Studies to Evaluate Alternative Methods of Bypassing Juvenile Fish at the Dalles Dam – 1985

Final Report

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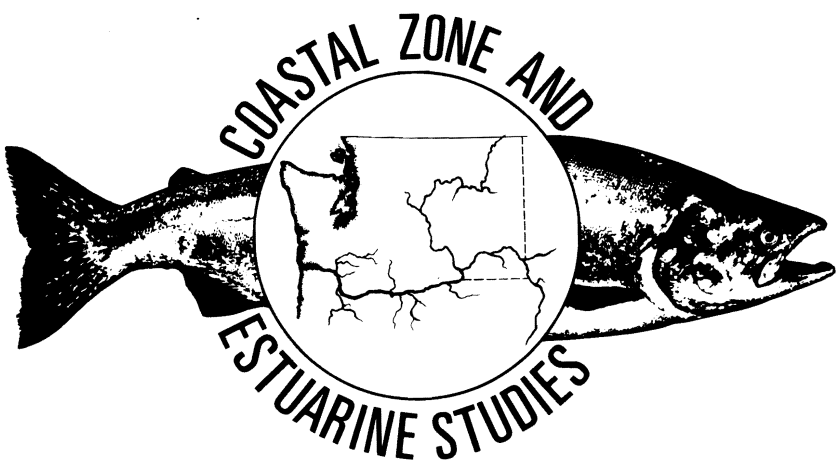

STUDIES TO EVALUATE ALTERNATIVE METHODS OF BYPASSING JUVENILE FISH AT THE DALLES DAM - 1985

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INTRODUCTION

At the present time, juvenile salmonids passing The Dalles Dam on their downstream migration must pass through the turbines or be bypassed by means of the ice and trash sluiceway or spillway. During periods of no spill, Nichols (1979) estimated that passage through the sluiceway was about 40 to 60%. To increase the overall percent passage, a fingerling bypass system similar to that being used at other U.S. Army Corps of Engineers (CofE) projects has been proposed. These systems consist of submersible traveling screens (STS) in the turbine intakes, vertical barrier screens and orifices in the gatewells, and a bypass channel (Fig. 1). In 1985, tests were conducted at The Dalles Dam to determine the benefits of this type of system.

Data from previous studies conducted by the Oregon Department of Fish and Wildlife (ODFW) indicated fewer yearling fish were usually found in the gatewells at the upstream end of the powerhouse at The Dalles Dam than at the downstream end (Fig. 2) (Nichols 1979). The data on subyearling chinook salmon, however, were insufficient to ascertain their distribution across the powerhouse. If the data for yearling fish could be verified and the same distribution was true for subyearlings, it might be possible to provide adequate protection for downstream migrants by installing screen systems in only a portion of the 22 turbine units.

In 1985, the National Marine Fisheries Service conducted a series of fish distribution and fish guiding efficiency tests to determine: (1) the benefits of an STS-type fingerling bypass system for The Dalles Dam and (2) if the system would need to be installed in all 22 turbine units or if installation in selected units would provide adequate protection. Vertical distribution and FGE studies were conducted to determine actual and potential fish guiding efficiencies (FGE) of an STS system. The vertical distribution studies would

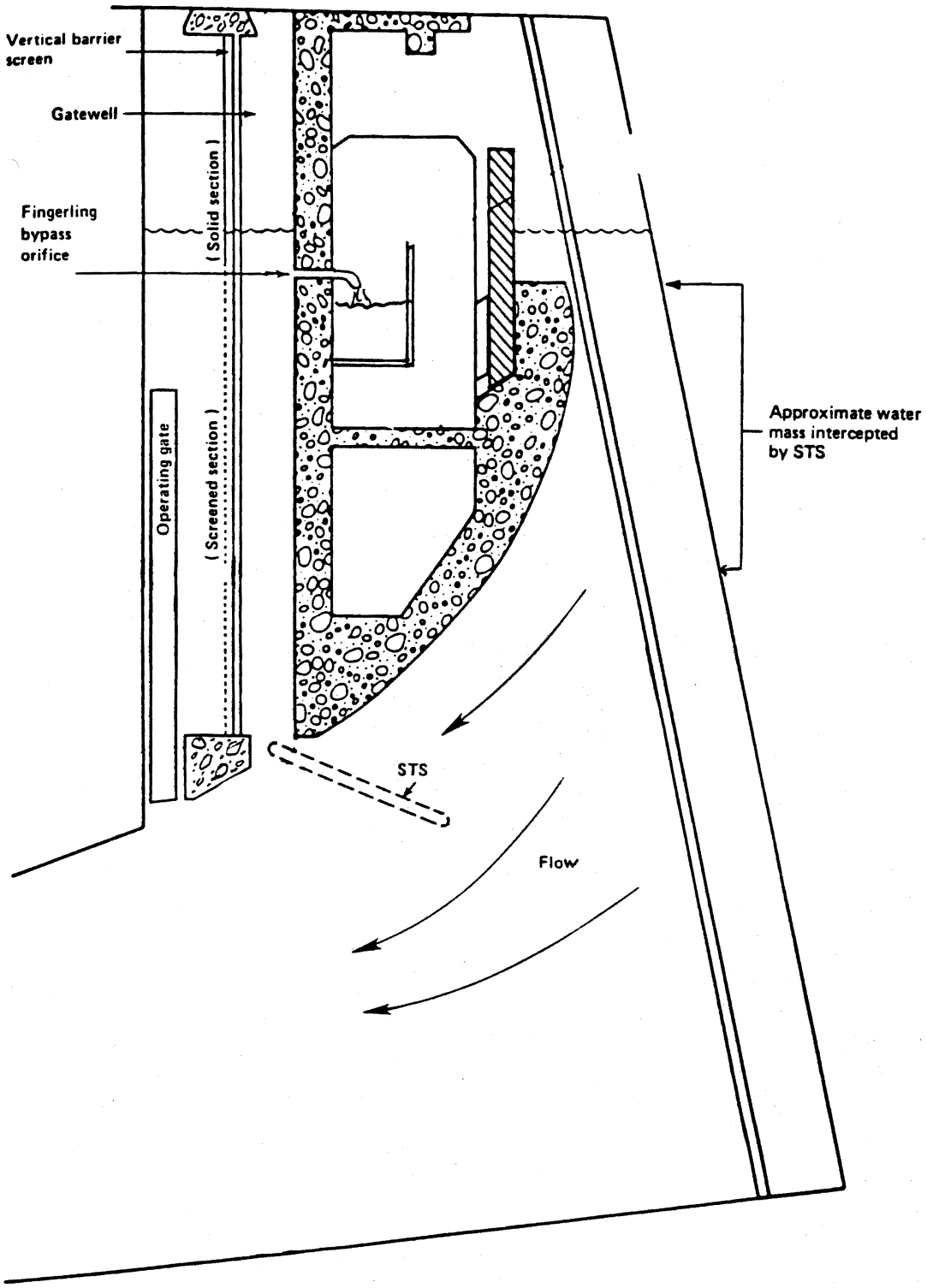


Figure 1.--Transverse section through a typical turbine unit.

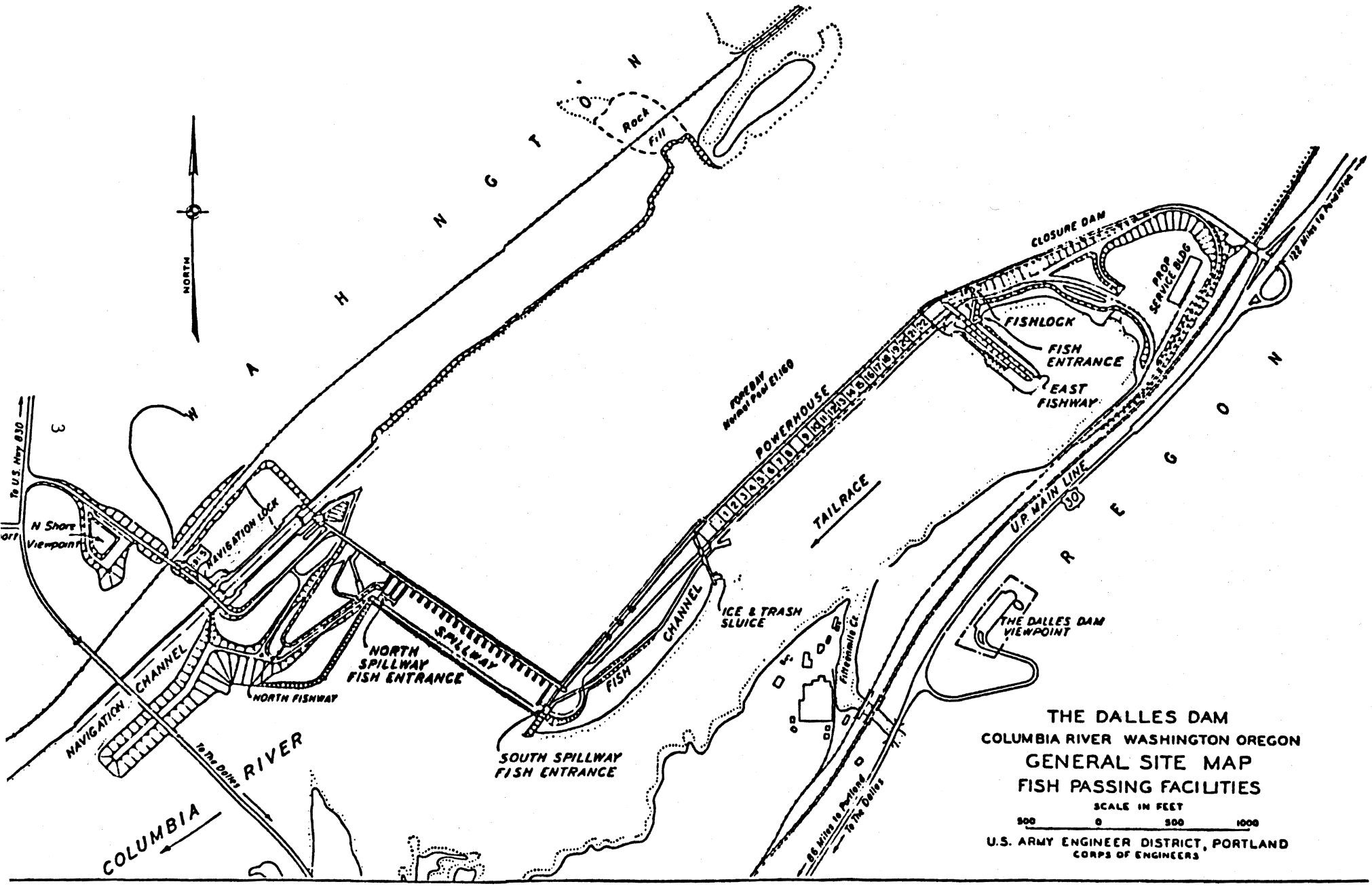


Figure 2.--Over view of The Dalles Dam showing the position and numbering sequence of the turbine units.

