Had additional testing been conducted, results could well have mirrored the temporal differences observed in 1986.

The temporal differences probably reflect varying migrational behavior in the many races of fish making up the subyearling seaward migration; they were not due to test procedures. As previously indicated, there was no significant difference between standard and partial net configurations. Test duration differences were also examined and found not to be a factor. In one test series, highest FGEs were observed on tests of 3 h whereas a second series showed highest FGEs when tests were 2 h or less. In the test series from 14 to 17 July, each of the 4 h and 3 h tests had one high and one low FGE recorded. The FGE results giving date, net coverage, and FGE measured for each test conducted in 1986 are shown in Figure 5. Additional details including numbers of fish in each net are provided in Appendix Table A1.

Table 1.--Comparison of fish guiding efficiency (FGE) of subyearling chinook salmon obtained using different net configurations on consecutive days at John Day Dam, 1986.

Date of test	FGE (%) Standard[a] nets	Partial[b] nets	Difference (%)
18-19 June	35.4	40.2	4.8
23-24 June	42.1	26.0	-16.1
26-26 June	38.1	19.8	-18.3
14-15 July	54.8	47.8	-7.0
15-16 July	53.2	47.8	-5.4
16-17 July	53.2	40.9	-12.3
21-22 July	23.9	23.9	0.0
23-24 July	24.8	29.6	4.8

Mean difference = -6.2
Standard deviation = 8.97
T-statistic of difference = 1.97[c]
Degrees of freedom = 7

[a] Standard net configuration having full net coverage, except only middle nets at Rows 4 and 5.

[b] Partial net configuration having full gap and closure net coverage, but only middle nets at Rows 1-5.

[c] Observed differences in FGE were not significantly different (P>0.05) from the hypothetical difference of 0; single sample t-statistic.

Table 2.--Evaluation of the proportions of subyearling chinook salmon captured in the middle nets versus left and right nets for net levels 1-3 when all nets were fished, John Day Dam, 1986.

Date	Net: Left	Net: Middle	Net: Right	Z-critical[a/]
19 June	125	145	143	0.7155 n.s.
23 June	188	194	186	0.3716 n.s.
26 June	140	164	146	1.3514 n.s.
Subtotal	453	503	475	1.4325 n.s.
14 July	21	17	32	1.4813 n.s.
16 July	44	56	44	1.3271 n.s.
21 July	260	203	229	2.1900**
24 July	152	110	135	2.3280**
Subtotal	477	386	440	2.8116**
Grand total	930	889	915	0.8782 n.s.
Percent total	34.0	32.5	33.5	

[a/] Z-critical statistic, calculated using the bionomial proportion test (Snedecor and Cochran 1967) of the hypothesis that the middle nets captured 33.3% of the total fish; n.s.=difference was non-significant, **=difference was significant (P>0.05).

Table 3.--Fish guiding efficiency (FGE), catch distribution, and descaling rate of subyearling chinook salmon; accumulated data from seven tests conducted at John Day Dam, 17-26 June 1986.

Net	Actual catch			Adjusted catch
	Left	Middle	Right	
Gap	8	a/	13	21
Closure	192	a/	200	392
Fyke Row 1 b/	91	78	99	268
Fyke Row 2 b/	438	489	445	1,372
Fyke Row 3 b/	310	322	317	949
Fyke Row 4	c/	128	c/	384
Fyke Row 5	c/	21	c/	63

Total in gatewell 1,792	Total in nets	FGE (%) 34.2
Descaled (%) 1.5	Actual 3,151	
	Adjusted 3,449	

a/ Gap and closure nets (two each) extended half way across the net row.

b/ Actual catches include an adjustment for missing side nets on 17, 18, 24, and 25 June.

c/ Only middle nets were used at Rows 4 and 5.

Table 4.--Fish guiding efficiency (FGE), catch distribution, and descaling rate of subyearling chinook salmon; accumulated data from four tests conducted at John Day Dam, 14-17 July 1986.

Net	Actual catch			Adjusted catch
	Left	Middle	Right	
Gap	1	a/	2	3
Closure	110	a/	101	211
Fyke Row 1 b/	19	26	26	71
Fyke Row 2 b/	147	149	145	441
Fyke Row 3 b/	59	58	65	182
Fyke Row 4	c/	16	c/	48
Fyke Row 5	c/	6	c/	18

Total in gatewell 843
Descaled (%) 2.2

Total in nets
Actual 930
Adjusted 974

FGE (%) 46.4

a/ Gap and closure nets (two each) extended half way across the net row.

b/ Actual catches include an adjustment for missing side nets on 15 and 17 July.

c/ Only middle nets were used at Rows 4 and 5.

Table 5.--Fish guiding efficiency (FGE), catch distribution, and descaling rate of subyearling chinook salmon; accumulated data from four tests conducted at John Day Dam, 21-24 July 1986.

