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THE VERTICAL DISTRIBUTION OF COHO SMOLTS IN THE FOREBAY OF MERWIN DAM IN 1964

by

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THE VERTICAL DISTRIBUTION OF COHO SMOLTS NEAR THE DOWNSTREAM MIGRANT COLLECTION FACILITIES AT MERWIN DAM IN 1964

The vertical distribution of juvenile coho salmon (Oncorhynchus kisutch) in the forebay of Merwin Dam was examined during the 1964 downstream migration. Of particular interest was the relationship of coho distribution to the successful operation of a floating downstream migrant collector at Merwin Dam. This migrant collector was provided for testing at Merwin Reservoir under the Accelerated Fish Passage Research Program sponsored by the Bureau of Commercial Fisheries. The collector was completed prior to the 1963 downstream migration and tested during the spring of the year. Results of the first year's operation showed a collection efficiency much lower than anticipated (Allen 1963). The vertical distribution and the size of Lake Merwin coho migrants appeared to be possible causes for the low collector efficiency. For this reason a limited coho distribution study was conducted concurrent to the operation of the collector during the 1964 downstream migration.

METHODS

Three gill net stations were established in the forebay area of Merwin Dam (Figure 1). Tests conducted during the first week of sampling demonstrated the inability of the nets to capture numbers of coho during daylight hours. Subsequent tests also indicated that the majority of coho caught entered the nets between dusk and dawn. Therefore, the sampling schedule usually consisted of setting gill nets in the late afternoon and removing them the following morning. At times it was necessary to leave the nets in for a full 24-hour day although in all cases the sampling period encompassed the dusk to dawn hours.

Each net consisted of three panels each of 1-inch and $1\frac{1}{4}$-inch, and $1\frac{1}{2}$-inch stretch measure multifilament nylon. A finished net measured 75 by 10 feet and could be fished horizontally at any depth. This was accomplished by using SCUBA divers to add or remove weights or corks while the nets were in fishing position. Once a given net was made to fish properly it was always used at the same level. Underwater examinations were conducted periodically to determine if changes in floatation were occuring which would affect the fishing position of the nets. The nets were supported between pairs of gill net suspension floats of the type described by Korn and Gunsolus (1962) (Figure 2). A maximum of three nets could be supported by a single pair of floats which necessitated the installation of a pair of adjacent floats in the areas where more than three depth intervals were sampled. On each set of suspension floats, nets were separated by 10-foot spacerlines on each end to minimize the possibility of fish encountering a net at a given level and moving on a vertical plane along the net to become entangled at a different level. The position of each net in relation to the water surface and the shorelines is shown in the cross sectional sketch of the forebay in Figure 3. Coho distribution by 10-foot intervals to the 50-foot depth was sampled at Stations AB and DE. At Station C near the center of the forebay only the surface to 10-foot and 20- to 30-foot intervals were sampled. Occasional sets made at depths greater than 50 feet throughout the season failed to catch any coho and are not treated in this report. All of the fish collected were measured to the nearest millimeter fork length. Scale samples were taken to aid in age determination for separating 1962 brood yearling and 1961 brood residual coho.

