

ESCAPEMENT OF JUVENILE SALMONIDS
FROM BROWNLEE RESERVOIR

by

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INTRODUCTION

An assessment of the escapement of juvenile salmonids from Brownlee Reservoir is essential to a comprehensive evaluation of the effect of the reservoir on the passage of salmon and steelhead stocks. To provide this assessment, an investigation of the escapement was begun in July 1963. The objectives of this study were to define in terms of size, time, and success, the escapement of juvenile salmonids from Brownlee Reservoir according to brood stock.

Prior to this study, the Idaho Department of Fish and Game carried out a number of experiments below Brownlee Dam in relation to juvenile fish passage and evaluation of fish facilities in this area. These studies began in July 1957 and continued intermittently through July 1963. Work by Bell (1959, 1960, & 1961) and Graban (1964) have provided valuable background information for the current investigation.

Brownlee Dam is a high head structure whose primary function is power production. It has a crest width of 1,320 feet and creates approximately 277 feet of hydraulic head at full reservoir. The powerhouse, located on the Idaho side, contains four Francis-type turbines. A single spillway is located on the Oregon side. A barrier net and skimmer units for the capture of downstream migrants were positioned about 1 mile upstream of the dam. A major portion of this facility was removed in the spring of 1964.

Below the powerhouse (fig. 1) the turbine tailrace extends approximately 600 feet to the old river channel. It is about 250 feet wide and varies in depth from 17 to 22 feet, depending upon the level of the Oxbow Reservoir.

The Brownlee Interstate Bridge is located approximately 2,000 feet downstream from the dam. At this point, the river is about 525 feet wide and has an average depth of 12 feet at mid-channel. Water levels at the bridge are subject to some fluctuation, depending on operations at Oxbow Dam.

METHODS AND EQUIPMENT

The objectives of this study required the sampling and enumeration of juvenile salmonids at some site below the dam. Preliminary investigation of the vertical distribution of salmonid smolts in the turbine tailrace indicated that turbine escapement could be adequately sampled by surface fishing scoop



Figure 1.--Area below Brownlee Dam showing turbine tailrace (foreground) and Interstate Bridge. Note scoop traps below tower on right bank. Spillway (inoperative in this photo) discharge enters old river channel on extreme left.

traps. Since the turbines represent the only avenue of escape available to the fish during most of the year, a position approximately 500 feet below the powerhouse was selected as our primary sampling site.

When the spillway was in operation, large counter eddies formed in the tailrace and made it impossible to operate the traps immediately below the powerhouse. A secondary sampling site was, therefore, established downstream at the Interstate Bridge. All traps were moved to this site during spilling periods.

Scoop Traps

Three scoop traps were used for sampling. These traps were obtained from the Idaho Department of Fish and Game in July 1963. Each trap was 10 feet wide by 15 feet long and fished to a depth of 4 feet. A pontoon-type barge, 18 by 25 feet, supported the individual traps and winch equipment.

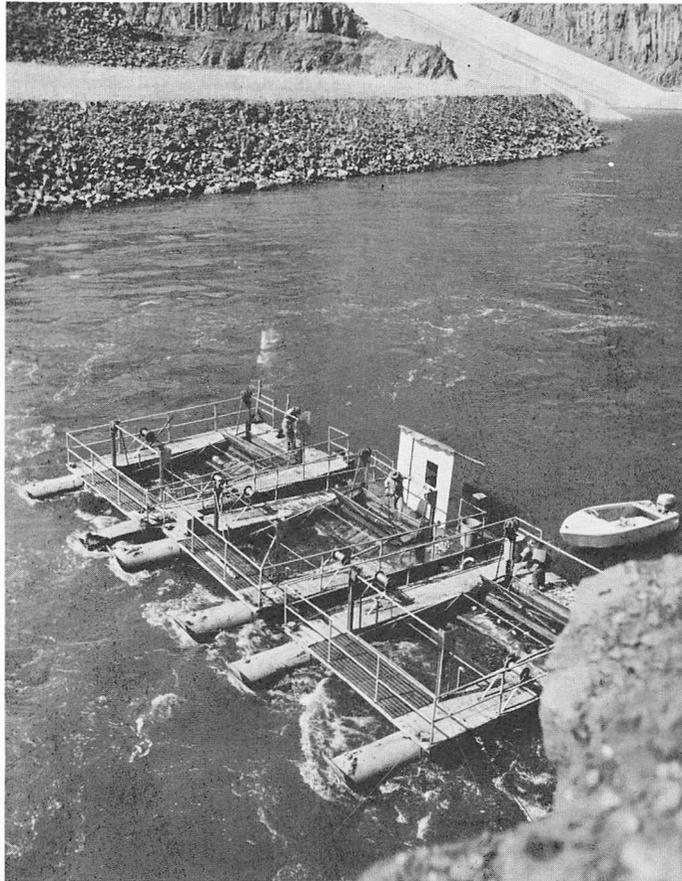
The traps were positioned in close proximity along the right (Idaho) bank at the tailrace site (fig. 2). At the Interstate Bridge, one trap was fished at the center of the channel and the other two were approximately 100 feet from the right and left bank respectively.

