Fish Guiding and Orifice Passage Efficiency Tests with Subyearling Chinook Salmon, McNary Dam, 1984

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COASTAL ZONE AND ESTUARINE STUDIES

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Final Report

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INTRODUCTION

Research studies to develop and test components for an improved fingerling bypass system for John Day Dam were conducted at McNary Dam in 1982. They showed an unacceptable (<70%) fish guiding efficiency (FGE) for the submersible traveling screens (STS) and a relatively poor orifice passage efficiency (OPE) for subyearling chinook salmon. Underwater video observations made towards the conclusion of these tests indicated the vertical barrier screens (VBS) accumulated debris as the field season progressed. By the time FGE tests were being conducted on subyearling chinook salmon (late July), four of the five screened panel sections of the balanced flow vertical barrier screens (BFVBS) were virtually occluded, only the bottom panel section (20% of the open area) remained unplugged (Krcma et al. 1983). Because plugging of the BFVBS would substantially reduce flow up into the gatewell while deflecting flow and presumably fish below the STS, we felt plugging could be a major factor causing the low FGE. In addition, plugged screens could also be causing increased injury and mortality of fish in the gatewells by creating excessively high velocities through the portions of the screen remaining unplugged.

Research to develop and test components and measures to improve the fingerling bypass system at John Day Dam were continued at McNary Dam in 1984. Specifically, the 1984 study at McNary Dam had the following objectives relating to subyearling chinook salmon:

1. Determine their normal vertical distribution in the turbine intakes with a clean BFVBS.

2. Measure FGE of the STS with a plugged vs a clean BFVBS.

3. Measure OPE with a modified BFVBS [similar modifications had shown promise at Lower Granite Dam (Swan et al. 1985)].

METHODS AND MATERIALS

Experimental Equipment

The following equipment was used to conduct the research:

1. One standard STS equipped with a full complement of fyke and gap nets.

2. One fyke net frame for determining vertical distribution of salmonids passing through the turbine intake.

3. One orifice trap capable of sampling the north and south orifices in Unit 6-B.

4. One gatewell dip net (Swan et al. 1979).

5. On-deck fish examining facilities.

6. A water jet vertical barrier screen cleaning device.

7. One mobile crane.

8. An underwater television camera.

The U.S. Army Corps of Engineers (CofE) provided the following services:

1. Gantry cranes for preparation and performance of vertical distribution tests and STS FGE.

2. Assistance in modifying and cleaning BFVBS and logistics involving positioning of STS and fyke net frames.

Measurements and Procedures

Vertical Distribution of Subyearling Chinook Salmon

A determination of the vertical distribution of fish in the turbine intake was needed to obtain base line information for theoretical maximum FGE. No previous information on vertical distribution for subyearling chinook salmon at McNary Dam existed. Standard procedures with the STS removed were used to obtain measures of vertical distribution (Krcma et al. 1983). Conventional fyke nets were used to capture fish that were entering the intake, and a dip basket was used to collect fish that volitionally entered the gatewell. Vertical distribution was determined from the percentage of fish captured at each net level. The number of fish in the gatewell plus the percentage of fish estimated to be in the upper 13.5 feet of the intake gave a theoretical measure of FGE (Fig. 1).

The following conditions were tested in 1984:

1. Vertical distribution with a clean BFVBS during pre- and post-dusk hours.

2. Vertical distribution with a standard vertical barrier screen (SVBS) during pre-dusk hours.

STS Fish Guiding Efficiency

FGE tests were originally planned to be conducted simultaneously in two separate turbine units, one with a clean barrier screen and one with an uncleaned screen. However, one of the two test units was not available so the study plan was modified for testing in only one unit.

Prior to testing, the gatewell was dewatered and the BFVBS was thoroughly cleaned. An uncleaned screen was created by introducing large amounts of water soaked shredded cedar shavings at the bottom of the gatewell and allowing the water currents to carry it up against the screen. This process was not completely successful. The extremely strong upward flows in the gatewell tended to concentrate most of the material on the upper screened panel sections leaving the bottom panel section virtually clean. An underwater television camera was used to verify the condition of the BFVBS prior to each replicate.

