

DAY-NIGHT OCCURRENCE AND VERTICAL DISTRIBUTION  
OF JUVENILE SALMONIDS AND LAMPREY AMMOCOETES  
IN TURBINE INTAKES (SUMMARY)

by

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## SUMMARY

Data on the day-night occurrence and vertical distribution of fingerling salmonids and lamprey ammocoetes were obtained in the turbine intakes of The Dalles Dam in 1960. In 1961, further studies were made to measure the vertical distribution of fingerling salmonids in the turbine intakes of McNary Dam.

The powerhouse of The Dalles Dam is positioned parallel to the course of the river and contains 12 turbines. The McNary powerhouse is positioned perpendicular to the course of the river and contains 14 turbines. Turbines at both dams each have three intakes--designated as A, B, and C.

A special steel intake frame (fig. 1), supporting six fyke nets, was used for this work. The frame and nets were lowered into the turbine intake through a slot in the gatewell. The fyke nets were positioned one above the other in the center of the frame and strained almost one-third of the flow in the individual intake. Vertically, the nets extended from the ceiling to within three feet of the floor. Each net measured  $6\frac{1}{2}$  feet wide by 7 feet high at the mouth and was 19 feet long including the cod end. Volumes strained were approximately equal for each net.

Fyke nets used at The Dalles incorporated  $\frac{1}{2}$ -inch stretched mesh webbing in the forward half of the body and  $3/16$ -inch square mesh in the back half. Fyke nets used at McNary were constructed entirely of  $\frac{1}{2}$ -inch stretched mesh. Generally, the same procedure was followed at both dams. Before installing the frame, each net was folded and tied to the frame with string that could be easily broken by the flows in the turbine intake. The flows through the intake were stopped before installing or removing the frame to prevent capturing fish while the nets were being raised or lowered through the intake.

Virtually all fish taken in the fyke nets were dead and extensively descaled from impingement on the webbing. The few live fish appearing in the catches presumably were caught just before the nets were brought up or were taken as the nets (a remote possibility) were drawn up through static water in the gatewells. Catches at The Dalles Dam included these live fish, but live fish were excluded from the catches at McNary Dam.

At The Dalles, catches of salmonids were composed of two major size groups. Fish under 80 mm. in length were classified arbitrarily as 0-year salmonids. Virtually all fish

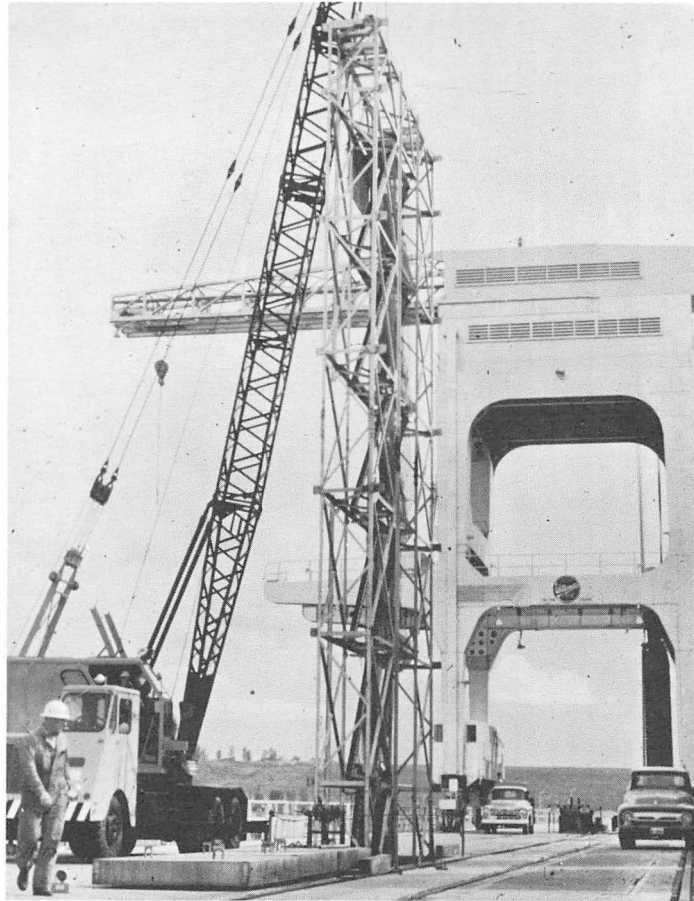


Figure 1.--Intake frame being lowered through gatewell into a turbine intake at McNary Dam. Frame supports fyke nets to sample vertical distribution of fingerlings.

