Vertical Distribution of Juvenile Salmonids in the Forebay Area at Howard Hanson Reservoir

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Introduction

This study is part of the investigations on fisheries aspects of the Howard Hanson additional water storage feasibility study. Because of the need for information on the vertical distribution of fish to assist in design of fish passage facilities, this preliminary effort was undertaken. The objectives of this preliminary work were to document catch by depth, species, and size. In addition, comparisons between species and age groups, prestratification and poststratification conditions, and trends in catch distribution would be made where possible.

Methods

The study site was located in Howard Hanson Reservoir, approximately 50 yards upstream of the intake structure. The depth of the reservoir at this location was approximately 100 feet. This site was stationary, in that anchors, to which the vertical gill nets were suspended, were left in place during the study. Two nylon vertical gill nets (6 feet wide X 150 feet deep), 1.5 inch and 1 inch stretch mesh, were use at each sampling during the study. An additional 5/8 inch net was called for in the scope of work, however, the Corps was not able to supply this net for the study because of limited availability in the United States.

Eight samples were taken during the study. Four during the period May 26 - June 5 and four during the period August 16 - 26. The first four samples were intended to reflect "prestratification" conditions, while the last four samples were intended to reflect "poststratification" conditions. Lack of the 5/8 inch net delayed the initial sampling start date. A decision was made to begin sampling without the 5/8 inch net on May 26. The procedures for netting at each sampling were as follows: the nets were unrolled to a depth of approximately 100 feet, the bottom, and rerolled about 24 hours later. Species and fork lengths of all individuals were recorded as well as capture location in 10-foot depth intervals. In addition, scales were obtained from a number of each species for each sample to determine age composition of the catch.

Results and Discussion

For discussion purposes, the four samples taken between May 26th and June 5th will be referred to as the early period and the four samples taken between August 16th to August 26th will be referred to as the late period. As Figure 1 indicates, thermal stratification appeared to have already occurred in the forebay during the early period.

A total of 411 fish were collected during the study. Of these, 389 chinook (Appendix A) were captured with 300 occurring during the early period and 89 in the late period. A total of 13 coho (Appendix B) were recorded with 8 in the early period and 5 in the late period. A total of 6 rainbow trout (Appendix C) were recorded with all fish occurring in the early period. In addition, 3 cutthroat trout (Appendix C) were recorded with 1 in the early period and 2 in the late period. The range in lengths of chinook for the early period was 93 mm to 130 mm with a mean of 107 mm. For the late period the range in lengths for chinook was 143 mm to 182 mm with a mean of 143 mm. The range in lengths of coho for the early period was 110 mm to 131 mm with a mean length of 117. For the late period the range in coho lengths was 102 mm to 137 mm with a mean length of 118. Lengths of both species of trout can be found in Appendix C.

Scale analysis revealed that all chinook were subyearlings planted earlier this year. Scale samples of 12 coho showed that 5 were yearlings and 7 were subyearlings.

A summary of the chinook catches by percent of catch relative to depth for each sample can be found in Figures 2 (early period) and Figure 3 (late period). When each sample is viewed separately, a large degree of variability was observed for both the early and late periods. When the numbers of fish were pooled together into late and early periods, Figure 4, a rather uniform distribution was observed for the early period with a majority of observations occurring in the 30 to 70 foot range. For the late period, a majority of the fish were observed in the 50 to 80 foot range. When the pooled vertical distribution of early versus late catches (Figure 4) were compared statistically by contingency table analysis (Snedecor and Cochran 1980) they were found to be significantly different (chi-square = 56.4, $P < 0.001$). Due to the low numbers of coho and trout these comparisons in distributions were not possible. Comparisons of temperature profiles, Figure 1, during approximately the same time periods, showed that surface temperatures increased approximately 2 degrees, and at lower depths, an increase of about 5 degrees between the early and late sampling periods.

Distribution of chinook during the late period was substantially different from that observed by Cropp (undated) in 1989 during the same time of year. He found, by hydroacoustic surveys, only about 10 percent of the fish population was below 35 feet. We observed almost the complete opposite with 93 percent of our catch occurring below 30 feet (Figure 4). However, it should be noted that our catch was biased toward only those fish of a size that would be captured in the two sizes of gill nets used. In addition, Cropp's observations were based on transects over the entire reservoir while this study observations were limited to one location in the forebay area.

REFERENCES

Cropp, T. Undated. Howard Hanson Reservoir fish population study, July - August, 1989. Washington Department of Wildlife.