All traps were checked at 8 a.m. and 4 p.m. daily during periods of normal operation. A noon and midnight check was added during periods of peak migration or when excessive amounts of debris required additional checks. At various times, 4- and 6-hour check schedules were used during special studies.

At each check, the trap was emptied of all fish and debris. All salmonids were identified, examined for marks or tags, and measured for fork and standard length. All live salmonids were anesthetized, processed, and released unless needed for special studies. Scale samples were taken from all dead and injured fish whenever possible.

Distribution Net

A special net capable of fishing at various depths was constructed to investigate the vertical distribution of the juvenile salmonids at the two sampling sites. This distribution net was 10 feet wide by 5 feet deep at the mouth, 31 feet long, and tapered to a 1.5-foot-square cod end.



**Figure 2.--Scoop traps in operation at tailrace
sampling site.**

The net was fished intermittently at both sampling sites. A rotating schedule was used to insure a uniform fishing effort at the various depths throughout the sampling period.

Trap Efficiency Tests

A mark and recapture program was used to evaluate the efficiency of the scoop traps at the two sampling sites. Most of the fish used in these efficiency tests were hatchery reared chinook (0-age) and coho (1-year) salmon. Less than 200 of the test fish were native yearling chinook.

Efficiency tests of traps at the Interstate Bridge required the release of fish into the turbine penstocks as well as directly into the spill. Tests at the tailrace site required only penstock releases. Test fish were marked by partial fin-clip or by tattoo.

Identification of Stocks

Length frequency distributions in combination with tag and fin-clip recovery information have been used to separate the various stocks of juvenile salmon present in the escapement. Hatchery reared chinook, planted in the Snake River above the reservoir in the spring of 1964, were not marked. Separation of this group from other native stocks was not possible during the latter part of the spring because of an overlap of length frequency distributions. However, scale analysis may provide an eventual basis for identification of these hatchery fish. Coho salmon were also planted in the Snake River above the reservoir. These were readily identified since there were no natural stocks of coho in the system.

Escapement Estimates

Numerical estimates of salmonid escapement (January 1, 1963 to June 30, 1964) from the reservoir were based upon scoop trap catches and related trap efficiency tests. Totals for the period January 1 to June 30, 1963, include catches by the Brownlee skimmer units (left intact for sampling purposes after removal of barrier net) and prorated estimates of the escapement based on scoop trap catches by the Idaho Department of Fish and Game.

Estimates of escapement during periods of fishing at the Interstate Bridge have been computed with Chapman and Bailey's general formula:
$$N = \frac{C (M + 1)}{(R + 1)}$$

where
 N = estimated population
 C = catch or sample
 M = number of marked fish
 R = number of recaptures

In using this formula, it was assumed that marked and unmarked fish were randomly distributed at the sampling site and that no marks were lost between the release point and the traps.

During turbine tailrace sampling, the escapement estimates were based upon the percent of recaptures of marked fish released through the various turbines. Recovery percentages were determined for two time periods (8 a.m. to 4 p.m. and 4 p.m. to 8 a.m.) in accordance with turbine operating combinations (number of turbines and discharge). These values were then applied to the respective day-night scoop trap catches to provide the estimate of escapement for periods in which the discharge from Brownlee Reservoir was solely through the turbines.

RESULTS

Horizontal and Vertical Distribution

Individual scoop trap catches at the Interstate Bridge site are presented in table 1. The 883 salmon (chinook and coho) represent the fish taken during periods when all three traps were in operation. The distribution of fish in the center of the channel and on the Idaho side appeared to be relatively uniform. The somewhat smaller percentage of fish taken by trap 3 (Oregon side) was expected because lower water velocities in that area undoubtedly resulted in a lowered trap efficiency.

Table 1.--Distribution of juvenile salmon at the Interstate Bridge site based on scoop trap catches.

<u>Trap location</u>	<u>Trap number</u>	<u>Catch^{1/}</u>	<u>Percent</u>
Idaho side	2	385	43.6
Center channel	1	317	35.9
Oregon side	3	181	20.5
Totals :		883	100.0

^{1/} Catch includes both chinook and coho salmon.

Catches in the distribution net during the period of spillway operation (table 2) show the vertical distribution of fish at the bridge site to be very uniform. With an average channel depth of approximately 12 feet, 253 salmonids were taken from the upper 5 to 6 feet while 247 fish were taken below that depth.