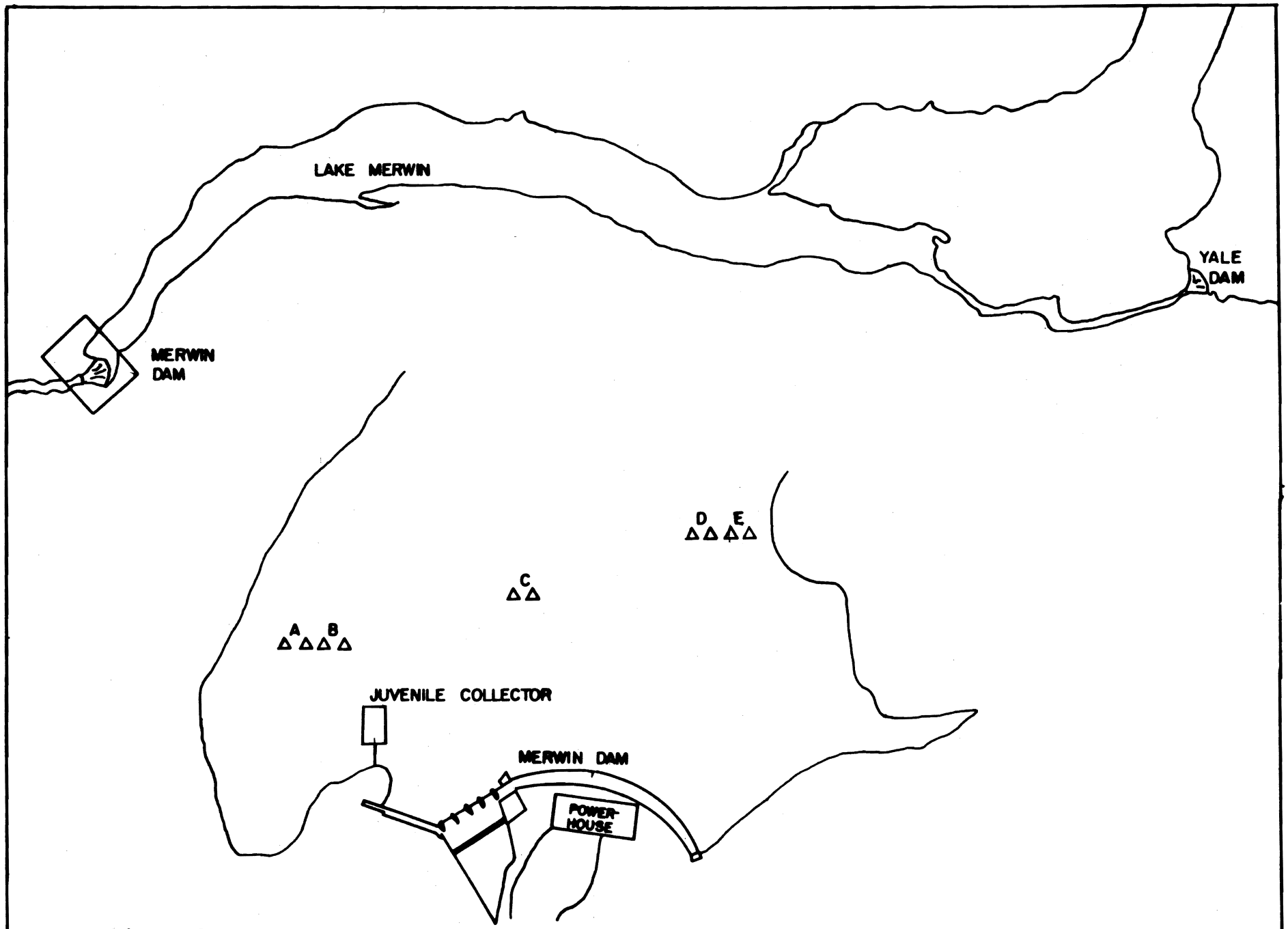

Figure 1.--Location of sampling stations and collection facilities--Merwin Dam, 1964.

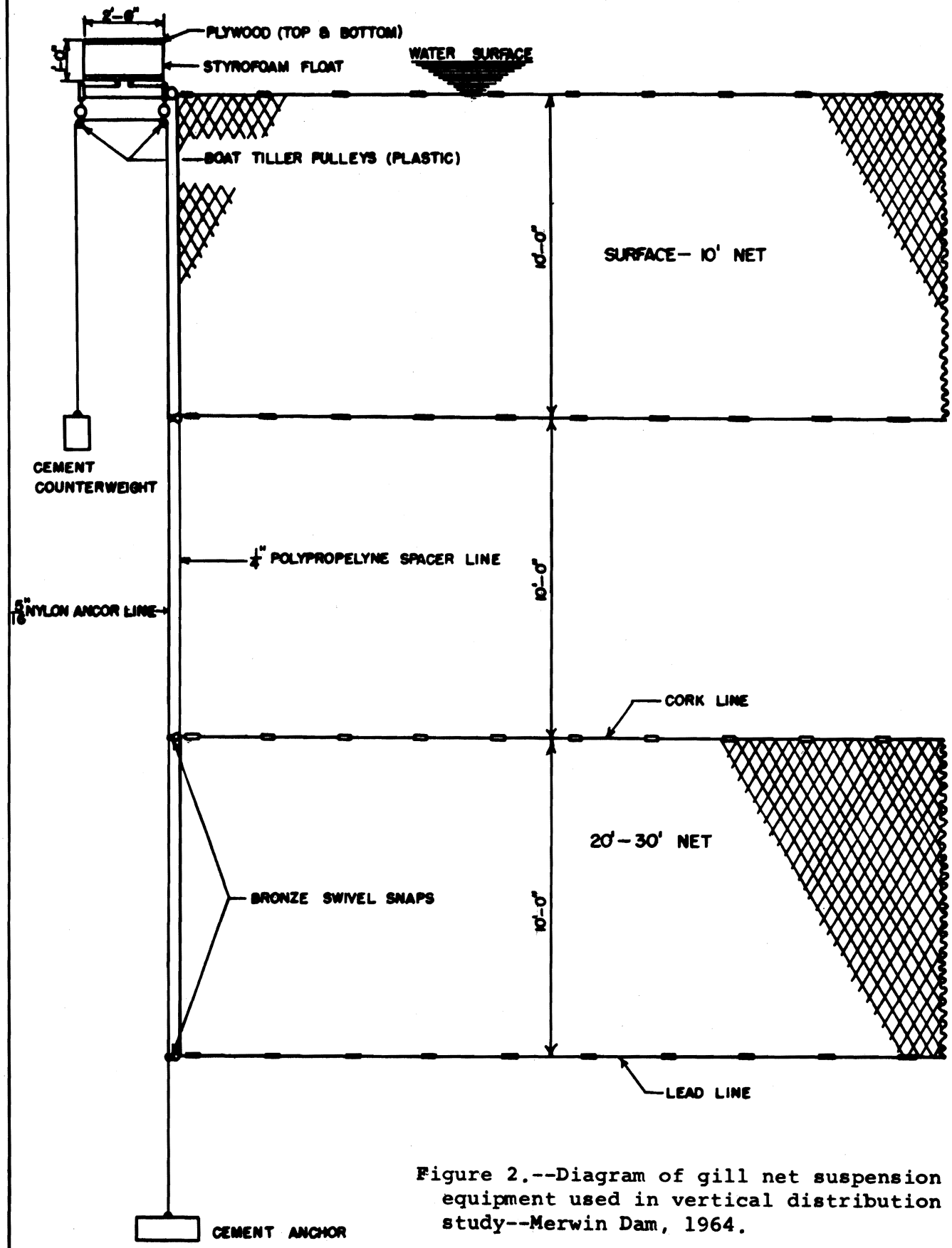

Figure 2.--Diagram of gill net suspension equipment used in vertical distribution study--Merwin Dam, 1964.