of this size were chinook salmon. Fish over 80 mm. in length were identified by species and referred to as 1+ age. At McNary, catches were composed primarily of the 1+ age group. Salmonid catches included chinook (*Oncorhynchus tshawytscha*), & sockeye (*O. nerka*) salmon, and steelhead trout (*Salmo gairdneri*). Lamprey ammocoetes (*Lampetra tridentata*) were also caught.

### The Dalles Dam Tests

Two series of tests were conducted during the period beginning April 7 and ending May 12, 1960. The first series was designed to compare day-night passage and the second, vertical distribution of fish in the turbine intakes.

#### Day-Night passage (test series #1)

Day fishing averaged 10½ hours within the 12-hour period from 7:00 a.m. to 7:00 p.m. Night fishing averaged 10½ hours within the 12-hour period from 7:00 p.m. to 7:00 a.m. In all cases, the frame was installed in the center or B intake of the unit, and the turbine was set to discharge 11,000 cubic feet per second. Each test included a day and night fishing period at the same location. Five tests were made at the downstream end of the powerhouse (unit number 1), seven at the middle (unit number 5), and seven at the upstream end (unit numbers 10 and 11).

Total catches made in each part of the powerhouse are presented in table 1 according to species and percent caught during each of the day and night fishing periods. The data for all powerhouse areas were combined and are presented graphically in figure 2.

Assuming that net efficiency was constant for day and night fishing periods, the data indicate that:

1. Passage of all species through the turbines was greater during the night than during the day.
2. A greater proportion of 1+ salmonids passed through the turbines at night than either the 0-year salmonids or the lamprey ammocoetes.

#### Vertical distribution (test series #2)

Fishing averaged 16 hours within the 17-hour period from 3:30 p.m. to 8:30 a.m. the following day. In all cases, the frame was installed in the center or B intake and the turbine

Table 1.--Day-night passage of fingerling salmonids and lamprey ammocoetes through the turbines of The Dalles Dam, 1960.

Species	Powerhouse Area								
	Upstream end			Middle			Downstream end		
	Night <sup>1/</sup>	Day <sup>1/</sup>	Total	Night	Day	Total	Night	Day	Total
	<u>Percent</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	<u>Percent</u>	<u>Number</u>
0-year salmonids	71.7	28.3	416	62.5	37.5	248	61.2	38.8	201
1+ chinook	93.9	6.1	326	94.2	5.8	189	94.4	5.6	358
1+ steelhead	81.7	18.3	71	82.7	17.3	127	89.8	10.2	118
ammocoetes	75.8	24.2	182	51.1	48.9	282	63.5	36.5	315

<sup>1/</sup> See text for timing.

