LAKE MERWIN JUVENILE FISH COLLECTOR STUDY

by

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DEPARTMENT OF FISHERIES

for

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INTRODUCTION

The Washington Department of Fisheries and other fisheries agencies have been working for many years to develop a downstream migrant collector which will successfully collect and bypass downstream migrants around dams. One of the many problems encountered in this field is the extreme fluctuation in forebay levels encountered at some dams which precludes the use of a juvenile fish collector attached to or made part of the dam structure proper.

In 1955 work conducted by the Department of Fisheries at the Lower Baker Dam in northern Washington demonstrated that an artificial surface current could be created by pumping. In 1957 the Department designed and tested a floating juvenile fish collector which could be used in reservoirs which experienced heavy drawdown. The structure, which utilized a current created by pumping to attract fish, successfully collected fish at Mud Mountain Dam in western Washington but the louver guidance system proved unsatisfactory (Regenthal and Rees 1957). Later that year experimentation in various louver type systems was carried out at the University of Washington Hydraulics Laboratory. Following this work a prototype floating juvenile collector employing a horizontal louver bank for fish guidance and water separation was constructed on Lake Union near the Fisheries College. In 1958 a production model was installed at the lower dam on the Baker River. The success of this unit led to the development of an improved version which was installed at Upper Baker Dam in 1960. These units have been used since to collect and bypass migrants around the two dams on the Baker River.

The Baker collectors as designed, although successfully passing fish, allow for little flexibility in operation. An experimental unit was desired to test the effectiveness of the collector at another reservoir and to determine the optimum attraction flows into the collector and the internal water velocities and depths required for the most efficient passage of fish. The determination of these factors could then effect a cost savings in the design of future floating collectors.

In 1962 the Department of Fisheries and the U.S. Bureau of Commercial Fisheries entered into an agreement which provided the Department with the funds to design, construct, and test a floating downstream migrant collector as part of the Accelerated Fisheries Research Program being conducted by the Bureau.

Lake Merwin located in southwest Washington was chosen as the test site. This reservoir has been under study since 1958 through a co-operative program by the Department of Fisheries, Pacific Power and Light Company, and the Cowlitz County P.U.D. to determine if the reservoir can be used as a natural rearing area for coho salmon (Oncorhynchus kisutch). As part of this investigation fixed downstream migrant collectors of the skimmer type were employed and evaluated at Merwin Dam in 1957, 1958, and 1959. None of the devices tested were considered successful. The selection of this site then provided for testing the experimental floating collector at a reservoir similar in size to the Baker reservoirs, at one in which other collection devices had not been successful, and at a site where related reservoir research was currently in progress.

DESCRIPTION OF LAKE MERWIN

Lake Merwin was formed by the construction of Merwin Dam in 1932 by Pacific Power and Light Company of Portland, Oregon. The dam is on the North Fork Lewis River in southwestern Washington, about 13 miles upstream from the community of Woodland. The reservoir (Figure 1) is about 12 miles long and at full pool contains 422,000 acre feet of water. Merwin Dam is approximately 1,400 feet long and has three-turbine units. The intakes for these are 180 feet below maximum pool. The maximum depth of the reservoir is 200 feet. Two other dams, Yale and Swift, completed in 1954 and 1958 respectively, are located upstream from Merwin Dam. Yale Dam provides the principal inflow to Lake Merwin.

METHODS AND MATERIALS

Description of the juvenile fish collector

The Lake Merwin juvenile fish collector is 70 feet long and 36 feet wide. It resembles a floating drydock in that it can be raised or lowered to desired depths.

Inflow into the collector is created by four electrical pumps, two 75 h.p. and two 10 h.p. Fish entering with the attraction water pass into the primary flume, where they are separated from the bulk of the water, and then into a secondary separation system, where more of the water is removed (Figure 2). The excess water is ejected from the sides of the collector. The fish and the small remaining amount of water pass on into two collection baskets.

The two larger pumps evacuate water through the primary flume and discharge it into the primary sump located 10 feet below the surface near the middle of the collector. Regardless of which pump is in operation, the design of this sump provides for the simultaneous ejection of water from both sides of the collector. One of the pumps is a two-speed unit; the other can only be operated at its maximum pumping rate. If only these two pumps are in operation, attraction flows in the amount of 86, 190, 254, or 305 cubic feet per second can be drawn into the main flume (Table 1). When the two secondary pumps are operated at their maximum pumping rates an additional 20 cfs is added to the inflow.

Table 1. Attraction flows into the Lake Merwin juvenile fish collector created by the two primary pumps.

Left Pump Speed	Right Pump Speed	cfs
Half	Off	86
Full	Off	188
Off	Full	192
Half	Full	254
Full	Full	305

Fish entering the main flume with the attraction water are screened out by a system of louvers before the water enters the pumps. The louvers are arranged

