PRELIMINARY REPORT ON THE EVALUATION OF THE 1-ON-10-SLOPE FISH LADDER AT ICE HARBOR DAM ON THE SNAKE RIVER

By

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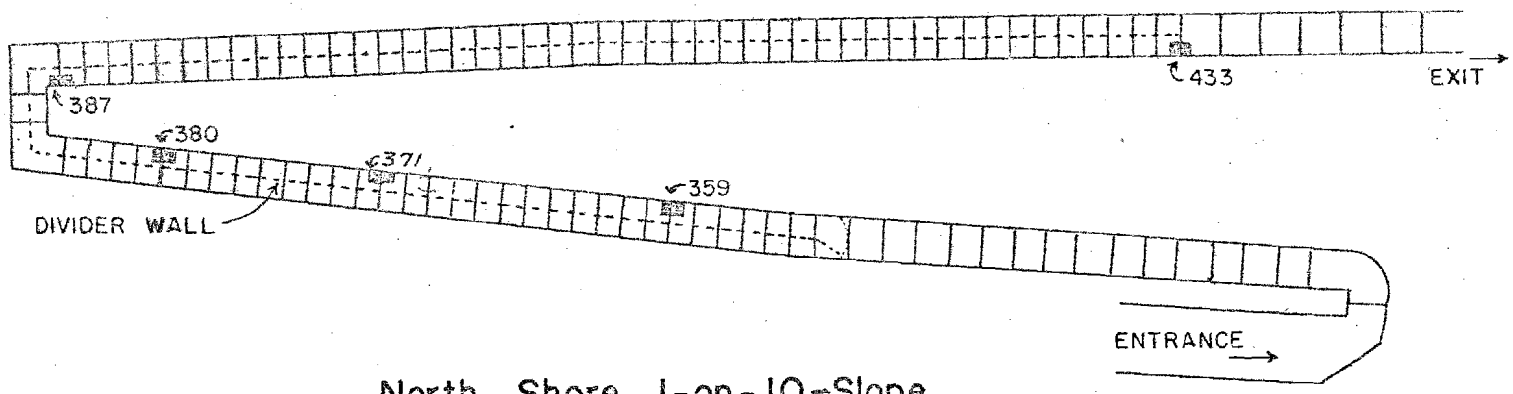
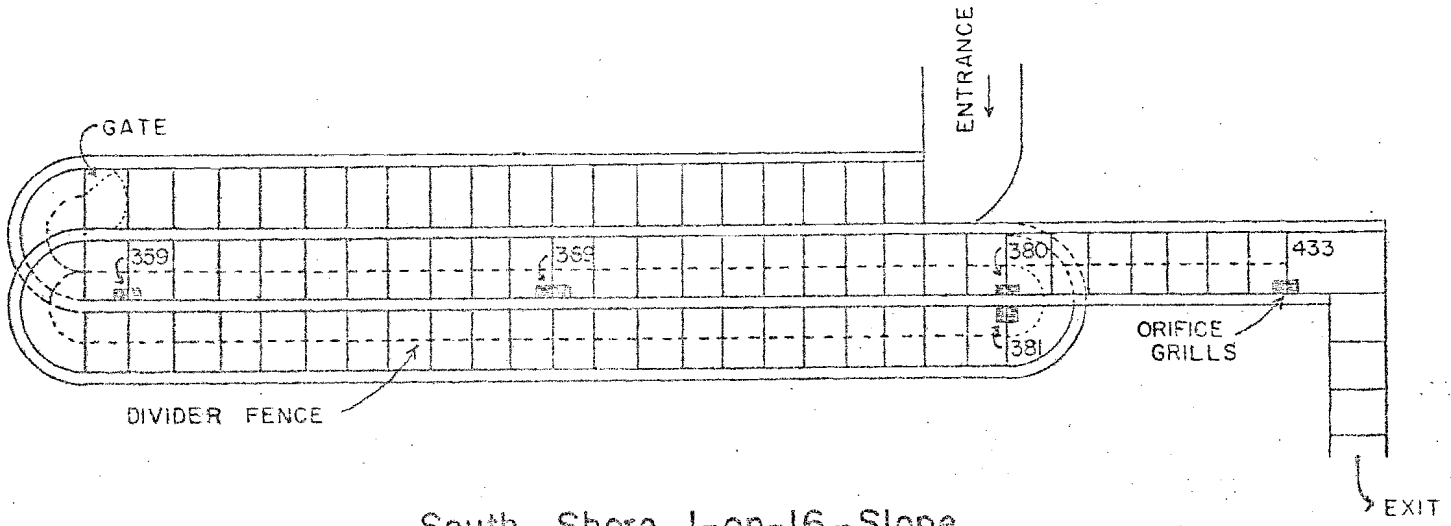
ICE HARBOR FISH LADDERS