Snedecor, G. and W. Cochran. 1980. Statistical Methods. Seventh Edition. Iowa State University Press. Ames, Iowa.

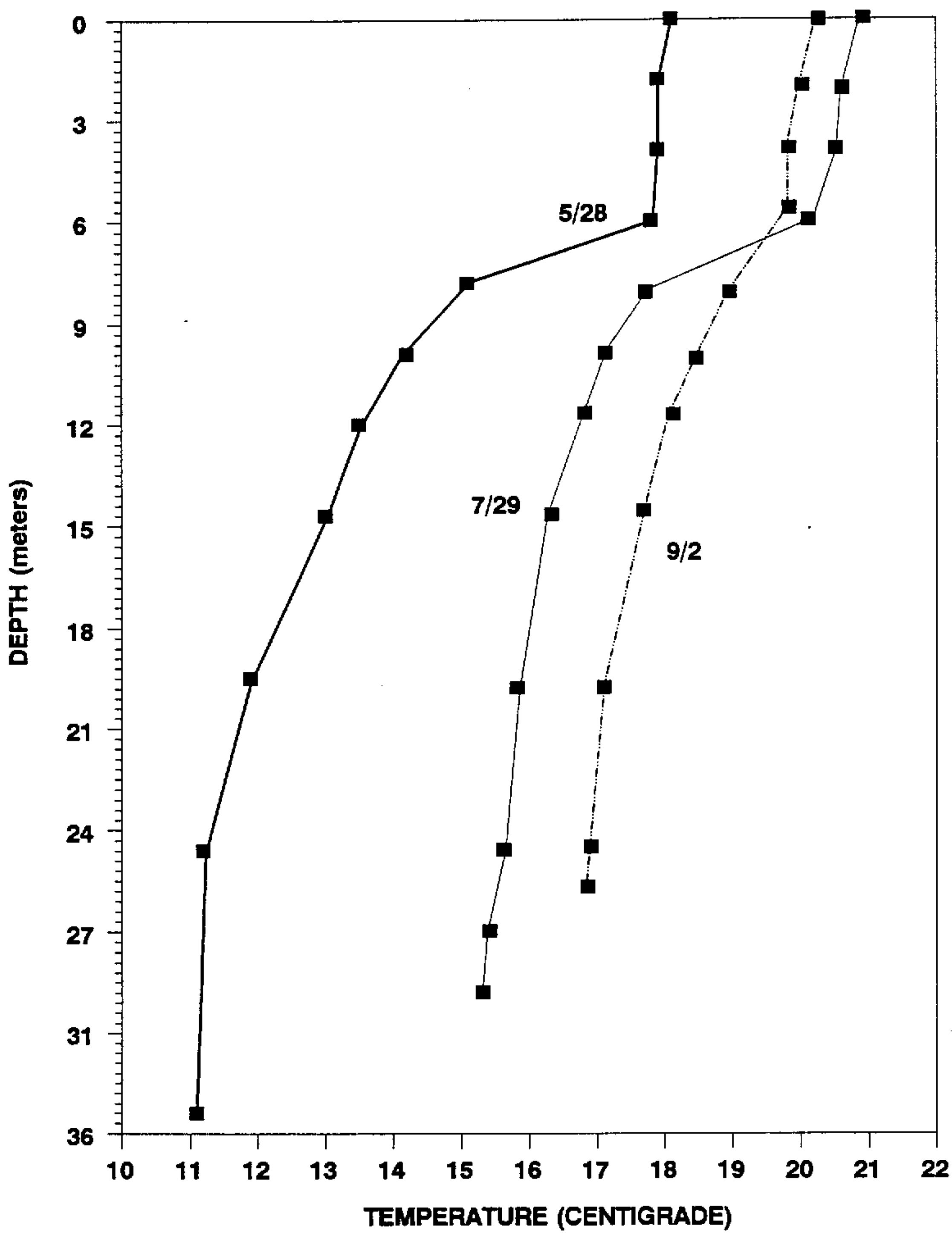

Figure 1. Temperature profiles of the Howard Hanson forebay area on the dates closest to sample periods (Data source: U.S. Army Corps of Engineers).