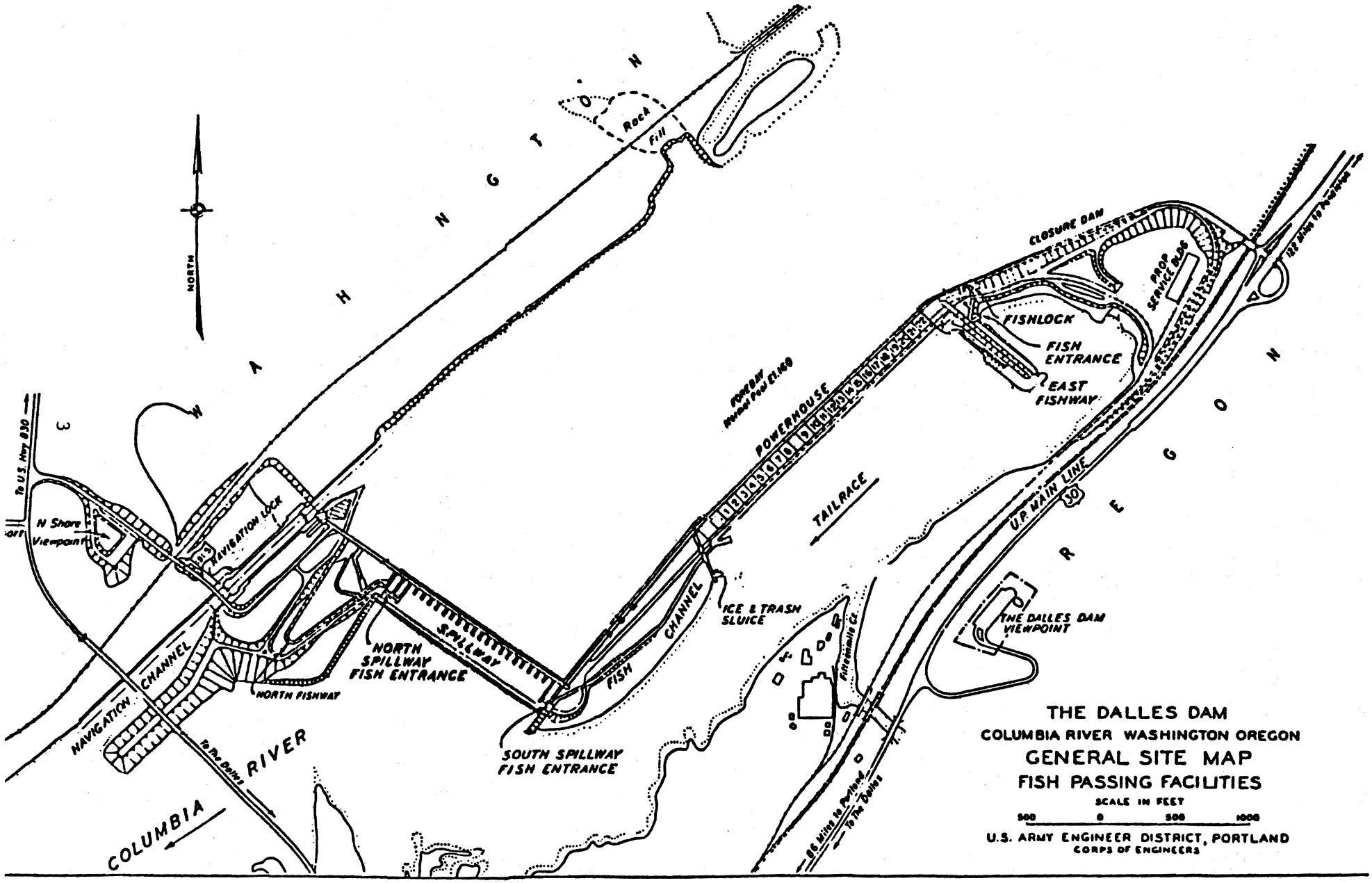


Figure 2.--Over view of The Dalles Dam showing the position and numbering sequence of the turbine units.

also help determine if there were actually less fish passing through parts of the powerhouse as other studies have indicated or if the fish were simply deeper in the water column which could give that impression. Horizontal distribution tests were conducted on subyearling chinook salmon to supplement the limited data obtained by Nichols (1979).

APPROACH

The FGE testing was conducted in only one unit (Unit 2-2)[1/], and vertical distribution testing was done in 3 of the 22 units (2-2, 12-2, and 18-2). Tests were conducted with and without sluiceway/spill operations to determine their effect on FGE. The tests were done in two phases: Phase I, 8 April to 6 June, on yearling fish and Phase II, 18 to 24 July, on subyearlings. Horizontal distribution was obtained on subyearlings from Units 1-2, 3-2, 6-2, 9-2, 13-2, 16-2, and 22-2 from 9 July through 15 August.

VERTICAL DISTRIBUTION

Methods

Procedures for conducting vertical distribution tests were similar to those conducted at other projects (Krcma et al. 1984). Rows of fyke nets supported by a metal frame provided the means to obtain fish samples at different depths in the turbine intake. Each individual fyke net was 6.0 x 6.5 feet at the mouth, 15 feet long, and tapered to an 8-inch wide throat to which a 3-foot cod-end bag was attached. The first three rows contained a full complement of three nets so the entire width of the intake was fished;

[1/] Each turbine unit consists of three intake sections and gatewells labeled 1, 2, and 3 left to right facing upstream.

the lower four rows contained only a middle net so the individual net catch was expanded (3x) to obtain an estimated total catch at these depths (Fig. 3).

Tests usually began at sunset (1800-2000 h) and ran from 1 to 3 h. During testing, the load on the test unit was maintained at approximately 80 MW, with an average discharge ranging from 15.2 to 16.0 kcfs. Before the start of each test, the orifice was closed and fish were removed by means of a dip basket (Swan et al. 1979). During the test, fish were removed periodically from the gatewell to determine when sufficient numbers had accumulated for statistical evaluation. To terminate the test, the unit was shut down, and all remaining fish were removed from the gatewell. The intake catch (total number in fyke nets) plus gatewell catch equalled total catch. Vertical distribution was calculated by the percentage of the total catch in the gatewell and in each of the fyke net levels.

Normally, during periods of downstream fish migration at The Dalles Dam, the three skimmer gates in front of Unit 1 are lowered during daylight hours (usually 16 h per day), allowing fish to pass through the sluiceway (CofE 1985). During the tests to measure sluiceway influence on vertical distribution, these gates were kept open until the tests were completed (2000 to 2200 h). Daytime spill was usually provided during these periods to further enhance smolt survival and consisted of releasing approximately 20% of total project discharge through the spillway during the spill hours of 1000 to 2000 h.

Vertical distribution tests were conducted in Units 2 and 12 both with and without operations of the sluiceway/spill and in Unit 18 without a sluiceway/spill operation.

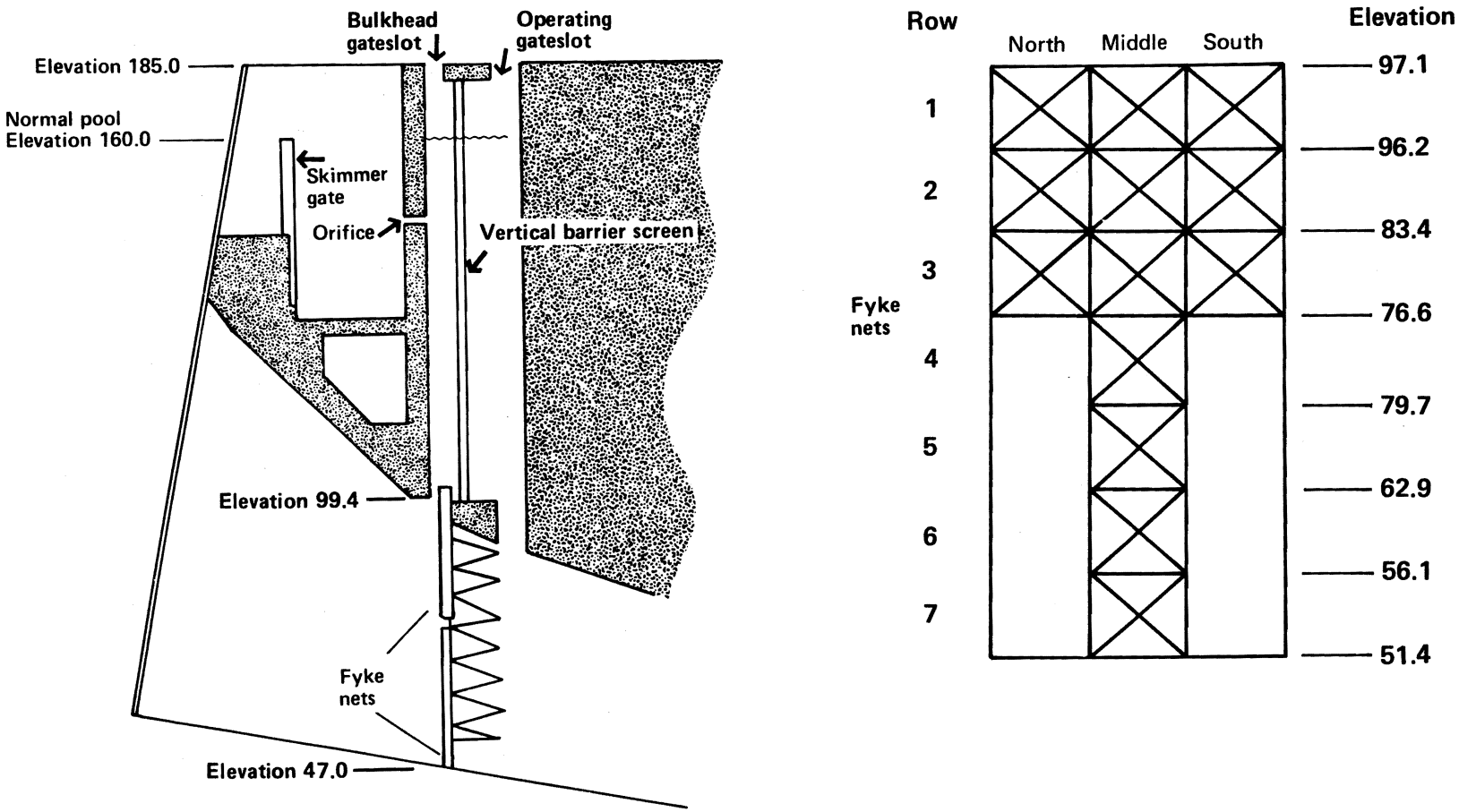


Figure 3.--Transverse section through a typical turbine intake at The Dalles Dam showing the layout and elevations of the nets on the vertical distribution frame.

The statistics used to establish the number of replicates and number of fish per replicate are given in Appendix A. Three to six replicates were required to establish 95% confidence limit estimates of the percentage of fish in each depth stratum for each test condition. Confidence intervals (CI) for each test condition were defined as:

$$P \pm t\ (1- /_2,\ k-1)s\ /\sqrt{k}$$

where: a = probability of Type I error

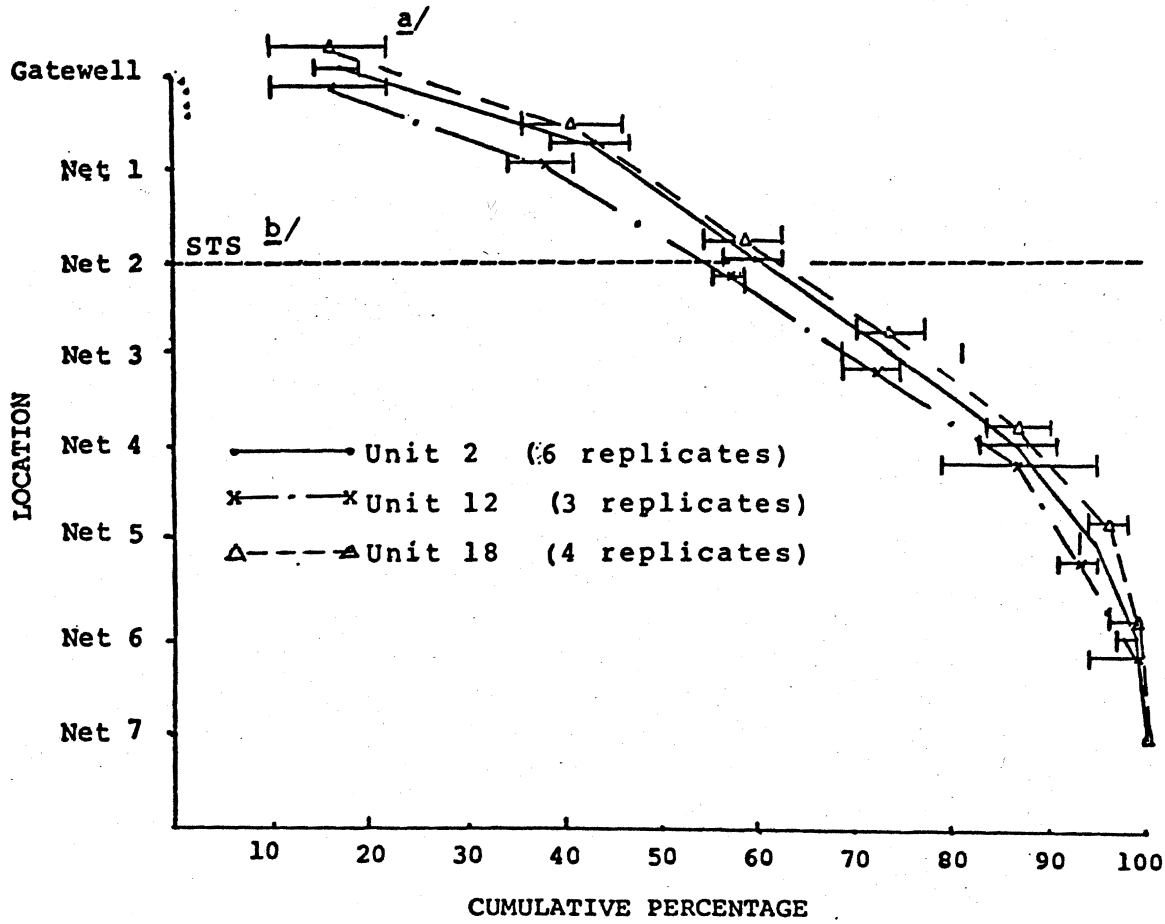
k = number of replicates

s = standard deviation among replicates.