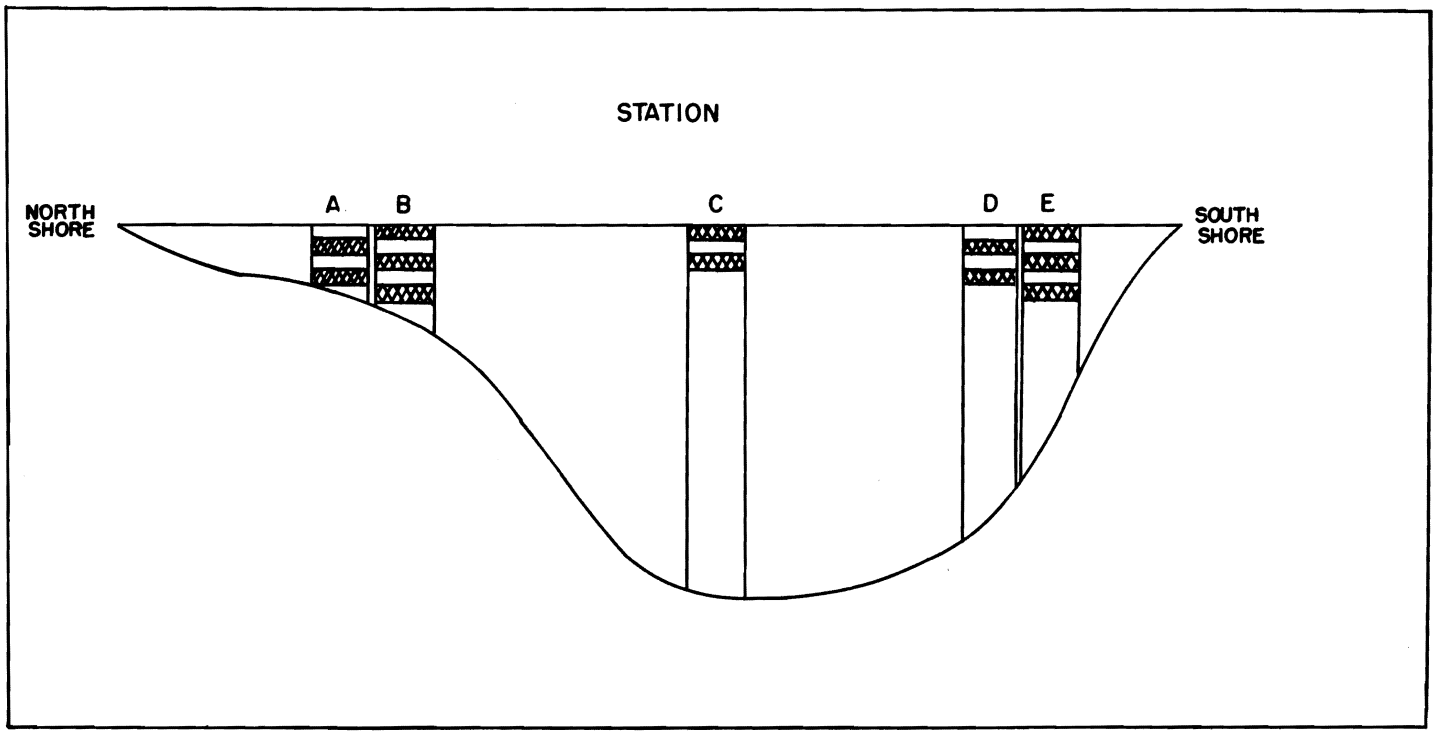

Figure 3.--Cross-sectional sketch of Merwin Dam forebay showing placement of gill nets, 1964.

RESULTS

Total catch

The total coho catch during the period of investigation, March 30 through June 27, was 306 fish. A tagging study, conducted concurrently as a facet of the co-operative Lake Merwin Research Program involving the Washington Department of Fisheries and Pacific Power and Light Company, resulted in a coho population estimate (yearling and residual) of approximately 17,000 fish during the migration period. Low catches in the gill nets probably reflects the low coho population present in the lake. The coho catch by two-week periods in each net is shown in Table 1.

Table 1. Gill net coho catch by 2-week intervals - Lake Merwin 1964.

	Station and depth (ft)												
	AB					C		DE					
Date	Surface 10	10-20	20-30	30-40	40-50	Surface 10	20-30	Surface 10	10-20	20-30	30-40	40-50	Total
3-29 to 4-4	12	6	0	0	-	5	-	24	-	1	-	-	48
4-5 to 4-18	13	4	1	0	0	8	1	16	3	0	0	0	46
4-19 to 5-2	5	2	2	0	1	5	0	12	6	0	1	0	34
5-3 to 5-16	39	13	1	0	1	5	0	23	6	0	0	-	88
5-17 to 5-30	18	10	1	0	0	0	0	8	1	0	0	-	38
5-31 to 6-13	10	4	4	0	0	2	0	3	3	4	2	-	32
6-14 to 6-27	7	2	2	0	0	4	0	2	3	0	0	-	20
Total	104	41	11	0	2	29	1	88	22	5	3	0	306

These figures have not been adjusted for net hours fished. More coho were collected in the surface to 10-foot nets than any of the other depth intervals fished. No attempt was made to interpolate catches for the 10- to 20-foot interval at Station C but it is likely that the relationship of coho abundance to depth would be similar to Stations AB and DE.

Adjusted catch and catch per unit of effort by depth interval

The predominance of coho in the 30 surface feet of the forebay can be seen in Table 2. Catch totals have been adjusted here for net hours fished and differ slightly from the previous table.