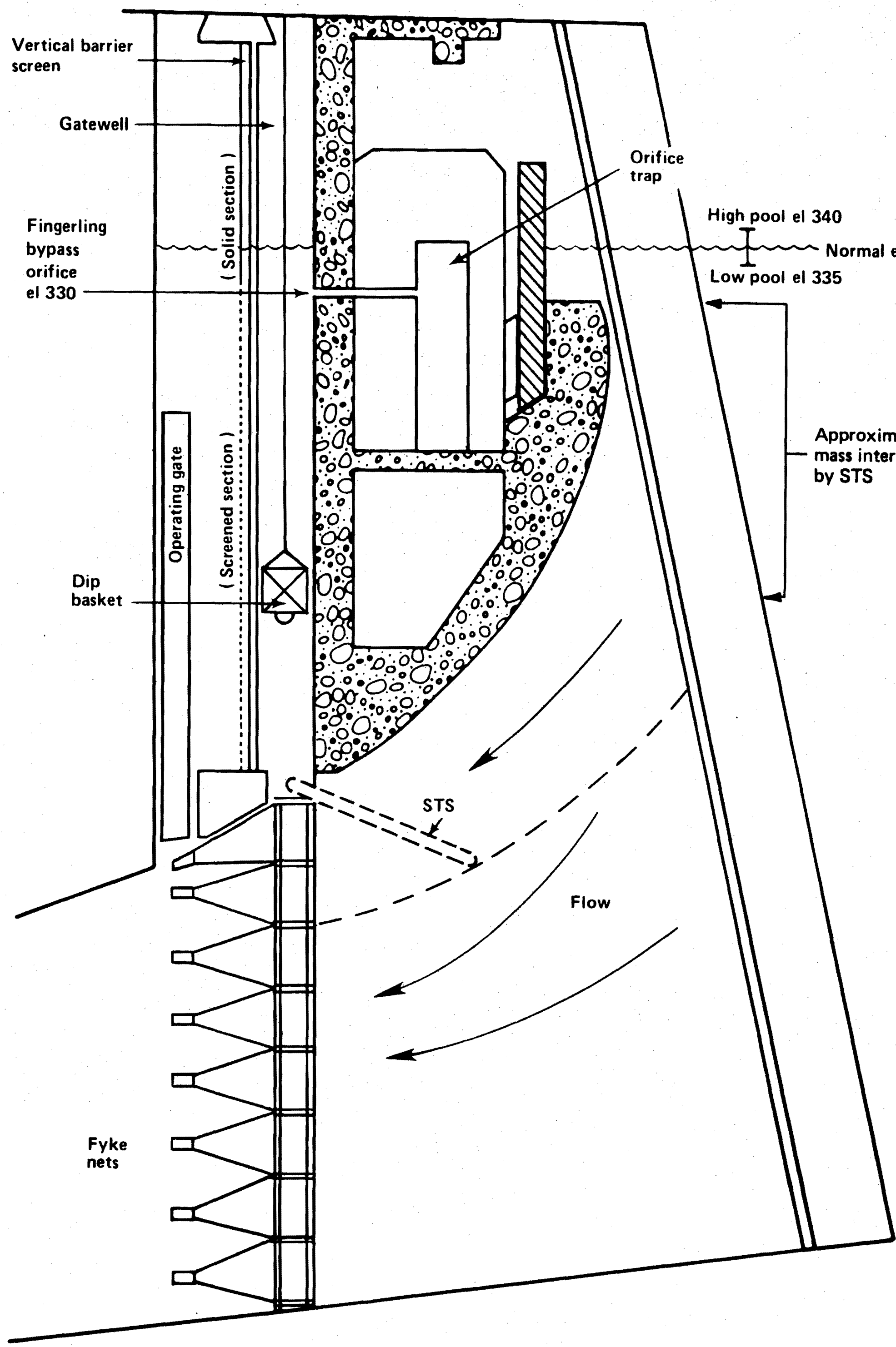

Figure 1.--Transverse section through a typical turbine unit at McNary Dam showing the normal test equipment used in 1984 to measure vertical distribution and the approximate water mass intercepted by the submerged traveling screen (when in place).

FGE tests were initially conducted in Unit 6-B which was equipped with a standard STS in normal operating position and a clean or uncleaned BFVBS (depending on test condition). Later, FGE tests were conducted in Unit 10-B equipped with a SVBS to measure differences, if any, between a BFVBS and SVBS. The tests in Unit 10-B were conducted with normal seasonal accumulations of debris on the screen. During all the tests, the operating gate was in the standard stored position.

During the FGE testing, the STS was equipped with a composite of nets for recovering a percentage of the unguided fish (Fig. 2). These nets included: a gap net attached near the top of the STS for capturing fingerlings that passed through the space between the top of the STS and the concrete beam, one closure net attached to the back (downstream side) of the STS, and a vertical column of five fyke nets supported by a net frame suspended below the STS. On the upper part of this frame, the nets were flanked on each side by a column of three additional fyke nets (Fig. 3). The uppermost net (one-half fyke net) in each column was approximately 3.5 by 6.5 ft, and the lower nets (full size fyke nets) were approximately 6.5 ft square.

The procedures for determining FGE were similar to those used in previous experiments of this type (Krcma et al. 1983). Gatewell dipnet catches provided the number of guided fish; catches from the gap, closure, and fyke nets attached to the STS provided numbers of unguided fish. FGE was calculated as guided fish 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 3 when fishing only one closure net)