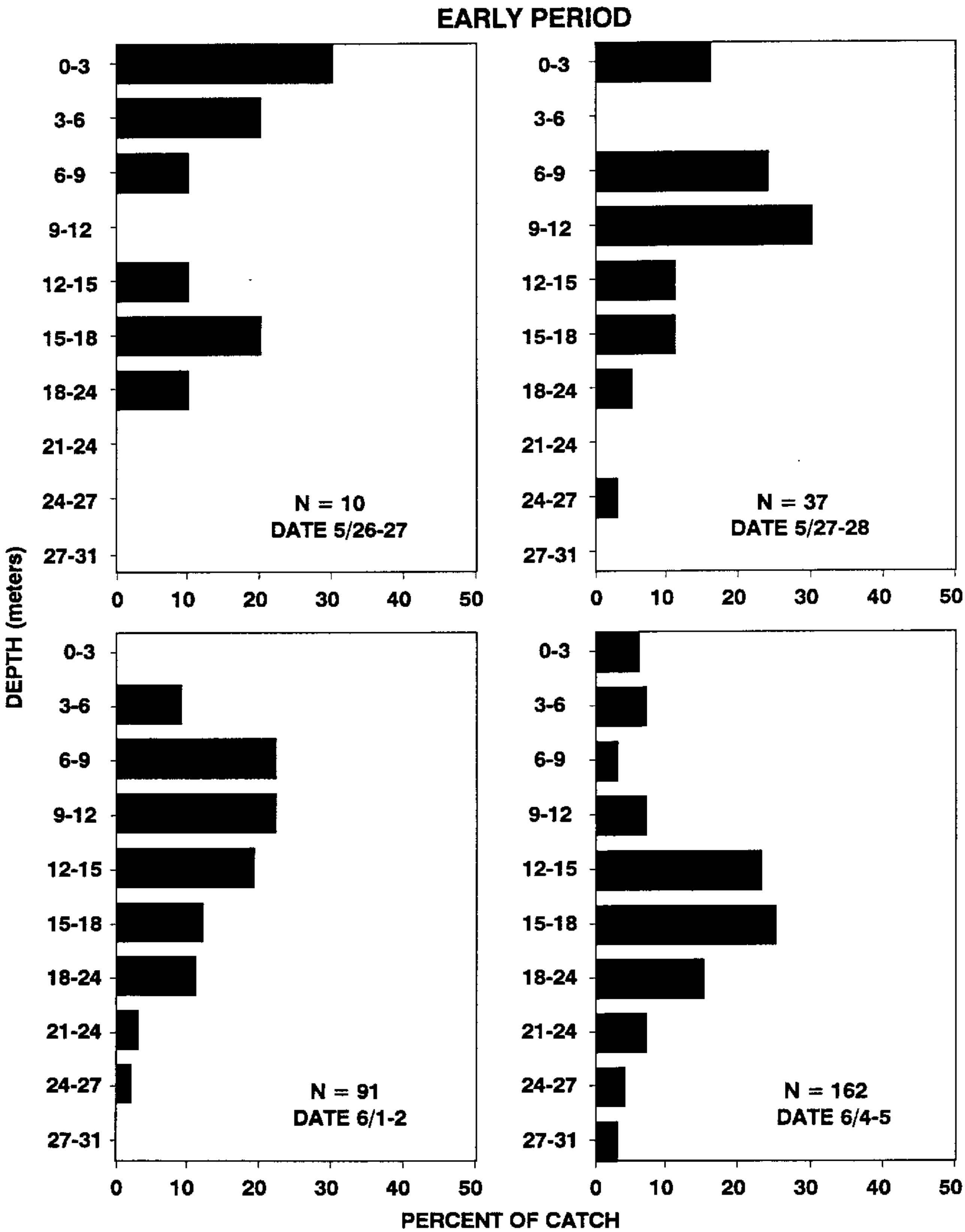

Figure 2. Percent of chinook subyearling catch by depth from Howard Hanson Reservoir (early period).