Fish caught in the gatewell plus the fish from Net Levels 1 and 2 were considered to be in the range interceptable by the STS. Therefore, the cumulative percentages to Net 2 probably represent the maximum guidance potential for the STS operating at 100% efficiency. A statistical analysis of the vertical distribution data was made using contingency tables and the log-likelihood G-test (Sokal and Rohlf 1981).

Results

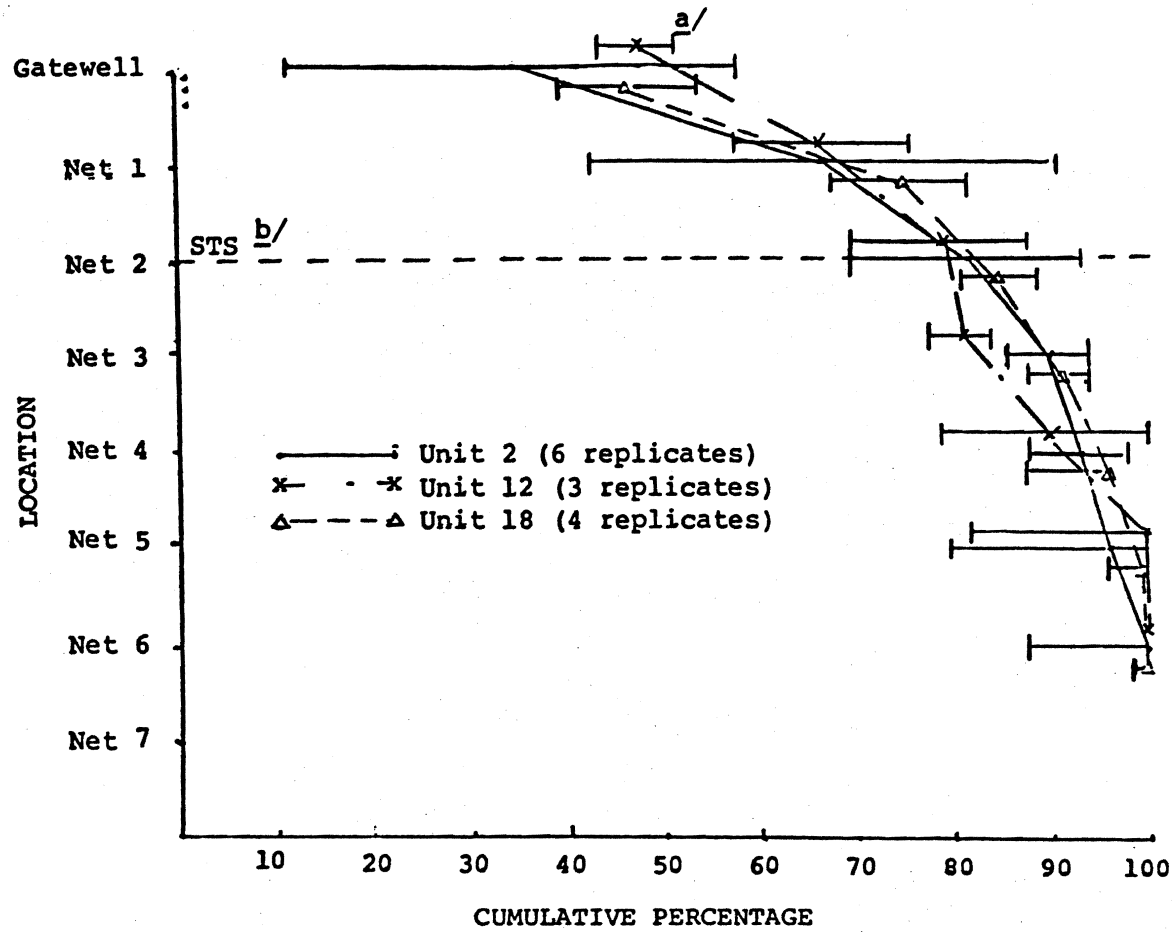
Between 8 April and 18 July, 26 vertical distribution tests were conducted. Figures 4 and 5 show the vertical distribution for yearling chinook salmon and steelhead for the three units tested. There were no significant differences in distribution between the three units for yearling chinook salmon or steelhead under a no sluiceway/spill operation (G = 4.79 and 1.81, respectively). Under normal sluiceway/spill operations (spill from 1000 to 2000 h and skimmer gates in Unit 1 open from daylight to the end of the test), there again were no significant differences in vertical distribution



a/ Starting points for curves were staggered vertically so that confidence intervals could be included.

b/ Approximate lowest point of intercept with STS.

Figure 4.--Vertical distribution curves for yearling chinook salmon in Units 2, 12, and 18 without sluiceway/spill operation, The Dalles Dam, 1985. ├──┤ symbol represents 95% confidence intervals.



a/ Starting points for curves were stagered vertically so that confidence intervals could be included.

b/ Approximate lowest point of intercept with STS.

Figure 5.--Vertical distribution curves for steelhead in Units 2, 12, and 18 without sluiceway/spill operation, The Dalles Dam, 1985. |——| symbol represents 95% confidence intervals.

between the three units (G = 0.001 for yearling chinook salmon and G = 2.00 for steelhead). The cumulative percentages and standard deviations for each net level are shown in Appendix Tables B1, B2, and B3 (Units 2, 12, and 18, respectively). Since there were no significant differences in vertical distribution between three units for the target species, the cumulative numbers at each net level were combined to give an estimated vertical distribution for the entire powerhouse (Table 1).

As stated previously, the cumulative percentages at Net 2 were considered to be the maximum guiding potential for the STS. Normally a 75 to 85% accumulation at this level is needed to obtain an acceptable FGE of 70%. Of the four species tested, only steelhead were concentrated enough in the upper levels of the intake to meet this criteria.

Sockeye salmon were distributed deeper than either yearling chinook salmon or steelhead (Table 1). The potential guidance for sockeye salmon was only 57.0% compared with 66.8% for yearling chinook salmon and 83.4% for steelhead. A deeper distribution of sockeye salmon was also noted in vertical distribution and FGE tests at Bonneville, John Day, and McNary Dams.

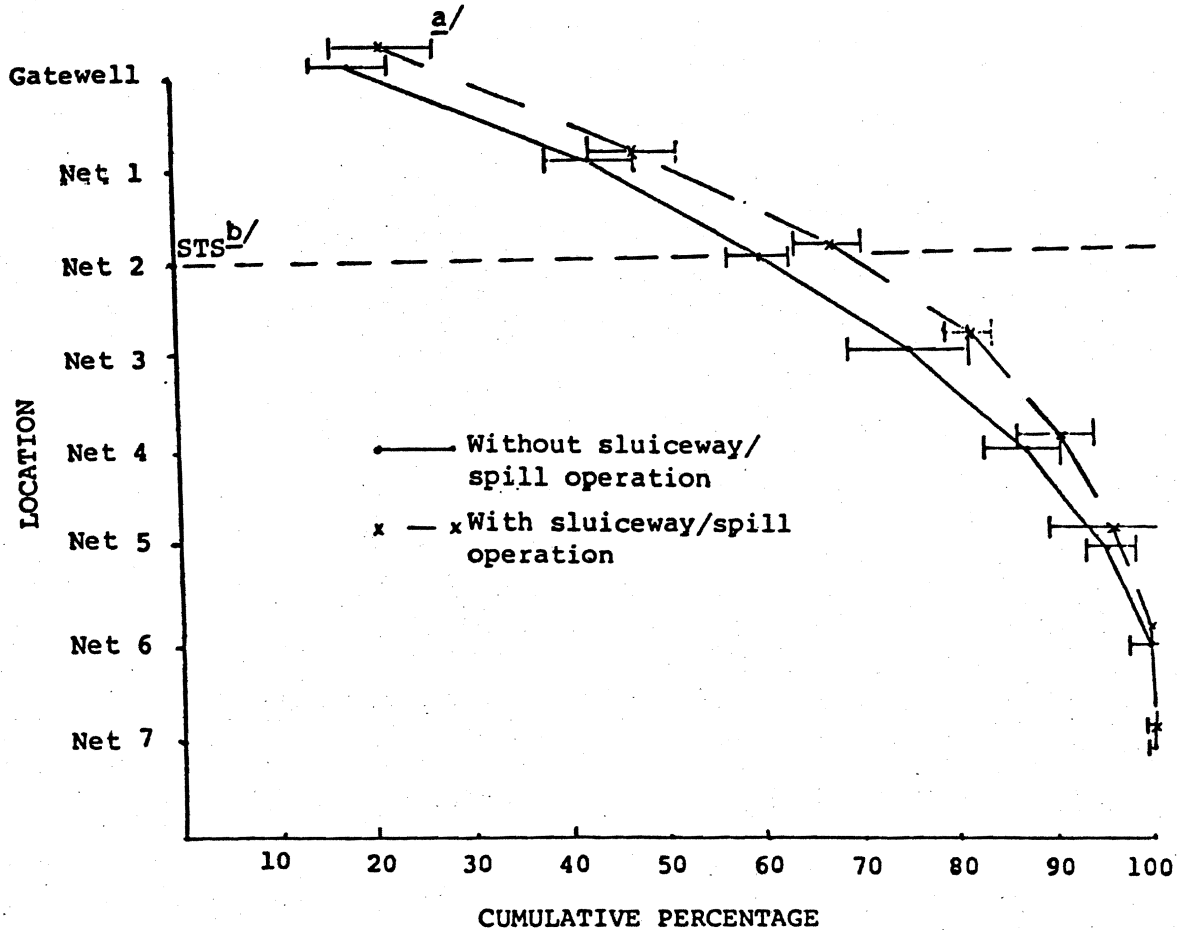
Subyearling chinook salmon were traveling much deeper in the turbine intake during Phase II testing (16-18 July) than salmonids tested earlier during Phase I. Only about 22% were potentially available for interception by the STS. This situation was not confined to The Dalles Dam. Similar depth distributions reported at John Day and Bonneville Dams indicated subyearling chinook salmon were running deeper at various locations in 1985. There is speculation that fish were swimming deeper, seeking cooler water because of record high water temperatures (74°F) occurring during July 1985.

Figures 6 and 7 show comparisons of vertical distribution (cumulative percentages) in Unit 2 between tests conducted with and without

Table 1.—Vertical distribution (cumulative percentages) and the standard deviations (SD) by species at The Dalles Dam in 1985 showing theoretical level where fish could be intercepted by the STS (data combined from Units 2, 12, and 18).