North Shore 1-on-10-Slope



South Shore 1-on-16-Slope

Figure 1.--Sketch of Ice Harbor fish ladders showing locations of count stations.

During this period, fish that had previously entered the test side were given time to pass through the fishway. This permitted beginning each test with relatively few fish in the test side of the ladder. At the beginning of each test, the position of the swinging gate was reversed and all fish were diverted into the test side for a period of from 2 to 3 hours. Following this entry period, the position of the gate was again reversed, blocking further entry into the test side. This permitted timing of the group of fish that had entered the test section of the ladder. Test sections in each ladder extended from weir elevation 359 to weir elevation 433, or 74 pools. Five count stations were provided within this section; counts were made at weir elevations 359, 371, 380, 387, and 433 in the 1-on-10-slope ladder and at weir elevations 359, 369, 380, 381, and 433 in the 1-on-16-slope ladder. The submerged orifices at each of these stations were blocked by removable grills during tests so that the fish were required to swim over the weir crest where they could be counted by observers stationed above the weirs.

Passage at each station was recorded on an electrically operated time-event recorder located in the control center. Each observer was provided with a switch box containing four pushbutton switches. When a fish crossed the weir, the observer pushed the appropriate button, which activated a pen on the recorder. A permanent graphic record on a time-scaled chart was thus obtained of the passage of each fish at each station. The four buttons at each station were employed to tally (1) the upstream passage of salmonids, (2) the downstream passage of salmonids, (3) the upstream passage of all other species, and (4) the downstream passage of other species.

Generally, tests were conducted simultaneously in the north and south ladders or on alternate days in one of the two ladders. In a few instances, tests were conducted in the same ladder for more than 1 successive day. The number of count stations employed in each ladder varied throughout the series of tests. Counts were always maintained at weir elevations 359, 380, and 433 in each ladder. Counts at the other two stations were used intermittently, depending on the type of test being conducted and the number of personnel available.

Tests were conducted intermittently throughout the summer, from May to October. Each series of tests was scheduled to concur with the arrival of the various species and races of salmonids entering the Snake River (fig. 2). The number of tests conducted during each portion of the run depended upon the number of fish available. When we were unable to obtain adequate numbers of fish during the 2- to 3-hour entry period, testing was discontinued until the run increased.

RESULTS

The following brief summary of the results must be considered preliminary until such time as the final report of the study is completed. At this time, evaluation of the performance of fish in the two ladders will be restricted to comparisons of median passage times of salmonids through the entire 74-pool test sections. These values were derived by subtracting the time at which 50 percent of the salmonids had crossed weir 359 from the time at which 50 percent of the salmonids had crossed weir 433. These times and the number of fish counted at the two weirs are presented in table 1.