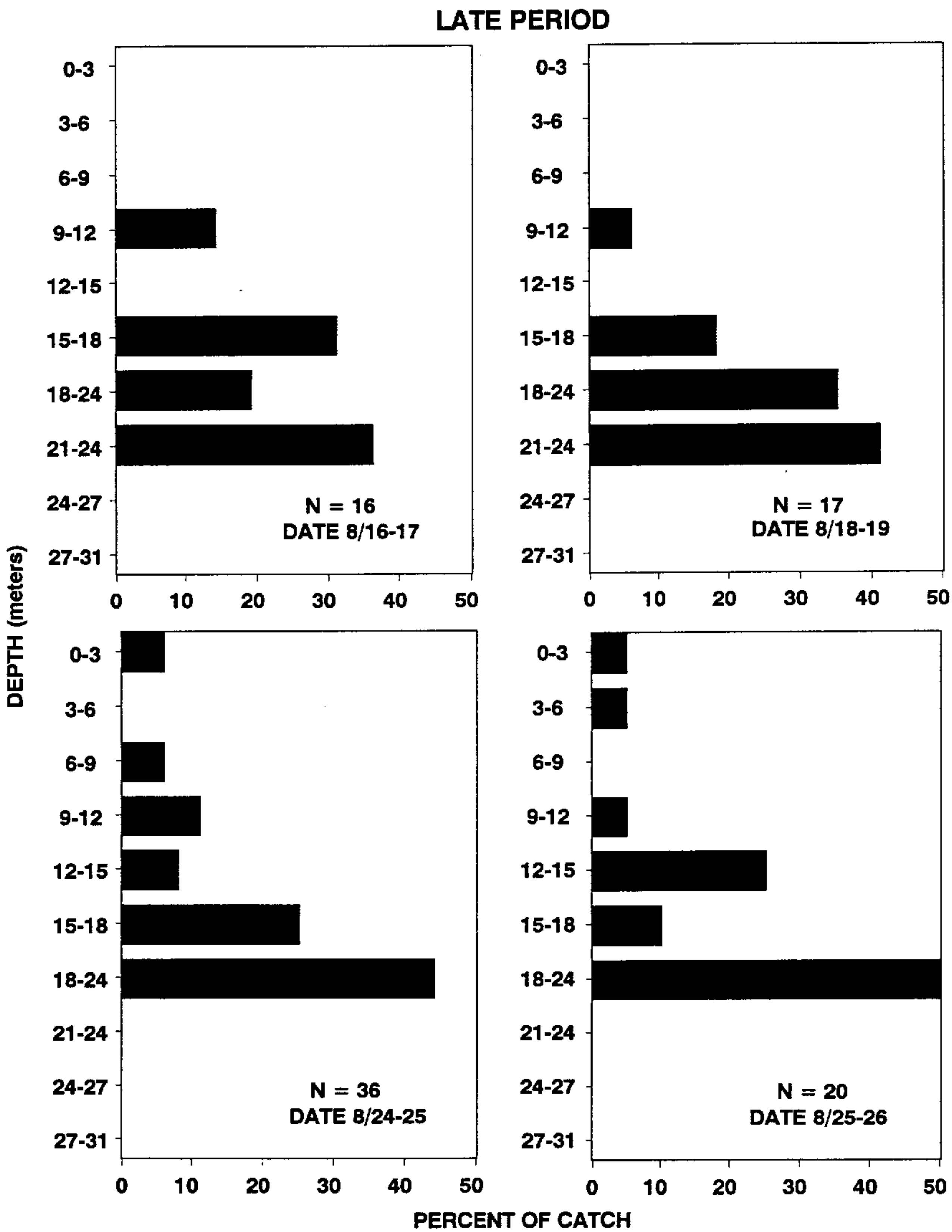

Figure 3. Percent of chinook subyearling catch by depth from Howard Hanson Reservoir (late period).