A very different distribution was inherent at the tailrace site (tables 3 and 4). Approximately 61 percent of 1,795 salmon (chinook and coho) taken by the scoop traps at this site were taken by trap 1, fishing within 5 feet of the Idaho bank. Traps 2 and 3 took approximately 26 and 13 percent respectively.

With reference to the vertical distribution of fish in the tailrace area, 97 percent of the fish taken by the distribution net were taken from the top 6 feet of the water mass.

Table 2.--Vertical distribution of salmon fingerlings at the Interstate Bridge sampling site as determined by distribution net catches, April 19 through May 25, 1964.

Dates fished	Location fished	Coho		Chinook		Rainbow-steelhead	
		Surface	Bottom	Surface	Bottom	Surface	Bottom
April 19- May 7	Oregon side	0	0	38	44	4	12
May 8- May 25	Idaho side	64	54	113	108	34	29
Totals:		64	54	151	152	38	41

Table 3.--Distribution of juvenile salmon at the tailrace sampling site based on scoop trap catches.

Trap number	Catch ^{1/}	Percent
1	1,092	60.8
2	474	26.4
3	229	12.8
Totals:	1,795	100.0

^{1/} Catch includes both chinook and coho salmon.

Table 4.--Vertical distribution of salmon fingerlings (chinook and coho) at the tailrace sampling site based on distribution net catches, 1963-1964.

Date	Catch by depth						Total catch
	Surface		Middle		Bottom		
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	
<u>1963</u>							
Aug. 12							
to	75	92.0	3	4.0	3	4.0	81
Dec. 16							
<u>1964</u>							
June 4							
to	408	98.0	6	1.5	4	0.5	418
June 9							
Total:	483	96.8	9	1.8	7	1.4	499

Scoop Trap Efficiency Tests

From April 24 through June 30, 1964, 3,165 marked fish were released into the spillway and penstocks to determine the efficiency of the scoop traps at the Interstate Bridge site (table 5). Thirty fish (1 percent) were recovered at the bridge. The recovery rate for fish released into the penstocks was slightly higher than for those released into the spillway, although the difference was not statistically significant. Spillway discharge during the tests ranged from 14,600 to 42,000 c.f.s. and turbine discharge from 12,000 to 15,000 c.f.s.

The scoop traps proved much more efficient at the tailrace site. From July 3 through 18, 1964, 5,500 marked fish were released into the various penstocks. Recoveries from the various releases are presented in tables 6 and 7. Recovery rates for daylight tests (8 a.m. to 4 p.m.) ranged from 1.4 to 7.0 percent and averaged 3.8 percent overall. Recovery rates during night tests (4 p.m. through 8 a.m.) were much higher, ranging from 5.8 to 17.5 percent and averaging 11.3 percent. The difference in recovery rates of day and night tests is most probably the result of more fish avoiding the trap during the daytime. Total turbine discharge during the tests ranged from 2,980 to 21,980 c.f.s. Individual turbine discharge ranged from 2,475 to 5,650 c.f.s.

Table 5.--Scoop trap efficiency tests at the Interstate Bridge,
April 24 through June 30, 1964.

Date	Number released	Where released	Average spill (cfs)	Number recovered	Percent recovered
April 24	101	Spillway	6,247	1	0.99
25	100	Spillway	6,530	1	1.00
26	103	Spillway	9,838	1	0.97
27	95	Spillway	14,312	0	0.00
28	100	Spillway	16,178	0	0.00
29	100	Spillway	15,968	1	1.00
May 7	106	Spillway	19,348	4	3.77
7	89	Turbine	19,348	4	4.49
8	100	Spillway	22,678	0	0.00
8	100	Turbine	22,678	1	1.00
15	100	Turbine	18,000	0	0.00
16	100	Turbine	18,000	2	2.00
20	102	Spillway	20,432	1	1.98
20	100	Turbine	20,432	0	0.00
21	116	Turbine	19,474	2	1.72
27	106	Turbine	0	1	0.94
June 11	79	Spillway	11,719	1	1.27
14	179	Spillway	25,000	1	0.56
15	189	Spillway	26,031	2	1.06
15	200	Spillway	28,076	2	1.00
16	200	Turbine	28,076	1	0.05
17	100	Turbine	34,547	1	1.00
18	100	Turbine	38,865	0	0.00
19	100	Turbine	40,115	1	1.00
23	100	Spillway	42,000	0	0.00
24	100	Spillway	40,167	1	1.00
25	100	Spillway	33,924	1	1.00
30	100	Spillway	6,000	0	0.00
Totals:	3165			30	0.95

TABLE 6. -- Tailrace Scoop Trap Efficiency Tests, 8 a. m. through 4 p. m., July 3 to 8, 1964