Net	Actual catch Left	Actual catch Middle	Actual catch Right	Adjusted catch
Gap	4	a/	1	5
Closure	227	a/	255	482
Fyke Row 1 b/	85	67	81	233
Fyke Row 2 b/	501	466	476	1,443
Fyke Row 3 b/	418	372	399	1,189
Fyke Row 4	c/	209	c/	627
Fyke Row 5	c/	55	c/	165

Total in gatewell 1,351
Descaled (%) 1.6

Total in nets
Actual 3,616
Adjusted 4,144

FGE (%) 24.6

a/ Gap and closure nets (two each) extended half way across the net row.

b/ Actual catches include an adjustment for missing side nets on 22 and 23 July.

c/ Only middle nets were used at Rows 4 and 5.

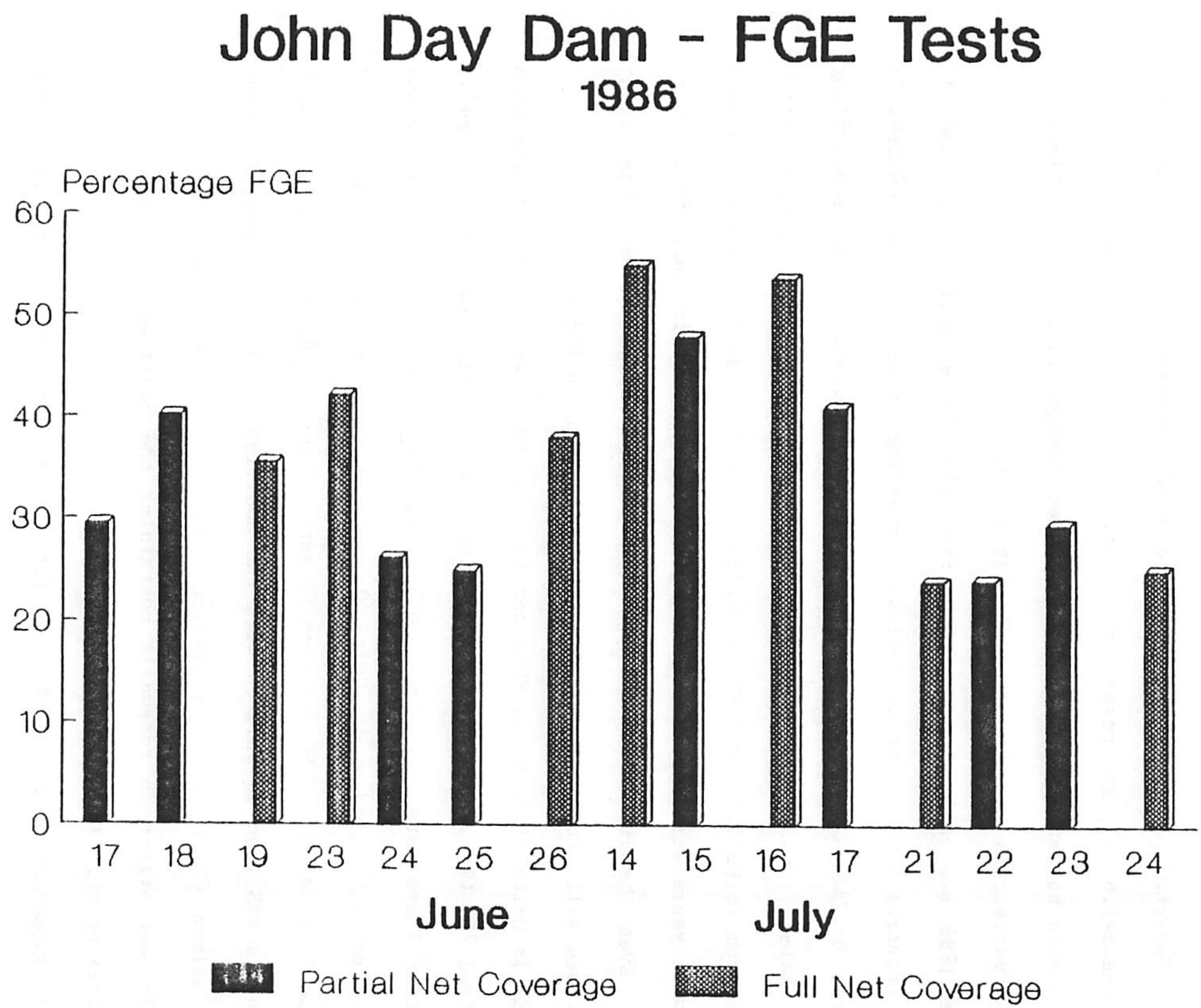

Figure 5.--Data groups for FGE tests conducted at John Day Dam, 1986.