Location	Yearling chinook				Subyearling chinook		Sockeye		Steelhead			
	Cond. 1[a]		Cond. 2[a]		Cond. 1[a]		Cond. 2[a]		Cond. 1[a]		Cond. 2[a]	
	%	SD	%	SD	%	SD	%	SD	%	SD	%	SD
Gatewell	17.0	0.7	20.7	1.3	3.8	1.2	14.7	8.3	44.6	6.0	42.5	0.3
Net 1	41.3	1.8	47.0	2.5	9.2	1.8	34.5	7.1	72.8	5.7	67.9	2.9
Net 2[b]	59.1	0.9	66.8	5.0	22.2	1.3	57.2	7.4	84.2	2.0	83.4	0.4
Net 3	74.1	0.4	81.5	3.8	44.1	2.3	77.3	4.9	90.0	2.6	93.1	3.7
Net 4	87.0	1.0	90.3	15.9	70.1	2.1	92.4	11.1	95.0	2.5	95.9	1.6
Net 5	94.2	1.0	95.2	14.6	88.1	1.6	97.8	7.1	98.5	3.0	97.6	1.0
Net 6	99.0	1.2	98.4	7.6	98.2	1.8	100.0	3.5	100.0	1.4	99.7	1.9
Net 7	100.0	0.3	100.0	3.2	100.0	0.3	100.0	0.0	100.0	0.0	100.0	0.2

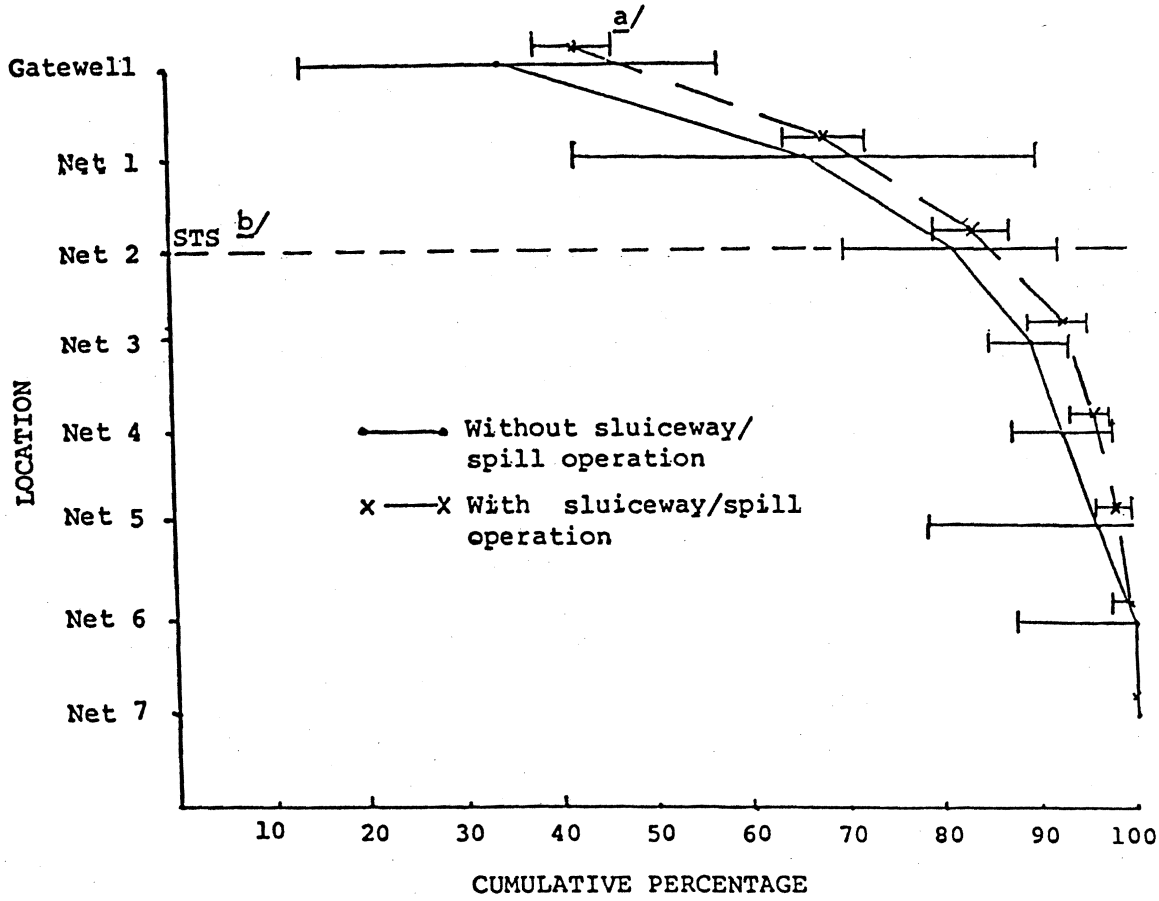
a/ Condition 1 = without sluiceway/spill; and Condition 2 = with sluiceway/spill.
b/ Theoretical level where fish could be intercepted by the STS.



a/ Starting point for the curves were staggered vertically so that confidence intervals could be included.

b/ Approximate lowest point of intercept with STS.

Figure 6.--Vertical distribution curves for yearling chinook salmon in Unit 2 with and without sluiceway/spill, The Dalles Dam, 1985. ├──┤ symbol represents 95% confidence intervals.



a/ Starting point for the curves were staggered vertically so that confidence intervals could be included.

b/ Approximate lowest point of intercept with STS.

Figure 7.--Vertical distribution curves for steelhead in Unit 2 with and without sluiceway/spill conditions, The Dalles Dam, 1985. |——| symbol represents 95% confidence intervals.

sluiceway/spill operation for yearling chinook salmon and steelhead, respectively. These comparisons showed that yearling chinook salmon were significantly higher in the intake during sluiceway/spill operations (G = 26.7), whereas no significant differences were found for steelhead (G = 1.0).

The fact that vertical distribution across the powerhouse was consistent (either with or without sluiceway/spill) lends credence to the ODFW data (based on gatewell catches) that a much higher proportion of the yearling chinook salmon and steelhead migration passes through the downstream end of the powerhouse. If, on the other hand, vertical distribution data had shown that fish were more surface oriented at the downstream end of the powerhouse, then the fish collected in the gatewells by ODFW were not representative of the actual fish distribution across the powerhouse.

FISH GUIDING EFFICIENCY TESTS

Methods

The methods for determining FGE were similar to those used in previous studies of this type (Krcma et al. 1985). Figure 8 shows the position of the STS in operation with the various nets attached. A gap net collected fish that escaped over the top of the STS back into the turbine intake. The closure net (large fyke net) collected fish from the area between the STS and the top of the fyke net frame created when the STS is extended into fishing position. In most tests, two closure nets were needed to cover this entire area.

As in the vertical distribution tests, the fish were removed from the gatewell, counted, and the test ended when sufficient numbers were collected

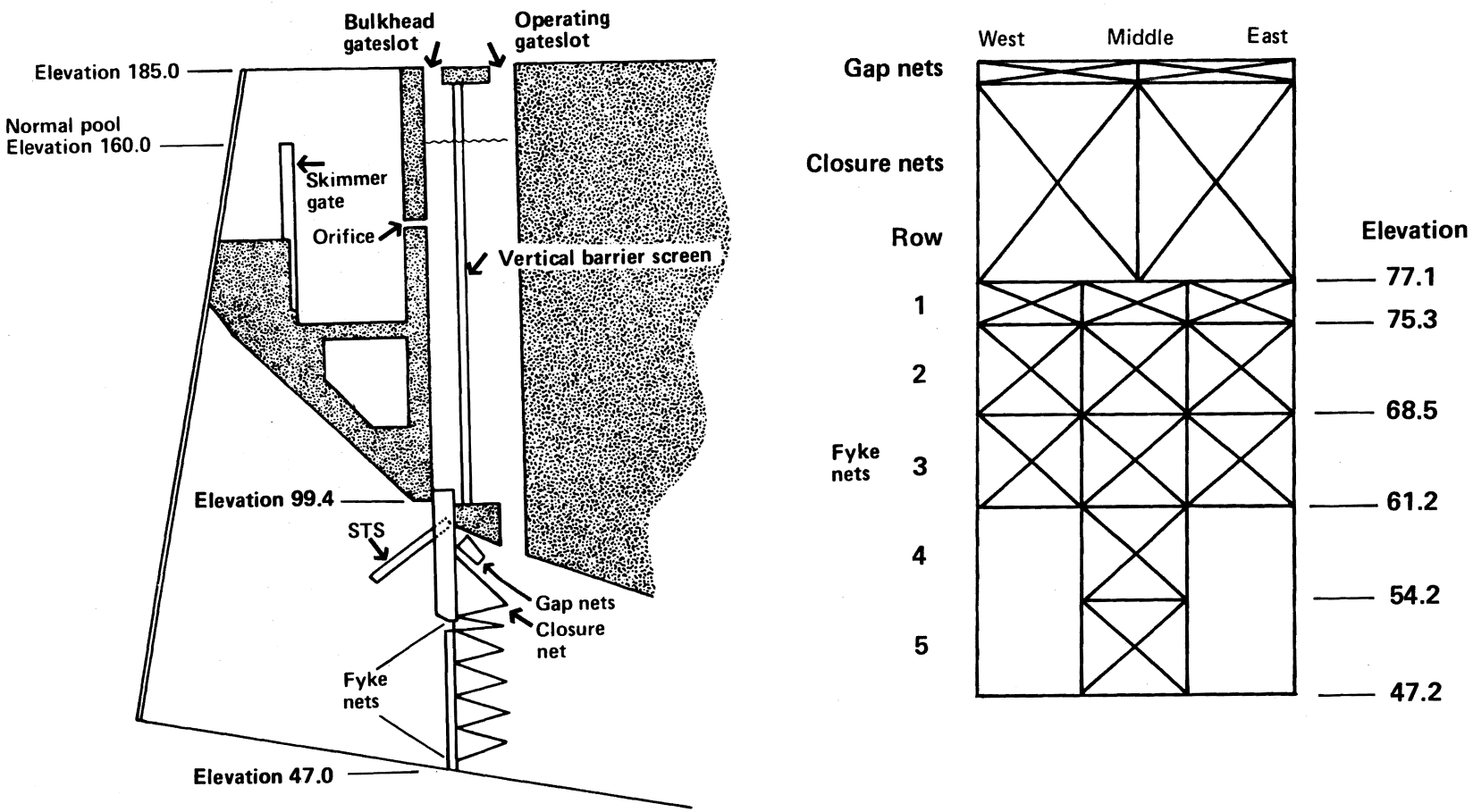


Figure 8.--Transverse section through a typical turbine intake at The Dalles Dam showing the STS and the layout and elevations of the fyke nets used for FGE testing.

for statistical evaluation (Appendix A). Gatewell dipnet catches provided the number of guided fish; catches from the gap and fyke nets attached to the STS provided 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:

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

GW = gatewell catch
GN = gapnet catch
FN = fyke net catch (times 3 when fishing only the center one-third of a row)
CN = closure net catch (times 2 when fishing only one closure net)

Tests from 16 April to 3 May were conducted both with and without a sluiceway/spill condition. Tests from 5 to 6 June were conducted primarily to see if FGE for well smolted fish migrating from the upper river would be different than that measured earlier for predominantly hatchery fish from the Deschutes River.

FGE tests with subyearling chinook salmon were conducted only with a no sluiceway/spill condition. Testing during 19-21 July used a standard STS, and tests between 22-24 July used a modified STS. For the latter tests, the STS was lowered 30 inches deeper into the intake in an attempt to improve the low FGE that occurred for subyearling chinook salmon during the earlier tests.

Results

As expected from vertical distribution tests, FGE measurements on all species except steelhead were below the minimum acceptable level of 70% (Table 2). During the testing between 16 and 21 April with the sluiceway closed and no spill, FGE for yearling chinook salmon was only 43.5% (73.1% for steelhead). Also, as expected from vertical distribution tests (showing fish higher in the intake with sluiceway/spill operations), FGE tests between

Table 2.--Summary of FGE test results for a 53° angle STS showing the percent FGE and standard deviation (SD) for the various test condition - Unit 2, The Dalles Dam, 1985.

Species	Date	STS	Sluiceway operation	No. replicates	Total sample size	FGE (%)	SD	G
Subyearling chinook	05 to 06 Jun	STD	closed	2	404	46.3	4.5	
	19 to 21 Jul	STD	closed	3	10,733	8.4	0.5	380.1[b/]
	22 tot 24 Jul	MOD[a/]	closed	3	3,171	13.9	3.0	79.2[b/]
Yearling chinook	16 to 21 Apr	STD	closed	6	4,903	43.5	5.0	
	30 Apr to 03 May	STD	open	4	5,739	55.4	2.5	40.21[b/]
	05 to 06 Jun	STD	closed	2	551	56.1	4.0	0.05
Sockeye	30 Apr to 03 May	STD	open	4	590	41.9	3.1	
	05 to 06 Jun	STD	closed	2	372	38.4	5.6	1.11
Steelhead	16 to 21 Apr	STD	closed	6	1,134	73.1	5.0	
	30 Apr to 03 May	STD	open	4	360	79.4	4.2	6.26[c/]
	05 to 06 Jun	STD	closed	2	371	70.9	1.5	7.19[d/]

a/ Lowered 30 inches
b/ $P \leq 0.001$
c/ $0.05 \geq P < 0.01$
d/ $0.01 \geq P > 0.001$

30 April and 3 May with sluiceway/spill showed a significant increase for both yearling chinook salmon and steelhead to 55.4% (G = 40.2) and 79.4% (G = 62.6), respectively. To determine whether the sluiceway was the major reason for the increase or if it resulted because of racial differences (more upriver fish and less Deschutes River fish were in the population during the second test series), the no sluiceway/no spill test was repeated on 5 and 6 June. The FGE of 56.1% measured for yearling chinook salmon (nearly the same as the 55.4% measured for a sluiceway/spill on condition) indicated the low FGE obtained earlier was probably due to racial differences, and the sluiceway/spill operations actually had minimal effect on FGE. Conversely, the sluiceway/spill on condition did appear to influence FGE for steelhead. Tests conducted both early and late (16-21 April and 5-6 June) with the no sluiceway/spill condition resulted in lower FGEs than for tests conducted with an operating sluiceway/spill condition.