Test Number	Date (July)	Turbine Tested								Turbines in Operation	Turbine Discharge
		1		2		3		4			
		Released	Recovery	Released	Recovery	Released	Recovery	Released	Recovery		
1	3	100	1	---	--	---	--	100	4	1, 2, 3 & 4	21, 825
2	3	100	1	---	--	---	--	100	6	1, 2, 3 & 4	21, 600
5	4	100	4	---	--	---	--	100	10	1, 2, 3 & 4	15, 490
6	4	100	0	---	--	---	--	100	7	1, 2, 3 & 4	15, 810
8	5	100	3	---	--	---	--	100	2	1, 3, & 4	13, 390
9	5	100	0	---	--	---	--	100	1	1, 3, & 4	14, 100
10	5	100	1	---	--	---	--	100	1	1, 3, & 4	13, 235
12	7	---	--	100	4	100	11	---	--	1, 2, 3 & 4	13, 680
13	7	---	--	100	5	100	5	---	--	1, 2, 3 & 4	15, 645
14	7	---	--	100	7	100	3	---	--	1, 2, 3 & 4	14, 730
15	8	---	--	100	0	100	9	---	--	1, 2, 3 & 4	18, 930
Totals:		700	10	400	16	400	28	700	31		
Per cent:			1.4		4.0		7.0		4.4		

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TABLE 7. -- Tailrace Efficiency Tests, 4 p. m. through 8. a. m., July 3 to 8, 1964

Number	Date (July)	Turbine Tested								Turbines in Operation	Turbine Discharge
		1		2		3		4			
		Released	Recovery	Released	Recovery	Released	Recovery	Released	Recovery		
3	3	100	0	---	--	---	--	100	10	1, 2, 3 & 4	20, 375
4	4	100	1	---	--	---	--	100	8	1, 2, 3 & 4	13, 330
7	4	100	4	---	--	---	--	100	9	1, 3, & 4	12, 325
11	7	---	--	---	--	100	7	---	--	1, 2, 3 & 4	12, 845
16	11	100	10	100	12	100	3	---	--	1, 2, & 3	9, 460
17	11	100	11	---	--	100	15	100	0	1, 3, & 4	9, 305
18	12	100	16	---	--	100	18	---	--	1 & 3	8, 050
19	12	---	--	100	22	100	12	---	--	1, 2 & 3	10, 380
20	14	100	10	---	---	100	5	---	--	1, 2 & 3	10, 620
21	15	100	6	---	--	---	--	---	--	1	2, 980
22	15	100	0	---	--	100	12	100	15	1, 3 & 4	12, 120
23	15	---	--	---	--	100	12	100	16	3 & 4	7, 555
24	16	---	--	100	23	100	39	100	27	2, 3 & 4	11, 975
25	17	100	0	---	--	100	12	---	--	1, 2, 3 & 4	10, 700
26	18	---	--	100	13	100	20	100	1	1, 2, 3 & 4	14, 425
Totals:		1000	58	400	70	1100	160	800	86		
Per cent:			5.8		17.5		14.5		10.8		

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Sample Catches

Scoop trap catches below Brownlee Dam from August 1, 1963, through June 30, 1964, are given in table 8. An additional 421 chinook, 140 cohos, and 94 trout were taken by the distribution net. The largest catches of chinook salmon were made during April, May, and June 1964. Approximately 64 percent of the total chinook catch was made during this period. Rainbow-steelhead catches peaked in April and May when 270 fish, representing 36 percent of the total catch, were taken by the scoop traps and distribution net. The first coho fingerling was taken on May 16, 1964. Peak coho catches were made during the latter part of May and early June. All reported catches are exclusive of special sampling to assess trap efficiency.

Approximately 62 percent of all juvenile chinook collected by the scoop traps were dead when removed from the trap. Coho and rainbow-steelhead mortality rates were 53.5 and 66.4 percent respectively. Most of these mortalities can be attributed to debris and turbulence in the trap holding pen. During recent trap efficiency tests, marked fish were run through the turbines and the traps checked 15 minutes later. Virtually all of the fish recaptured were alive and in excellent condition.

Length Distribution

Fork-length measurements were made on 3,408 chinook salmon, 555 coho salmon, and 335 rainbow-steelhead.

The chinooks ranged in size from 45 to 256 millimeters (table 9). Two major size groups were evident. The larger size group, or holdover fall-run progeny, constituted the greatest portion of the catch until April 1964. After that time, the smaller size group, or spring-run chinook progeny and hatchery plants, were dominant.

Rainbow-steelhead ranged from 45 to 340 millimeters (table 10). The larger fish (250 mm. or more) probably represent resident or residual trout.

Coho salmon of hatchery origin ranged from 75 to 170 millimeters (table 11).

Escapement

The estimated escapement from the reservoir during 1963-64 is presented in table 12. Comparisons of escapement (including Brownlee skimmer catches) and recruitment are given in table 13.