Table 2. Adjusted coho catch and catch per hour by 10-foot depth intervals - Lake Merwin - 1964

	Surface 10 ft.		10-20 ft.		20-30 ft.		Less than 30 ft.	
Date	Catch	Catch per hour	Catch	Catch per hour	Catch	Catch per hour	Catch	Catch per hour
3-29 to 4-4	41	.325	6	.143	1	.012	0	-
4-5 to 4-18	37	.171	7	.058	2	.009	0	-
4-19 to 5-2	22	.075	8	.041	2	.007	2	-
5-3 to 5-16	67	.176	19	.075	1	.003	1	-
5-17 to 5-30	26	.107	11	.050	1	.004	0	-
5-31 to 6-13	15	.040	13	.052	8	.022	2	-
6-14 to 6-27	13	.025	10	.027	2	.004	0	-
Total	221	.167	74	.061	17	.014	5	

Over 72% of the total coho catch came from the surface to 10-foot depth interval. Catch per unit of effort at this depth ranged from .325 to .025 coho per net hour study period. The nets fished at the 10-20 and 20-30-foot intervals caught 20.6 and 5.6% of the total coho catch respectively. Catch per unit of effort ranged from .143 to .027 coho per net hour at 10 to 20 feet compared to a range of .022 to .033 per net hour at 20 to 30 feet. Only five coho or 1.6% of the total were caught below the 30-foot level. Catch per unit of effort averaged .002 per net hour below 30 feet.

Percentage distribution by depth

Although 72% of the coho catch was taken in the surface to 10-foot nets, the incidence of coho in deeper nets increased as the season progressed. The percentage of the total coho catch, taken in the surface to 10-foot depth interval, during each two 2-week period declined from over 85% for the period March 27 - April 4 to 39.5 and 52% in June (Figure 4). Conversely, catches in

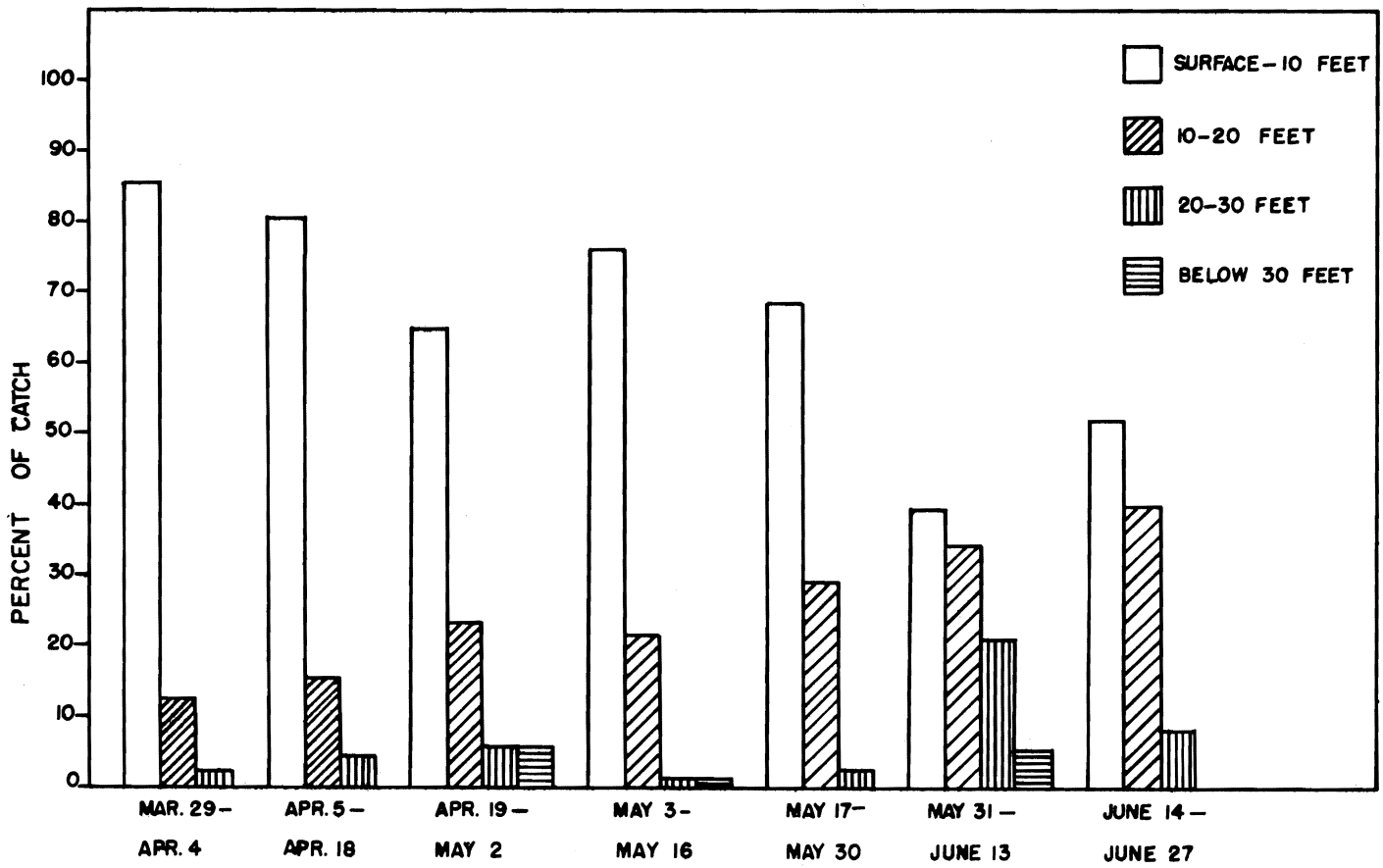

Figure 4.--Percent distribution by depth interval of gill net caught coho, Lake Merwin, 1964.

the 10- to 20-foot depth interval increased from 12.5% through April 4 to 40% of the total for the period ending June 27. The percentage catch taken in the 20-to 30- foot interval and below 30 feet was erratic due to the smaller number of fish caught at these depths. However, the percentage taken at these depths appears to be higher in June than previous months.