OPE Tests

During 1986, 36 of 48 possible orifices were connected to the bypass system. Seasonal variations in orifice head (mean=4.0 ft), tainter gate opening (mean=1.6 ft), and reservoir elevation (mean=265 ft) were low, and there were no obvious correlations between changes in these conditions and daily variations in OPEs (Appendix Table A3).

The 1986 seasonal average OPEs (±90% confidence limits) for fish in Unit 11 (control VBS) were as follows: yearling chinook salmon, 69.2±6.4%; steelhead, 66.2±6.9%; sockeye salmon, _O. nerka_, 81.9±5.0%; and subyearling chinook salmon, 65.6±11.3%. Except for yearling chinook salmon, which declined from 76.8±16.1% in 1985 to 69.2±6.4% in 1986, differences in seasonal OPE between years were minimal despite a decrease in orifice head from 5.8 to 4.0 ft. Even the difference for yearling chinook salmon was not significant since it was well within the 90% C.L. about the mean in 1985.

OPEs in Units 11 (control VBS) and 10 (test VBS) were generally less than the desired 75% (Table 6), and daily within slot variation was large (Appendix Table A2). There were significant differences ($P \leq 0.05$) in OPEs between B and C Slots for all species in Unit 10 and for yearling chinook salmon and steelhead in Unit 11. OPE was significantly higher ($P \leq 0.05$) in Unit 11 with the standard VBS than in Unit 10 with the modified VBS for all species except sockeye salmon (Table 7). In previous studies at Lower Granite and McNary Dams, OPE was higher in gatewells containing the modified VBS (Swan et al. 1985; Krcma et al. 1985).

The proportional catch of fish for the A Slot compared to the other closed slots (B or C) was consistent--about 30:70 for Unit 10 and 37:63 for Unit 11 (Table 8). Because there were no significant within unit differences ($P > 0.05$) in the A:B or A:C catch ratios, we assumed that similar numbers of

Table 6.--Indirect orifice passage efficiency (OPE) estimates and standard deviations (SD) for B and C Slots of Units 10 (test) and 11 (control), John Day Dam, 1986.

Species	Unit 10 (test)				Unit 11 (control)			
	Slot B		Slot C		Slot B		Slot C	
	OPE (%)	SD (%)	OPE (%)	SD (%)	OPE (%)	SD (%)	OPE (%)	SD (%)
Yearling chinook sal.[a]	69.0	11.8	54.1	13.7	77.8	13.4	61.5	15.0
Steelhead[a]	49.2	14.2	64.0	10.5	75.9	15.1	56.6	15.2
Sockeye[a] salmon	88.9	8.0	75.4	15.6	82.4	17.0	81.6	7.1
Subyearling chinook sal.[b]	44.7	16.8	62.2	15.8	62.7	24.0	67.6	19.6

a/ Number of paired tests = 13.
b/ Number of paired tests = 7.

Table 7.--OPE comparisons between modified VBS (Unit 10) and standard VBS (Unit 11) John Day Dam, 1986.

Species	Degrees freedom	t-value[a]
Yearling chinook salmon	12	- 3.629*[b]
Steelhead	12	- 4.056*
Sockeye salmon	12	0.6775
Subyearling chinook salmon	6	- 3.064*

a/ The t-test was conducted so that positive t-values indicated that OPE in Unit 10 was higher than in Unit 11; negative t-values indicated the opposite.

b/ * = significant difference ($P<0.05$).

Table 8.--Proportional catch (%) in the A Slot versus the B or C Slots[a/] (when orifices were closed to the bypass) of Units 10 and 11, John Day Dam, 1986.

	A Slot			B Slot			C Slot		
Species	$\bar{x}$[b/]	SD[c/]	df[d/]	$\bar{x}$	SD	df	$\bar{x}$	SD	df
				Unit 10					
Yearling Chinook salmon	33.4	4.4	26	65.2	2.7	12	68.0	4.8	13
Steelhead	38.1	5.2	26	62.0	3.1	12	63.1	5.4	13
Sockeye salmon	39.8	6.1	25	59.2	7.2	12	61.5	4.8	13
Subyearling chinook sal.	37.4	3.6	14	63.6	1.7	7	61.4	4.8	6
Mean (all species)	37.2	---	--	62.5	---	--	63.5	---	--
				Unit 11					
Yearling chinook salmon	28.5	5.1	26	70.1	6.1	12	72.7	3.7	13
Steelhead	30.8	6.0	26	68.0	7.3	12	70.4	4.5	13
Sockeye salmon	35.2	5.7	25	63.2	4.3	12	68.7	11.0	13
Subyearling chinook sal.	26.6	6.2	14	74.2	3.6	7	72.4	8.5	6
Mean (all species)	30.3	---	--	68.9	---	--	71.0	---	--

a/ The orifices in the B and C Slots alternated daily between the open/closed position, the orifice in the A Slot was always closed.

b/ $\bar{x}$ = mean.

c/ SD = standard deviation.

d/ df = degrees of freedom.

fish moved into the B and C Slots daily. The unexplained large daily variations in OPEs suggest that fish behavior or physiological differences in fish populations approaching the dam can influence OPEs.