TABLE 8. -- Scoop Trap Catches Below Brownlee Dam, August 1, 1963 to June 30, 1964

		Chinook				Rainbow-Steelhead				Coho			
		Alive	Dead	Total	% Dead	Alive	Dead	Total	% Dead	Alive	Dead	Total	% Dead
August	1963	40	42	82	51.2	2	11	13	84.6	---	---	---	---
September	1963	1	15	16	93.9	1	0	1	0.0	---	---	---	---
October	1963	2	6	8	75.0	1	0	1	0.0	---	---	---	---
November	1963	13	36	49	73.5	1	0	1	0.0	---	---	---	---
December	1963	47	54	101	53.4	---	---	---	---	---	---	---	---
January	1964	19	228	247	92.3	0	14	14	100.0	---	---	---	---
February	1964	11	260	271	96.6	0	11	11	100.0	---	---	---	---
March	1964	215	155	370	41.9	11	19	30	63.4	---	---	---	---
April	1964	379	506	885	57.2	57	49	106	46.3	---	---	---	---
May	1964	136	374	510	73.4	18	61	79	77.2	128	91	219	41.5
June	1964	333	278	611	77.2	21	56	77	72.7	107	179	286	62.6
Totals:		1, 196	1, 954	3, 150	62.0	112	221	333	66.4	235	270	505	53.5

Table 9. -- Fork-length distribution of 3,408 chinook salmon collected below Brownlee Dam,
August 1, 1963 through June 30, 1964.

Length (mm.)	1963		1964									
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	
40												
45									1			
50									1			
55									19			
60									31			
65									98	1		
70				1					102	8		
75									104	21		
80							2		74	32		
85							2		68	44	1	
90	1				1		4	6	56	43	1	
95				1	5		2	15	55	55	12	
100					2	1	10	29	51	76	20	
105					4	6	8	32	45	62	58	
110					7	3	12	15	50	65	131	
115					14	5	9	13	28	58	158	
120					2	3	6	10	12	66	111	
125	1				3	3	4	7	7	89	52	
130	1				1		1	4	11	86	16	
135	4							1	4	37	1	
140	15								1	14	4	
145	42	2								4	2	
150	36	8								2	1	
155	13	4	2									
160	8	3	1	2			1	3				
165	3	2	3	3	1	1	3	2				
170	1	1		2	1	3	4	3				
175			1	13	2	2	0	4	3			
180			1	13	7	5	6	4	6	1		
185				21	22	12	4	7	7	1		
190				12	14	23	21	15	6	2		
195			1	2	13	43	26	17	9	2		
200					7	48	55	34	10	1		
205					1	41	47	45	24			
210					1	13	25	49	25			
215						7	8	29	16	2		
220							2	13	6	1		
225								3	4			
230								1				
235												
240												
245												
250												
255												
Totals:	124	20	9	70	108	219	262	360	934	762	568	

Table 10. -- Fork-length distribution of 335 rainbow-steelhead trout collected below Brownlee Dam, August 1, 1963 through June 30, 1964.

Length (mm.)	1963		1964								
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
100										1	
105									1		
110									2		
115						1			2		
120											1
125									2	2	
130									3	2	
135									7	3	
140									5	5	
145									4	5	
150									6	5	1
155						1			6	9	
160								1	6	8	
165							1		7	13	
170									5	10	
175									6	14	3
180				1				1	2	11	2
185										7	2
190									3	5	
195									3	7	
200								1	3	7	2
205								1		2	
210									2	4	1
215								1	2	2	
220									1	3	1
225	1								1	2	
230	1							1		6	
235	1									3	
240	2	1						1		2	
245								1			
250	2									1	
255			1							1	
260								2			
265	2										
270								1	1		
275								2			
280											
285						1		1	1	1	1
290						1	1	2	2	1	
295				1			4	3		1	1
300	1					2	2	5	7	3	
305						2	2	2	7	2	1
310							1	4		1	
315						2		2	2	3	
320								1		1	
325						2			3		
330						2			1	1	
335								1			
340									1		
Totals:	10	1	1	2	0	14	11	30	106	154	16

Table 10. -- Fork-length distribution of 335 rainbow-steelhead trout collected below Brownlee Dam, August 1, 1963 through June 30, 1964.