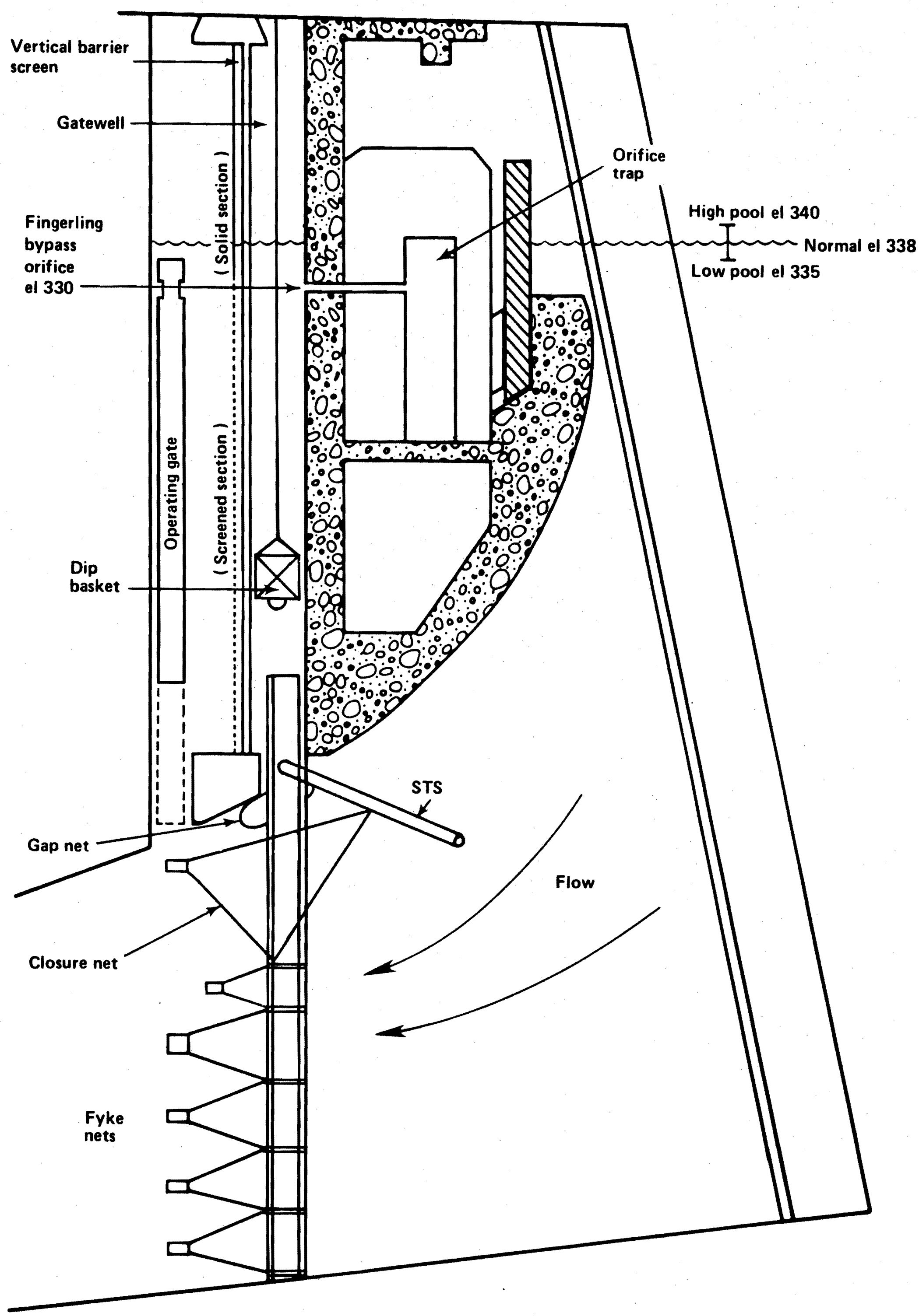

Figure 2.--Transverse section through a typical turbine unit at McNary Dam showing the normal test equipment used in 1984.

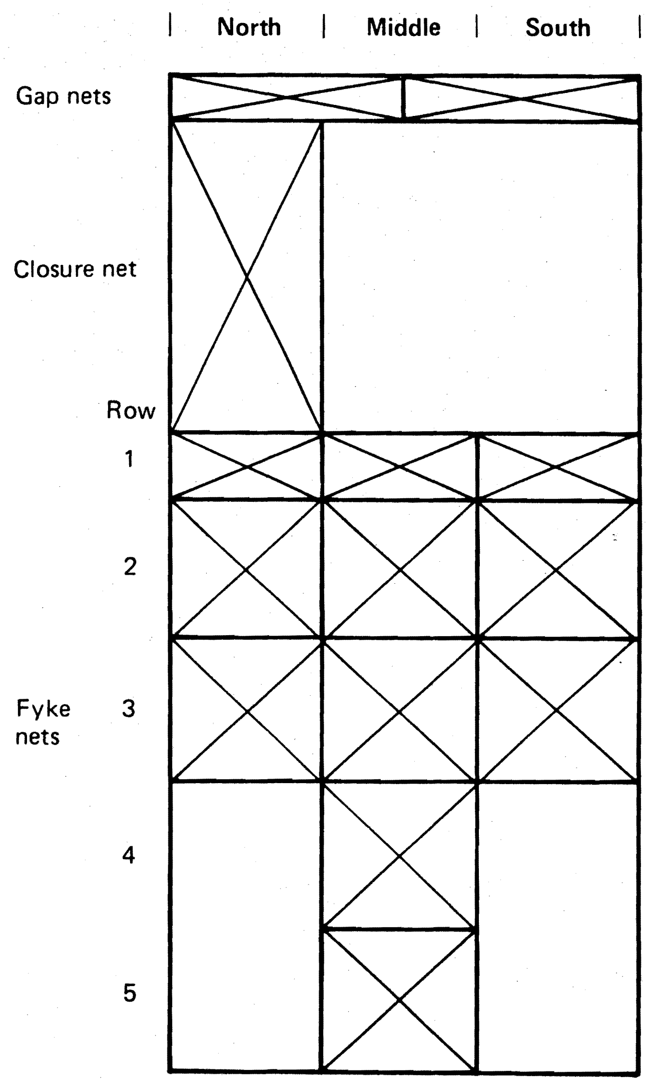

Figure 3.--Layout of fyke nets used to measure FGE at McNary Dam in 1984.