Fish Sampler Evaluation

The fish sampler in the transportation channel was operated for 8 days in May and 4 days in July. During these 12 days, a total of 45,569 smolts was captured and examined (Table 9). Numbers of fish marked, released, and recaptured for assessment of sampler efficiency are given in Appendix Table A4. Sampler efficiency was similar for all three release sites (gatewell, air vent, and manhole) and lower than the expected 10% for all species--3.4% yearling chinook salmon, 1.7% subyearling chinook salmon, and 0.7% steelhead.

During May, there were no apparent differences in descaling rates between unmarked fish recovered in the sampler and fish dipped from the gatewells; mean descaling values(±90% confidence limits) were 11.8±2.9% and 12.9±3.1%, respectively (Tables 9 and 10). During July, descaling rates of unmarked subyearling chinook salmon from the two sampling sites were similar--3.1±1.9% and 3.2±1.4%, respectively, for sampler and gatewell fish. Average daily mortality of sampler caught fish was less than 1%--range 0.1-1.9%.

Hourly catches of sampler caught fish and Unit 3 airlift caught fish (Johnsen[3/]) for a typical 24-h period in May are shown in Figure 6. As can be seen, fish catches at the Unit 3 monitoring station closely mirror the diel fish movements through the fingerling bypass system.

[3/] R. Johnsen, Biologist, National Marine Fisheries Service, ETSD, Portland, Oregon, pers. comm. 1986.

Table 9.--Catch, descaling, and mortality at the fish sampler on the transportation channel, John Day Dam, 1986.

Date	No. des.	% des.	No. mort.	% mort.	Sample size	Species
1-2 May	375	11.3	4	0.1	3325	all[a]
4-5 May	261	11.9	4	0.2	2201	all
7-8 May	280	11.2	11	0.4	2495	all
10-11 May	211	11.2	4	0.2	1879	all
13-14 May	319	11.4	12	0.4	2795	all
16-17 May	345	10.1	12	0.3	3421	all
22-23 May	608	11.0	24	0.4	5535	all
30-31 May	784	16.0	91	1.9	4897	all
	Mean =	11.76	Mean =	0.49		
17-18 Jul	129	4.3	38	1.3	3001	Sub. chinook
20-21 Jul	48	3.7	12	0.9	1295	" "
23-24 Jul	141	2.8	10	0.2	4940	" "
31Jul-1 Aug	167	1.7	14	0.2	9785	" "
	Mean =	3.14	Mean =	0.65		

[a] Includes steelhead, sockeye, coho, and yearling chinook salmon.

Table 10.--Catch and descaling of dipnetted fish taken during OPE testing at John Day Dam, 1986.

Date	Unit	% des.	Sample size	Species
6 May	10A	12.1	812	all[a/]
6 May	10B	16.6	487	all
6 May	11A	11.3	416	all
6 May	11B	11.2	870	all
12 May	11A	13.1	260	all
15 May	10A	14.9	864	all
15 May	11A	10.8	518	all
21 May	10A	12.5	1,184	all
21 May	11A	11.7	488	all
29 May	10A	12.9	1,654	all
30 May	11A	15.1	1,449	all
	Mean = 12.93			
18 Jul	11B	4.0	1,798	Subyearling chinook
21 Jul	11C	3.4	1,104	" "
23 Jul	10C	4.4	4,209	" "
24 Jul	11A	3.7	648	" "
25 Jul	10A	2.4	1,636	" "
25 Jul	11A	2.7	1,042	" "
29 Jul	11B	2.1	1,783	" "
31 Jul	10A	3.3	1,682	" "
	Mean = 3.25			

a/ Includes steelhead and sockeye, coho, and yearling chinook salmon.

