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SUMMARY REPORT

FISH GUIDING AND ORIFICE PASSAGE EFFICIENCY TESTS WITH SUBYEARLING CHINOOK SALMON, MCNARY DAM - 1984

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by
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INTRODUCTION

Research studies to develop and test components for an improved fingerling bypass system for John Day Dam conducted at McNary Dam in 1982 showed an unacceptable (<70%) fish guiding efficiency (FGE) as well as relatively poor orifice passage efficiency (OPE) for subyearling salmon.

Underwater video observations made during the course of these tests indicated the vertical barrier screens (VBS) accumulated debris as the field season progressed. By late July (the time when FGE tests were being conducted on subyearling chinook salmon), four of the five screened panel sections of the balanced flow vertical barrier screens (BFVBS) were found to be virtually occluded, only the bottom panel section (20% of the open area) remained unplugged.

We hypothesized that the lower FGE measured on subyearling chinook salmon could have been caused by the plugging of the BFVBS from debris which would substantially reduce flow up into the gatewell while deflecting flow and presumably fish below the submersible traveling screen (STS). 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. This hypothesis was tested in 1984 beginning in mid-July and continuing into August.

Tests of OPE were also conducted to determine whether modifications to the BFVBS would improve OPE as similar modifications had done at Lower Granite Dam.

RESEARCH OBJECTIVES

The 1984 study at McNary Dam had the following objectives:

1. Determine the normal vertical distribution of subyearling chinook salmon fingerlings entering 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 and subyearling chinook salmon.

METHODS AND PROCEDURES

Vertical Distribution

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 were used to obtain measures of vertical distribution. Conventional fyke nets were used to fish the intake while a specially designed dip basket was employed to collect the fish entering the gatewell. Vertical distribution was determined by the percentage of the total fish captured that were taken in the gatewell and in each horizontal row of fyke nets. Percentage of fish in the gatewell plus the percentage of fish in the upper 13.5 feet of the intake gave the theoretical maximum FGE.

FGE Tests

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

Prior to each test, the unit was dewatered and the BFVBS was thoroughly cleaned. An uncleaned screen was created by introducing large amounts of water soaked shredded cedar at the bottom of the gatewell and allowing the currents to carry it against the screen. Each test was replicated three times to obtain statistically significant results. An underwater television camera was used to verify the condition of the BFVBS prior to each replicate.

The procedures for determining FGE were similar to those used in previous experiments of this type. Gatewell dipnet catches provided the number of guided fish; catches from the gap and fyke nets attached to the STS provided numbers of unguided fish. FGE was calculated as guided fish divided by an estimate of the total number of fish passing through the intake during the test period.

FGE tests were intially 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 standard vertical barrier screen (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 at the standard stored position.

OPE Tests

OPE tests were conducted in Unit 6-B equipped with a BFVBS. To enumerate fish passing through the north and south orifices, each of the two 12-inch diameter orifices was connected to a trap in the ice and trash sluiceway. The BFVBS originally consisted of five screen panel sections on

the lower part and three solid panel sections on the upper part. For tests to measure OPE with a modified BFVBS, the second solid panel section was modified so each end (approximately one-third of the total width) could be converted from solid to screen, and the third panel was changed from a solid to a screened section.

Initial tests were conducted with the north orifice only and a solid second panel. Each end of the second panel was uncovered for the second test series with the north orifice only. The third test series was the same as the second but with a south instead of north orifice only.

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.

RESULTS

Vertical Distribution and FGE Tests

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) (Table 1). However, FGE measurements in tests conducted immediately following the vertical distribution tests were 34-39%, 50% of that expected. These tests were conducted with both clean and plugged[1/] BFVBS and during post-dusk hours.

1/ The process for creating a plugged screen 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.

Table 1.--A comparison of the percentage of subyearling chinook salmon guided by the STS and the percentage theoretically 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)
July 14-16 Post-dusk	clean BFVBS(6-B)		77(3)[b] ± 11[c]	65
July 18-20 Post-dusk	clean BFVBS(6-B)	34(3) ± 5		66
July 21-23 Post-dusk	uncleaned BFVBS(6-B)	39(3) ±13		66
July 24-29 Pre-dusk	clean BFVBS(6-B)	46(4) ±13		68
July 31-August 2 Pre-dusk	clean BFVBS(6-B)		59(3) ± 8	70
August 4-6 Pre-dusk	SVBS(10-B)		56(3) ± 9	70
August 7-9 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/ Number of replicates ( ).

c/ ± calculated at the 90% confidence level.

The test was 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 that higher FGE occurred during daylight (Krcma et al. 1978)]. 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 but during pre-dusk hours resulted in a theoretical FGE potential of only 59% $\pm$ 8--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 (uncleaned) during pre-dusk hours as a means of determining whether the BFVBS was possibly responsible for the lower FGE. These results showed a theoretical FGE of only 56% $\pm$ 9 (nearly 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, and the temperature level showed an inverse relationship with the magnitude of 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 water temperatures. During the earlier tests surface water temperatures were only 65°F.