The reasons for this change in coho distribution during the migration period are not well defined. One factor may have been warming of the surface layer in the forebay during this period. The surface temperature rose from 5.6 C on March 30 to 14.7 C on June 10. Although the maximum temperature is well within the accepted tolerance range for coho smolts, there may have been factors associated with rising water temperatures which indirectly affected coho distribution. For example, rising water temperatures may have resulted in an increase in the subsurface abundance of zooplankton, the most important food form for Lake Merwin coho (Hamilton and Rothfus, 1963).

Water transparency, another possible factor in coho depth distribution, was measured at least once every other week in the forebay at Merwin Dam near the gill net locations. Comparison of secchi disk readings at this location revealed little change in water transparency from early April to the end of June. Therefore, it is doubtful that water transparency alone was responsible for the increasing percentage of coho in the subsurface depth intervals.

Preference of coho for the surface layer of Baker reservoir during the migration period was shown by Rees 1957. Lake Merwin coho demonstrate this same preference during the migration period and the increase in percentage of the catch in the subsurface layers may actually be a function of the relative abundance of migrating and non-migrating fish. The highest percentage catch in the 10- to 20-foot depth interval occurred during June after the peak of the downstream migration. By this time approximately 90% of the coho migrants captured at Merwin Dam had already been removed from the reservoir. This decrease in percentage of coho in the surface 10-foot nets may have been a result of the removal of migrating fish from the reservoir during the period of investigation.

Comparison of coho depth distribution at Stations AB and DE

A comparison of the depth distribution at Station AB, located in close proximity to the migrant collector, and Station DE located near the south shore of the forebay is shown in Table 3. A correlation coefficient (r) of .96 shows a definite correlation between the vertical distribution of coho caught at these two stations. This correlation discounts the possibility that the vertical distribution of coho at Station AB was affected by the currents associated with the subsurface discharge of the collector.

Table 3. Comparison of coho depth distribution at Stations AB and DE by 2-week intervals - Lake Merwin - 1964

	Depth (ft) and station							
	Surface - 10		10-20		20-30		Below 30	
Date	AB	DE	AB	DE	AB	DE	AB	DE
3-29 to 4-4	12	24	6	0	0	1	0	0
4-5 to 4-18	13	16	4	3	1	0	0	0
4-19 to 5-2	5	12	2	6	2	0	1	1
5-3 to 5-16	39	23	13	6	1	0	1	0
5-17 to 5-30	18	13*	10	2*	1	0	0	0
5-31 to 6-13	10	3	4	3	4	4	0	2
6-14 to 6-27	7	2	2	3	2	0	0	0
Total	104	93	41	23	11	5	2	3

* Adjusted for net hours fished.

Size of fish

Prior studies conducted under a joint Department of Fisheries and Pacific Power and Light Lake Merwin research program have demonstrated an extremely rapid growth rate and large migration size of coho reared in the reservoir [1]. The average length of 1959 brood year coho collected at Merwin Dam in 1961 was 196 mm while the 1961 brood coho collected in 1963 averaged 210 mm fork length. During both years the catch was composed primarily of yearling migrants. Coho collected during the 1964 downstream migration included both 1961 and 1962 brood year fish.

1/ Washington Department of Fisheries and Pacific Power and Light Company, unpublished data.

Examination of scale samples provided the basis for separating the two year classes. It was concluded that coho over 260 mm fork length were predominantly 1961 brood while those under 260 mm were from the 1962 brood year (Hamilton etal, 1964). Overlap in the 240 to 280 mm range prevents exact separation of the two groups. The size range of migrants in the downstream collection facilities in 1964 was 85 to 357 mm.

Gear selectivity

Coho caught in gill nets during the migration season ranged from 119 to 344 mm fork length. The size range was similar for each mesh size but there were certain differences in distribution with the size range (Figure 5). A larger percentage of coho over 250 mm was caught in the 1-inch mesh than in the $1\frac{1}{4}$-inch mesh (60% compared to 35 and 32% respectively). Rees (ibid) found that coho gilled in the 1-inch mesh at Baker Lake were predominantly 110 to 130 mm in length. Since very few fish at Merwin were within this size range, the majority of coho caught in the 1-inch mesh were entangled in the mesh by their teeth. It is possible that large fish, over 250 mm, are captured more readily in this manner than fish under 250 mm. Coho over 250mm did not gill in the $1\frac{1}{4}$- or $1\frac{1}{2}$-inch mesh either but the fact that fish as large as 200 mm did gill in these mesh sizes could account for the percentage difference between the 1- $1\frac{1}{4}$- and 1-inch mesh.

Size composition by depth interval

The length frequency of coho caught in the gill nets at each depth interval was examined to determine if the size and/or age composition of the catch was a factor of depth distribution. No appreciable difference was noted in size composition of coho collected at intervals from the surface to 30 feet (Figure 6). Catches below 30 feet were omitted from the analysis due to the small numbers of fish involved. Residual coho over 260 mm accounted for 37.6% of the coho caught in the surface nets compared to 34.5% at the 10- to 20-foot interval and 33.4% at 20 to 30 feet.