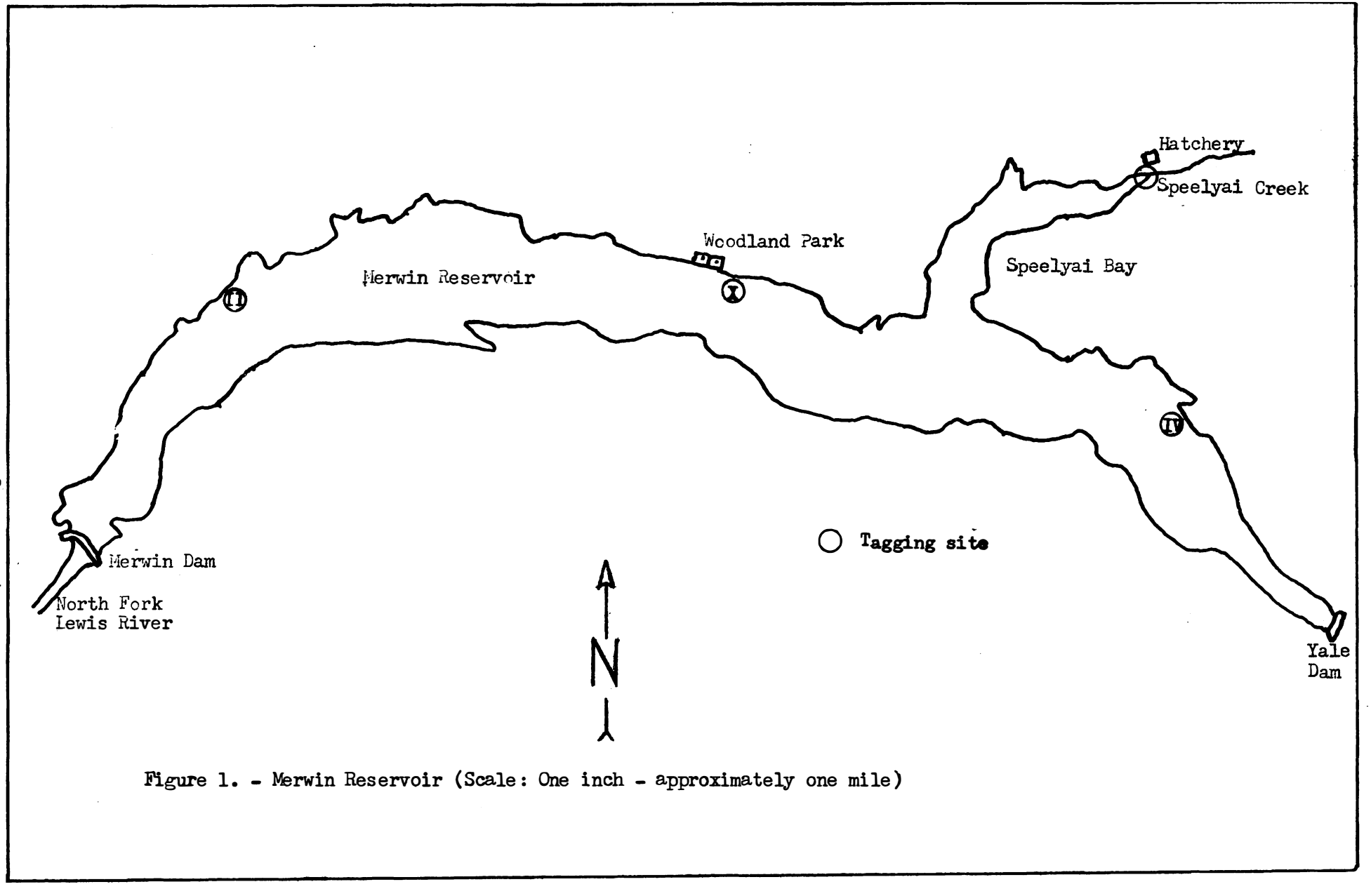

Figure 1. - Merwin Reservoir (Scale: One inch - approximately one mile)

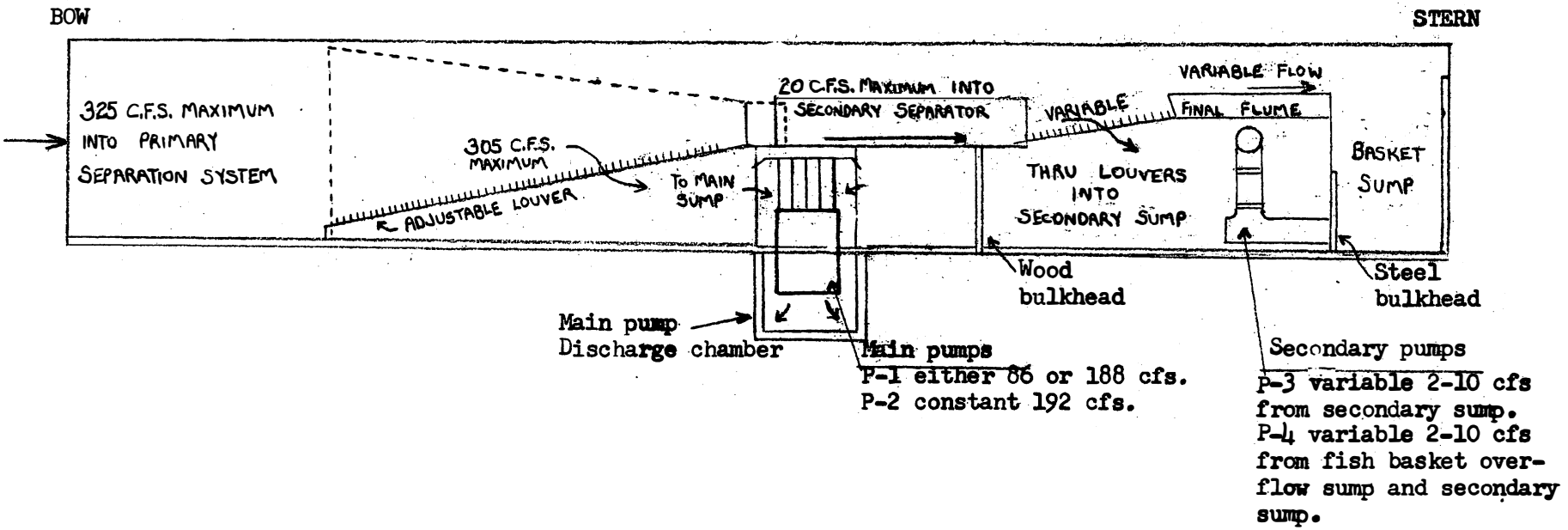

Figure 2. - Diagram of the fish separation and collection systems of the Lake Merwin juvenile fish collector. Small arrows denote directions of water flow. (From an original drawing prepared by the Andersen - Bjornstad - Kane consulting engineering firm).

horizontally and vertically across the flume to provide a sloping, gradually tapering ramp that guides the fish into the secondary separation channel. These louvers are fir, spaced 1.5 inches apart. The vertical louvers taper from the 15 foot width of the primary flume to the four foot width of the secondary separator (Plates 1 and 2) over a distance of 21.5 feet. The horizontal louvers rise a maximum of 6.5 feet over the same distance. Two hydraulic jacks, located at the junction of the two separation systems, are used to adjust the slope of the louvers and control the depth of the water entering the secondary channel.