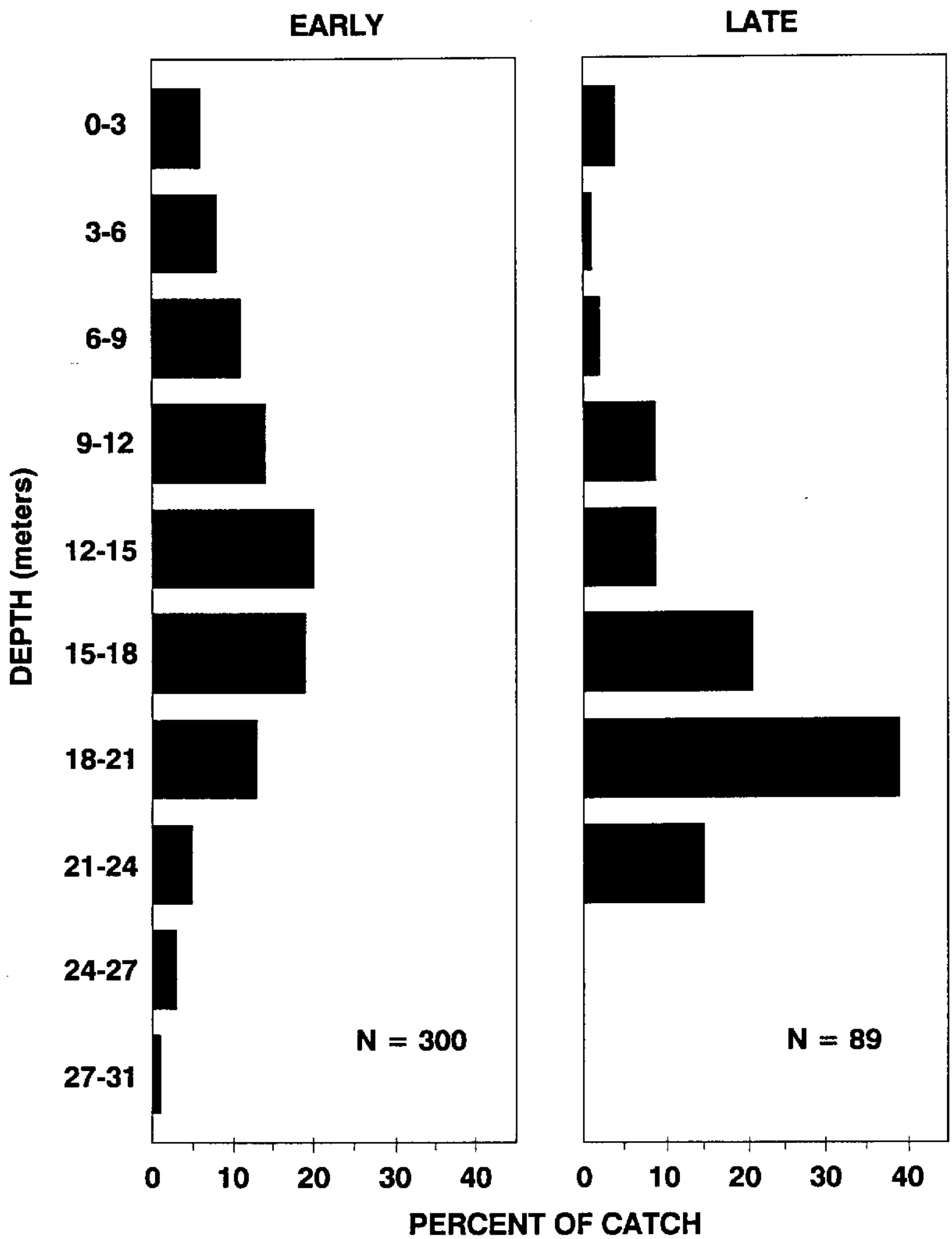

Figure 4. Combined chinook subyearling catches for early and late periods from Howard Hanson Reservoir.

Appendix A. Juvenile chinook collected during the study period. All chinook were subyearlings.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)
May 26	0	2.5	125
May 26	0	2.5	110
May 26	0	2.5	95
May 26	3	2.5	98
May 26	3	2.5	111
May 26	6	2.5	96
May 26	12	2.5	110
May 26	15	2.5	108
May 26	15	2.5	111
May 26	18	2.5	108
May 28	0	2.5	107
May 28	0	2.5	106
May 28	0	2.5	111
May 28	0	2.5	114
May 28	0	2.5	121
May 28	0	2.5	103
May 28	6	2.5	104
May 28	6	2.5	114
May 28	6	2.5	105
May 28	6	2.5	110
May 28	6	2.5	110
May 28	6	2.5	130
May 28	6	2.5	109
May 28	6	2.5	110
May 28	6	2.5	114
May 28	9	2.5	104
May 28	9	2.5	101
May 28	9	2.5	102
May 28	9	2.5	101
May 28	9	2.5	105
May 28	9	2.5	103
May 28	9	2.5	101
May 28	9	2.5	107
May 28	9	2.5	106
May 28	9	2.5	102
May 28	9	2.5	105
May 28	12	2.5	105
May 28	12	2.5	102
May 28	12	2.5	104
May 28	12	2.5	114
May 28	15	2.5	105
May 28	15	2.5	101
May 28	15	2.5	105
May 28	15	2.5	110