In considering the relationship of gill net coho distribution to the distribution of fish in the immediate vicinity of the migrant collector, it is necessary to determine if the gill net caught coho were representative of the available coho population. The length frequencies of gill net and migrant collector coho were examined by two-week intervals for comparison of size composition throughout the migration (Figure 7). A definite similarity existed between gill net and collector coho during the period of investigation, supporting the belief that the gill net catch was representative of the coho caught in the collector.

The length frequencies in Figure 7 show a decrease in the size composition of both gill net and migrant collector coho during the migration period. Residual coho, in this case 1961 brood year fish, migrate early in the spring prior to the peak of the yearling migration. A definite break between the migration of residual and yearling fish occurs in late April or early May. Following the peak of the yearling lake-reared coho migration, the size composition of the catch continues to decline. The bulk of the catch at that time includes stream-reared coho which escaped from Speelyai Creek.

Direction of movement

The directional orientation of 281 gill net captured coho was noted during the course of the study (Table 4). It was found that most of the coho (68.7%) were traveling in a downlake direction when they entered the nets. The downlake movement was more pronounced at Stations AB and DE near the north and south shores than at Station C near the center of the forebay as evidenced by 70.2% at Stations AB and DE and only 55.2% at Station C. Only 8.5% of the coho captured at Baker Lake travel in an uplake direction when they entered the nets (Rees, ibid). The difference in directional orientation between Baker and Merwin

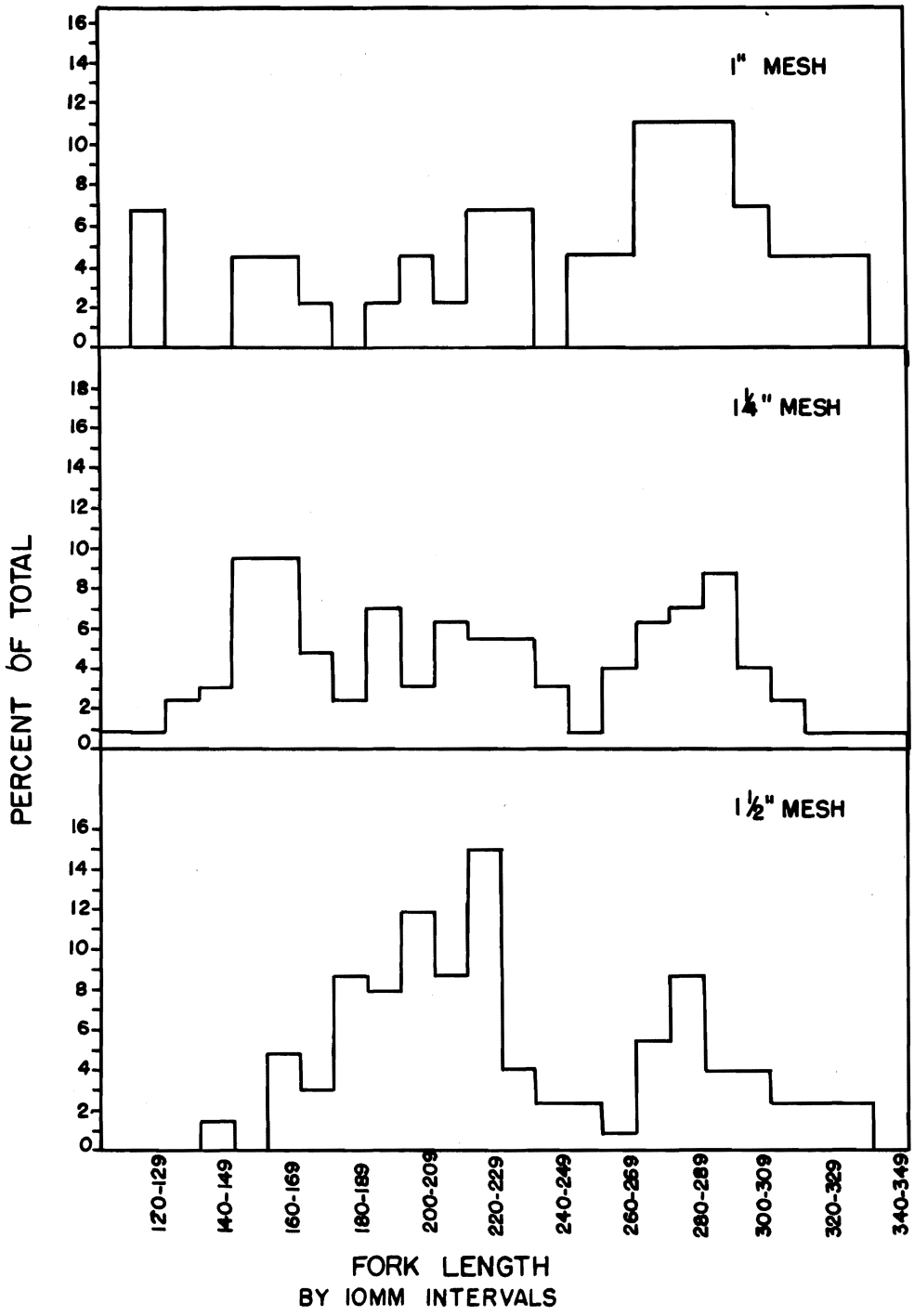

Figure 5.--Length frequencies of Lake Merwin Gill net coho by mesh size, 1964.