The secondary separator has an overall length of 23 feet. This channel is constructed of galvanized sheet metal and is divided into three over-lapping components. The first section is a rectangular flume 15 feet long and 30 inches deep. The rear section is 8 feet long and 18 inches deep and empties into the collection baskets. The center section is 8 feet long and the floor is a louvered area of aluminum grating backed with 18 gauge hardware cloth. The drawdown from the left secondary pump into the secondary sump is through these metal louvers, creating a further separation of the fish and water. Three hydraulic jacks independently raise or lower the front and rear sections, controlling the slope of the louvered area.

The right secondary pump can evacuate water both from the secondary sump and from the collection basket sump; however, it is primarily used to pump water from the latter. Both secondary pumps are variable speed and their combined pumping rates, together with the slope of the louvers in the secondary channel, control the amount of water entering into the collection baskets. Maintaining the water level in the collection basket sump below the floor of the channel prevents fish from swimming back into the secondary separator.

The sides of the two collection baskets (Plate 3) are constructed of No. 18 gauge hardware cloth, (No. 4 mesh); the bottoms and frames are galvanized sheet metal. The larger basket is 5 feet 4 inches long, 3 feet 4 inches wide, and 4 feet 1 inch deep. The smaller basket has identical length and depth dimensions but it is only 2 feet 4 inches wide. The baskets are raised to a height of about six feet above the work deck by a small electrically operated hoist. At this point the water remaining in the baskets has a maximum depth of 10 inches. The fish are transferred from the baskets to live boxes through a 6-inch flexible hose which attaches to the bottom of the baskets.

The entire collector can be raised or lowered nine feet (Plates 4 and 5). In operating position the 22 ballast tanks, which are 13.5 feet high and 5 feet in diameter, are filled with water. To raise to the maintenance (highest) position the top nine feet of these tanks are filled with air. Styrofoam blocks under the work deck aid the 28 sealed floatation tanks in preventing the collector from sinking below eight inches freeboard. Ten stabilizer tanks prevent the collector from raising violently when water is evacuated by the pumps. The collector is moored in position by one-half inch steel cables mounted on five-ton "Beebe" winches.

Attraction light at night is provided by 13 mercury vapor lamps. Three of these lights are on pivoted posts over the primary flume, the others are mounted singly or in pairs over the secondary flume (Plates 2 and 4).

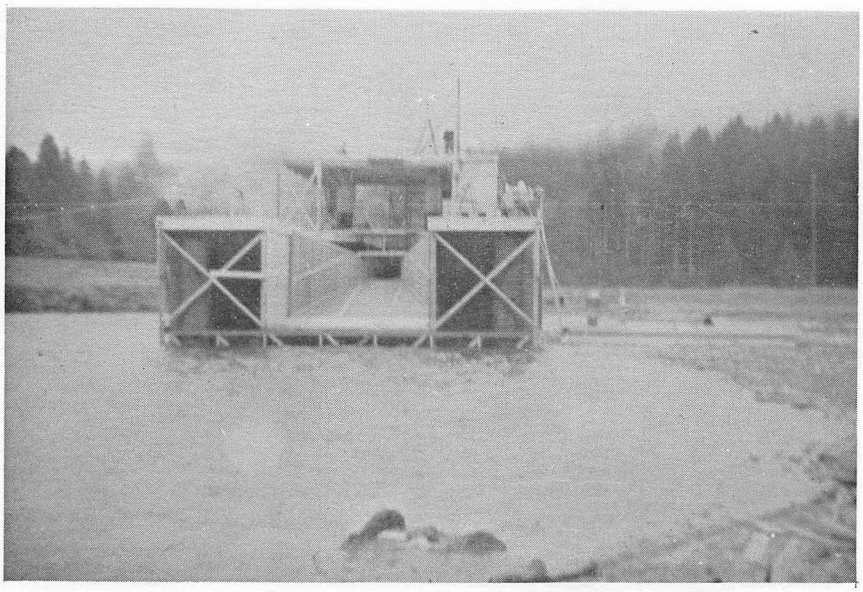

Plate 1.

Bow of juvenile fish collector and entrance to main flume.

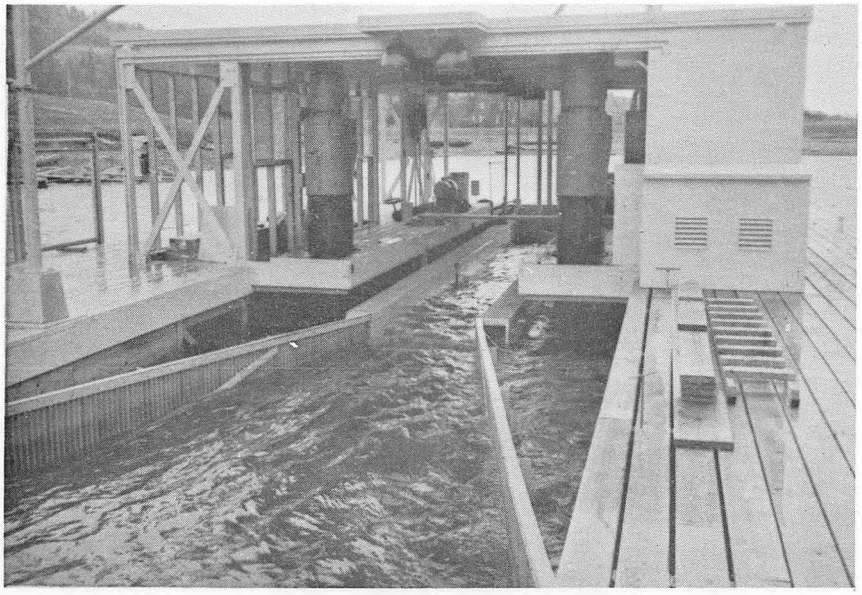

Plate 2.