Length (mm.)	1963		1964								
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
100										1	
105									1		
110									2		
115						1			2		
120											1
125									2	2	
130									3	2	
135									7	3	
140									5	5	
145									4	5	
150									6	5	1
155						1			6	9	
160								1	6	8	
165							1		7	13	
170									5	10	
175									6	14	3
180				1				1	2	11	2
185										7	2
190									3	5	
195									3	7	
200								1	3	7	2
205								1		2	
210									2	4	1
215								1	2	2	
220									1	3	1
225	1								1	2	
230	1							1		6	
235	1									3	
240	2	1						1		2	
245								1			
250	2									1	
255			1							1	
260								2			
265	2										
270								1	1		
275								2			
280											
285						1		1	1	1	1
290						1	1	2	2	1	
295				1			4	3		1	1
300	1					2	2	5	7	3	
305						2	2	2	7	2	1
310							1	4		1	
315						2		2	2	3	
320								1		1	
325						2			3		
330						2			1	1	
335								1			
340									1		
Totals:	10	1	1	2	0	14	11	30	106	154	16

Table 11.--Fork-length distribution of 555 coho salmon collected below Brownlee Dam, May 16 through June 30, 1964.

Fork-length in millimeters	May 16-31	June 1-15	June 16-30
75	1		
80			
85	1		
90	3		
95	8	1	
100	9	4	
105	8	8	1
110	12	18	0
115	28	34	1
120	43	30	1
125	69	22	1
130	77	16	6
135	37	14	3
140	15	12	1
145	5	13	1
150	2	17	1
155	2	11	2
160		5	3
165		1	3
170		1	6
175			
180			
Total:	318	207	30
Mean Length:	124	128	146

Table 12.--Estimated number of salmonids passing sampling sites below Brownlee Dam, January 1963 to June 1964.

Month	'62 Brood Snake R.	'62 Brood Eagle Cr.	'63 Brood	'62 Brood	Rainbow- steelhead
	Fall chinook	Spring chinook	Hatchery chinook	Hatchery cohos	
Jan. 1963					
Feb. 1963					
Mar. 1963					
Apr. 1963					
May 1963	200 ^{2/}				
June 1963	30,500 ^{2/}				
July 1963	1,700 ^{2/}				
Aug. 1963	1,800				220
Sep. 1963	300				10
Oct. 1963	200				10
Nov. 1963	500	50			10
Dec. 1963	800	450			0
Jan. 1964	2,700	300			100
Feb. 1964	2,500	750			150
Mar. 1964	2,800	1,650			350
Apr. 1964	2,700	1,000 ^{1/}	18,500		2,300
May 1964	700	1,500 ^{1/}	53,800	22,400	10,800
June 1964		300 ^{1/}	22,700	17,200	7,600
Totals:	47,400	6,000	95,000	39,600	21,550

1/ An accurate separation of Eagle Creek fish from hatchery plant chinook during April, May, and June, 1964 was not possible due to an overlap in length frequency distributions. The numbers presented here represent an approximation based upon the total number of Eagle Creek fish available in the reservoir.

2/ Based on Idaho Department of Fish and Game catches.

Table 13.--Estimated escapement from Brownlee Reservoir (May 1963 through June 1964) as related to recruitment.

Stock	Brood year	Species	Estimated recruitment	Escapement estimated ^{2/}	Percent escapement
Snake River	1962	Chinook	390,000	50,130 ^{2/}	12.8
Hatchery plant	1963	Chinook	175,000	95,000	54.0
Eagle Creek	1962	Chinook	12,200 ^{1/}	6,000	49.2
Hatchery plant	1962	Coho	92,500	40,000	43.0

^{1/} Fish actually entering reservoir. 18,800 additional fish were collected in Eagle Creek and transported below Oxbow Dam and released.

^{2/} Includes fish taken at skimmer net.

1962 Brood Snake River Fall-run Progeny.--A total of 50,130 fish from the Snake River fall chinook run of 1962 are estimated to have left the reservoir during 1963 and 1964. This represents approximately 13 percent of the total recruitment estimate. Of this total, an estimated 47,400 fish left the reservoir via the turbines or spillway. The remaining fish were taken at the Brownlee barrier net and transported downstream. Peak migration occurred in June 1963, but fair numbers of fish from this brood continued to appear in the scoop trap catches through the spring of 1964.

1962 Brood Eagle Creek Spring-run Progeny.--Escapement amounted to approximately 6,000 fish by June 30, 1964. This total represents approximately 50 percent of the number of fish estimated to have entered the reservoir. (Total recruitment from Eagle Creek was estimated at 31,000, of which approximately 19,000 were collected and transported for release below Oxbow Dam.) Accurate separation of this stock from the hatchery plant of chinook was not possible during April, May, and June, 1964. The escapement estimates for these months were based upon migration curves from previous years, which were prorated in accordance with the current recruitment and escapement estimates.

1962 Brood Coho (Hatchery Plants).--A total of 92,500 coho salmon were estimated to have entered the reservoir during April, May, and June of 1964. During May and June 1964, an estimated 40,000 fish (43 percent) passed the sampling sites below the dam.

1963 Brood Chinook (Hatchery Plants).--The hatchery plant of chinook fingerlings passed through the reservoir with somewhat more success than the coho salmon. Fifty-four percent (95,000) of the estimated 175,000 fish entering the reservoir passed Brownlee Dam.