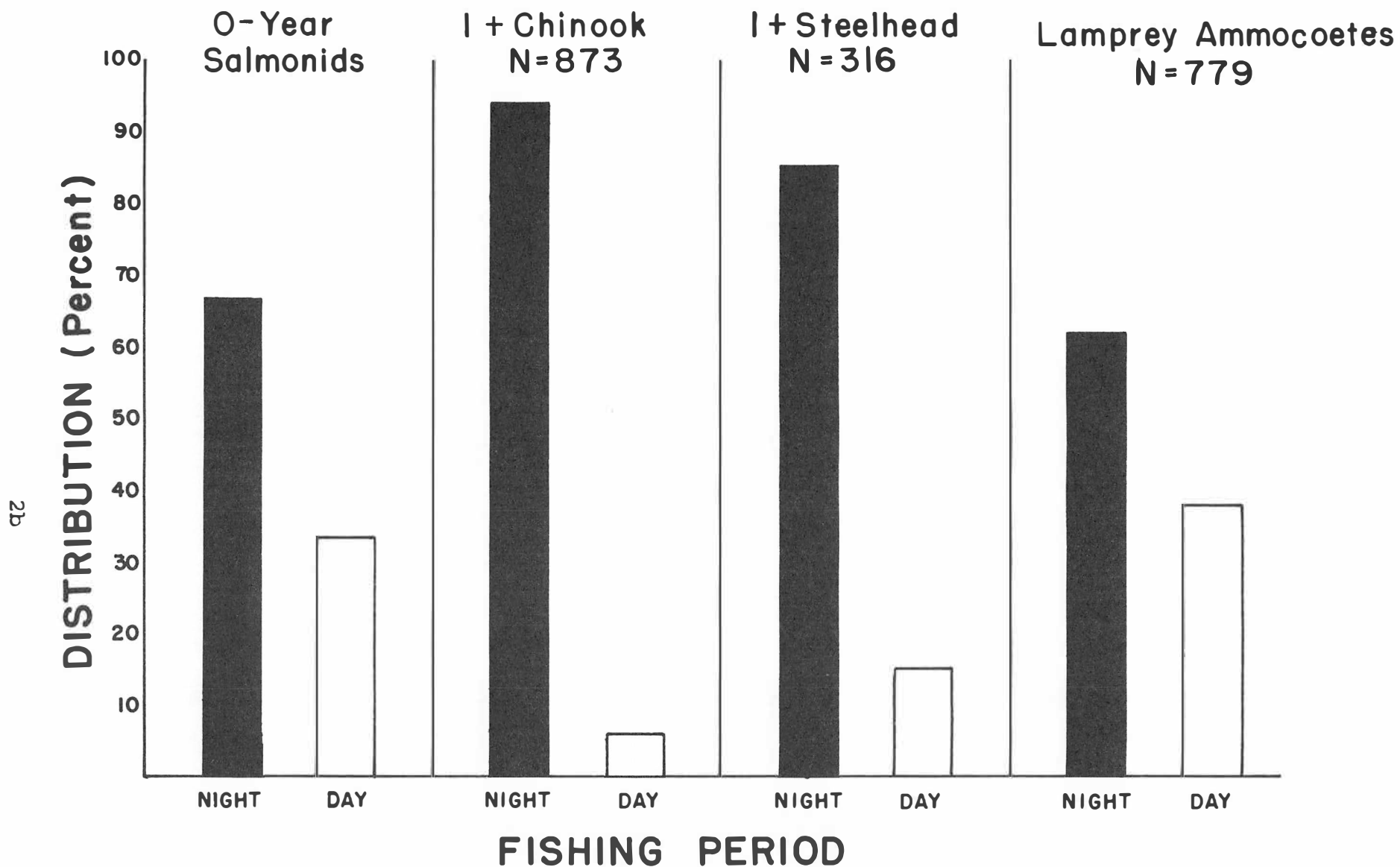


Figure 2.--Comparison of day and night passage of salmonids and lamprey ammocoetes through turbine intakes at the Dalles Dam, 1960.

was set to discharge 11,000 c.f.s. Five samples were made at the downstream end of the powerhouse (unit number 1); six at the middle (unit numbers 5 and 6), and three at the upstream end (unit numbers 10 and 12).

Tables 2 through 6 give the vertical distribution in the various powerhouse areas according to age and species. Combined results are given in table 7 and presented graphically in figure 3.

The catches showed that:

1. A majority of the 1+ salmonids (from 58 to 74 percent) were caught in the two top nets, or within 15 feet of the turbine intake ceiling.

2. Zero-year salmonids were less strongly stratified. Only 48 percent were caught in the two top nets.

3. Lamprey ammocoetes were concentrated toward the bottom of the intake. A majority were caught in nets 4, 5, and 6.

4. Vertical distribution of all species was essentially the same at each area of the powerhouse.

#### McNary Dam Tests

Tests at McNary Dam were confined to one part of the powerhouse (unit 12, intake C) at McNary Dam. Fishing periods averaged 8 hours, generally from 9:00 p.m. to 5:00 a.m. on the following day. During the period from April 24 to May 26, 1961, ten tests were conducted at a turbine discharge of 8,000 c.f.s., and ten at a discharge of 12,500 c.f.s.

Over four times as many fish were caught at a turbine discharge of 12,500 c.f.s. than at a discharge of 8,000 c.f.s. The following results are based on testing at the 12,500 c.f.s. discharge.

The total number and percent of each species caught in each net are presented in table 8. A majority of each species (from 62 to 79 percent) was caught in the two top nets (fig. 4), or within 15 feet of the intake ceiling.