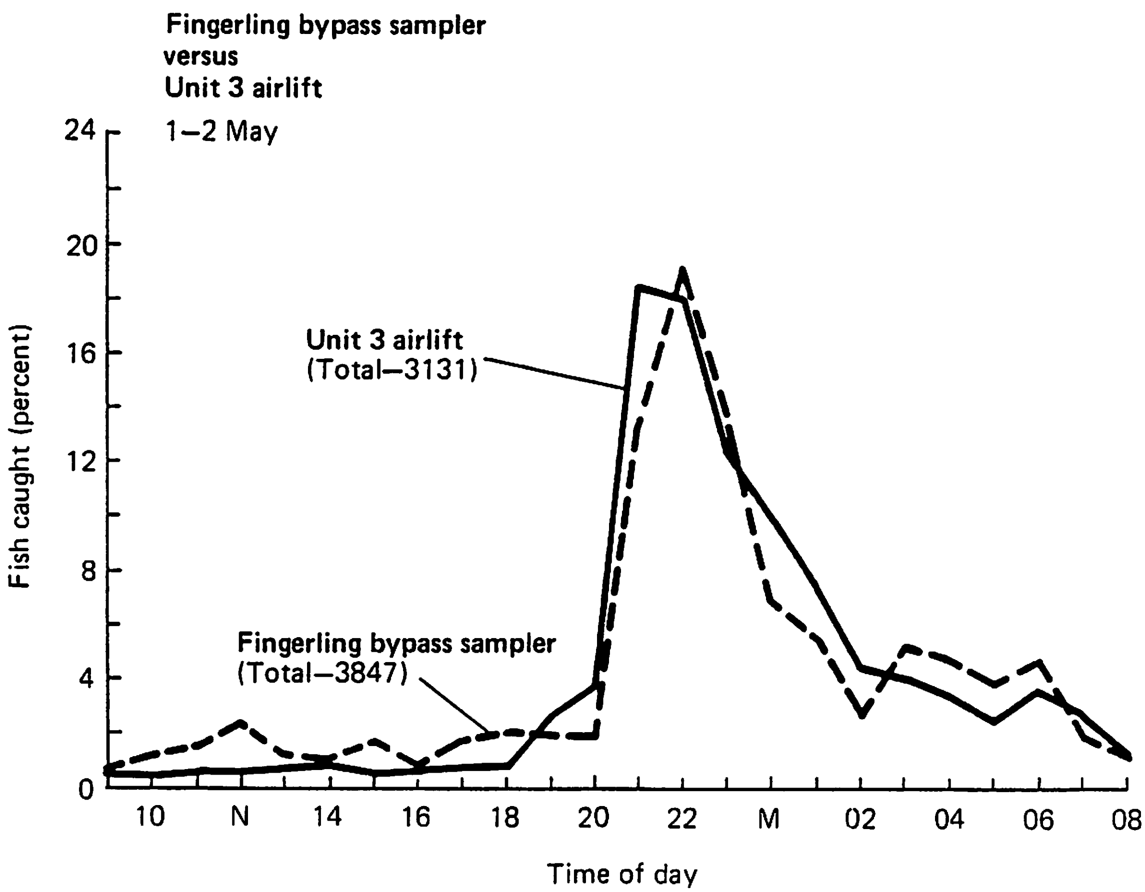

Figure 6.--Comparison of sampler caught fish and Unit 3 airlift caught fish at John Day Dam, 1986.

CONCLUSIONS

1. Data for subyearling chinook salmon from the three test periods showed significant differences in FGE.

2. FGE for 1986, although higher than in 1985, is still well below the interim goal of 70%.

3. The control VBS configuration shows a marked increase in OPE over the test VBS configuration.

4. OPEs for all species except sockeye salmon were generally less than the research target goal of 75%.

5. OPEs in Unit 10 (test VBS) were significantly lower than OPEs in Unit 11 (control VBS) for all species except sockeye salmon.

6. There were no significant differences in seasonal average OPE, between 1985 and 1986 despite a decline in orifice head from 5.8 to 4.0 ft.

7. There were no significant differences in the daily catch ratios of the two closed slots (A:B and A:C) in either unit; therefore, we assume that similar numbers of fish entered both the B and C Slots.

8. The large daily variations in OPEs suggest that fish behavior or physiological differences in fish populations approaching the dam can influence OPE.

9. The efficiency of the fingerling sampler is less than the expected 10%.

10. Since there was no apparent increase in descaling at the fingerling sampler, we assume that fish are being safely passed through the bypass system.

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APPENDIX A

Catch data for fish guiding efficiency, orifice passage efficiency, and fish sampler evaluation

Appendix Table A1.--Catch data and fish guiding efficiency (FGE) from submersible traveling screen evaluation studies in Turbine Unit 6, Slot B, John Day Dam, 1986.