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

Elevation		Unit 3	Unit 7	Unit 10	Unit 14
338	surface	69.8	70.7	69.8	69.8
333	5'	68.5	70.7	69.8	69.6
328	10'	68.5	69.1	69.1	68.5
318	20'	68.0	68.4	68.4	68.4
308	30'	68.0	68.0	68.4	68.4
298	40'	68.0	68.0	68.4	68.2
288	50'	68.0	68.0	68.4	68.2
278	60'	68.0	68.0	68.0	68.2
	Bottom	68.0	68.0	68.0	68.2

An average of 30% of the fish (60% of the unguided fish) were found in the first full fyke net below the STS for all FGE tests combined (Figure 1). This suggests a combination of deflection under the STS and fish running too deep to be intercepted by the STS. An additional deflector located at the trashrack would offer a means to intercept these deeper running fish and theoretically improve FGE of subyearling chinook salmon by 20-30%.

OPE Tests

In all cases tested, the 12-inch diameter orifice provided adequate OPE (Figure 2). The north orifice, in conjunction with a solid second panel section in the gatewell, had an OPE of 79%. The north orifice, combined with a BFVBS that had a partially screened second panel section (screened at both ends), produced 78% OPE. The most beneficial configuration for Gatewell 6-B was with both ends of the second panel section screened and an open south orifice; this provided 95% OPE. Unfortunately, the south orifice is not normally used because of the peculiar way the water jets into the bypass flume.

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).

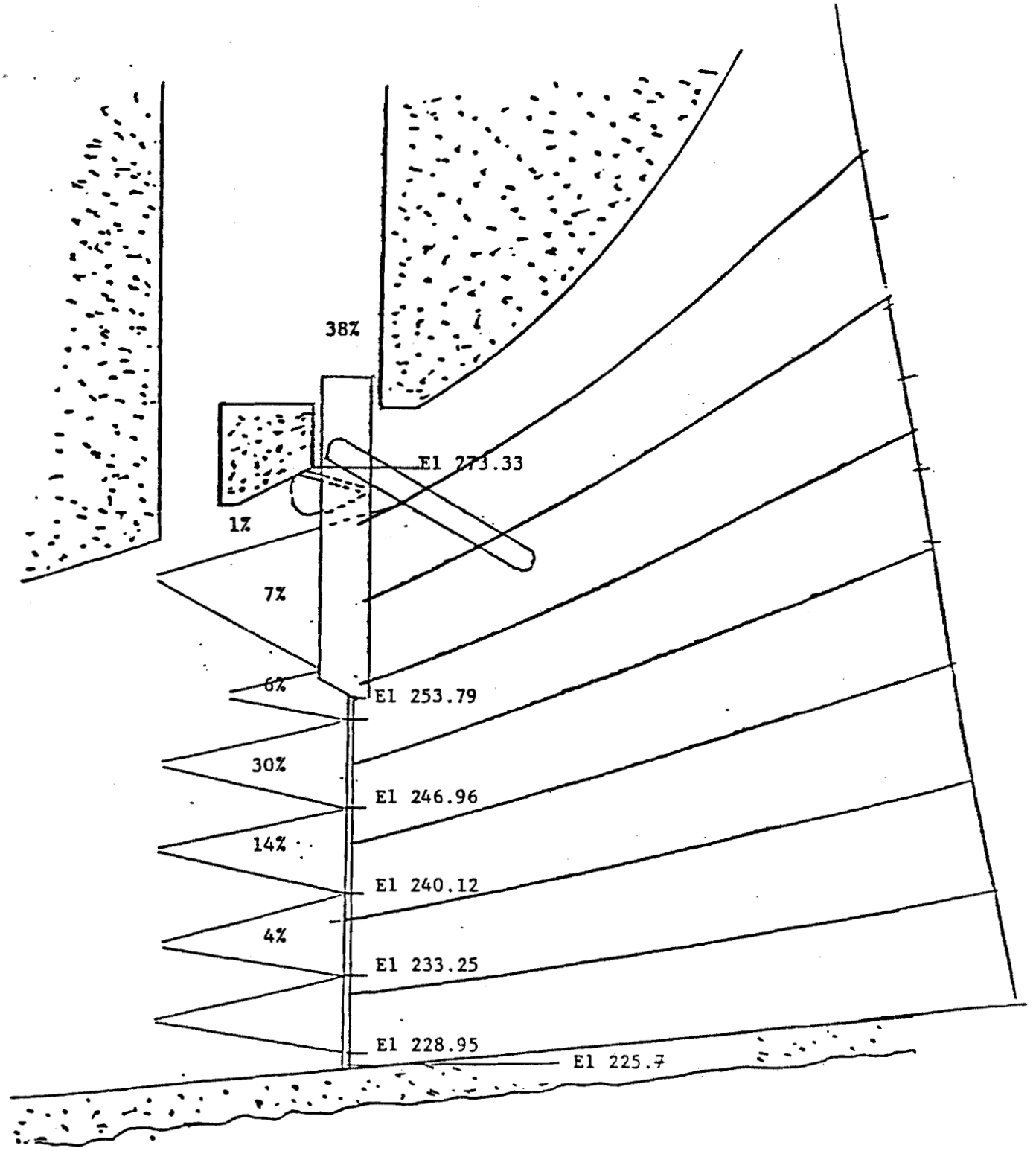

Figure 1.--Results of all FGE tests combined for subyearling Chinook salmon showing the distribution of the unguided fish at McNary Dam - 1984