During tests on 5 and 6 June when water temperatures were about 60°F, the mean FGE (two replicates) for subyearling chinook salmon was 46.3%. However, during testing in July when water temperatures were 74°F, FGE dropped to only 8.4%. This dramatic reduction in FGE resulted because the fish were deeper in the turbine intake as shown by vertical distribution data obtained during this same period in July (Table 1). The higher 46% FGE for subyearling chinook salmon obtained in June, only moderately lower than the 56% measured for yearling chinook salmon during the same test, provides hope that acceptable FGE might be attained for subyearlings under more normal environmental conditions.

Test with the 30-inch lower STS significantly increased FGE from 8.4 to 13.9% (G = 79.2). The increase, while not much in total, was proportionately

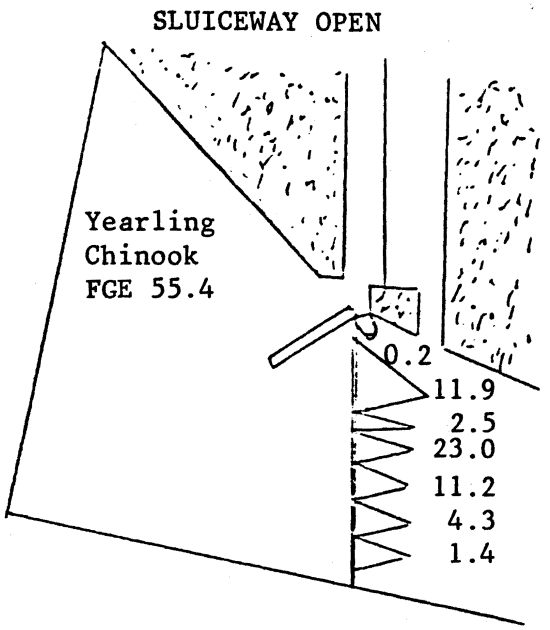
a 40% increase in FGE. What actual benefit might result from a lowered STS when fish are higher in the water column is not known, but even a 30% increase in FGE when FGE is closer to 50% would result in an acceptable 71% FGE.

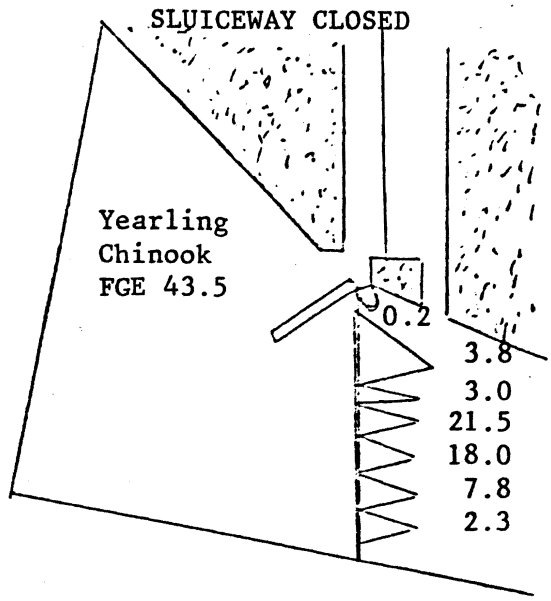
There was concern that an increased fish loss would occur through the larger gap opening at the top of the traveling screen with a lowered STS. In all tests, guided fish that escape through this gap are caught in the gap net. To determine the percentage of subyearling chinook salmon passing through the gap for the standard vs lowered STS test conditions, the total in the gap net was divided by the total guided fish (number in the gap net plus number in the gatewell). The resulting gap loss for both conditions was less for the lowered screen (0.4%) than the standard screen (0.77%). The average percent gap losses for other species during standard STS tests were also low, 0.2% for yearling chinook salmon, 0.6% for steelhead, and 0.5% for sockeye salmon. Figures 9 and 10 show the FGE and the distribution of the unguided fish for the various test conditions.

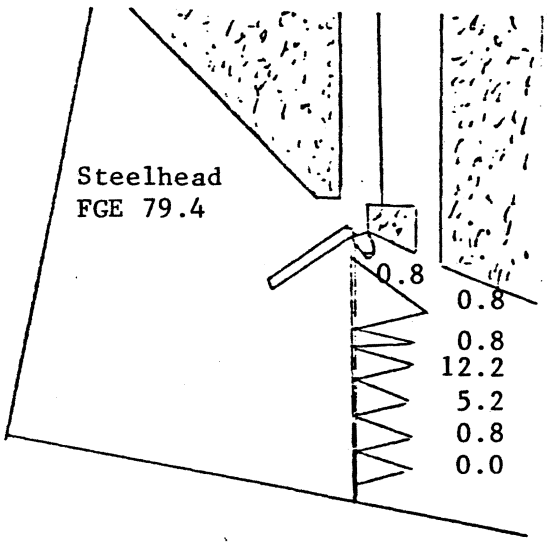
Fish Quality

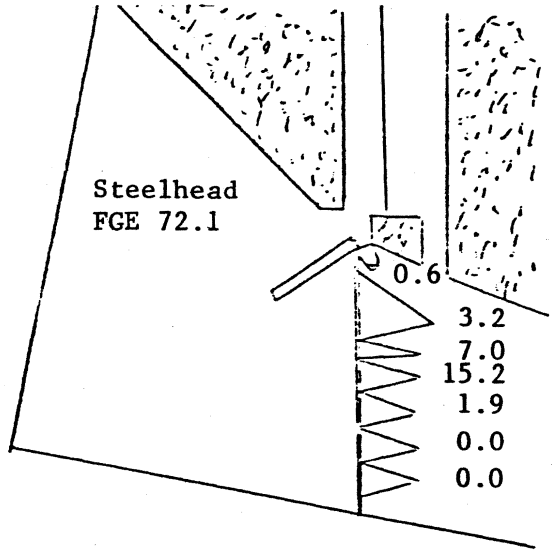
Live salmonids taken from the gatewell during the vertical distribution and FGE tests were examined for descaling. Fish classified as descaled are considered to have a poor chance of survival. It was felt that fish entering gatewells without an STS were representative of the quality of fish coming down the river and entering the bypass system. Therefore, a comparison between fish collected in the gatewell during vertical distribution tests and fish entering the gatewell during FGE tests would indicate if any damage was being done to the fish by the STS.

Descaling was determined by dividing an anesthetized fish into five equal areas per side; if any two areas on a side were 50% or more descaled, the fish









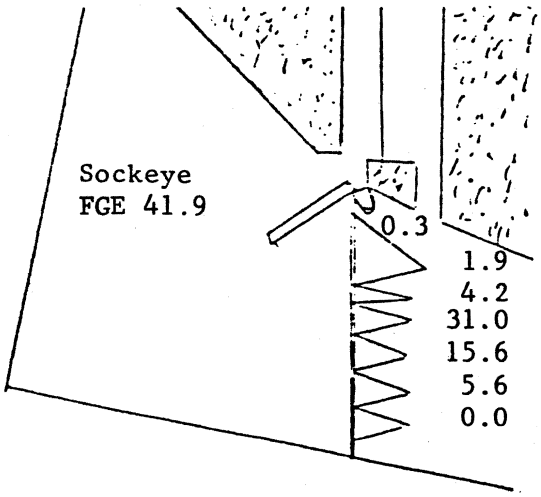


Figure 9 .--Results of STS tests at The Dalles Dam showing FGE and percentage of fish captured at various net levels for the sluiceway open vs sluiceway closed, 1985.

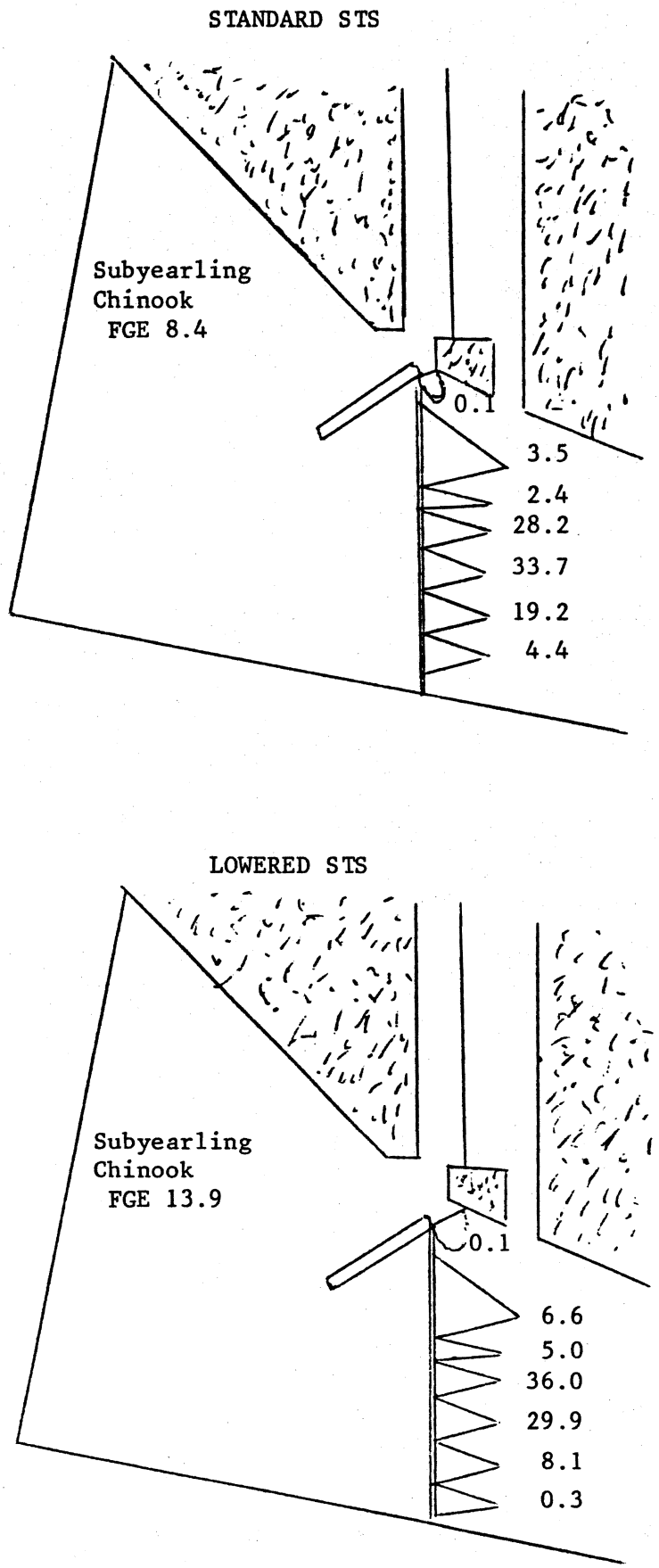


Figure 10.--Results of STS tests at The Dalles Dam showing FGE and percentage of fish captured at various net levels for the standard elevation STS vs the 30-inch lowered STS, 1985.

was classified as descaled. The log likelihood G-test was used to compare the percentage of descaled yearling chinook salmon and steelhead taken from Unit 2 with and without the STS.

The difference in descaling for yearling chinook salmon without an STS (1.9%) and with and STS (2.9%) was nonsignificant (G = 1.97). However for steelhead, the 2.3% increase in descaling with the STS in operation was significant (G = 5.28). The overall descaling rates for all species with the STS in operation, however, remained low ($\bar{x}$ = 2.6% with a range of 0.3 to 7.2%). Therefore, under the loads and discharges tested, use of the STS for fish guidance at The Dalles Dam does not appear to be unduly harmful or injurious to migrating juvenile salmonids. Appendix Table B8 gives descaling percentages for yearling chinook salmon, subyearling chinook salmon, sockeye salmon, and steelhead taken from the gatewells during both series of tests.

Length Frequency

Fork lengths were taken for fish from both the gatewell and fyke net catches to ascertain if there was a difference in the size composition between guided and unguided fish. These length frequency data were also used to differentiate between yearling and subyearling chinook salmon to determine the percent composition of the two races in the river.