Date[a]	Time		Spp.[b]	Flag[c]	Nets[d]															Adjusted total[e]	Gatewell		
	Start	End			LG	RG	LC	RC	L1	M1	R1	L2	M2	R2	L3	M3	R3	M4	M5		Catch (%)	Descale (%)	FGE[f] (%)
6/17	2200	2400	9	+1	2	1	18	15	--[g]	4	--	--	45	--	--	29	--	14	2	318	133	0.8	29.5
6/17	2200	2400	5		0	0	0	0	--	0	--	--	0	--	--	0	--	0	0	0	1		100.0
6/17	2200	2400	1		0	0	0	0	--	0	--	--	0	--	--	1	--	0	0	3	8		72.7
6/17	2200	2400	4		2	2	2	0	--	3	--	--	9	--	--	6	--	0	1	63	32	0.0	33.7
6/17	2200	2400	6		0	0	0	0	--	0	--	--	0	--	--	0	--	0	0	0	3		100.0
6/18	2130	0036	9	+1	0	0	6	14	--	7	--	--	17	--	--	15	--	5	1	155	104		40.2
6/18	2130	0036	5		0	0	0	0	--	0	--	--	0	--	--	0	--	0	0	0	1		100.0
6/18	2130	0036	1		0	0	0	1	--	0	--	--	0	--	--	0	--	1	0	4	6		60.0
6/18	2130	0036	4		0	0	0	0	--	0	--	--	1	--	--	3	--	6	2	36	18		33.3
6/18	2130	0036	6		0	0	0	0	--	0	--	--	0	--	--	0	--	0	0	0	3		100.0
6/19	2130	2400	9	+1	0	3	29	27	9	14	19	66	88	76	50	43	48	17	3	532	292	1.7	35.4
6/19	2130	2400	1		0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	3	5		62.5
6/19	2130	2400	4		0	1	0	0	2	0	1	3	0	1	0	3	0	3	2	26	7		21.2
6/19	2130	2400	6		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	3		75.0
6/23	2130	2248	9	+1	4	4	70	65	27	20	35	108	113	96	53	61	55	25	6	804	585	1.2	42.1
6/23	2130	2248	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0	100.0
6/23	2130	2248	1		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0		0.0
6/23	2130	2248	4		2	1	0	1	0	1	1	10	5	1	3	1	2	1	2	37	12	0.0	24.5
6/24	2100	0036	9	+1	1	5	26	28	--	8	--	--	67	--	--	62	--	29	1	561	197	3.0	26.0
6/24	2100	0036	1		0	0	0	0	--	0	--	--	0	--	--	0	--	0	1	3	0	0.0	0.0
6/24	2100	0036	4		0	0	0	0	--	0	--	--	5	--	--	1	--	2	0	24	12	0.0	33.3
6/24	2100	0036	6		0	0	0	0	--	0	--	--	0	--	--	0	--	0	0	0	3	0.0	100.0
6/25	2100	0030	9	+1	0	0	21	23	--	12	--	--	66	--	--	54	--	21	4	495	122	0.8	19.8
6/25	2100	0030	1		0	0	0	0	--	0	--	--	0	--	--	0	--	1	0	3	2		40.0
6/25	2100	0030	4		0	0	0	1	--	0	--	--	1	--	--	2	--	1	2	19	4		17.4

Appendix Table A1.--cont.

Date[a/]	Time Start	Time End	Spp.[b/]	Flag[c/]	Nets[d/] LG	RG	LC	RC	L1	M1	R1	L2	M2	R2	L3	M3	R3	M4	M5	Adjusted total[e/]	Gatewell Catch (%)	Descale (%)	FGE[f/] (%)
6/25	2100	0030	6		0	0	0	0	--	0	--	--	0	--	--	0	--	0	0	0	2		100.0
6/26	2024	2236	9	+1	1	0	32	38	24	13	14	69	93	78	47	58	54	17	4	584	359	1.4	38.1
6/26	2024	2236	1		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0		0.0
6/26	2024	2236	4		1	2	2	3	0	3	4	3	2	2	0	0	3	0	0	25	30		54.5
6/26	2024	2236	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2		100.0
7/14	2018	2400	9	+2	0	0	8	20	2	5	5	15	8	14	4	4	13	2	0	104	126	2.4	54.8
7/14	2018	2400	1		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0.0	0.0
7/15	2000	2400	9	+2	1	1	21	20	--	3	--	--	23	--	--	8	--	3	0	154	141	2.1	47.8
7/15	2000	2400	5		0	0	0	0	--	0	--	--	1	--	--	0	--	0	0	3	0	0.0	0.0
7/15	2000	2400	1		0	0	0	0	--	0	--	--	0	--	--	0	--	0	0	0	2	0.0	100.0
7/16	2000	2300	9	+2	0	0	21	15	5	9	9	28	37	27	11	10	8	0	0	180	205	2.0	53.2
7/17	2000	2300	9	+2	0	1	60	46	--	9	--	--	81	--	--	36	--	11	6	536	371	2.2	40.9
7/21	2000	2300	9	+3	0	0	56	60	26	19	27	122	101	103	112	83	99	39	12	961	301	0.7	23.9
7/22	2000	2300	9	+3	2	0	122	136	--	36	--	--	260	--	--	197	--	128	35	2,228	699	1.7	23.9
7/22	2000	2300	1		0	0	0	0	--	0	--	--	0	--	--	1	--	0	0	3	2	0.0	40.0
7/23	2000	2300	9	+3	1	1	18	19	--	4	--	--	48	--	--	47	--	18	4	402	169	1.8	29.6
7/24	2000	2300	9	+3	1	0	31	40	19	8	14	71	57	65	62	45	56	24	4	553	182	2.2	24.8

a/ Month/day.

b/ Species codes: 1=sockeye salmon, 4=subyearling chinook salmon <65mm fork length, 5=yearling chinook salmon, 6=steelhead, 9=subyearling chinook salmon >65mm fork length.

c/ Flag codes: 1st character, +=150 or more actual fish in the test; 2nd character designates the test series.

d/ Net codes: 1st character, L=left, M=middle, R=right; 2nd character, G=gap, C=closure, 1-5=fyke net level (Fig. 1).

e/ Actual net catch adjusted for any missing nets.

f/ FGE = Gatewell catch/(Gatewell catch + Total adjusted net catch) X 100.

g/ -- = net removed.