Interior of the collector showing vertical louvers of main flume, secondary separation channel and the two primary pumps.

Plate 3.

Discharge into the two fish collection baskets from end of the secondary separator.

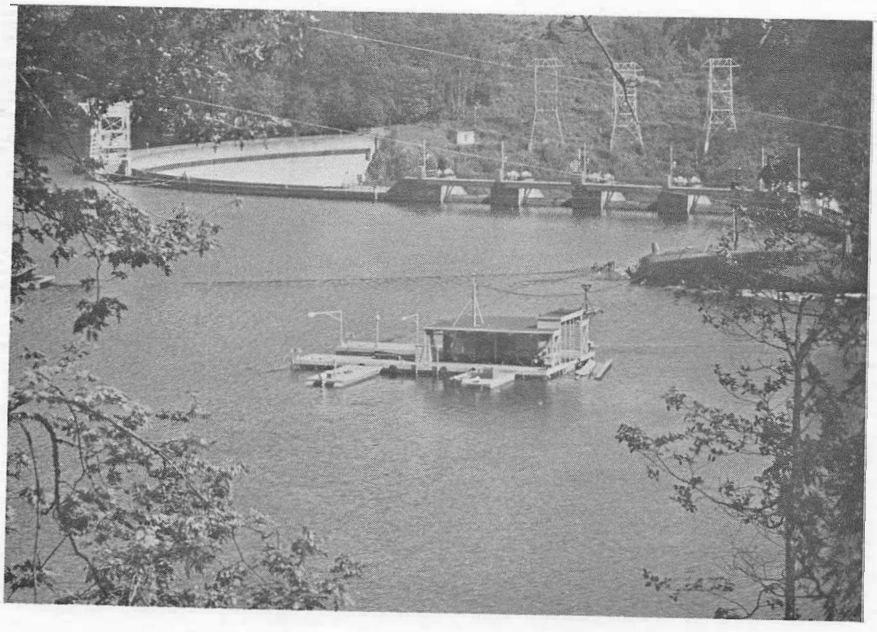

Plate 4.

Juvenile fish collector in position No. 2 in Merwin Dam forebay, 1963.

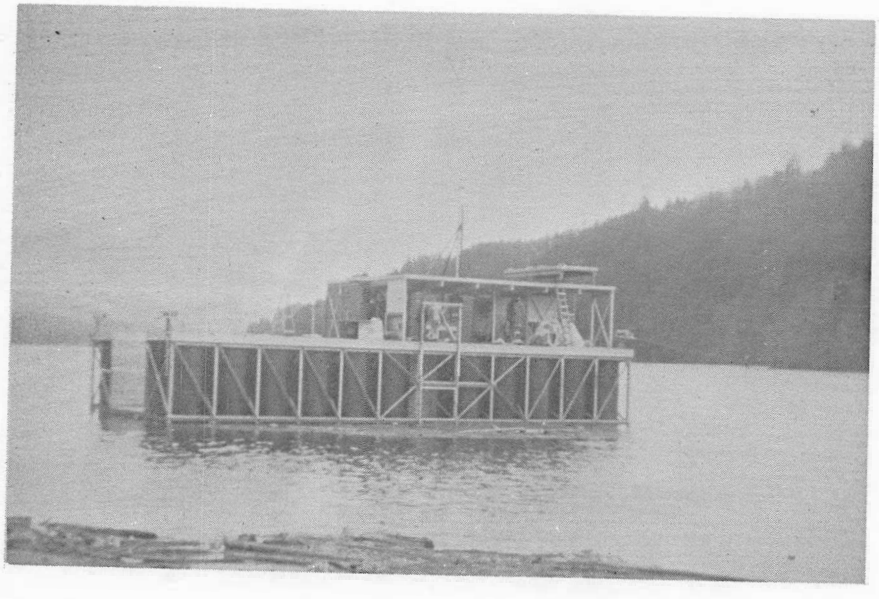

Plate 5.

Collector raised to the maintainence (highest) position.

Collector modification for the 1964 season

The Lake Merwin floating juvenile fish collector was constructed in early 1963 and operated during the spring downstream migration period with disappointing results. The recovery rate of lake-reared yearling coho, based on a population estimate, was only 10.2%. The recovery rate of fish tagged upon egress from Speelyai Creek, approximately eight miles uplake from the dam (Figure 1) was 13.7%. The highest recovery rate, 20.5%, was obtained for fish transplanted from the Baker River system in late May 1963 (Allen, 1963).

Analysis of the 1963 catch data indicated that the low catch in the collector was related to the size and/or the vertical distribution of the coho. During the winter of 1963 the collector was modified to enable it to draw water from greater depths.

The primary flume of the collector is only ten feet deep, therefore most of the attraction into the unit in 1963 was obtained from a surface inflow. In 1964 an addition to the collector was constructed, which enabled the inflow to be brought up vertically from depths as great as 28 feet.

The addition is essentially a "floating well" which attaches to the primary flume of the collector (Figure 3). The main floatational support is afforded by cedar logs, covered by a work deck of 2-inch by 12-inch fir planks. The deck is about 12 feet wide and supports a framework of steel macomber beams (Plate 6) which serve as guides for the raising and lowering of 91 plywood panel units, each 4 feet by 8 feet. These panels are constructed of 2-feet by 4-feet wood frames, covered with one-half inch exterior marine plywood on one side and coated with cement on the other side to reduce their buoyancy. The panels form the front and side walls of a rectangular underwater box 43 feet long, 25 feet wide, and 28 feet deep, open only at the bottom. The fourth wall consists of a large plywood panel which fits around the main flume of the collector and between the two side walls.