Each test was about 2 to 4 h long, starting between 1700 and 2200 h and terminating between 2100 and 2400 h depending upon if it was a pre- or post-dusk test (one test/day). The number of guided fish removed from the gatewell by dipnetting during the test determined the actual length of a test. The experimental design required specific sample sizes and replicates to satisfy specified statistical significance levels for detecting relevant differences of a stated magnitude. This usually required three or more replicates with a goal of 300 fish/sample (gatewell catch) for each condition tested. Contingency table procedures using the G-test were used in the statistical analysis (Sokal and Rohlf 1981). The formulas and procedures used are given in Appendix A.

The following conditions were tested in 1984:

1. STS FGE with a clean BFVBS during pre- and post-dusk hours.
2. STS FGE with an uncleaned BFVBS during post-dusk hours.
3. STS FGE with a SVBS during pre-dusk hours.

During all tests, the STS was operated in a screen cycling mode of 8 min on and 20 min off (consistent with normal project STS operations), and turbine loading was held constant at 80 MW. The following sequence of events was typical for conducting an STS FGE test:

1. The turbine was out of service except during actual testing. With the unit off, the STS with attached fyke net frame was lowered into position in the appropriate unit (6-B or 10-B).

2. The bypass orifice for the test unit was closed, and the gatewell was dipped to remove any fish prior to the test.

3. The unit was returned to service and brought to the standard load (80 MW) appropriate for the time of year.

4. The numbers of fish entering the gatewell were monitored by periodic dipping to determine when adequate numbers of fish for statistical needs were collected.

5. The turbine was shut down, and final cleanout dips were made to recover all of the guided fish from the gatewell.

6. The STS with attached fyke nets and frames were brought to the surface, and the fish were removed from the nets for identification and enumeration.

7. The nets were made ready for the next test, and the STS was dogged off at the deck level.

Orifice Passage Efficiency

OPE tests were also conducted in Unit 6-B because it was already equipped with a BFVBS. The original BFVBS consisted of five screen panel sections on the lower part and three solid panel sections on the upper part. Changes were made to the solid panel sections for the OPE tests. The third solid panel section (from the top) was converted to a screened panel section, and the second solid panel section was designed so each end (approximately one-third of the total width) could be converted to either solid or screen. The first panel was not changed because it was usually above water.

To enumerate fish passing through the north and south orifices, each of the two 12-inch diameter orifices were connected to a trap in the ice and trash sluiceway. Initial tests were conducted with the north orifice and a solid second panel. Both ends of the second panel were screened for the next two test series that compared OPE through north and south orifices, respectively. All OPE tests were replicated three times. When each orifice was tested, it was open for 24 h, and fish passing into the trap were routinely monitored. After 24 h, the orifice was closed and the dip basket was used to remove residual fish from the gatewell. The OPE was measured by comparing the number of residual fish to the total number of fish caught in the trap after 24 h. Confidence intervals (CI) for each test condition at the 95% level were defined using the formula:

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

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

Fish Quality

Descaling of fish from the gatewells was monitored as a measure of fish quality throughout the FGE and OPE testing. Standard descaling procedures were followed. Descaling was determined by dividing the fish into five equal areas per side; if any two areas on a side were 50% or more descaled, the fish was classified as descaled.

RESULTS

Vertical Distribution and STS Fish Guiding Efficiency

Individual catch data collected during the FGE and vertical distribution tests of subyearling chinook salmon are shown in Appendix B. A comparison of the percentage guided by the STS vs a theoretical percentage that could be guided based on vertical distribution data is shown in Table 1.

Results of initial vertical distribution tests with a clean BFVBS indicated a theoretical FGE potential of 77% $\pm$ 11 (percentage of fish caught within 13.5 feet of the intake ceiling). However, FGE in tests conducted immediately following the vertical distribution tests were 34-39%, 50% of that expected. These tests were conducted with both clean and uncleaned BFVBS during post-dusk hours.

Table 1.--A comparison of the percentage of subyearling chinook salmon guided by the STS and the percentage theorectically available for guiding as determined from vertical distribution data at McNary Dam-1984.