Table 2.--Vertical distribution of 0-year salmonids in turbine intakes of The Dalles Dam by powerhouse area.

Net number (top to bottom)	Powerhouse area					
	Upstream end		Middle		Downstream end	
	Number	Percent	Number	Percent	Number	Percent
1	107	24.6	111	31.6	88	30.4
2	93	21.4	70	19.9	42	14.5
3	76	17.5	49	14.0	41	14.2
4	81	18.7	63	18.0	43	14.9
5	62	14.3	40	11.4	32	11.1
6	15	3.5	18	5.1	43	14.9
Totals	434	100.0	351	99.9	289	100.

Table 3.--Vertical distribution of 1+ chinook fingerlings in turbine intakes of The Dalles Dam by powerhouse area.

Net number (top to bottom)	Powerhouse area					
	Upstream end		Middle		Downstream end	
	Number	Percent	Number	Percent	Number	Percent
1	51	35.2	211	45.8	321	55.9
2	46	31.7	113	24.5	131	22.8
3	29	20.0	67	14.5	62	10.8
4	13	9.0	36	7.8	25	4.4
5	5	3.4	24	5.2	17	3.0
6	1	0.7	10	2.2	18	3.1
Totals	145	100.0	461	100.0	574	100.0



Table 4.--Vertical distribution of 1+ steelhead fingerlings  
in turbine intakes of The Dalles Dam by powerhouse area.

Powerhouse area						
Net number (top to bottom)	Upstream end		Middle		Downstream end	
	Number	Percent	Number	Percent	Number	Percent
1	9	56.3	87	46.3	66	44.9
2	3	18.7	51	27.1	39	26.6
3	3	18.7	25	13.3	19	12.9
4	0	0.0	18	9.6	9	6.1
5	1	6.3	3	1.6	8	5.4
6	0	0.0	4	2.1	6	4.1
Totals	16	100.0	188	100.0	147	100.0

Table 5.--Vertical distribution of 1+ sockeye fingerlings  
in turbine intakes of The Dalles Dam by powerhouse area.

Powerhouse area						
Net number (top to bottom)	Upstream end		Middle		Downstream end	
	Number	Percent	Number	Percent	Number	Percent
1	17	50.0	52	26.1	70	36.6
2	6	17.6	54	27.2	47	24.6
3	3	8.8	37	18.6	31	16.2
4	4	11.8	33	16.6	20	10.5
5	2	5.9	8	4.0	15	7.9
6	2	5.9	15	7.5	8	4.2
Totals	34	100.0	199	100.0	191	100.

Table 6.--Vertical distribution of lamprey ammocoetes in turbine intakes of The Dalles Dam by powerhouse area.

Powerhouse area						
Net number (top to bottom)	Upstream end		Middle		Downstream end	
	Number	Percent	Number	Percent	Number	Percent
1	13	4.4	36	4.9	52	8.0
2	19	6.5	92	12.4	98	15.1
3	41	14.0	142	19.3	128	19.7
4	62	21.2	171	23.2	154	23.7
5	89	30.4	204	27.7	167	25.8
6	69	23.5	92	12.5	50	7.7
Totals	293	100.0	737	100.0	649	100.0

Table 7.--Vertical distribution of salmonids in turbine intakes of The Dalles Dam, 1960.

Net number (top to bottom)	All species and age groups	
	Number	Percent
1	1,190	39.3
2	695	22.9
3	442	14.6
4	345	11.4
5	217	7.2
6	140	4.6
Total	3,029	100.0