Net leads were employed in both seasons to guide fish to the collector. In 1963 leads were extended from each side of the primary flume to shore or from the center of the primary flume to shore depending on the fishing location. These sites are described in the following section. The leads were 30 feet deep and up to 700 feet long. Regardless of location the nets did not provide a barrier from surface to bottom and fish could sound and pass beneath them.

In 1964 net lead, extending from surface to bottom, was installed from the front of the addition to shore. Net walls were attached to each side of the addition and extended from the surface to the lake bottom. These walls were also attached to a herring web wall which extended from the bottom of the primary flume to the lake floor. Fish following along the lead from shore to the collector were thus prevented from passing beneath the collector (Figure 4).

The 1963 and 1964 fishing sites

During the 1963 season the collector was fished at three different sites in the Merwin Dam forebay; however, movement of the unit was limited by the length of the electrical cable, and the locations were very close together.

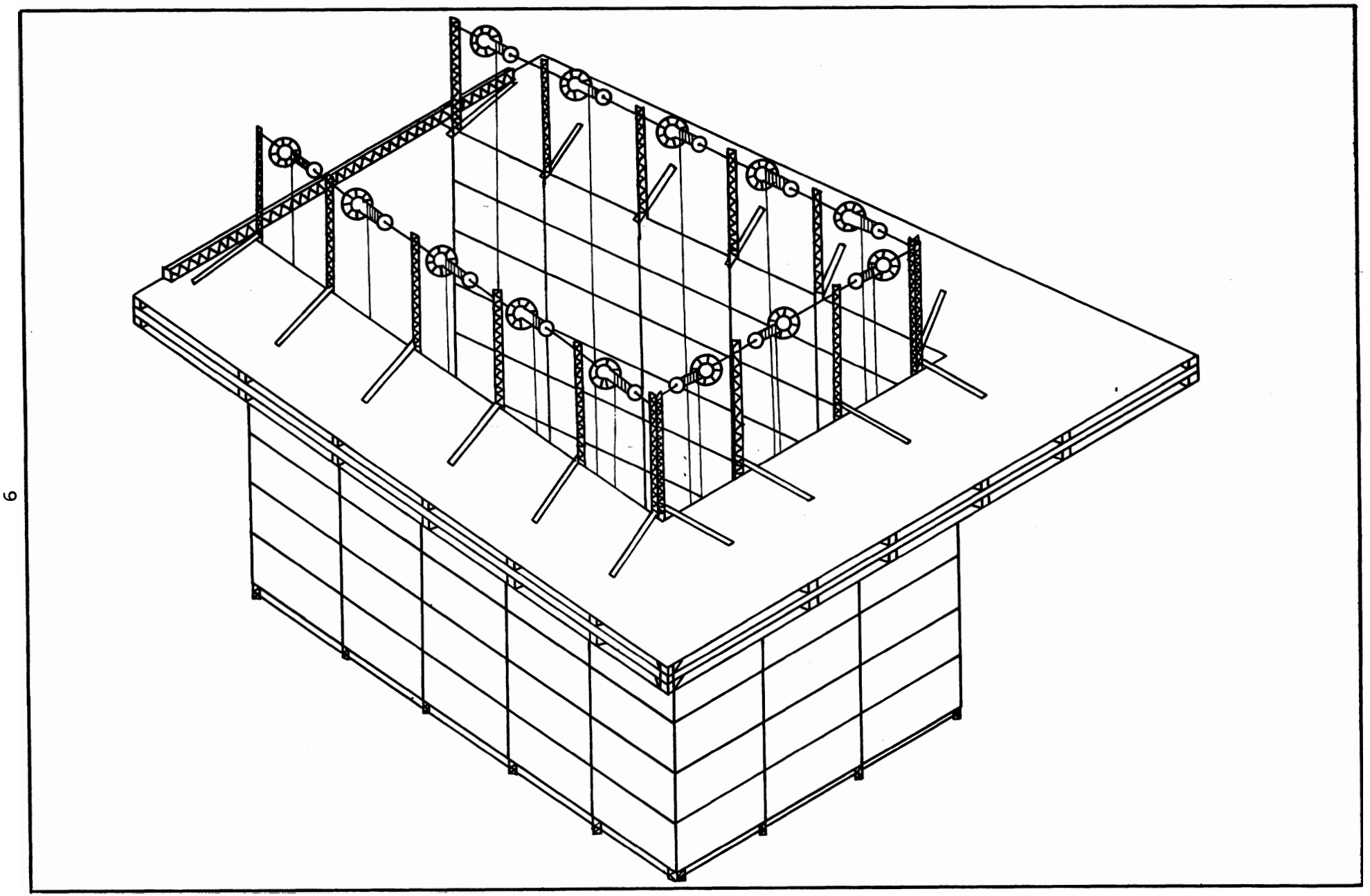

Figure 3.--Diagram of the well addition to the juvenile fish collector.