Appendix A. Continued.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)
May 28	18	2.5	104
May 28	18	2.5	105
May 28	24	2.5	93
Jun 1	3	2.5	107
Jun 1	3	2.5	113
Jun 1	3	2.5	110
Jun 1	3	2.5	109
Jun 1	3	2.5	110
Jun 1	3	2.5	103
Jun 1	3	2.5	120
Jun 1	3	2.5	108
Jun 1	6	2.5	103
Jun 1	6	2.5	105
Jun 1	6	2.5	103
Jun 1	6	2.5	106
Jun 1	6	2.5	104
Jun 1	6	2.5	108
Jun 1	6	2.5	106
Jun 1	6	2.5	123
Jun 1	6	2.5	105
Jun 1	6	2.5	108
Jun 1	6	2.5	104
Jun 1	6	2.5	109
Jun 1	6	2.5	103
Jun 1	6	2.5	109
Jun 1	6	2.5	105
Jun 1	6	2.5	100
Jun 1	6	2.5	98
Jun 1	6	2.5	108
Jun 1	6	2.5	108
Jun 1	6	2.5	110
Jun 1	9	2.5	107
Jun 1	9	2.5	110
Jun 1	9	2.5	104
Jun 1	9	2.5	108
Jun 1	9	2.5	104
Jun 1	9	2.5	103
Jun 1	9	2.5	105
Jun 1	9	2.5	102
Jun 1	9	2.5	107
Jun 1	9	2.5	110
Jun 1	9	2.5	111
Jun 1	9	2.5	106
Jun 1	9	2.5	106
Jun 1	9	2.5	104
Jun 1	9	2.5	108

Appendix A. Continued.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)
Jun 1	9	2.5	105
Jun 1	9	2.5	105
Jun 1	9	2.5	108
Jun 1	9	2.5	113
Jun 1	9	2.5	110
Jun 1	12	2.5	106
Jun 1	12	2.5	106
Jun 1	12	2.5	110
Jun 1	12	2.5	100
Jun 1	12	2.5	108
Jun 1	12	2.5	104
Jun 1	12	2.5	105
Jun 1	12	2.5	108
Jun 1	12	2.5	105
Jun 1	12	2.5	109
Jun 1	12	2.5	107
Jun 1	12	2.5	110
Jun 1	12	2.5	103
Jun 1	12	2.5	107
Jun 1	12	2.5	111
Jun 1	12	2.5	108
Jun 1	12	2.5	106
Jun 1	15	2.5	102
Jun 1	15	2.5	112
Jun 1	15	2.5	108
Jun 1	15	2.5	103
Jun 1	15	2.5	107
Jun 1	15	2.5	106
Jun 1	15	2.5	102
Jun 1	15	2.5	104
Jun 1	15	2.5	103
Jun 1	15	2.5	109
Jun 1	15	2.5	105
Jun 1	18	2.5	106
Jun 1	18	2.5	108
Jun 1	18	2.5	105
Jun 1	18	2.5	108
Jun 1	18	2.5	103
Jun 1	18	2.5	98
Jun 1	18	2.5	105
Jun 1	18	2.5	110
Jun 1	18	2.5	102
Jun 1	18	2.5	103
Jun 1	21	2.5	109
Jun 1	21	2.5	100
Jun 1	21	2.5	101

Appendix A. Continued.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)
Jun 1	24	2.5	110
Jun 1	24	2.5	100
Jun 4	0	2.5	114
Jun 4	0	2.5	104
Jun 4	0	2.5	112
Jun 4	0	2.5	109
Jun 4	0	2.5	110
Jun 4	0	2.5	109
Jun 4	0	2.5	104
Jun 4	0	2.5	112
Jun 4	0	2.5	111
Jun 4	3	2.5	108
Jun 4	3	2.5	112
Jun 4	3	2.5	110
Jun 4	3	2.5	104
Jun 4	3	2.5	112
Jun 4	3	2.5	104
Jun 4	3	2.5	112
Jun 4	3	2.5	106
Jun 4	3	2.5	100
Jun 4	3	2.5	105
Jun 4	3	2.5	113
Jun 4	3	2.5	104
Jun 4	6	2.5	105
Jun 4	6	2.5	113
Jun 4	6	2.5	110
Jun 4	6	2.5	107
Jun 4	6	2.5	110
Jun 4	9	2.5	105
Jun 4	9	2.5	104
Jun 4	9	2.5	105
Jun 4	9	2.5	109
Jun 4	9	2.5	104
Jun 4	9	2.5	110
Jun 4	9	2.5	112
Jun 4	9	2.5	106
Jun 4	9	2.5	107
Jun 4	9	2.5	113
Jun 4	9	2.5	104
Jun 4	12	2.5	106
Jun 4	12	2.5	107
Jun 4	12	2.5	105
Jun 4	12	2.5	109
Jun 4	12	2.5	100
Jun 4	12	2.5	104
Jun 4	12	2.5	115