Appendix Table A2.--Daily OPEs for yearling chinook and subyearling chinook salmon, steelhead, and sockeye salmon at John Day Dam, 1986.

			OPE (%)								
			Species code[a]					Species code			
Day	Month	Gatewell	5	9	6	1	Gatewell	5	9	6	1
29	April	10B	76.7	---	68.8	89.2	11B	86.7	---	93.2	95.6
30	April	10C	59.1	---	77.7	84.4	11C	67.7	---	62.9	87.0
01	May	10B	54.1	---	38.7	80.1	11B	37.7	---	49.8	44.1
02	May	10C	66.5	---	85.4	86.0	11C	82.2	---	79.4	88.0
03	May	10B	78.1	---	70.8	86.2	11B	76.6	---	90.8	97.0
04	May	10C	44.3	---	51.6	81.9	11C	66.0	---	59.6	91.2
05	May	10B	70.9	---	50.1	91.5	11B	83.8	---	89.4	78.8
06	May	10C	45.2	---	70.2	72.9	11C	63.5	---	63.8	82.8
07	May	10B	86.7	---	54.4	96.7	11B	92.2	---	91.3	99.3
08	May	10C	31.1	---	58.9	81.1	11C	35.3	---	57.1	84.3
09	May	10B	75.2	---	43.7	99.0	11B	75.6	---	80.2	93.4
10	May	10C	75.9	---	70.4	91.7	11C	61.5	---	30.0	89.1
11	May	10B	46.0	---	35.4	97.7	11B	81.1	---	81.6	86.6
12	May	10C	72.5	---	72.8	92.6	11C	46.1	---	29.6	87.8
13	May	10B	64.1	---	36.6	95.3	11B	76.1	---	58.6	74.6
14	May	10C	53.1	---	56.6	85.3	11C	51.2	---	58.9	71.9
15	May	10B	68.2	---	31.3	93.0	11B	76.6	---	79.5	89.0
16	May	10C	37.8	---	59.6	80.7	11C	46.6	---	43.8	70.9
17	May	10B	68.3	---	32.9	95.0	11B	57.0	---	66.1	80.4
20	May	10B	68.8	---	31.5	90.3	11B	85.7	---	69.9	89.7
21	May	10C	63.8	---	63.1	61.6	11C	51.9	---	65.5	71.6
22	May	10B	78.8	---	51.3	86.2	11B	88.3	---	85.5	95.6
23	May	10C	53.7	---	58.1	71.2	11C	66.0	---	61.6	77.2
28	May	10B	53.3	---	62.9	72.9	11B	77.8	---	57.0	54.8
29	May	10C	41.4	---	49.8	47.4	11C	74.7	---	47.5	80.3
30	May	10B	76.1	---	64.0	78.0	11B	73.1	---	59.8	72.9
31	May	10C	59.3	---	58.5	44.1	11C	87.3	---	75.6	78.1
16	July	10C	---	72.4	---	---	11C	---	89.6	---	---
17	July	10B	---	71.3	---	---	11B	---	95.7	---	---
18	July	10C	---	72.5	---	---	11C	---	92.2	---	---
19	July	10B	---	51.4	---	---	11B	---	63.0	---	---
20	July	10C	---	52.7	---	---	11C	---	66.7	---	---
21	July	10B	---	56.2	---	---	11B	---	42.7	---	---
22	July	10C	---	57.5	---	---	11C	---	58.2	---	---
23	July	10B	---	37.5	---	---	11B	---	85.5	---	---
24	July	10C	---	74.8	---	---	11C	---	71.1	---	---
25	July	10B	---	41.3	---	---	11B	---	75.5	---	---
26	July	10C	---	73.0	---	---	11C	---	71.2	---	---
29	July	10C	---	73.5	---	---	11C	---	60.0	---	---
30	July	10B	---	37.2	---	---	11B	---	45.4	---	---
31	July	10C	---	32.2	---	---	11C	---	35.2	---	---
01	August	10B	---	18.3	---	---	11B	---	31.3	---	---

a/ Species codes: 5 = yearling chinook salmon, 9 = subyearling chinook salmon, 6 = steelhead, and 1 = sockeye salmon.

Appendix Table A3.--Tainter gate openings, orifice heads,[a/] and surface elevations in the reservoir of John Day Dam during OPE studies, 1986.