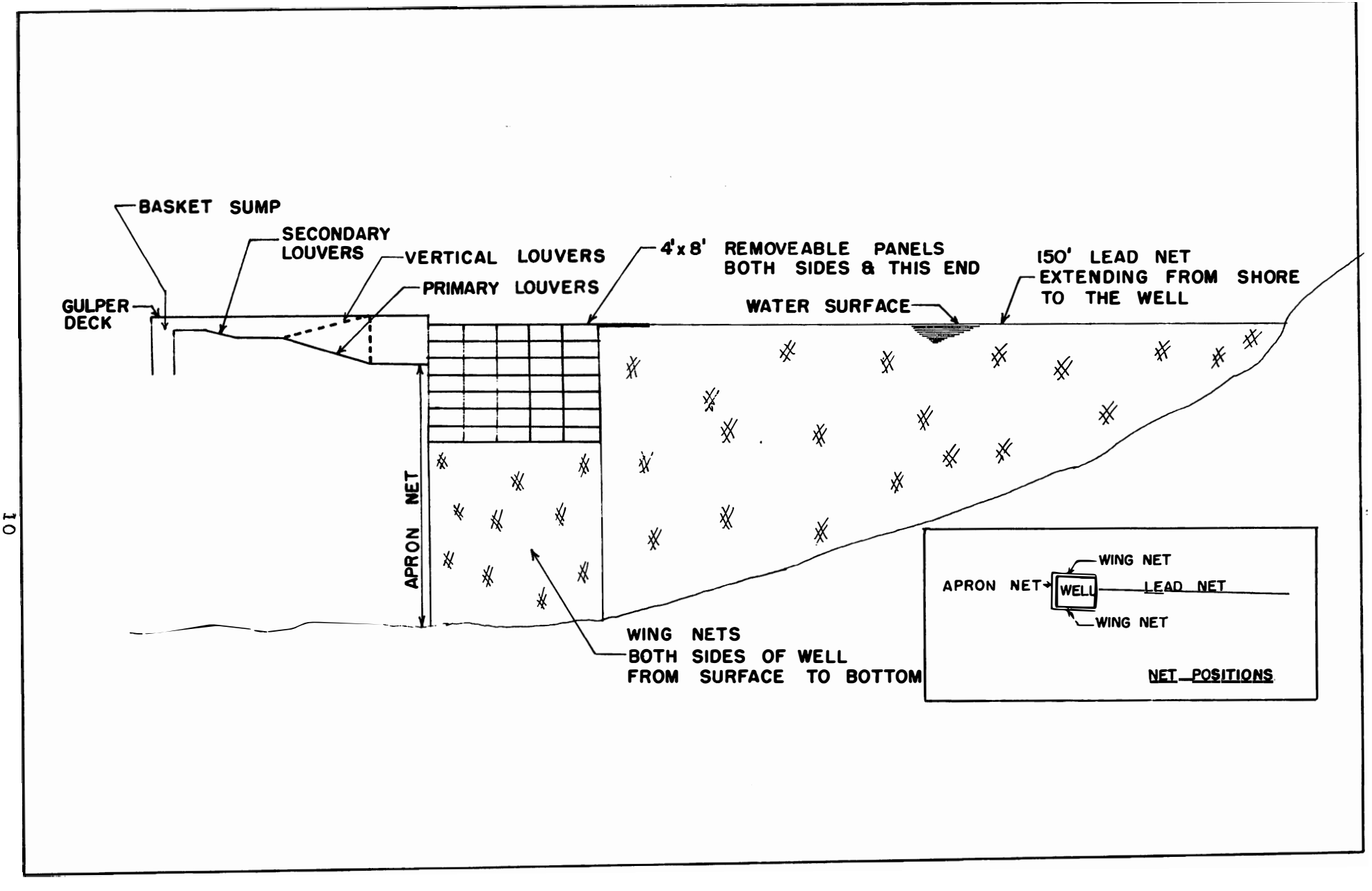

Figure 4.--Diagram of the 1964 fish concentration and collection facilities.

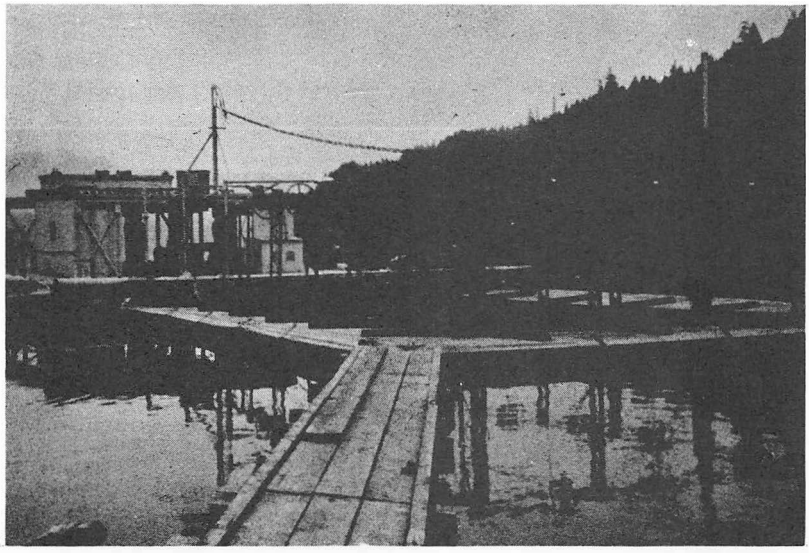

Plate 6. 1964 well addition to the juvenile fish collector in fishing position.

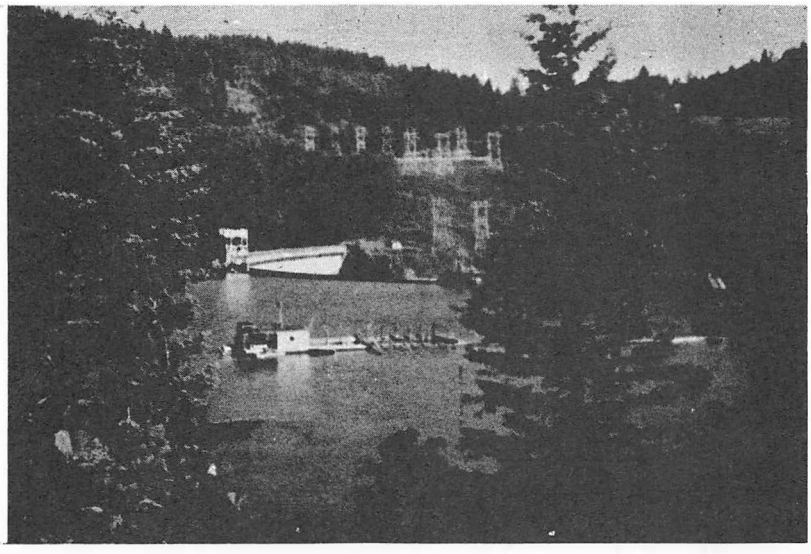

Plate 7. Juvenile collector 1964 fishing site in relation to Merwin Dam.