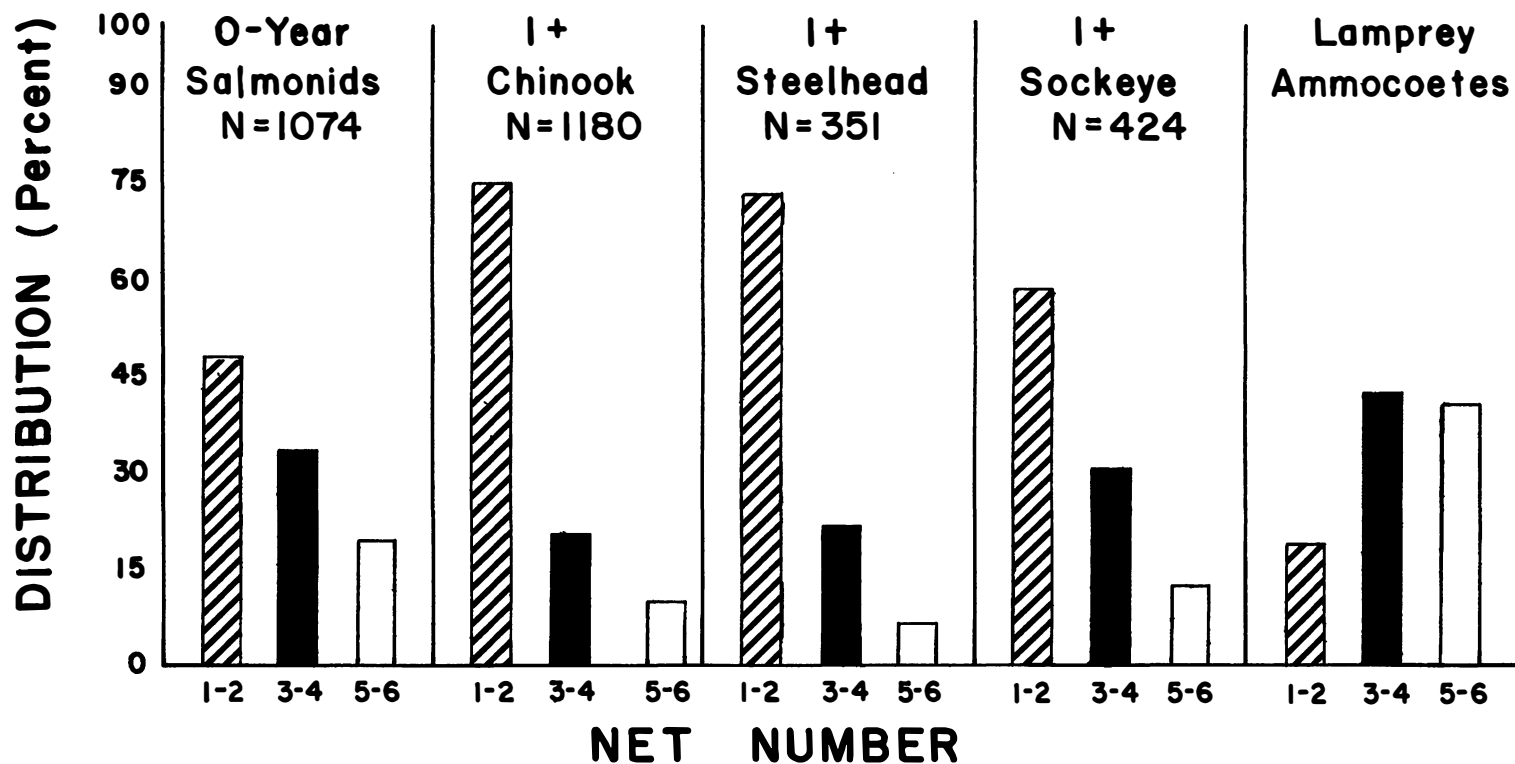


Figure 3.--Vertical distribution of fingerling salmonids and lamprey ammocoetes at the Dalles Dam, 1960.

Table 8.--Vertical distribution of fingerling salmonids in turbine intake  
12-C at McNary Dam, 1961.

Net number (top to bottom)	1+ Chinook		1+ Steelhead		1+ Sockeye		All Species	
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>
1	351	56.7	47	54.0	104	33.6	502	49.4
2	140	22.6	17	19.5	89	28.7	246	24.2
3	74	12.0	16	18.4	46	14.8	136	13.4
4	33	5.3	5	5.8	35	11.3	73	7.2
5	12	1.9	2	2.3	22	7.1	36	3.5
6	<u>9</u>	<u>1.5</u>	<u>0</u>	<u>0.0</u>	<u>14</u>	<u>4.5</u>	<u>23</u>	<u>2.3</u>
Totals	619	100.0	87	100.0	310	100.0	1,016	100.0