Date and time of test	Test condition	Actual FGE (%)	Theoretical[a] estimate (%)	Water temp. (°F)
14-16 Jul[b] Post-dusk	Clean BFVBS(6-B)		77(3)[c] ±11[d]	65
18-20 Jul Post-dusk	Clean BFVBS(6-B)	34(3) ±5		66
21-23 Jul Post-dusk	Uncleaned BFVBS(6-B)	39(9) ±13		66
24-29 Jul Pre-dusk	Clean BFVBS(6-B)	46(4) ±13		68
31 Jul-2 Aug[b] Pre-dusk	Clean BFVBS(6-B)		59(3) ±8	70
4-6 Aug Pre-dusk[b]	SVBS(10-B)		56(3) ±9	70
7-9 Aug Pre-dusk	SVBS(10-B)	33(3) ±13		70

[a] Percentage of the fish estimated to be within 13.5 feet of the ceiling.

[b] Vertical distribution test.

[c] Number of replicates ( ).

[d] ± calculated at the 90% confidence level.

The tests were repeated during pre-dusk hours with a clean BFVBS to determine if diurnal distribution could have been the cause for the low FGE [previous FGE studies conducted at McNary Dam showed the higher FGE occurred during daylight (Krcma et al. 1979)]. Results showed a slightly higher FGE (46% $\pm$ 13) but still well below acceptable standards. A second series of vertical distribution tests with a clean BFVBS during pre-dusk hours resulted in a theoretical FGE potential of only 59% $\pm$ 8. Contrary to our expectation, it was 18% less than the earlier post-dusk test.

A series of vertical distribution and FGE tests were then conducted in Unit 10-B with a SVBS to determine whether the BFVBS was possibly responsible for the lower FGE. These tests were conducted with typical amounts of debris plugging and during a pre-dusk period. The vertical distribution indicated a theoretical FGE of only 56% $\pm$ 9 (about the same as in Unit 6-B) and an actual FGE of only 33% $\pm$ 13. It should be noted that for the later tests there was no statistical difference between the theoretical or actual FGE because of the overlap of the confidence interval at the 90% level. In summary, FGE for all tests conducted were well below acceptable levels for the subyearling chinook salmon at McNary Dam.

Water temperatures were steadily rising throughout the testing. The temperature level appeared to show an inverse relationship with the theoretical estimate of FGE from the vertical distribution tests (Table 1). On 15 August, a temperature profile taken approximately 100 yards upstream from the powerhouse indicated there was over a 2°F difference between the 20-foot depth (68.4°F) and the surface (70.7°F) in front of Unit 7 (Table 2). There is a possibility that the reason for subyearling chinook salmon running deeper during the later tests was to avoid the higher (70°F) surface

Table 2.--Temperature profile (°F) taken approximately 100 yards upstream from the McNary Dam powerhouse, 15 August 1984.

Depth (ft)	Unit 3	Unit 7	Unit 10	Unit 14
Surface	69.8	70.7	69.8	69.8
5	68.5	70.7	69.8	69.6
10	68.5	69.1	69.1	68.5
20	68.0	68.4	68.4	68.4
30	68.0	68.0	68.4	68.4
40	68.0	68.0	68.4	68.2
50	68.0	68.0	68.4	68.2
60	68.0	68.0	68.0	68.2
Bottom	68.0	68.0	68.0	68.2

water temperatures. During the earlier tests, surface water temperatures were 65°F.

The majority of the unguided fish were taken in the first full sized net below the STS. The combined results of all 1984 FGE tests showed that nearly 50% of the unguided fish were found in this one net (Fig. 4). This suggests a combination of deflection under the STS and fish traveling too deep to be intercepted by the STS. An additional deflector located at the trashrack may offer a means to intercept these deeper running fish and improve FGE of subyearling chinook salmon by 20-30%.

Orifice Passage Efficiency

Generally, the OPE for subyearling chinook salmon was acceptable (>70%) for all the combinations of the modified BFVBS tested (Fig. 5). The north orifice, in conjunction with a solid second panel and the screened third panel section on the BFVBS produced an OPE of 79% ($\pm$ 1.6). The additional screening in the second panel did not improve OPE for the north orifice but may have for the south orifice (78% $\pm$ 11.4 vs 95% $\pm$ 9.3). Unfortunately, the south orifice is normally not used because of the undesirable way the water jets into the bypass flume. Individual replicate catch information is shown in Appendix B.

Fish Quality

Quality of the fish sampled throughout the season, as determined by descaling measurements, was relatively good. Descaling for subyearling chinook salmon averaged 3% in Unit 6-B (clean BFVBS), 4% in Unit 6-B (artificially uncleaned BFVBS), and 3% in Unit 10-B (normal debris accumulation on the SVBS).