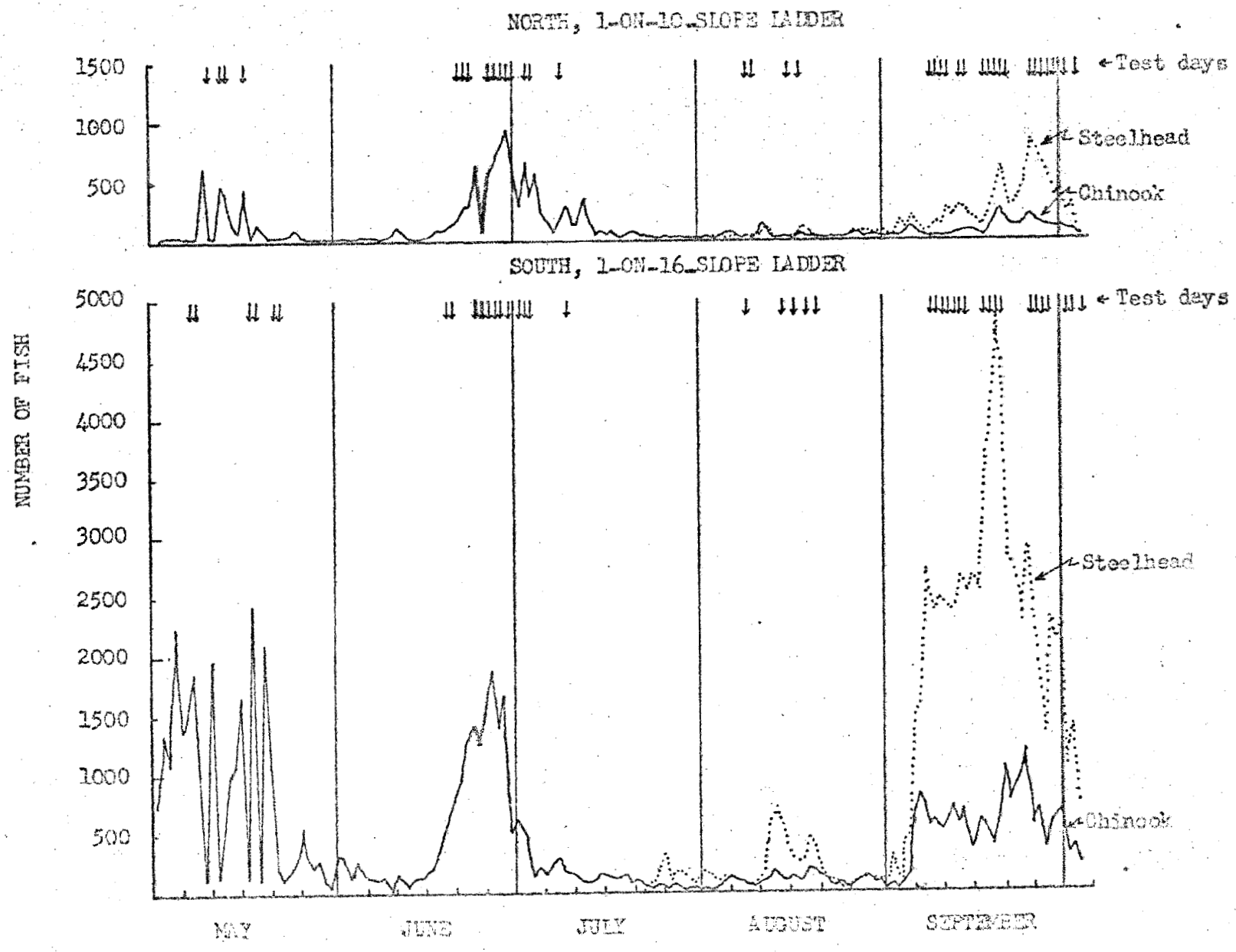


Figure 2.--Daily counts of chinook salmon and steelhead trout ascending the Ice Harbor fish ladders (Corps of Engineers count stations). Arrows at the top of each graph indicate days tests were conducted.

Table 1.--Passage times through the 74-pool test section in the 1-on-10- and 1-on-16-slope ladders and numbers of fish counted at the lower and upper count stations.