At the first two sites the primary flume of the collector was facing uplake, (Plate 4) but in the last position the collector was turned around and pointed towards shore. The primary reason for the latter change was the successful fish sampling with "Lake Merwin" floating traps that were fished at the site previously. This third site, about 100 yards above the dam (Plate 7) was the location of the collector during the 1964 season.

When attached to the collector, the anterior most part of the 1964 well addition was approximately 150 feet offshore. The water depth below the addition was about 50 feet and there was a gradual increase to 70 feet in depth below the stern of the collector. At the other two fishing sites utilized in 1963, the collector was fished closer inshore and the water depth was approximately 30-40 feet.

Operation of the collector

The construction and initial testing of the collector was completed in April 1963, with routine operation of the collector commencing on April 16. On April 25 mechanical failure of the right secondary pump necessitated a 34-hour shutdown for repairs. On May 24 the right secondary pump again ceased functioning and operations were not resumed until June 1. The collector was then operated until June 29 when the migration appeared over.

The collector was also operated in October and November 1963 to determine if there was a full migration but only 19 coho were taken in 220 hours of operation.

In 1964 the collector addition was constructed at Merwin Dam during February and March. Operation of the collector on a part-time basis began on March 23. The first catch of fish occurred on March 27 and operation of the collector on a continuous basis began April 1. The operation was continued through June 28, 1964 when the migration appeared to have ceased.

Mechanical difficulties, apparently resulting from an improperly aligned shaft, were experienced with the right secondary pump of the collector on two different occasions. The collector was inoperative for 21 hours on April 14 and 15 while new bearings were installed in the pump. When this failed to correct the problem, the collector was raised to its maintenance position on April 16-20, and was inoperative for 127 hours while repair work continued on the pump. On May 13 the pump again behaved adversely but this was corrected with a loss of only seven hours fishing time. This latter repair work apparently resolved the mechanical problem, as the pump ran normally the remainder of the 1964 season.

Operational procedures

For the initial operation of the collector, it was decided to approximate the conditions at the Baker collectors as closely as possible. Therefore standard operating conditions of approximately 200 cfs into the main flume and a weir crest height (initial depth of water in the secondary separation channel) of about 20 inches were created. From these standards it was intended to test the collector under other conditions to determine optimum operation criteria.

Catches were tabulated by two-hour periods, although the collection baskets were raised and emptied whenever fish were seen in them in order to minimize possible injury from the turbulence.

All salmon captured in the collector were measured; tagged yearlings and 1962 brood coho were returned to the lake. All of the untagged yearling (1961 brood) coho were marked as part of the Lake Merwin research program. These latter fish were then barged into the beach and transferred to a 200-gallon aerated tank mounted on a pick-up truck for transportation to a release area in the river approximately one-quarter mile below Merwin Dam.

In 1964 it was desired to run further tests on the wide range of internal water depths and velocities possible in the collector, in order to determine optimum conditions for fish attraction, but it was first considered more important to test the effect of the new addition. An attraction flow of approximately 190 cubic feet per second into the collector had appeared most favorable during the 1963 operation but the inflow was set at 254 cfs during the initial 1964 operation to provide increased current inside the addition. The 1963 results indicated fish passage over the primary flume weir crest was aided by increasing the depth of water over the crest. Consequently in 1964 it was decided to retain a maximum amount of water over the crest and, in practice, this depth was generally about 27 inches.

During the 1963 season various combinations of the mercury vapor lights were employed for fish attraction at night. To standardize the 1964 operation, only the three lamps over the primary flume were used during all hours of darkness for fish attraction. All other lights on the collector, excepting fluorescent fixtures required for fish handling, remained off.

Except for changes in the enumeration of the catch and in handling the tagged coho, the fish processing procedures were similar to those followed in 1963. In enumeration the catches were tabulated in four-hour intervals in contrast to every two hours as had been done in 1963. This allowed the entire catch for a 24-hour period to be held in only six separate live boxes and enumeration of the catch was not necessary at night. Tagged coho were also released into the river instead of being returned to the lake as was done in 1963.

THE LAKE MERWIN RESEARCH PROGRAM

The Washington Department of Fisheries and Pacific Power and Light Company conducted tagging studies in 1961 and 1963 to enumerate the yearling coho salmon populations and to study the distribution and movement of these fish in the reservoir. Hamilton and Rothfus (1963) demonstrated that Lake Merwin reared coho moved to the vicinity of the dam during the normal spring migratory period. A similar tagging study was also conducted in the spring of 1964; however, its primary purpose was to enumerate the coho population, Hamilton et al (1964).

Identical tagging sites, at approximate distances of 2, 6, and 10 miles above the dam (Figure 1) were utilized for both the 1963 and 1964 studies. Lake Merwin floating traps, units of gear very similar in design to the floating traps used commercially in Alaska to capture adult salmon, were used to capture the uplake coho for tagging. In both years a Lake Merwin trap, referred to as

Trap 1-A, was utilized as recovery gear at the dam. The primary function of this trap was to serve as an indicator of the relative abundance of coho in the area. In 1963 a second Lake Merwin trap (Trap 1) was fished at the dam during the period of major breakdown of the collector near the end of May.