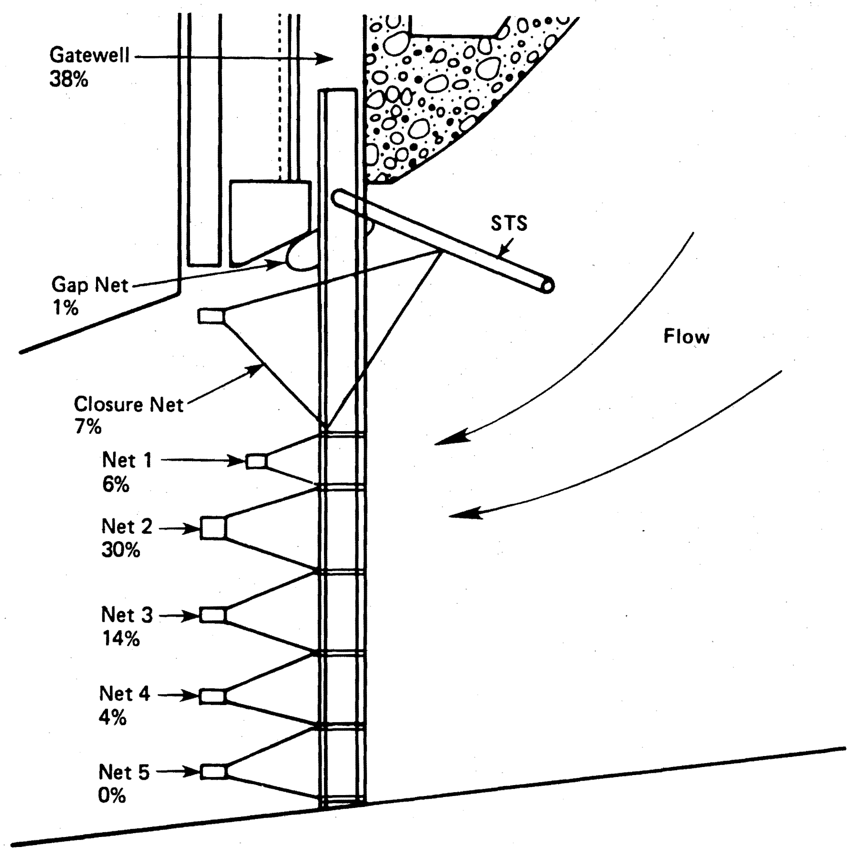

Figure 4.--Results of all FGE tests combined for subyearling chinook salmon showing the distribution of the unguided fish at McNary Dam - 1984.

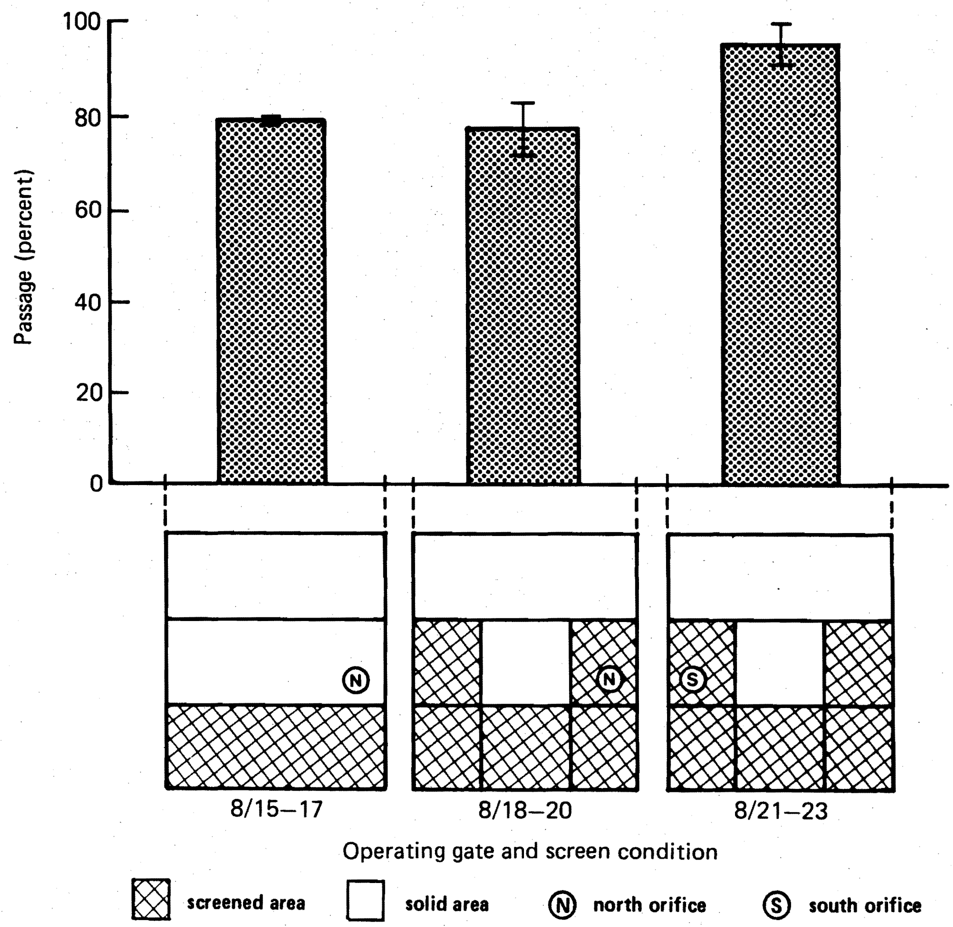

Figure 5.--Average percent orifice passage efficiency and 95% confidence limits of subyearling chinook salmon through a single 12-inch diameter orifice in conjunction with a partially blocked balanced flow vertical barrier screen, with each condition replicated three times over a 24-h period at McNary Dam - 1984.

CONCLUSIONS

1. Theoretical FGE, based on vertical distribution, varied from a high of 77% early to only 56% later in the migration. Higher surface water temperatures during the later period may have caused the deeper distribution.