Figure 11 shows the mean fork lengths and standard deviations for yearling and subyearling chinook salmon and steelhead taken from the gatewell and fyke net catches. In three out of five comparisons, the mean fork length of yearling chinook salmon from the gatewell catch was less than that from the fyke nets and was significantly less (at 95% confidence levels) in two cases (see Appendix Table B9). The difference could be the result of a decreased swimming ability in the smaller fish, making them more susceptible to the

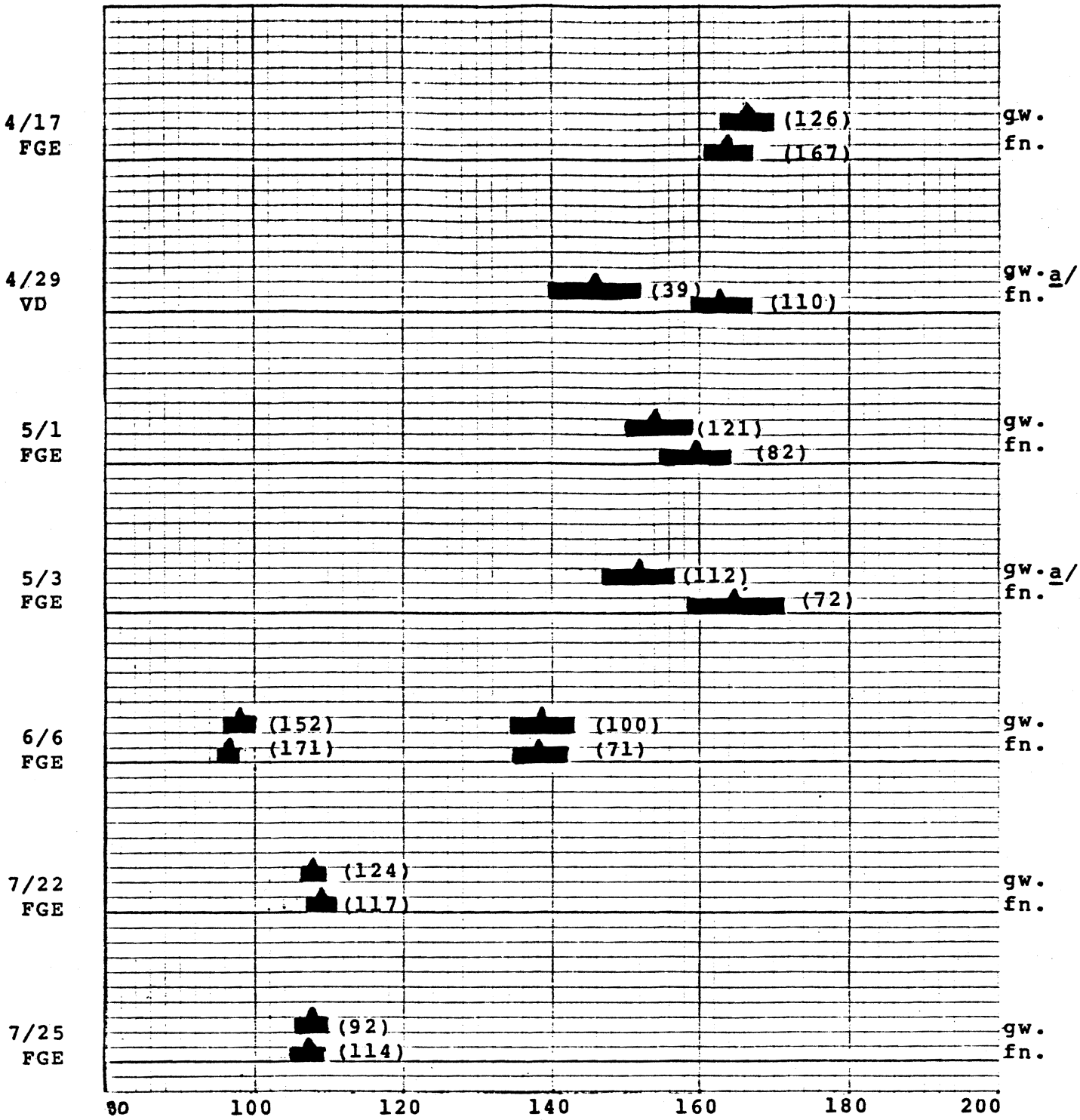


Figure 11.--Length frequencies comparing gatewell (gw.) and fyke net (fn.) catches for vertical distribution (VD) and FGE tests for subyearling (< 120mm) and yearling (> 120mm) chinook salmon at The Dalles Dam, 1985. The sample mean is shown by the small triangle, the black bar represents two standard errors to each side of the mean ($\pm$ 2$S\bar{y}$). Sample size is in parenthesis.

a/ Significant at 95% confidence limits.

deflecting flows of the STS, or caused by two subpopulations in the river, one being slightly higher in the water column. There were no significant size differences between the gatewell and fyke net catches of subyearling chinook salmon or steelhead.

HORIZONTAL DISTRIBUTION

Methods

To provide additional information on the horizontal distribution of subyearling chinook salmon, we intended to sample the center gatewell slot of every other unit across the powerhouse. However, because of lack of water, there was only partial powerhouse operation during the July and August study period. Also, a hydroacoustics study was in progress which required a special powerhouse operation. Therefore, after the first week, it was necessary to modify our sampling scheme to parallel the hydroacoustic schedule (Units 1, 3, 6, 9, 13, 16, and 22). Figure 12 shows the average percentage of time turbines were operated during the horizontal distribution study.

Since units at the Dalles Dam have small orifices (6 inches in diameter) from the gatewell to the ice and trash sluiceway and also lack vertical barrier screens, it was assumed that the level of orifice passage would be low enough to allow sampling without closing orifices. This was done to: (1) decrease project impacts--since closing orifices would require removing the upstream deck lid of each slot sampled; (2) reduce the amount of fish to be handled, while still providing enough fish for a relative comparison; and (3) provide information on fish accumulation in a gatewell with an operating orifice.

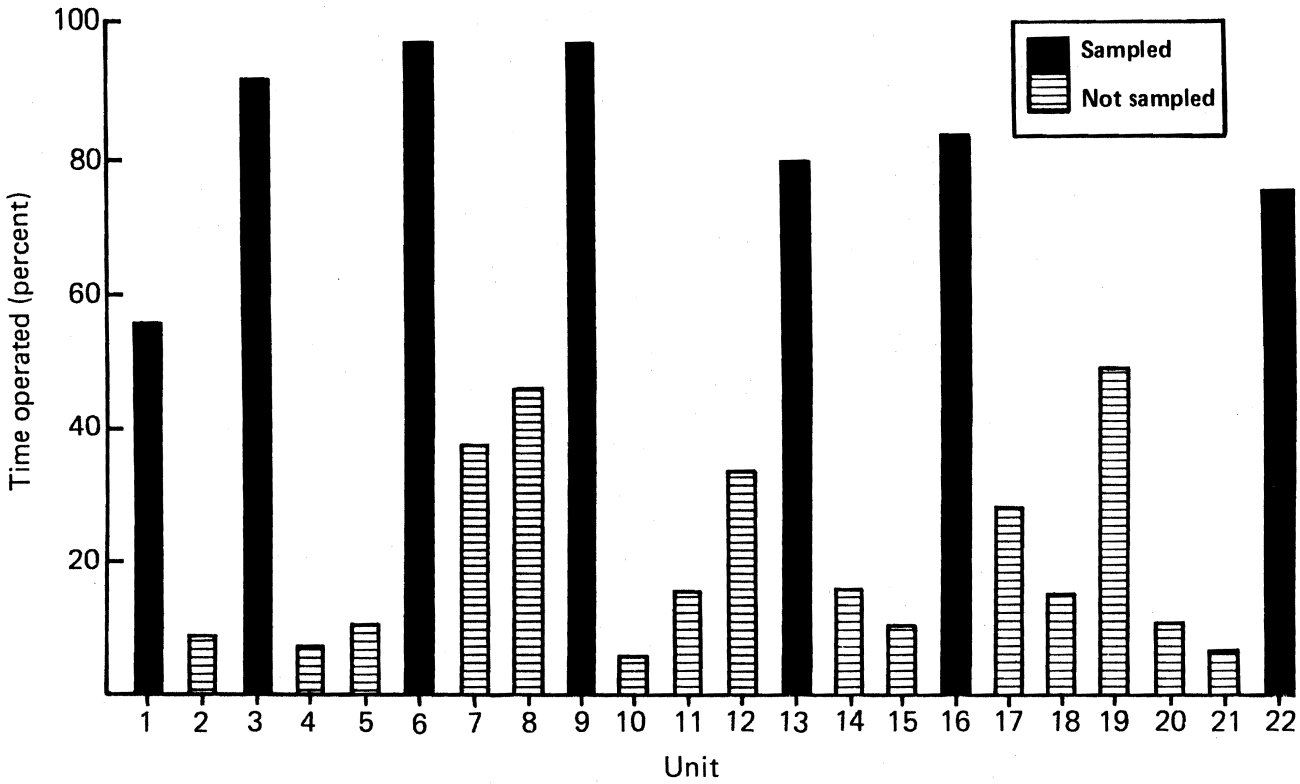


Figure 12.--Average percent time of operation of units during sampling periods (sample days plus 2 prior days) during the horizontal distribution study at The Dalles Dam, 1985.

The center slot of each monitored unit was sampled at least twice a week (consecutive days) with a dipnet similar to the one used at John Day Dam for fish salvage (Brege et al. 1986). Fish were anesthetized with MS-222, enumerated by species, a subsample measured, allowed to recover in fresh water, and released into the ice and trash sluiceway.

While conducting horizontal distribution studies, information pertaining to orifice passage efficiency was also obtained by comparing dip net catch data. This was not one of the study objectives, but is presented here as a matter of information. The first dipnet effort each week represented the accumulation of salmonids since the prior week's dipnet effort. The first day of the week's catch represented 1 to 8 days accumulation, depending on unit operation. The following day's dipnet effort represented a 1-day accumulation. If 24-h orifice passage approached 100%, then catches would be approximately equal between days.

Results

Sampling began on 9 July (16 July for hydroacoustic monitored units) and ended on 15 August. During this period, the sluiceway was operated every day from approximately 0500 to 2100 h with no spill after 10 July. Although sluiceway/spill operations were fairly constant during the study period, unit operation was not. When a turbine unit is turned off, it not only ceases attracting fish, it also allows accumulated fish in the gatewells to more readily exit the orifices as well as exit the gatewell entrance. Thus, data collected from any unit not operating for the entire 24-h period prior to dipnetting are of little value.

Daily catches of subyearling chinook salmon are shown in Table 3. Catches of other salmonids species were very small. Daily catches of

Table 3.--Numbers of subyearling chinook salmon captured in the horizontal distribution study at The Dalles Dam during 1985. All catches are shown regardless of unit operation.

Date	Unit 1	3	6	9	13	16	22
09 Jul	-	334	-	-	85	-	-
10 Jul	-	147	-	-	120	-	-
16 Jul	-	796	819	477	237	131	44
17 Jul	-	356	479	38	332	165	43
25 Jul	420	699	1,362	550	735	310	226
26 Jul	4	68	87	46	14	22	2
31 Jul	41	74	158	193	267	100	0
01 Aug	2	123	201	138	178	16	43
07 Aug	7	304	263	115	84	14	20
08 Aug	0	35	21	11	2	12	4
09 Aug	34	73	21	13	36	23	-
14 Aug	15	49	64	33	-	16	0
15 Aug	9	17	17	15	10	10	7

subyearling chinook salmon from units operating at least 24 h prior to dipnetting are shown in Table 4. As can be seen, approximately 40% of the data collected had to be eliminated because of unit operation. This made it difficult to determine the horizontal distribution of subyearling chinook salmon, particularly because of the lack of data from the upstream end of the powerhouse. Unit 22 was operated continuously for 24 h prior to dipnetting on only one occasion and that was on the last day of sampling when few salmonids were available. On no occassion were all seven test units operated continuously. For this reason, no statistical evaluation was attempted. However, some trends in horizontal distribution of subyearling chinook salmon were evident. In general, fewer fish were found at the upstream end of the powerhouse; the largest numbers occurred in Units 3 and 6. This is probably influenced by powerhouse operation (Fig. 12).

If the number of turbine units typically operated at The Dalles Dam is similar to the summer 1985 operation, then future operations could be manipulated so that only screened units are operated at times when large numbers of subyearling chinook salmon are present. However, additional horizontal distribution studies should be repeated if only partial screening is implemented.