Date		Counts at lower and upper stations of 74-pool test section				Median passage time through 74-pool test section	
		1-on-10 slope		1-on-16 slope		1-on-10 slope	1-on-16 slope
		Lower (359)	Upper (433)	Lower (359)	Upper (433)		
		Number of salmonids				Minutes	
May	12	37	35	--	--	140	--
	13	60	55	--	--	152	--
	16	280	234	--	--	114	--
	17	--	--	562	550	--	122
	18	--	--	7	4	--	142
	21	--	--	9	19	--	162
	22	--	--	14	18	--	168
June	19	--	--	66	82	--	114
	20	--	--	108	157	--	110
	21	26	21	--	--	91	--
	22	14	15	--	--	85	--
	23	19	18	--	--	67	--
	24	--	--	193	216	--	103
	25	--	--	134	145	--	113
	26	7	7	--	--	81	--
	27	137	139	320	321	110	108
	28	244	224	284	303	116	104
	29	262	261	63	76	124	102
	30	93	92	--	--	106	--
July	1	--	--	58	56	--	105
	2	90	79	16	16	104	95
	3	19	18	20	16	108	100
	8	5	6	--	--	130	--
	9	--	--	17	15	--	80
August	2	--	--	9	8	--	155
	8	3	3	--	--	95	--
	9	3	3	--	--	95	--
	14	--	--	282	183	--	149
	15	11	12	--	--	73	--
	16	--	--	59	38	--	92
	17	65	67	--	--	100	--
	18	--	--	126	120	--	121
	20	--	--	31	43	--	110

Table 1.--Passage times through the 74-pool test section in the 1-on-10- and 1-on-16-slope ladders and numbers of fish counted at the lower and upper count station (continued).

Date		Counts at lower and upper stations of 74-pool test section				Median passage time through 74-pool test section	
		1-on-10 slope		1-on-16 slope		1-on-10 slope	1-on-16 slope
		Lower (359)	Upper (433)	Lower (359)	Upper (433)		
		Number of salmonids				Minutes	
September	8	26	24	206	314	85	95
	9	37	48	323	403	77	105
	10	34	25	149	94	95	95
	11	69	84	626	652	80	94
	12	--	--	336	343	--	88
	13	168	154	620	719	118	98
	14	71	60	335	413	108	104
	17	21	22	796	636	84	1/
	18	172	185	979	588	85	1/
	19	319	298	1274	853	113	1/
	20	227	234	943	694	79	1/
	21	108	100	--	--	90	
	25	243	227	491	525	97	123 2/
	26	70	67	204	229	122	110
	27	184	181	181	184	106	104
	28	207	199	588	612	106	100
	29	147	161	--	--	97	--
October	1	45	48	190	239	94	106
	2	--	--	229	252	--	96
	3	18	16	--	--	84	--

1/ Hole in divider screen just below weir 433, allowing fish to escape into bypass side.

2/ Heavy concentration of floating algae in fish ladder.

Number of Fish in Tests

There was considerable variation in the numbers of fish involved in the various tests both within and between ladders. Differences within ladders were generally associated with the seasonal pattern of the run. The consistently larger sample sizes in the 1-on-16-slope ladder, however, were due to the fact that generally more fish utilized this ladder. Several factors contributed to the unequal utilization of the two ladders. During the spring chinook run (May), a section of cofferdam remaining from the construction phase of the dam was instrumental in creating a large eddy downstream from the entrance to the north-shore ladder. This condition is believed to have prevented many fish from locating the entrance. During the month of May, 90 percent of the total chinook passage over the dam was counted through the south (1-on-16-slope) ladder. The test on May 16 in the 1-on-10-slope ladder, involving 280 fish, was made possible by special arrangement with the Corps of Engineers whereby the spillway gates were closed for a 2-hour period during the test.