2. Actual FGE ranged from 33 to 46%, well below acceptable levels, and only 40 to 50% of potential FGE (from vertical distribution tests).

3. No significant difference in FGE for a clean or uncleaned BFVBS was measured. However, efforts to create an uncleaned BFVBS equal or similar to what was observed in 1982 were unsuccessful.

4. Acceptable OPE for subyearling chinook salmon at McNary Dam was measured with a modified BFVBS that had one additional screened panel section. OPE for a south orifice was higher than for a north orifice.

ACKNOWLEDGMENTS

We wish to express our appreciation to our maintenance staff and seasonal personnel for their interest and effort during this project. We also extend special thanks to CofE personnel at McNary Dam for their assistance and cooperation in completing this study.

LITERATURE CITED

Krcma, R. F., C. W. Long, C. S. Thompson, W. E. Farr, T. W. Newcomb, and M. H. Gessel.
1979. The Development of an Improved Fingerling Protection System for Low-Head Dams, 1978. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin, Natl. Mar. Fish. Serv., Northwest and Alaska Fish. Cent.,Seattle, Wash. 41 p. plus Appendix (Report to U.S. Army Corps of Engineers, Contract DACW57-78-F-0354).

Krcma, R. F., M. H. Gessel, and F. J. Ossiander
1983. Research at McNary Dam to Develop and Implement a Fingerling Protection System for John Day Dam, 1982. U.S. Dep. Commer, Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Northwest and Alaska Fish. Cent., Seattle, Wash. 24 p. plus Appendix (Final Report to U.S. Army Corps of Engineers, Contract DACW57-82-F-0373).

Sokal, R. R. and F. J. Rohlf.
1981. Biometry. 2nd edition. Freeman and Company, San Francisco, California, U.S.A.

Swan, G. A., R. F Krcma, and W. E. Farr
1979. Dipbasket for collecting juvenile salmon and trout in gatewells at hydroelectric dams. Jan. 1979. Prog. Fish Cult. 41(1):48-49.

Swan, G. A., R. F. Krcma, and F. J. Ossiander.
1985. Development of an Improved Fingerling Protection System for Lower Granite Dam - 1984. U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Northwest and Alaska Fish. Cent., Seattle, Wash. 35 p. (Final Report to U.S. Army Corps of Engineers, Contract DACW68-84-H-0034.)

APPENDIX A

Sample Sizes Needed to Detect Differences Among Test Groups

by

Frank J. Ossiander

Typically, the information needed to determine the number of replicates and the sample sizes required per test group are the treatment variability expected (which may be expressed as a difference between treatment means of interest), the number of means (or experimenetal categories) being compared, and the α and β (the probability of the type I error, α , and the probability of the type II error, β) levels desired from the statistical test.

In these experiments, we have mainly chosen to 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 difference. The exact calculation of the probability is rather complicated. The procedures used provide an approximation that is adequate for design purposes.

Very often in field work, conditions may provide the opportunity for more measurements or force some curtailment. In view of field uncertainties, which may result in more or fewer measurements, alternative statistical analyses were planned. The primary statistical analyses being categorical data analysis using the count data. The alternative analysis being a data transformation to stabilize the variance and approximate normality and then apply analysis of variance procedures. The alternative procedure is usually less powerful than a direct categorical analysis of the count data, but may be necessary in some cases where the requirements for categorical analysis cannot be fulfilled.

Occasionally we plan 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.

The information for sample size determination is applied for the following cases. 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.

2. More than two groups or multinomial case: The procedures used for obtaining confidence intervals and sample sizes follow methods given by Angers (1974), 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) and Cochran and Cox (1957).

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 sample 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 $1 - \beta$. This corresonds to the probability of obtaining a significant result. Note that ZB = -ZB' where B' equals β. Hence, (ZA + ZB) could be written as (ZA - ZB') without altering the value of NT.

P1 - proportion in the control group.

P2 - proportion in the test group.

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

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

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

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

R - the number of replicates per treatment.

T_1 - t - distribution value associated with type I error, 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 of (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 associated with tabulated probability distribution values depends on sample size.

LITERATURE CITED

Angers, C.
1974. A graphical method to evaluate sample sizes for the multinomial distribution. Technometrics 16, 469-471.

Bailey, B. J. R.
1980. Large sample simultaneous confidence intervals for the multinomial probabilities based on transformations of the cell frequencies. Technometrics 22, 583-589.

Cochran, W. G. and G. M. Cox.
1957. Experimental Designs. 2nd ed., Chapter 2. John Wiley and Sons, Inc.: New York, N.Y., USA.

Feigl, P.
1981. A graphical aid for determining sample size when comparing two independent proportions. Biometrics 34, 111-122.

Goodman, L. A.
1965. On simultaneous confidence intervals for multinomial proportions. Technometrics 7, 247-254.

Lemeshow, S., D. W. Hosmer, and J. P. Steward.
1981. A comparison of sample size determination methods in the two group trial where the underlying disease is rare. Commun. Statist-Simula. Computa. B10, 437-449.