Appendix A. Continued.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)
Jun 4	12	2.5	111
Jun 4	12	2.5	108
Jun 4	12	2.5	105
Jun 4	12	2.5	108
Jun 4	12	2.5	110
Jun 4	12	2.5	113
Jun 4	12	2.5	107
Jun 4	12	2.5	108
Jun 4	12	2.5	112
Jun 4	12	2.5	110
Jun 4	12	2.5	105
Jun 4	12	2.5	112
Jun 4	12	2.5	107
Jun 4	12	2.5	104
Jun 4	12	2.5	109
Jun 4	12	2.5	109
Jun 4	12	2.5	106
Jun 4	12	2.5	95
Jun 4	12	2.5	108
Jun 4	12	2.5	106
Jun 4	12	2.5	109
Jun 4	12	2.5	108
Jun 4	12	2.5	100
Jun 4	12	2.5	99
Jun 4	12	2.5	104
Jun 4	12	2.5	105
Jun 4	12	2.5	105
Jun 4	12	2.5	111
Jun 4	12	2.5	110
Jun 4	12	2.5	107
Jun 4	15	2.5	98
Jun 4	15	2.5	108
Jun 4	15	2.5	97
Jun 4	15	2.5	109
Jun 4	15	2.5	109
Jun 4	15	2.5	106
Jun 4	15	2.5	100
Jun 4	15	2.5	109
Jun 4	15	2.5	108
Jun 4	15	2.5	106
Jun 4	15	2.5	109
Jun 4	15	2.5	105
Jun 4	15	2.5	107
Jun 4	15	2.5	111
Jun 4	15	2.5	113
Jun 4	15	2.5	111

Appendix A. Continued.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)
Jun 4	15	2.5	110
Jun 4	15	2.5	102
Jun 4	15	2.5	108
Jun 4	15	2.5	106
Jun 4	15	2.5	110
Jun 4	15	2.5	110
Jun 4	15	2.5	103
Jun 4	15	2.5	106
Jun 4	15	2.5	102
Jun 4	15	2.5	111
Jun 4	15	2.5	110
Jun 4	15	2.5	111
Jun 4	15	2.5	110
Jun 4	15	2.5	106
Jun 4	15	2.5	103
Jun 4	15	2.5	105
Jun 4	15	2.5	110
Jun 4	15	2.5	106
Jun 4	15	2.5	97
Jun 4	15	2.5	100
Jun 4	15	2.5	107
Jun 4	15	2.5	101
Jun 4	15	2.5	109
Jun 4	15	2.5	101
Jun 4	15	2.5	100
Jun 4	18	2.5	106
Jun 4	18	2.5	105
Jun 4	18	2.5	106
Jun 4	18	2.5	105
Jun 4	18	2.5	106
Jun 4	18	2.5	104
Jun 4	18	2.5	101
Jun 4	18	2.5	105
Jun 4	18	2.5	104
Jun 4	18	2.5	109
Jun 4	18	2.5	107
Jun 4	18	2.5	101
Jun 4	18	2.5	112
Jun 4	18	2.5	104
Jun 4	18	2.5	110
Jun 4	18	2.5	110
Jun 4	18	2.5	105
Jun 4	18	2.5	108
Jun 4	18	2.5	108
Jun 4	18	2.5	103
Jun 4	18	2.5	101

Appendix A. Continued.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)
Jun 4	18	2.5	100
Jun 4	18	2.5	104
Jun 4	18	2.5	111
Jun 4	18	2.5	105
Jun 4	21	2.5	106
Jun 4	21	2.5	110
Jun 4	21	2.5	109
Jun 4	21	2.5	111
Jun 4	21	2.5	104
Jun 4	21	2.5	112
Jun 4	21	2.5	108
Jun 4	21	2.5	113
Jun 4	21	2.5	104
Jun 4	21	2.5	107
Jun 4	21	2.5	110
Jun 4	21	2.5	109
Jun 4	24	2.5	110
Jun 4	24	2.5	112
Jun 4	24	2.5	117
Jun 4	24	2.5	101
Jun 4	24	2.5	102
Jun 4	24	2.5	113
Jun 4	27	2.5	102
Jun 4	27	2.5	107
Jun 4	27	2.5	110
Jun 4	27	2.5	112
Aug 17	9	3.8	153
Aug 17	9	3.8	154
Aug 17	15	3.8	154
Aug 17	15	3.8	161
Aug 17	15	3.8	152
Aug 17	15	3.8	149
Aug 17	15	3.8	151
Aug 17	18	3.8	154
Aug 17	18	3.8	165
Aug 17	18	3.8	162
Aug 17	21	3.8	155
Aug 17	21	3.8	158
Aug 17	21	3.8	165
Aug 17	21	3.8	166
Aug 17	21	3.8	151
Aug 17	21	3.8	150
Aug 18	9	3.8	148
Aug 18	15	3.8	158
Aug 18	15	3.8	167
Aug 18	15	3.8	154