Information regarding orifice passage obtained during the horizontal distribution studies revealed there was some accumulation of salmonids in gatewells at The Dalles Dam. A total of 5,912 subyearling chinook salmon were captured on the first day of the week efforts and 1,594 on the second day efforts. The average ratio of first day catch to second day catch was 3.7:1 ranging up to 54:1. This accumulation is not surprising since the gatewells at The Dalles Dam have undersized orifices that are relatively inefficient,

Table 4.--Numbers of subyearling chinook salmon captured in the horizontal distribution study at The Dalles Dam during 1985. Only units which are operated a minimum of 24 h prior to dipnetting are shown.

Date	Unit 1	3	6	9	13	16	22
09 Jul	-	334	-	-	-	-	-
10 Jul	-	147	-	-	120	-	-
16 Jul	-	796	819	-	-	-	-
17 Jul	-	356	479	-	332	165	-
25 Jul	420	-	1,362	550	735	-	-
26 Jul	-	68	87	46	14	22	-
31 Jul	-	-	-	193	267	100	-
01 Aug	-	123	201	138	178	-	-
07 Aug	-	304	263	115	-	-	-
08 Aug	-	35	21	11	-	12	-
09 Aug	-	73	1	3	36	23	-
14 Aug	-	49	64	33	-	16	-
15 Aug	-	17	17	15	-	10	7

especially during sluiceway operation. This delay would result in increased fish loss if residual salmonids are inclined to follow the flow and return to the turbine intake.

SUMMARY AND CONCLUSIONS

In 1985, FGE, vertical distribution, and horizontal distribution studies were conducted at The Dalles Dam to determine what portion of the powerhouse would need to be screened for adequate protection of migrating smolts. Major findings were:

1. Vertical distribution did not vary significantly between Units 2, 12, and 18 regardless of sluiceway/spill operations. These data lend credence to earlier ODFW data that suggest that a much higher proportion of the yearling salmon and steelhead migration passes through the downstream end of the powerhouse.

2. Vertical distribution studies showed that 83% of the steelhead, 67% of the yearling chinook salmon, 57% of the sockeye salmon, and only 22% of the subyearling chinook salmon were high enough in the turbine intake for interception by the standard STS.

3. As expected from vertical distribution results, FGE measurements on all species except steelhead were below the minimum acceptable level of 70%.

4. Sluiceway operations did not adversely effect FGE.

5. Steelhead were more surface oriented when the sluiceway and spill were operating.

6. In June, FGE for subyearling chinook salmon was 46%. By mid-July, FGE was only 8.4%. Similar low FGEs were found in July for subyearling chinook salmon at Bonneville and John Day Dams indicating it was a river-wide

problem. Above average water temperatures (> 74°F) for this time of year may have caused these fish to migrate at greater depths, seeking cooler water.

7. Descaling for most species remained low (< 5%) throughout the season for all conditions tested.

8. Lowering the STS 30 inches deeper in the intake significantly increased FGE from 8.4 to 13.9% for subyearling chinook salmon without a significant loss over the top of the STS.

9. Low water and fluctuating unit operation made it difficult to obtain any meaningful measures of horizontal distribution. The data obtained indicated larger numbers of fish were in Units 3 and 6, with fewer at the upstream end of the powerhouse. This may have resulted because of higher loading of units at the downstream end of the powerhouse.

RECOMMENDATIONS

1. To reach the minimum level FGE (70%) at The Dalles Dam, standard STSs will probably have to be modified to intercept more flow.

2. The benefits of a lowered STS should be tested for yearling chinook salmon.

ACKNOWLEDGMENTS

We wish to express our appreciation to the Project Engineer at The Dalles Dam, Mr. John Thornton; the Chief of Maintenance, Mr. Richard Rife; and the Maintenance Superintendent, Mr. Bill Frickey for their cooperation and suggestions. We would also like to thank their respective staffs whose help made the project possible, and Mr. Ernie Dollarhide (gantry operator) and Mr. Michael Gibson (powerplant mechanic/rigger) who provided the daily assistance needed for getting the work accomplished in a safe and successful manner.

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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, ..., 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, α.

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

Test Data

Appendix Table B1.—Vertical distribution test results [numbers, percentages, and standard deviations (SD)] for yearling chinook salmon for the individual replicates in Units 2, 12, and 18 with and without sluiceway/spill operation – The Dalles Dam, 1985.

UNIT 2 – SLOT 2

	Without sluiceway/spill operation										With sluiceway/spill operation								
	Date								Cum.		Date							Cum.	
	4/8	4/9	4/10	4/11	4/12	4/13	Tot	%	%	SD	4/23	4/24	4/25	4/26	4/29	Tot	%	%	SD
Gatewell	19	21	27	130	230	222	649	17.6	17.6	3.3	35	33	42	26	40	176	20.7	20.7	4.6
Net 1	25	33	46	193	317	318	932	25.3	42.9	4.2	49	53	31	41	49	223	26.2	46.9	3.7
Net 2	14	10	33	126	230	221	634	17.2	60.1	3.1	43	32	27	41	28	171	20.1	67.0	3.5
Net 3	3	6	33	109	173	217	541	14.7	74.8	5.7	33	21	20	23	27	124	14.6	81.6	1.0
Net 4[a]	6	15	6	90	156	177	450	12.2	87.0	4.0	27	15	9	12	6	69	8.1	89.7	3.2
Net 5[a]	3	3	9	66	75	108	264	7.2	94.2	1.9	9	0	3	9	27	48	5.6	95.3	5.2
Net 6[a]	6	6	3	48	57	60	180	4.9	99.1	1.9	9	6	9	3	3	30	3.5	98.8	1.7
Net 7[a]	0	0	3	12	12	3	30	.8	100.0	.7	3	3	3	0	0	9	1.1	100.0	.9

UNIT 12 – SLOT 2

	Without sluiceway/spill operation							With sluiceway/spill operation							
	Date							Date						Cum.	
	4/14	4/15	4/16	TOT	%	%	SD	4/30	5/1	5/2	5/3	Tot	%	%	SD
Gatewell	72	146	38	256	16.6	16.6	2.7	6	34	22	15	77	20.9	20.9	3.6
Net 1	109	165	55	329	21.3	37.9	1.4	8	41	29	20	98	26.6	47.5	3.8
Net 2	96	142	55	293	19.0	56.9	0.2	7	26	24	14	71	19.3	66.8	0.6
Net 3	68	129	44	241	15.6	72.5	1.4	5	16	23	12	56	15.2	82.0	2.7
Net 4[a]	72	93	60	225	14.6	87.1	3.5	6	6	18	9	39	10.6	92.6	4.4
Net 5[a]	27	48	21	96	6.2	93.3	0.7	3	6	3	0	12	3.3	95.9	2.9
Net 6[a]	45	27	18	90	5.8	99.1	2.2	3	3	3	0	9	2.4	98.3	2.9

UNIT 18 – SLOT 2

	With sluiceway/spill operation							
	Date						Cum.	
	4/18	4/19	4/20	4/21	Tot	%	%	SD
Gatewell	82	54	17	23	176	16.0	16.0	3.6
Net 1	122	77	46	30	275	25.0	41.0	2.4
Net 2	89	63	30	15	197	17.9	58.9	2.5
Net 3	89	43	24	12	168	15.3	74.2	2.2
Net 4[a]	72	42	18	9	141	12.8	87.0	2.2
Net 5[a]	45	24	15	12	96	8.7	95.7	1.2
Net 6[a]	21	6	0	6	33	3.0	98.7	2.0
Net 7[a]	3	3		3	15	1.4	100.0	1.3

a/ Numbers at this level are catches from the middle net expanded x 3.

Appendix Table B2. --Vertical distribution test results [numbers, percentages, and standard deviations (SD) for steelhead for the individual replicates in Units 2, 12, and 18 with and without sluiceway/spill operation - The Dalles Dam, 1985.

UNIT 2 - SLOT 2

	Without sluiceway/spill operation										With sluiceway/spill operation								
	Date								Cum.		Date							Cum.	
	4/8	4/9	4/10	4/11	4/12	4/13	Tot	%	%	SD	4/23	4/24	4/25	4/26	4/29	Tot	%	%	SD
Gatewell	1	2	1	23	11	28	66	28.9	28.9	9.2	55	63	60	60	80	318	42.6	42.5	3.4
Net 1	0	1	6	32	14	11	64	28.1	57.0	9.7	40	43	44	32	36	195	26.1	68.7	3.6
Net 2	2	2	1	12	8	5	41	18.0	75.0	4.6	15	19	32	24	25	115	15.4	84.1	3.0
Net 3	1	2	4	5	3	6	21	9.2	84.2	1.6	12	15	10	17	11	65	8.7	92.8	2.2
Net 4[a]	3	0	3	3	0	3	12	5.3	89.5	2.2	3	3	9	3	6	24	3.2	96.0	1.3
Net 5[a]	0	6	3	0	6	0	15	6.6	96.1	6.7	3	3	3	3	3	15	2.0	98.0	0.2
Net 6[a]	0	0	3	0	0	6	9	3.9	100.0	4.8	0	3	3	0	6	12	1.6	99.6	1.3
Net 7[a]	0	0	0	0	0	0	0	0.0		0.0	0	3	0	0	0	3	0.4	100.0	0.8

UNIT 12 - SLOT 2

	Without sluiceway/spill operation							With sluiceway/spill operation							
	Date					Cum.		Date						Cum.	
	4/14	4/15	4/16	Tot	%	%	SD	4/30	5/1	5/2	5/3	Tot	%	%	SD
Gatewell	7	14	10	31	48.4	48.4	1.6	4	28	7	8	47	42.0	42.0	4.7
Net 1	2	8	2	12	18.8	67.2	7.0	0	13	5	5	23	20.5	62.5	6.3
Net 2	2	5	1	8	12.5	79.7	7.1	3	11	2	2	18	16.1	78.6	1.2
Net 3	0	0	1	1	1.6	81.3	2.3	0	15	2	1	18	16.1	94.7	5.8
Net 4[a]	3	3	0	6	9.4	90.7	8.7	0	0	0	0	0	0.0	94.7	0.0
Net 5[a]	0	0	6	6	9.4	100.0	14.1	0	0	0	0	0	0.0	94.7	0.0
Net 6[a]	0	0	0	0	0.0			0	6	0	0	6	5.4	100.0	3.8

UNIT 18 - SLOT 2

	With sluiceway/spill operation							
	Date						Cum.	
	4/18	4/19	4/20	4/21	Tot	%	%	SD
Gatewell	72	48	18	26	164	47.1	47.1	4.6
Net 1	50	28	12		100	28.7	75.8	4.4
Net 2	15	7	6		34	9.8	85.6	3.7
Net 3	12	3	3		20	5.7	91.3	1.9
Net 4[a]	12	0	0		18	5.2	96.5	5.1
Net 5[a]	6	3	0		9	2.6	99.1	1.7
Net 6[a]	3	0	0		3	0.9	100.0	0.8
Net 7[a]	0	0	0		0	0.0		0.0

a/ Numbers at this level are catches from the middle net expanded x 3.