Day	Month	Tainter gate (ft)	Orifice head (ft)	Reservoir elevation (ft)
29	April	2.0	5.9	263.2
30	April	1.8	4.4	264.6
01	May	1.8	4.6	264.1
02	May	1.8	4.3	264.0
03	May	1.8	4.3	264.1
04	May	1.8	4.3	264.5
05	May	1.8	4.4	264.8
06	May	1.8	4.1	263.6
07	May	1.8	6.2	263.8
08	May	1.6	3.6	264.3
09	May	1.6	3.9	264.0
10	May	1.6	3.8	263.9
11	May	1.6	4.3	263.9
12	May	1.3	3.5	263.8
13	May	1.5	3.3	263.2
14	May	1.5	3.3	264.1
15	May	1.5	3.0	264.6
16	May	1.5	3.0	264.1
17	May	1.5	3.0	264.0
20	May	1.7	3.5	262.4
21	May	1.7	3.5	262.2
22	May	1.7	3.4	261.8
23	May	1.7	3.4	261.5
28	May	1.7	3.3	262.7
29	May	1.7	3.6	263.0
30	May	1.7	3.4	262.8
31	May	2.0	3.7	262.9
16	July	1.8	5.9	266.0
17	July	1.6	4.1	266.0
18	July	1.6	4.0	266.2
19	July	1.6	4.1	266.7
20	July	1.6	3.9	267.1
21	July	1.6	4.4	267.3
22	July	1.6	4.2	267.3
23	July	1.6	4.1	266.8
24	July	1.6	4.0	266.6
25	July	1.6	4.0	266.6
26	July	1.6	4.2	266.9
29	July	1.6	4.0	267.5
30	July	1.6	4.2	267.6
31	July	1.6	4.2	267.6
01	August	1.6	4.2	267.7

a/ Orifice head was defined as the difference between the water surface elevation in the gatewell slot (Unit 9C) and the elevation in the bypass gallery (accessed through a manhole opening near Unit 9C).

Appendix Table A4. Catch data for fish sampler evaluation at John Day Dam, 1986.

Date	Species	Number of fish released			Number of fish recaptured		
		Gatewell	Unit 1	Manhole	Gatewell	Unit 1	Manhole
1-2 May	Chin 1s	0	1000	1000	0	34	28
4-5 May	Chin 1s	0	1000	1000	0	30	38
7-8 May	Chin 1s	339	1000	1000	15	36	31
10-11 May	Chin 1s	339	1000	1000	10	30	33
13-14 May	Chin 1s	449	1000	1000	22	31	52
16-17 May	Sthd	243	1000	1000	3	5	5
22-23 May	Sthd	485	923	1000	3	9	8
30-31 May	Chin 1s	524	1000	1000	9	19	44
17-18 July	Chin 0s	879	1000	1000	16	6	2
20-21 July	Chin 0s	501	1000	1000	1	11	5
23-24 July	Chin 0s	853	1000	1000	25	19	20
31 July-Aug 1	Chin 0s	687	1000	1000	30	30	23

Appendix Table A5. Number of river run fish caught during sampler evaluation, John Day Dam, 1986.

Date		Chin 1s	Chin 0s	Sthd	Coho	Sockeye	Totals
1-2 May	Acceptable condition	1587	0	197	0	1162	2946
	Descaled fish	265	0	7	0	103	375
	Mortality	4	0	0	0	0	4
	Total caught	1856	0	204	0	1265	3325
4-5 May	Acceptable condition	1263	0	236	1	436	1936
	Descaled fish	212	0	23	0	26	261
	Mortality	4	0	0	0	0	4
	Total caught	1479	0	259	1	462	2201
7-8 May	Acceptable condition	1506	1	214	0	483	2204
	Descaled fish	220	0	14	0	46	280
	Mortality	7	1	1	0	2	11
	Total caught	1733	2	229	0	531	2495
10-11 May	Acceptable condition	1068	3	193	0	400	1664
	Descaled fish	148	0	11	0	52	211
	Mortality	1	0	2	0	1	4
	Total caught	1217	3	206	0	453	1879
13-14 May	Acceptable condition	1765	4	202	0	493	2464
	Descaled fish	253	0	12	0	54	319
	Mortality	8	1	2	0	1	12
	Total caught	2026	5	216	0	548	2795
16-17 May	Acceptable condition	2172	4	129	1	758	3064
	Descaled fish	191	2	15	0	137	345
	Mortality	5	3	4	0	0	12
	Total caught	2368	9	148	1	895	3421
22-23 May	Acceptable condition	2825	414	384	49	1231	4903
	Descaled fish	253	4	37	4	310	608
	Mortality	7	8	5	1	3	4
	Total caught	3085	426	426	54	1544	5535
30-31 May	Acceptable condition	1785	355	323	54	1505	4022
	Descaled fish	195	7	24	0	558	784
	Mortality	24	24	3	0	40	91
	Total caught	2004	386	350	54	2103	4897