Beginning about mid-June, spillway discharges began decreasing, and it was possible to adjust the various spillway gates to provide a more desirable entrance condition to the north-shore ladder. A larger percentage of salmonids entered the 1-on-10-slope ladder during this period, and during the peak passage days of the summer chinook run, up to 260 fish entered the ladder during the 2- to 3-hour entry period.

There was virtually no spill during the fall chinook and steelhead runs as the entire river flow was being passed through the turbines. Fish following the main flow of the river were thus attracted to the powerhouse collection system and entrance to the 1-on-16-slope ladder. During this period, Corps of Engineers personnel were quite cooperative in opening spillway gates on the north shore prior to and during tests in an attempt to attract more fish into the 1-on-10-slope ladder. Although sample sizes were still smaller than those in the 1-on-16-slope ladder, many were large enough to provide a reliable measure of fish performance in the 1-on-10-slope ladder.

Accuracy of Counts

It may be noted that there are discrepancies in the numbers of fish counted at the lower (weir elevation 359) and upper (weir elevation 433) count stations in both ladders; i.e., there were more fish counted out than had entered. This can be attributed in part to error in identification of species at the two count sites. In addition to salmonids, generally equal or greater numbers of other species (suckers, squawfish, carp, etc.) were present during the tests. Many of these fish were as large as small salmonids. Observers, having to decide whether these fish were salmonids or other species in the brief time required for the fish to cross the weir, could understandably make errors in identification. Visibility and distance from observer to weir varied between count stations, and it is likely that chances for error were greater at some stations than others. The upper stations in both ladders were at the downstream end of the nonoverflow section of the ladder; consequently, the flow over the weir was smooth and free from turbulence. Counts

here were therefore probably more accurate than at any other station. The lower stations in each ladder were typically rough due to turbulence, entrained air, and the upwelling from the orifice in the pool above. Observers were quite conscientious in their efforts to achieve accurate counts, and periodic checks of their accuracy by biologistsconducting the study indicated counts were probably as accurate as could be expected under these adverse conditions. Counts in the 1-on-16-slope ladder were probably susceptible to a greater degree of error than those in the 1-on-10-slope ladder, as observers were required to maintain surveillance over a greater weir span (12 feet in the 1-on-16 compared to 5 feet in the 1-on-10-slope ladder).

Passage Times

There was considerable variation in passage times in both ladders throughout the season. Passage times through the 74-pool test section ranged from 67 to 152 minutes in the 1-on-10-slope ladder and from 80 to 168 minutes in the 1-on-16-slope ladder (table 1). A comparison of passage times in the two ladders for selected tests is presented in figure 3. In presenting these data, only tests conducted on the same day or alternate days were considered. Certain tests were omitted due to small sample sizes, or to operational difficulties or abnormal occurrences during the tests.

Although passage times for paired tests in the two ladders differed by as much as 36 minutes (fig. 3), there was no consistent pattern that indicated passage might be slower or faster in the 1-on-10-slope ladder. In 11 instances, passage times were greater in the 1-on-10-slope ladder, and in 10 instances they were greater in the 1-on-16-slope ladder.