Miller, R. G., Jr.
1966. Simultaneous Statistical Inference. pp 215-218. McGraw-Hill Book Company: New York, N.Y., USA.

Paulson, E. and W. A. Wallis.
1947. Planning and analyzing experiments for comparing two percentages. Chapter 7 in, Techniques of Statistical Analysis, editors, C. Eisenhart, M. W. Hastay, and W. A. Wallis. McGraw-Hill Book Company: New York, N.Y., USA.

Steel, R. G. D. and J. H. Torrie.
1960. Principles and Procedures of Statistics. pp 90-93 and 154-156. McGraw-Hill Book Company: New York, N.Y., USA.

Tsao, H. and T. Wright.
1983. On the maximum ratio: a tool for assisting inaccuracy assessment. The American Statistician 37, 339-342.

APPENDIX B

Catch Data

Appendix Table B1.--Catches of subyearling chinook salmon during fish guiding efficiency tests at McNary Dam at 80 megawatt turbine load in the summer of 1984.

SUBYEARLING CHINOOK SALMON

Date	Clean BFVBS (6-B)						Uncleaned BFVBS (6-B)						Clean BFVBS (4-A)						SVBS (10-B)[a/]					
	BHS catch	Gap net catch	Fyke net catch	Total unguided (Est.)	Total guided and unguided	% FGE	BHS catch	Gap net catch	Fyke net catch	Total unguided (Est.)	Total guided and unguided	% FGE	BHS catch	Gap net catch	Fyke net catch	Total unguided (Est.)	Total guided and unguided	% FGE	BHS catch	Gap net catch	Fyke net catch	Total unguided (Est.)	Total guided and unguided	% FGE
	Post-dusk																							
7/18	156	7	297	333	489	32																		
7/19	102	1	158	174	276	37																		
7/20	69	2	100	121	190	36																		
Total	327	10	555	628	955																			
				Grand Average		34																		
							Post-dusk																	
7/21							908	21	938	1082	1990	46												
7/22							724	19	1366	1622	2346	31												
7/23							779	17	943	1079	1858	42												
Total							2411	57	3247	3783	6194													
										Grand Average		39												
													Pre-dusk											
7/24													1667	46	1268	1432	3099	54						
7/27													147	3	241	265	412	36						
7/28													198	7	228	249	447	44						
7/29													314	7	765	807	1121	28						
Total													2326	63	2502	2753	5079							
																Grand Average		46						
																			Pre-dusk					
8/7																			808	26	1385	1569	2377	34
8/8																			1479	43	2541	2837	4316	34
8/9																			641	17	1310	1488	2129	30
Total																			2928	86	5236	5894	8822	
																						Grand Average		33

a/ Tests were completed without any special effort to clean SVBS (upon completion, the gatewell was unwatered and SVBS was found to be clean.

Appendix Table B2.--Catches of subyearling chinook salmon during vertical distribution tests at McNary Dam, 1984.

Level[a]	6-B BHS					6-B BHS					10-B BHS				
	14 Jul	15 Jul	16 Jul	Total	Cumulative (%)	31 Jul	1 Aug	2 Aug	Total	Cumulative (%)	4 Aug	5 Aug	6 Aug	Total	Cumulative (%)
Gatewell	1,047	270	522	1,839	14	205	699	748	1,652	12	166	48	56	270	10
1	1,746	333	714	2,793	36	153	567	648	1,368	22	105	24	21	150	16
2	1,875	507	984	3,366	62	336	987	1,377	2,700	41	351	69	66	486	35
3	1,287	603	732	2,622	82	402	1,251	1,641	3,294	64	567	102	57	726	63
4	717	393	327	1,437	93	303	1,179	1,230	2,712	84	420	105	45	570	85
5	285	183	198	666	98	192	834	609	1,635	95	207	42	33	282	96
6	57	66	54	177	99	42	348	141	531	99	66	12	3	81	99
7	6	6	9	21	99	6	63	27	93	99	12	3	0	15	100
8	3	3	0	6	100	3	0	0	3	100	0	0	0	0	
Total	7,023	2,364	3,540	12,927		1,642	5,928	6,421	13,988		1,894	405	282	2,580	

[a] Levels one through eight refer to the level of the water column fished by the fyke nets used to determine the vertical distribution--Level One being the top net and Level Eight the bottom net (Fig. 1).

Appendix Table B3.--Numbers of subyearling chinook salmon collected during OPE testing at McNary Dam-1984.

Condition tested	Date	Trap catch	Gatewell catch	Total catch	OPE (%)
North orifice,	14-15 Aug	1,227	348	1,575	78
2 solid panels	15-16 Aug	1,719	457	2,176	79
	16-17 Aug	1,650	387	2,037	81
Total		4,596	1,192	5,788	
North orifice,					
end panels	17-18 Aug	351	144	495	71
of 2nd panel	18-19 Aug	533	65	598	89
screened	19-20 Aug	213	100	313	68
Total		1,097	309	1,406	
South orifice,					
end panels	20-21 Aug	933	197	1,130	83
of 2nd panel	21-22 Aug	2,239	39	2,278	98
screened	22-23 Aug	1,185	10	1,195	99
Total		4,357	246	4,603	