Appendix Table B3.--Vertical distribution test results (number and percentages) for subyearling chinook salmon for the individual replicates in Units 2, 12, and 18 with and without sluiceway/spill operation - The Dalles Dam, 1985.[a]

UNIT 2 - SLOT 2

	Without sluiceway/spill operation									With sluiceway/spill operation							
	Date								Cum.	Date							Cum.
	4/8	4/9	4/10	4/11	4/12	4/13	Tot	%	%	4/23	4/24	4/25	4/26	4/29	Tot	%	%
Gatewell	2	6	25	6	10	1	50	26.6	26.6	1	0	4	5	5	15	46.9	46.9
Net 1	0	6	3	28	3	1	41	21.8	48.4	1	1	1	2	2	7	21.9	68.8
Net 2	5	11	21	8	3	2	50	26.6	75.0	3	1	0	0	0	4	12.5	81.3
Net 3	5	6	8	6	4	2	32	17.0	92.0	1	0	1	1	0	3	9.4	90.7
Net 4[b]	0	0	0	9	0	0	9	4.8	96.8	0	0	0	3	0	3	9.4	100.0
Net 5[b]	0	3	0	0	0	0	3	1.6	98.4	0	0	0	0	0	0	0.0	
Net 6[b]	0	0	0	3	0	0	3	1.6	100.0	0	0	0	0	0	0	0.0	
Net 7	0	0	0	0	0	0	0	0.0		0	0	0	0	0	0	0.0	

UNIT 12 - SLOT 2

	Without sluiceway/spill operation						With sluiceway/spill operation								
	Date					Cum.	Date							Cum.
	4/14	4/15	4/16	Tot	%	%	4/30	5/1	5/2	5/3	Tot	%	%
Gatewell	5	2	1	8	32.0	32.0	4	3	4	5	16	27.1	27.1
Net 1	1	1	1	3	12.8	44.8	4	0	3	7	14	23.7	50.8
Net 2	2	0	3	5	20.0	64.8	0	0	0	3	3	5.1	55.9
Net 3	0	0	0	0	0.0	64.8	1	0	1	0	2	3.4	59.3
Net 4[b]	0	0	6	6	24.0	88.8	6	3	3	6	18	30.5	89.8
Net 5[b]	0	3	0	3	12.0	100.0	0	0	0	6	6	10.2	100.0
Net 6	0	0	0	0	0.0		0	0	0	0	0	0.0	
Net 7	0	0	0	0	0.0		0	0	0	0	0	0.0	

UNIT 18 - SLOT 2

	With sluiceway/spill operation						
	Date						Cum.
	4/18	4/19	4/20	4/21	Tot	%	%
Gatewell	3	3	1	4	11	37.9	37.9
Net 1	1	0	0	4	5	17.2	55.1
Net 2	1	1	1	2	5	17.2	72.4
Net 3	1	0	2	2	5	17.2	89.7
Net 4[b]	0	0	3	0	3	10.3	100.0
Net 5[b]	0	0	0	0	0	0.0	
Net 6	0	0	0	0	0	0.0	
Net 7	0	0	0	0	0	0.0	

a/ These tests were conducted from 4/8 to 5/3 when yearling chinook salmon salmon were the target species. Because of the small sample sizes of subyearlings no statistical evaluations were made.

b/ Numbers at this level are catches from the middle net expanded x 3.

Appendix Table B4.—Vertical distribution test results [numbers, percentages, and standard deviations (SD)] for subyearling chinook salmon for the individual replicates in Units 2 and 12.

UNIT 2 - SLOT 2	Without sluiceway/spill operation							UNIT 12 - Slot 2	Without sluiceway/spill operation	
	Date					Cum.		Date		Cum.
	7/16	7/17	7/18	TOT	%	%		6/5	%	%
Gatewell	78	84	63	225	3.8	3.86	2.9	13	17.8	17.8
Net 1	117	120	81	318	5.4	9.2	4.6	14	19.2	37.0
Net 2	261	228	273	762	13.0	22.2	3.5	16	21.9	58.9
Net 3	372	354	561	1287	21.9	44.1	5.7	9	12.3	71.2
Net 4[a]	522	345	657	1524	26.0	70.1	5.3	9	12.3	83.5
Net 5[a]	384	237	435	1056	18.0	88.1	3.9	6	8.2	91.7
Net 6[a]	225	114	252	591	10.1	98.2	4.1	6	8.2	100.0
Net 7[a]	33	33	36	102	1.7	100.0	0.8	0	0.0	

a/ Numbers at this level are catches from the middle net expanded x 3.

Appendix Table B5. —Vertical distribution test results [numbers, percentages, and standard deviations (SD)] for sockeye salmon for the individual replicates in Units 2 and 12 - The Dalles Dam 1985.

UNIT 2 - SLOT 2	With sluiceway/spill operation						UNIT 12 - SLOT 2	With sluiceway/spill operation						
	Date				Cum.		Date						Cum.	
	4/26	4/29	Tot	%	%	SD[a]	4/30	5/1	5/2	5/3	Tot	%	%	SD
Gatewell	2	6	8	7.8	7.8		4	23	2	1	33	18.8	18.8	8.7
Net	1	19	20	19.6	27.4		1	22	9	3	35	19.9	38.7	7.3
Net 2	2	21	23	22.5	49.9		2	22	11	5	40	22.7	61.4	8.4
Net 3	3	15	18	17.6	67.5		3	28	4	3	38	21.6	83.0	4.5
Net 4[b]	3	21	24	23.5	91.0		3	15	0	0	18	10.2	93.2	9.7
Net 5[b]	0	6	6	5.9	96.9		0	6	0	3	9	5.1	98.3	8.2
Net 6[b]	0	3	3	2.9	100.0		0	0	3	0	3	1.7	100.0	4.1
Net 7	0	0	0	0.0			0	0	0	0	0	0.0		0.0

a/ Because of small sample sizes in Unit 2 tests, no statistical evaluation was conducted.
b/ Numbers at this level are catches from the middle net expanded x 3.

Appendix Table B6.—Numbers of fish (SC-subyearling chinook, YC-yearling chinook, ST-steelhead, CO-coho, SO-sockeye) collected in the individual replicates of STS FGE tests, Unit 2 — The Dalles Dam 1985.

	Date and (test condition)[a]														
	16 April (1)					17 April (1)					18 April (1)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	1	67	9			3	253	21			3	743	255		
Gap Net	1						2					3	1		
Closure Net	7	5					19					65	6		
Net 1		39	1			3	14	1				43	9		
Net 2	2	47	2			2	107	6			2	331	45		
Net 3		30	1			1	135	1				201	10		
Net 4[b]		12					60	6				81	9		
Net 5[b]							6					27	6		
Totals	11	200	13			9	596	35			5	1494	341		

	19 April (1)					20 April (1)					21 April (1)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	1	339	245			3	381	202		1	1	352	228		1
Gap Net			1				2	3				2	2		
Closure Net	1	33	9				35	5				34	10		
Net 1		34	11				22	7				28	22		
Net 2	2	200	48			2	206	35			1	170	48		
Net 3		171	15			2	196	13			5	132	6		
Net 4[b]		72	3				87	6				51			
Net 5[b]		27	3				18	3				21			
Totals	4	876	335			7	947	274		1	7	790	316		1

	30 April (2)					1 May (2)					2 May (2)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	7	119	104		52	4	127	80		59	4	105	33		63
Gap Net			2		1			1				1			1
Closure Net		5	1		2		2			2	1	5			2
Net 1	1	7	1		7		2	1		5	1	1			3
Net 2	2	42	16		33	2	55	12		49	4	58	2		48
Net 3	6	18	3		21	5	36	3		33	4	20	4		19
Net 4[b]		15	3		6		3			12	6	12			12
Net 5[b]		3					3					3			
Totals	16	209	130		122	11	228	97		160	20	205	39		148

Appendix Table B6.—cont.

	Date and (test condition)[a]														
	3 May (2)					5 June (1)					6 June (1)				
Location	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO	SC	YC	ST	CO	SO
Gatewell	4	112	69		73	35	73	149	18	89	152	100	114	7	54
Gap Net		1						1		1			1		
Closure Net		4	2		5	3	7	7		6	25	5	1		10
Net 1	1	1	1		10	4	6	5	1	5	9	10	4		1
Net 2	16	37	14		53	2	28	43		65	87	47	24		52
Net 3	14	20	8		16	16	11	9		33	39	25	10		35
Net 4[b]	6	6			3	5	3			6	18	9	3		15
Net 5[b]		3				3	3				9				
Totals	41	194	94		160	65	131	214	19	205	339	196	157	7	167

a/ Condition 1 = without sluiceway/spill operation; Condition 2 = with sluiceway/spill operation.

b/ These numbers are middle net catches expanded x 3.

Appendix Table B7.--Numbers of subyearling chinook salmon collected in individual replicates of standard and modified STS FGE tests.[a/].

Location	Standard traveling screen			Modified traveling screen[b/]		
	7/19	7/22	7/23	7/24	7/25	7/26
Gatewell	330	363	210	126	92	224
Gap Net	1	4	1	2	0	0
Closure Net[c/]	128	158	90	20	40	150
Net 1[d/]	63	126	72	27	33	99
Net 2[d/]	1080	1245	705	285	195	663
Net 3[d/]	1515	1266	834	171	132	645
Net 4[d/]	1011	663	340	63	33	162
Net 5[d/]	252	129	96	3		6
Totals	4380	3954	2398	697	525	1949

a/ These tests were conducted from 19 to 26 August when only subyearling chinook salmon were caught.

b/ STS lowered 30 inches.

c/ Numbers at this level are catches from the net on one side expanded x 2.

d/ Numbers at this level are catches from the middle net expanded x 3.

Appendix Table B8. —Rates of descaling for subyearling chinook salmon, yearling chinook salmon, sockeye salmon, and steelhead taken in gatewell catches during vertical distribution and fish guiding efficiency tests in Units 2, 12, and 18 — The Dalles Dam 1985.

VERTICAL DISTRIBUTION TESTS

Date	Yearling chinook N	Yearling chinook #	Yearling chinook %	Steelhead N	Steelhead #	Steelhead %	Date	Subyearling chinook N	Subyearling chinook #	Subyearling chinook %
Unit 2										
4/11	130	3	2.3	23	0	0.0	7/16	78	0	0.0
4/12	160	1	0.6	11	0	0.0	7/17	84	0	0.0
4/13	222	22	0.9	28	0	0.0	7/18	63	0	0.0
4/23	35	1	2.9	55	0	0.0		225	0	0.0
4/24	33	1	3.0	63	3	4.8				
4/25	42	2	4.8	60	2	3.3				
4/26	26	1	3.8	60	0	0.0				
4/29	40	2	5.0	80	1	1.3				
Total	688	13	1.9	380	6	1.6				
Unit 12										
4/15	146	2	1.4	14	0	0.0				
4/16	38	0	0.0	10	0	0.0				
5/11	34	1	2.9	28	1	3.6				
5/02	22	0	0.0	7	0	0.0				
5/03	15	0	0.0	8	0	0.0				
Total	255	3	1.2	67	1	1.5				
Unit 18										
4/18	82	1	1.2	72	1	1.4				
4/19	54	0	0.0	48	0	0.0				
4/20	17	0	0.0	18	0	0.0				
4/21	23	1	4.3	26	1	3.8				
Total	176	2	1.1	164	2	1.5				

FISH GUIDING EFFICIENCY TESTS

Date	Yearling chinook N	Yearling chinook #	Yearling chinook %	Steelhead N	Steelhead #	Steelhead %	Sockeye N	Sockeye #	Sockeye %	Date	Subyearling chinook N	Subyearling chinook #	Subyearling chinook %
Unit 2													
4/16	67	1	1.5							6/05	35	2	5.7
4/17	253	4	1.6	21	0	0.0				6/06	152	0	0.0
4/18	150	4	2.7	41	0	0.0				7/19	330	0	0.0
4/19	157	3	1.9	99	0	0.0				7/22	124	1	0.8
4/20	150	4	2.7	150	3	2.0				7/23	210	0	0.0
4/21	150	0	0.0	150	0	0.0				7/24	126	0	0.0
4/30	119	3	2.5	104	4	3.8	52	1	1.9	7/25	92	1	1.1
5/01	127	5	3.9	80	4	5.0	59	0	0.0	7/26	224	0	0.0
5/02	105	2	1.9	33	5	15.1	63	3	4.8	Total	1293	4	0.3
5/03	112	8	7.1	69	1	1.4	73	3	4.1				
6/05	73	7	9.5	149	9	6.0	89	16	17.9				
6/06	100	4	4.0	114	13	11.4	54	5	9.3				
Total	1563	45	2.9	1010	39	3.9	390	28	7.2				

Appendix Table B9.—Mean fork length comparisons between salmonids captured in the gatewell and the fyke nets in FGE and vertical distribution tests in Unit 2, the Dalles Dam, 1985.

			Yearling chinook			Subyearling chinook			Steelhead		
Date	Test	Location[a/]	N	$\overline{X}$	2 SE	N	$\overline{X}$	2 SE	N	$\overline{X}$	2 SE
4/17	FGE	GW	126	166.6	3.6						
		FN	167	164.0	3.0						
4/29	VD	GW	39	145.8	6.2 *				80	200.1	6.0
		FN	110	162.9	4.0				81	202.8	5.4
5/1	FGE	GW	121	154.6	4.4						
		FN	82	159.6	5.0						
5/3	FGE	GW	112	151.8	4.6 *						
		FN	72	164.6	6.2						
6/6	FGE	GW	100	138.7	4.2	152	98.1	1.8			
		FN	71	138.4	3.4	171	96.6	1.0			
7/22	FGE	GW				124	107.9	1.4			
		FN				117	109.4	1.4			
7/25	FGE	GW				92	107.6	2.1			
		FN				114	107.4	2.2			

* = 0.05 > P>0.01

a/ GW = Gatewell catch; FN - Fyke net catch