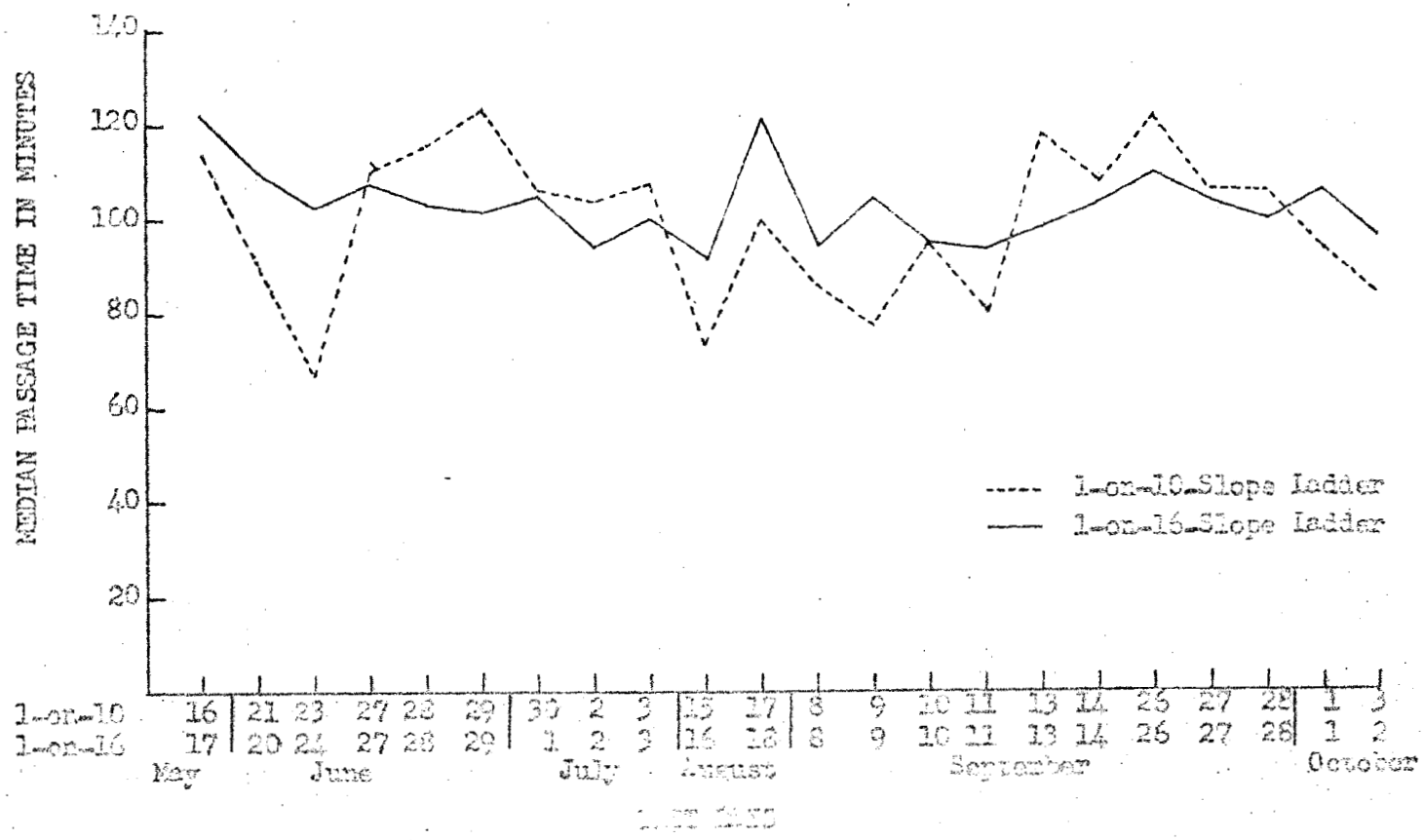


Figure 3.--Comparison of times required for salmonids to ascend the 74-pool test sections in the 1-on-10- and 1-on-16-slope ladders. Passage times are based on the median.

Conclusions

Although final conclusions from this study must be reserved until a more comprehensive analysis of the data has been completed, it is obvious that adult salmonids successfully ascended the 1-on-10-slope ladder, and comparisons of passage times in the 1-on-10- and 1-on-16-slope ladders indicate that performance patterns did not differ markedly. It is recognized that many of the comparisons of passage times are based upon relatively small sample sizes. Despite this, one might expect that any undesirable design features in the 1-on-10-slope ladder serious enough to cause passage problems would have been manifested in even the small samples. As has been shown, no such problems developed.

Although only total passage times have been considered here, further analysis will include an examination of passage rates in the various sections of the ladders to determine if any differences in behavior are in evidence. In addition, passage rates and behavior of other species will be compared.