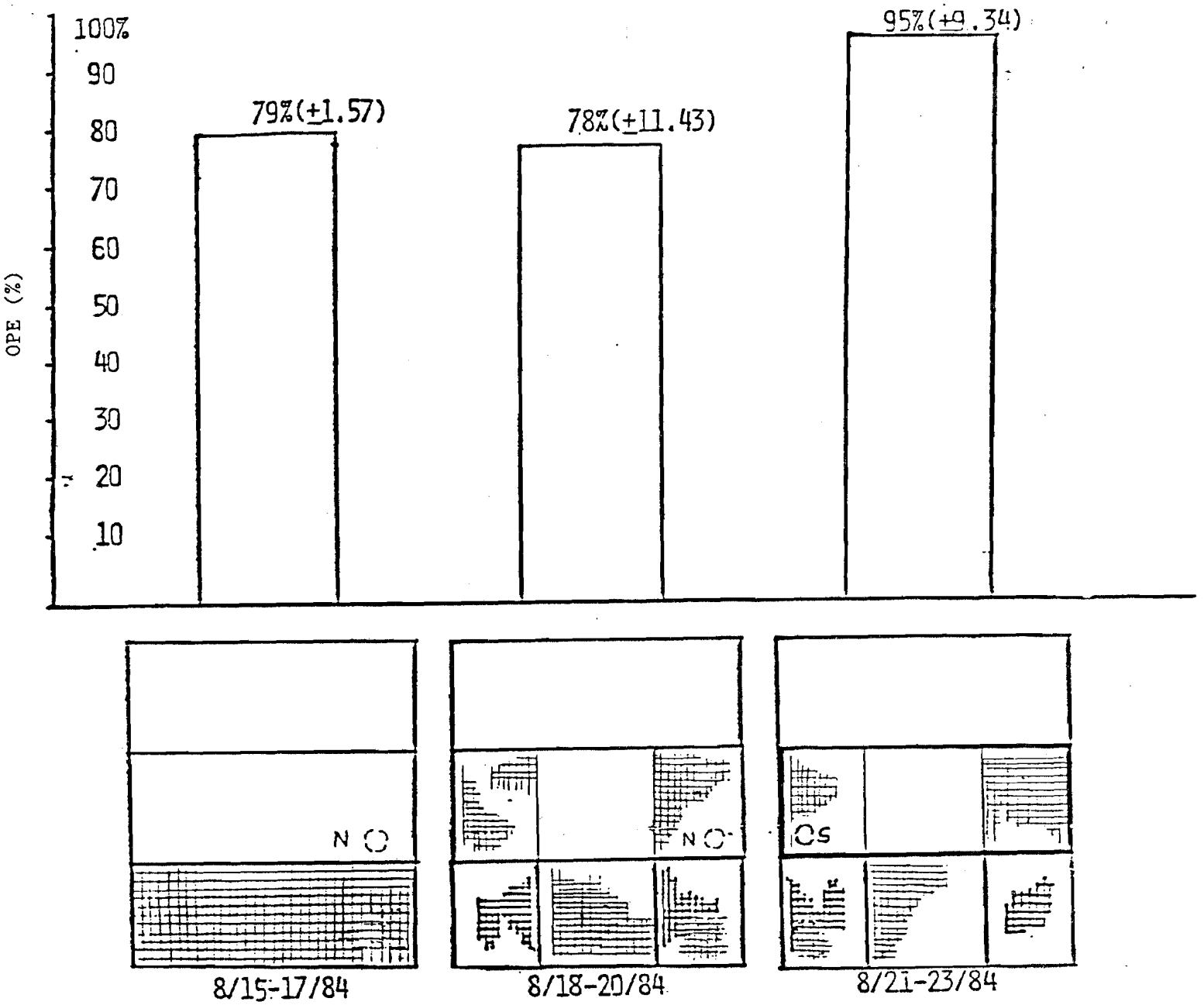

Figure 2.--Average percent orifice passage efficiency and 95% confidence limits of subyearling chinook salmon through a single 12-inch diameter orifice in conjunction with a partially blocked balanced flow vertical barrier screen, with each condition replicated three times over a 24-h period at McNary Dam - 1984.

3. No significant difference in FGE for a clean or uncleaned BFVBS was measured. Cause of the low FGE is therefore not due to plugged barrier screens.

4. Acceptable OPE for subyearling chinook salmon at McNary Dam was measured with a modified BFVBS. OPE for a south orifice was higher than for a north orifice.

LITERATURE CITED

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