Appendix A. Continued.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)
Aug 18	18	3.8	
Aug 18	18	3.8	146
Aug 18	18	3.8	163
Aug 18	18	3.8	161
Aug 18	18	3.8	165
Aug 18	18	3.8	156
Aug 18	21	3.8	170
Aug 18	21	3.8	153
Aug 18	21	3.8	145
Aug 18	21	3.8	150
Aug 18	21	3.8	157
Aug 18	21	3.8	153
Aug 18	21	3.8	157
Aug 24	0	3.8	158
Aug 24	0	3.8	159
Aug 24	6	3.8	149
Aug 24	6	3.8	157
Aug 24	9	3.8	159
Aug 24	9	3.8	156
Aug 24	9	3.8	151
Aug 24	9	3.8	155
Aug 24	12	3.8	162
Aug 24	12	3.8	173
Aug 24	12	3.8	173
Aug 24	15	3.8	157
Aug 24	15	3.8	157
Aug 24	15	3.8	170
Aug 24	15	3.8	155
Aug 24	15	3.8	163
Aug 24	15	3.8	163
Aug 24	15	3.8	160
Aug 24	15	3.8	143
Aug 24	15	3.8	150
Aug 24	18	3.8	155
Aug 24	18	3.8	160
Aug 24	18	3.8	159
Aug 24	18	3.8	165
Aug 24	18	3.8	153
Aug 24	18	3.8	170
Aug 24	18	3.8	155
Aug 24	18	3.8	166
Aug 24	18	3.8	167
Aug 24	18	3.8	168
Aug 24	18	3.8	165
Aug 24	18	3.8	157
Aug 24	18	3.8	182

Appendix A. Continued.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)
Aug 24	18	3.8	
Aug 24	18	3.8	153
Aug 24	18	3.8	169
Aug 25	0	3.8	163
Aug 25	3	3.8	163
Aug 25	9	3.8	155
Aug 25	12	3.8	172
Aug 25	12	3.8	165
Aug.25	12	3.8	162
Aug 25	12	3.8	158
Aug 25	12	3.8	158
Aug 25	15	3.8	159
Aug 25	15	3.8	163
Aug 25	18	3.8	163
Aug 25	18	3.8	158
Aug 25	18	3.8	158
Aug 25	18	3.8	163
Aug 25	18	3.8	172
Aug 25	18	3.8	153
Aug 25	18	3.8	152
Aug 25	18	3.8	163
Aug 25	18	3.8	158
Aug 25	18	3.8	160

[a] Beginning date of 24-hour sampling.
[b] Top of 3-meter depth stratum where captured.
[c] Stretch mesh of gillnet in centimeters.

Appendix B. Juvenile coho collected during the study period.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)	Year class
May 26	3	2.5	110	0+
May 26	6	2.5	115	1+
May 28	3	2.5	124	1+
May 28	9	2.5	117	1+
Jun 1	0	2.5	105	0+
Jun 1	6	2.5	131	1+
Jun 1	6	2.5	119	1+
Aug 17	9	2.5	108	0+
Aug 17	15	3.8	137	0+
Aug 17	21	3.8		
Aug 18	9	2.5	109	0+
Aug 18	15	3.8	136	0+
Aug 25	18	2.5	102	0+

[a] Beginning date of 24-hour sampling.
[b] Top of 3-meter depth stratum where captured.
[c] Stretch mesh of gillnet in centimeters.

Appendix C. Juvenile trout collected during the study period.

Date[a]	Depth[b]	Mesh[c]	Forklength (mm)	Species[d]	Year class
May 26	3	3.8	202	rbt	2+
May 26	3	3.8	195	rbt	1+
May 26	6	3.8	194	rbt	1+
May 28	3	3.8	178	rbt	1+
Jun 1	0	3.8	184	rbt	1+
Jun 4	0	3.8	193	rbt	1+
May 26	0	2.5	124	cut	1+
Aug 25	9	2.5	123	cut	
Aug 25	12	2.5	113	cut	

[a] Beginning date of 24-hour sampling.
[b] Top of 3-meter depth stratum where captured.
[c] Stretch measure of gillnet in centimeters.
[d] Rbt- rainbow trout; cut- cutthroat trout.