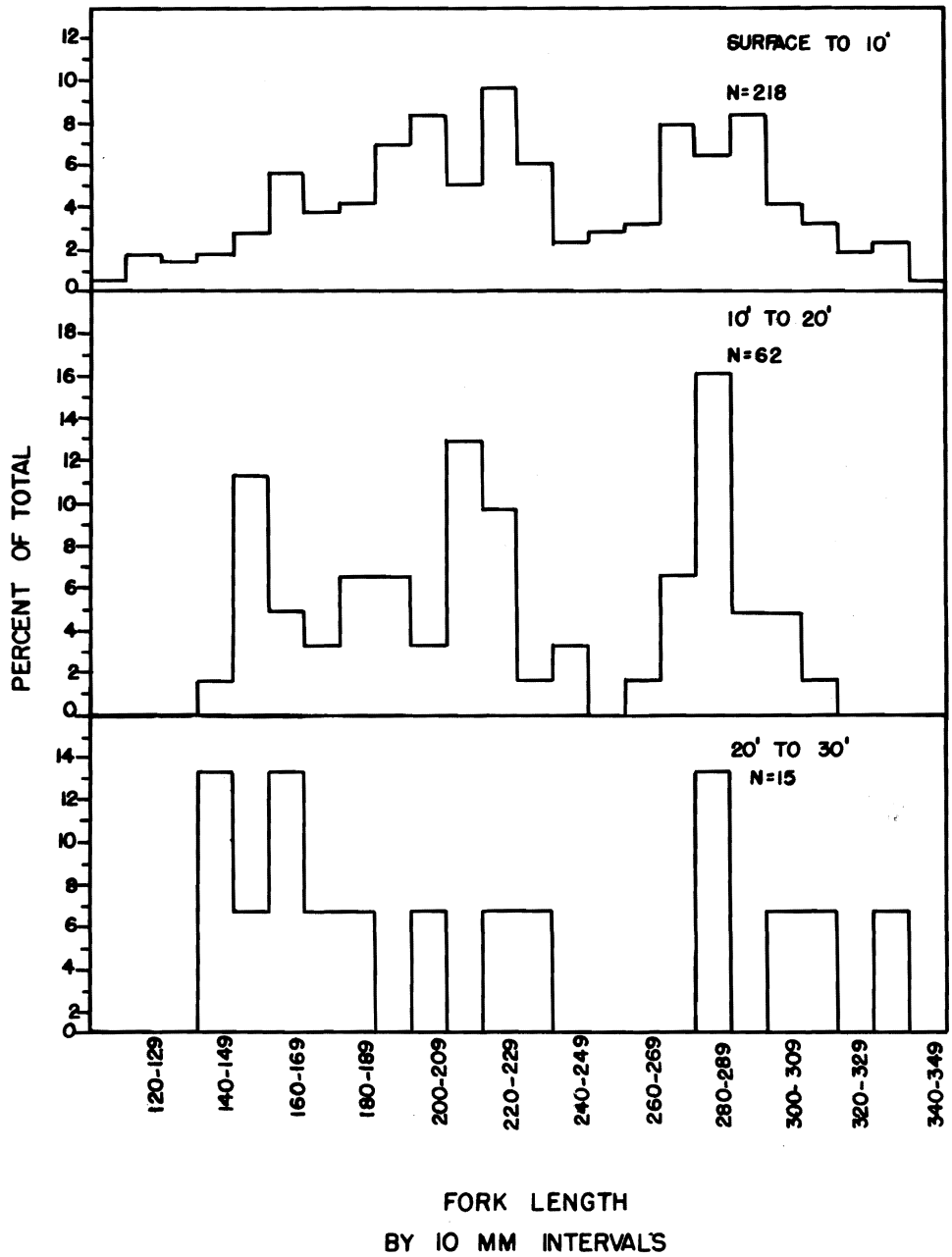

Figure 6.--Length frequencies of Lake Merwin gill net coho by depth interval, 1964.