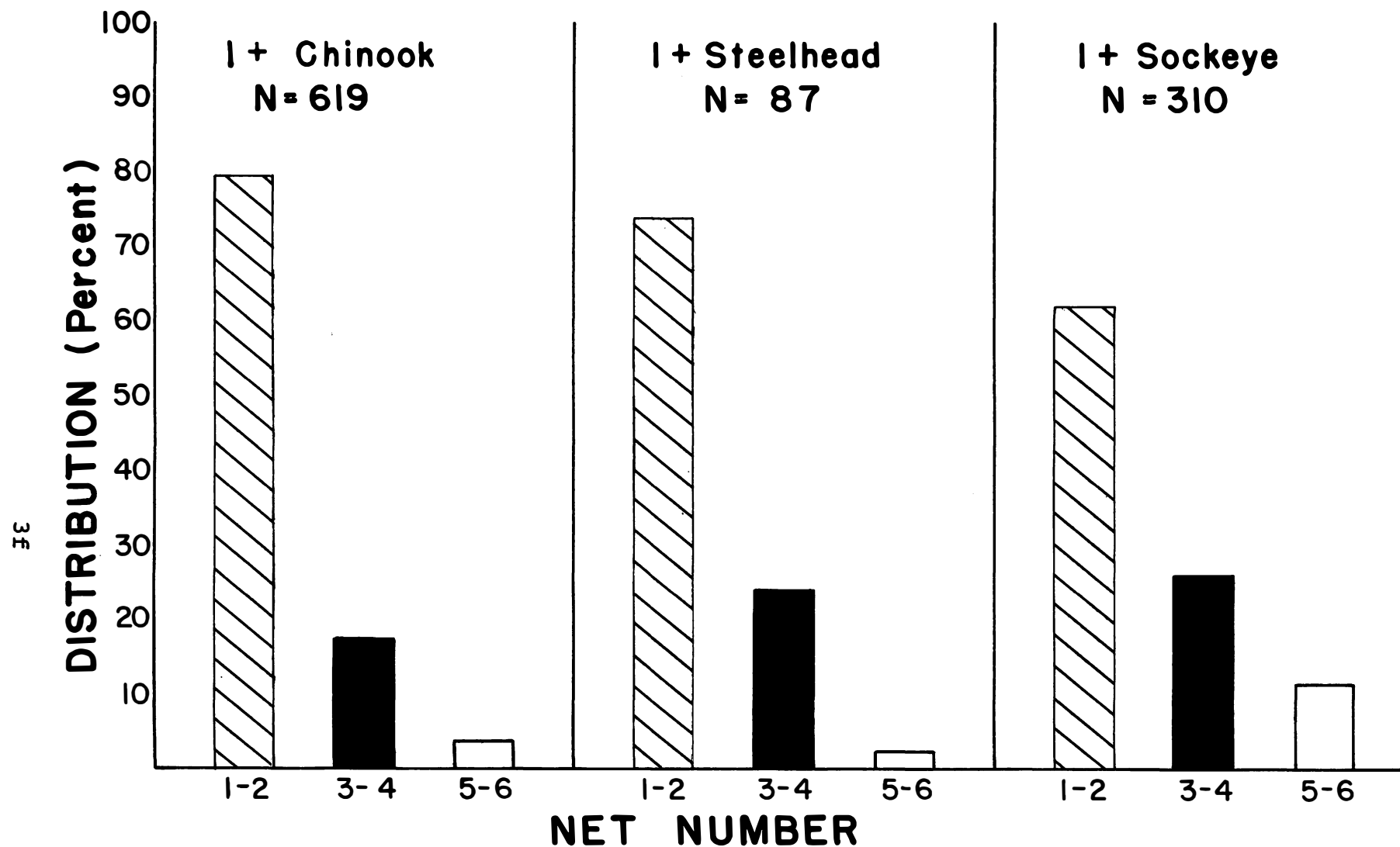


Figure 4.--Vertical distribution of fingerling salmonids in intake 12-C at McNary Dam, 1961.

### Application

The indication that far greater numbers of salmonid pass through the turbines at night than during the day points to the need for careful control of turbine operation during the peak hours of migration.

Information on the vertical distribution of fingerlings in turbine intakes has set the stage for current studies designed to assess turbine mortalities in relation to depth of the fish at time of entry. If mortalities are related to depth at entry, preventive measures could be taken to reduce losses among groups suffering the highest mortality.