Rainbow-steelhead.--No attempt has been made to differentiate the stocks of trout or to estimate the recruitment at this time. Approximately 22,000 fish are estimated to have left the reservoir during 1963 and 1964. About one-third of these fish were considered to be resident rainbow trout.

DISCUSSION

Conditions for the passage of young salmonids through Brownlee Reservoir may have been more favorable in 1964 than in any previous period since construction of the dam. The reservoir was at a low level throughout most of the spring migration period, and both before and after filling, there was an extended period of heavy spill. These factors resulted in an escapement of approximately 50 percent of all fish entering the reservoir in 1964. Data for comparison of total escapements in previous years are limited. However, information on the recruitment and escapement of progeny from the 1962 Snake River fall run suggests that escapement success was considerably less in 1963 than in 1964. Offspring of the above brood year entered the reservoir in the spring of 1963 and passed out of the reservoir both in 1963 and 1964. Total escapement of this brood in 1963 (through December 31) was about 10 percent of the estimated recruitment, or only one-fifth the escapement of broods entering the reservoir in 1964.

A comparison of the relative escapement success of various stocks of chinook salmon may be made by examining the Brownlee barrier net and scoop trap catches for the 1962-64 period (table 14). These catches give indication of the proportions of the respective recruitments that have appeared in the escapement over the past 3-year period. Apparently the progeny of spring run stocks (Eagle Creek and Weiser River) have been more successful in passing through the reservoir than those of the fall-run stock (Snake River).

TABLE 14. -- Recruitment Estimates of Individual Chinook Salmon Stocks and Respective Catches at the Brownlee Barrier Net and in Scoop Traps Below Brownlee Dam.

Estimated Recruitment	Origin of Stock	Brood Year	Barrier Net Catches			Scoop Trap Catches		Total	Per cent Caught at Barrier Net and Scoop Traps
			1962	1963	1964	1963 _{3/}	1964		
9,235 ^{1/}	Eagle Creek	1960	710 ^{1/}	---	---	---	---	710	7.7
2,613 ^{2/}	Weiser River	1960	279 ^{2/}	---	---	---	---	279	10.3
529,000	Snake River	1961	1,645	4,381	---	947	---	6,973	1.3
117,000	Eagle Creek	1961	---	5,893	---	191	---	6,084	5.2
34,000	Weiser River	1961	---	620	---	107	---	727	2.1
390,000	Snake River	1962	---	2,218	520	764	786	4,288	1.1
31,000	Eagle Creek	1962	---	---	---	---	4/	---	---
7,000	Weiser River	1962	---	---	---	---	4/	---	---

1/ Numbers marked and recaptured only (Oregon Game Commission).

2/ Numbers marked and recaptured only (Idaho Department of Fish and Game).

3/ Includes catches by Idaho Department of Fish and Game.

4/ These stocks were known to be present in the reservoir, but they were not distinguishable in the escapement.

Catches at the barrier net have usually amounted to only a small fraction of the total recruitment. The recent estimates of escapement below the dam indicate that far greater numbers passed the dam than were taken at the skimmer net. In 1963, for example, 2,218 chinook of the 1962 Snake River brood were collected at the skimmer facility and 36,000 were estimated in the escapement below Brownlee Dam. Since the barrier net was removed in 1964, a comparison of the escapement and skimmer catches would not be appropriate for this year.

SUMMARY

Assessments of the escapement of salmonids below Brownlee Dam were initiated by Bureau of Commercial Fisheries personnel on August 1, 1963, and have continued to the present date. Prior to the above period, the Idaho Department of Fish and Game carried out a number of experiments below Brownlee Dam in relation to juvenile fish passage and evaluation of fish facilities in this area. These studies began in July 1957 and continued intermittently through July 1963.

Equipment used in the present study included three scoop traps, formerly employed in the aforementioned investigations, and a special sampling net, which was used to assess vertical distribution of fingerlings at the sampling sites. Areas sampled included the tailrace immediately below the powerhouse at Brownlee Dam and the channel at the Interstate Bridge, which is about 2,000 feet below the dam. The latter site was used primarily during periods of spill. Sampling in the turbine tailrace was usually done when there was no spill, since an active spillway discharge created large counter eddies in the turbine tailrace area.

The three scoop traps were positioned in close proximity along the right bank in the turbine tailrace. At the Interstate Bridge, they were located on the right and left banks, with one trap in the center of the channel. The traps were checked for fish at least two times a day, and during peak runs they were serviced four times a day.

Special releases of marked fingerlings were made in the spillway and the turbine penstocks to determine the percentage of fish caught at the respective sampling sites. Hatchery fish (0-age chinook and yearling cohos) were used in these studies.

Length frequency distributions combined with tag and fin-clip recovery information provided a basis for separation of the various stocks of juveniles present in the escapement.