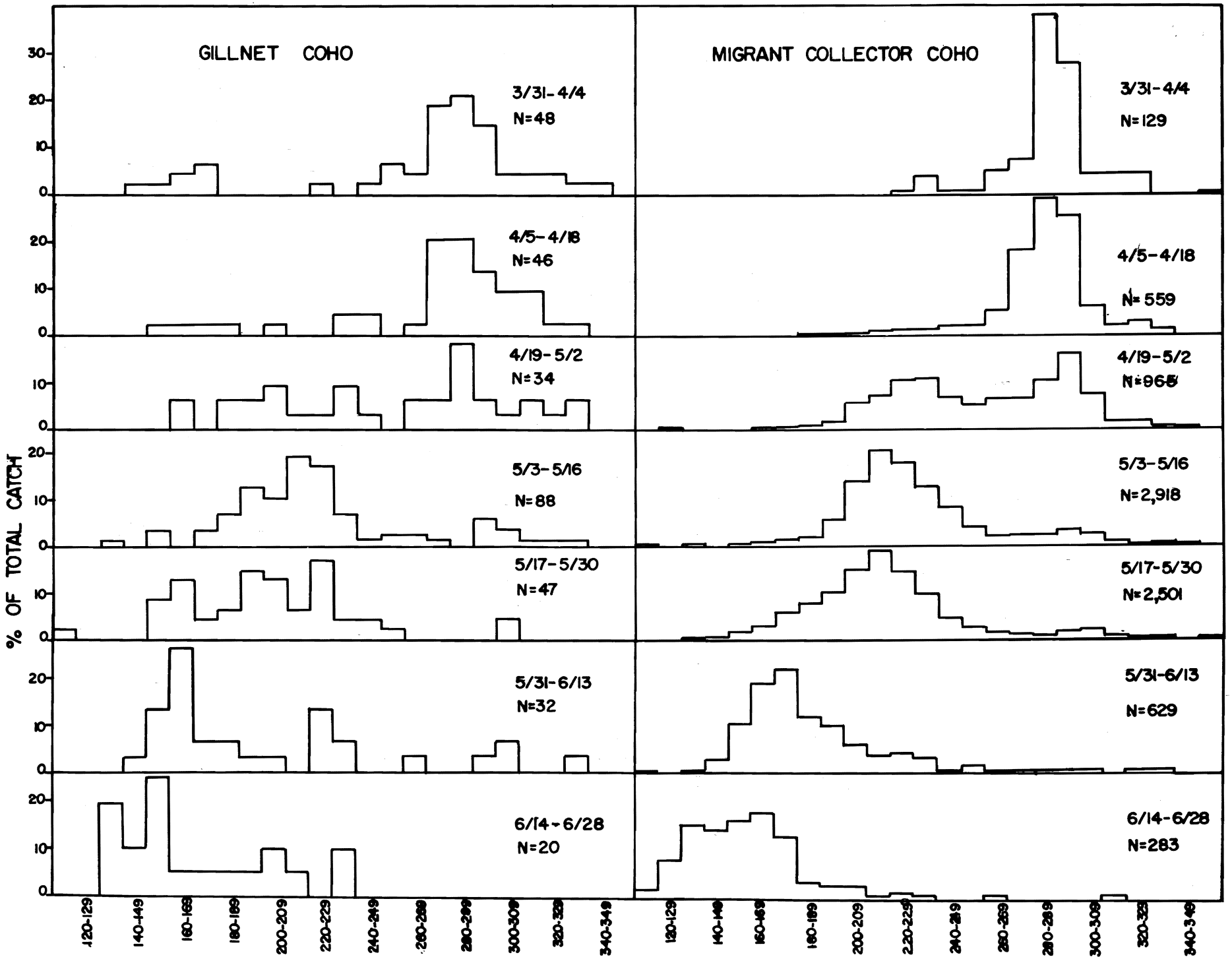

Figure 7.--Comparison of length frequencies of gill net and migrant collector caught coho, Lake Merwin, 1964.

coho may be due to a tendency of Lake Merwin fish to mill in the vicinity of the dam during the migration period. Hamilton and Rothfus (1963) found that the majority of tagged coho released from a recovery trap near Merwin Dam in 1961 were recaptured in the same trap. This indicates that the tagged coho remained in or returned to the vicinity of the dam.

Table 4. Percentage of coho traveling in a downlake direction when entering shoreline and center - forebay gill nets by 2- week intervals - Merwin Reservoir 1964

	Period ending							
Location	April 4	April 18	May 2	May 16	May 20	June 13	June 27	Total
Shoreline	57.9	70.2	79.3	71.1	71.1	66.7	73.3	70.2
Center of forebay	25.0	56.7	60.0	60.0	-	100.0	50.0	55.2
Total	52.2	67.4	76.5	70.5	71.1	68.8	65.0	68.7

Incidental fish catch

In addition to coho salmon (Onchorhynchus kisutch) six other species were caught in the distribution study gill nets (Table 5). These included, in order of numbers caught, rainbow trout (Salmo gairdnerii), squawfish (Ptychocheilus oregonensis), sockeye salmon or kokanee (O. nerka), chinook salmon (O. tshawytscha), sculpins, (Cotus sp.), and dolly varden (Salvelinus malma). The incidence of these species in the gill nets increased during the season and reached a peak during the month of June when 116 or 55.8% of total catch was taken.

The chinook salmon collected in the gill nets were yearling fish which had failed to migrate after release into the reservoir in the spring of 1963. Kokanee (sockeye) enter Merwin reservoir through surface spill or turbine discharge from Yale Dam located immediately upstream. The vertical distribution of these species has not been analyzed.

Table 5. Incidental gill net caught fish - Lake Merwin 1964.

Species	3/29-4/4	4/5-4/8	4/19-5/2	5/3-5/16	5/17-5/30	5/31-6/13	6/14-6/27	Total
Chinook		1	1	1	1	2		6
Sockeye (Kokanee)		2		1		6	3	12
Rainbow trout	4	12	4	15	12	41	27	115
Squawfish	1	2	5	14	15	12	23	72
Dolly Varden						1		1
Sculpins				1		1		2

SUMMARY

1. A Gill net study was conducted in the forebay of Merwin Dam during the 1964 downstream migration to determine the vertical distribution coho smolts in the vicinity of the downstream migrant collector.

2. Coho distribution by 10-foot depth intervals was sampled at the 3 sampling stations established in the forebay area. Two stations were sampled to a depth of 50 feet while the other station was sampled to a maximum depth of 30 feet.

3. The majority (72%) of the 306 coho captured during the study were caught in the surface to 10 foot depth interval while the 10-to 20-, 20-to 30-, and below 30-foot intervals accounted for 20.6, 5.6, and 1.6% of the total respecively.

4. The percentage distribution of coho in the surface layer dropped from a high of 85% in early April to a low of 39.5% in June while the percentage in the deeper layers increased gradually throughout the migration.

5. The size range of coho caught in each mesh size was similar although the percentage of fish over 250 mm was highest in the 1-inch mesh.

6. No significant difference was noted in size composition of the coho catch by depth interval.

7. The similarity between gill net and migrant collector coho length frequencies indicates that the gill nets and migrant collector were operating on the same population.

8. Over 68% of the gill net caught coho were traveling in a downlake direction when they entered the nets. The percentage was higher at the stations near the shorelines than at the station in the center of the forebay.

9. Rainbow trout and squawfish were the most numerous incidental species captured in the gill nets.

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