Hatchery-reared chinook, planted in the Snake River above Brownlee Reservoir in the spring of 1964, were not marked. Consequently, separation of this group from other native stocks was not possible during the latter part of the spring because of an overlap in their length frequency distributions. However, scale analysis may provide an eventual basis for identification of the hatchery fish.

All salmonids were classified by species, examined for marks or tags, and measured for fork lengths. Live fish were anesthetized before handling and were released after processing. Scale samples were taken from a number of dead and injured fish.

Distribution

Recoveries at the Interstate Bridge showed that fish were approximately evenly distributed from top to bottom, and generally the same was true for the horizontal distribution. By contrast, 97 percent of the fish taken in the turbine tailrace were in the surface layer (top 6 feet). Previous studies by the Idaho Department of Fish and Game showed that most fish were concentrated along the right bank (Idaho side) of the turbine tailrace. This was confirmed in the recent work.

Efficiency of Scoop Traps

Interstate Bridge.--Catches of marked fish in the scoop traps at the Interstate Bridge showed a recovery of approximately 1 percent from respective releases in the spillway and the turbines. Recoveries from the turbines were slightly higher than those from the spillway. Spill discharges during fish releases in the spillway ranged from 14,600 to 42,000 c.f.s., and velocities at the Interstate Bridge ran from 2 to 8 f.p.s. Releases of fish in the turbines were made at discharges of 12,000 to 15,000 c.f.s.

Turbine Tailrace.--Recoveries of marked fish from daylight releases ranged from 1.4 to 7.0 percent and averaged 3.4 percent overall. Recoveries from night releases ranged from 5.8 to 17.5 percent and averaged 11.3 percent overall. The higher recovery at night may have been the result of less fish avoiding the trap during the dark than in daylight hours. Total turbine discharge during tailrace tests ranged from 2,980 to 21,825 c.f.s. and from 2,980 to 5,650 c.f.s. by the individual turbine.

Catches Below Brownlee

Scoop trap catches from August 1, 1963, through June 30, 1964, included 3,150 chinook, 505 coho, and 333 rainbow-steelhead. These totals are exclusive of special sampling to assess trap efficiency and vertical distribution. The largest catches of salmon were made during April, May, and June, 1964. Rainbow-steelhead trout peaked in April and May. The first coho salmon was taken on May 16, and peak catches were made during the latter part of May.

Length frequencies were as follows: chinook--45 to 256 mm., coho--75 to 170 mm., and rainbow-steelhead--45 to 340 mm. The larger chinook were identified as progeny of the 1962 run of fall chinook.

Condition of Captured Fish

Approximately 62 percent of all juvenile chinook collected in the scoop traps were dead. Mortalities on cohos and rainbow-steelhead were 53.5 and 66.4 percent respectively. Most of these mortalities can be attributed to turbulence and debris in the trap holding pen. During recent tests with marked fish in the turbine penstocks, the barge traps were serviced shortly after the fish were released. Virtually all of the recaptured fish were in excellent condition.

Escapement

1962 Brood Snake River Fall-run Chinook.--An estimated 50,130 fish (including skimmer catches) migrated through the reservoir during 1963-1964. This represents about 13 percent of the recruitment estimate. Peak migration occurred in June of 1963 followed by a secondary peak from January through April 1964.

1962 Brood Eagle Creek Spring-run Chinook.--Forty-nine percent (6,000 fish) of the total entering the reservoir was successful in passing through it. Peak migration occurred in March, April, and May of 1964.

1962 Brood Coho (Hatchery Plants).--Approximately 40,000 fish (43 percent of estimated recruitment) are estimated to have passed the sampling sites below the dam during May and June 1964.

1963 Brood Chinook (Hatchery Plants).--Fifty-four percent (95,000 fish) of the estimated recruitment was estimated to have migrated through the reservoir as of June 30, 1964. Peak migration occurred in May, 1963--approximately 8 weeks after planting.

Rainbow-steelhead.--An estimated 21,550 trout migrated from the reservoir from August 1963 through June 1964. No attempt has been made to separate the various stocks, but approximately 31 percent of the total escapement were considered resident rainbow trout.

Relative Escapement.--Based on the proportions of the various stocks of chinook salmon contributing to the escapement, spring-run progeny appear to have been more successful in passing through the reservoir than those from the fall-run.

CONCLUSIONS

1. Escapement of juvenile salmonids from Brownlee Reservoir can be successfully monitored by scoop traps below the dam.
2. Escapement from the reservoir in 1963 greatly exceeded the barrier net catches in that year.
3. Progeny of spring-run chinook stocks are more successful in passing through the reservoir than fall-run chinooks.
4. The ability of juveniles to pass through the reservoir apparently varies from year to year (10 to 54 percent) depending on conditions in the reservoir.

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