Fish available to the collector

On August 21-22, 1962 a plant of fingerling, 1961 brood, coho salmon was made at Speelyai Bay, about eight miles uplake from Merwin Dam, as part of the regular Lake Merwin program. These fish had been reared in holding ponds at the Speelyai hatchery. In the spring of 1963 the previously mentioned tagging study demonstrated a population of 28,452 yearling coho in the lake. The 1964 tagging study indicated 4,894 of these fish were present in the lake as two-year-old fish.

To determine if stream reared fish would utilize the collector to a greater extent than those which were lake reared, 949 migrant coho from Speelyai Creek were tagged and released into the lake from March through June 1963. This experiment was repeated the following season and 742 tagged Speelyai migrants were released in the lake from April 13 through June 3, 1964.

On April 3, 1963, 102,000 unfed Lewis River chinook salmon fry (1962 brood) were released at the Woodland Park resort, about five miles uplake from the dam, to determine if this species would migrate through the reservoir and utilize the collector.

On May 27, 1963, 682 yearling coho and 116 yearling sockeye salmon, obtained from the Lower Baker Dam collector, were released into Speelyai Bay. Recognizing that the additional factors of handling and placing the fish in a different environment were being introduced, this experiment was designed to test possible differences in behavior patterns between these fish and the Lake Merwin yearling coho.

Also during the spring of 1963, a plant of unfed coho fry was made in Speelyai Bay. These 1962 brood fish were reared in the lake and migrated in the spring of 1964, at which time their population was estimated at 12,229 fish.

Other salmonoid fish present in the lake in unknown numbers included land-locked sockeye salmon or kokanee, and rainbow and cutthroat trout.

RESULTS

Catches during the 1963 and 1964 spring migrations

The total number of yearling coho obtained in the collector in 1963 was 2,525. This total includes 2,269 Lake Merwin yearlings, 130 Speelyai Creek migrants, and 126 Baker River stock. The catch of 1962 brood salmon was 383 coho and 38 chinook. None of the Baker River sockeye salmon were caught in the collector. The incidental fish catch was 166 trout and two kokanee (Table 2).

The collector was operated for a total of 1,482 hours, the yearling coho catch amounting to only 1.7 fish per hour over the entire 1963 season. During the five weeks of highest catches in the collector, May 12 to June 22, the yearling catch was 3.0 fish per hour.

The peak yearling coho catch in the collector occurred during the week ending June 8 when 900 fish were obtained. The highest daily catch was 283 coho yearling on June 2. Catches in recovery Trap 1-A, utilized as an indicator of fish abundance at the dam, reached a peak during the last week in May when the collector was inoperative due to mechanical failure of one of the pumps. However, due to tests to determine its affect upon catches in the collector, this trap was fished only part time during the period June 1-10.

Table 2. Weekly catches in the Lake Merwin juvenile fish collector, 1963.

Week Ending	Lake Merwin	1961 Brood Coho Speelyai Creek	1961 Brood Coho Baker River	1962 Brood Coho	1962 Brood Chinook	Kokanee	Trout
April 20	2	0	0	2	0	0	0
27	6	0	0	0	0	0	0
May 4	6	0	0	0	0	0	1
11	60	0	0	0	0	0	1
18	279	0	0	0	0	0	5
25	152	0	0	0	0	0	11
June 1	Not operating						
8	853	24	23	0	0	0	48
15	625	49	50	5	0	1	51
22	235	44	39	13	0	0	30
29	58	14	14	63	7	0	19
July 10-19	2	1	0	300	31	1	0
Season Totals	2,278 1/	132 2/	126	383	38	2	166

1/ Includes 9 multiple tag recoveries.
2/ Includes 2 multiple tag recoveries.

The total number of coho obtained in the collection baskets in 1964 was 9,598. This total includes 2,088 coho of the 1961 year class; 7,054 lake reared yearling coho, and 456 Speelyai Creek migrants. The catch of other species was 94 chinook salmon, 22 kokanee, and 718 trout (Table 3). The trout catch includes at least 41 multiple tag and mark recoveries; the salmon totals are individual recoveries only.

Table 3. Weekly catches in the Lake Merwin juvenile fish collector, 1964.

Week Ending	Tagged coho recoveries: Lake 1961 Brood	Tagged coho recoveries: Lake 1962 Brood	Tagged coho recoveries: Speelyai Creek	Untagged coho 1961 Brood	Untagged coho 1962 Brood	1962 Chinook	Kokanee	Trout
March 28	0	0	0	21	1	0	0	0
April 4	1	0	0	121	7	0	0	2
April 11	14	0	0	366	19	0	0	9
April 18	18	0	0	206	29	0	0	1
April 25	3	3	0	98	60	0	0	2
May 2	83	27	0	436	412	6	0	10
May 9	43	115	0	310	1,269	6	1	22
May 16	8	121	2	110	1,250	6	4	32
May 23	29	216	13	168	1,695	31	3	68
May 30	5	137	51	32	617	16	3	100
June 6	0	92	101	12	397	13	9	121
June 13	0	58	156	2	221	8	2	101
June 20	0	21	93	1	140	2	0	148
June 28	0	5	40	1	142	6	0	102
Totals	204	795	456	1,884	6,259	94	22	718

The collector was operated for a total of 2,000 hours; the coho catch amounting to 4.80 fish per hour over the entire 1964 season. During the five weeks of highest catches in the collector, April 26 - May 30, the coho catch was 8.6 fish per hour.

The peak coho catch occurred during the week ending May 23 when 2,048 fish were collected (Figure 5). The highest daily catch was 617 coho on May 18, 1964.

Size composition of the coho catches.

As a result of rearing in the highly productive lake environment, the Lake Merwin yearling coho were considerably larger than either the Speelyai Creek or the Baker River stocks. The Lake Merwin yearlings captured in the collector in 1963 averaged 205.9 mm in fork length as compared with 167.5 mm for the Speelyai Creek fish and 159.9 mm for the Baker River coho (Figure 6). There were probably

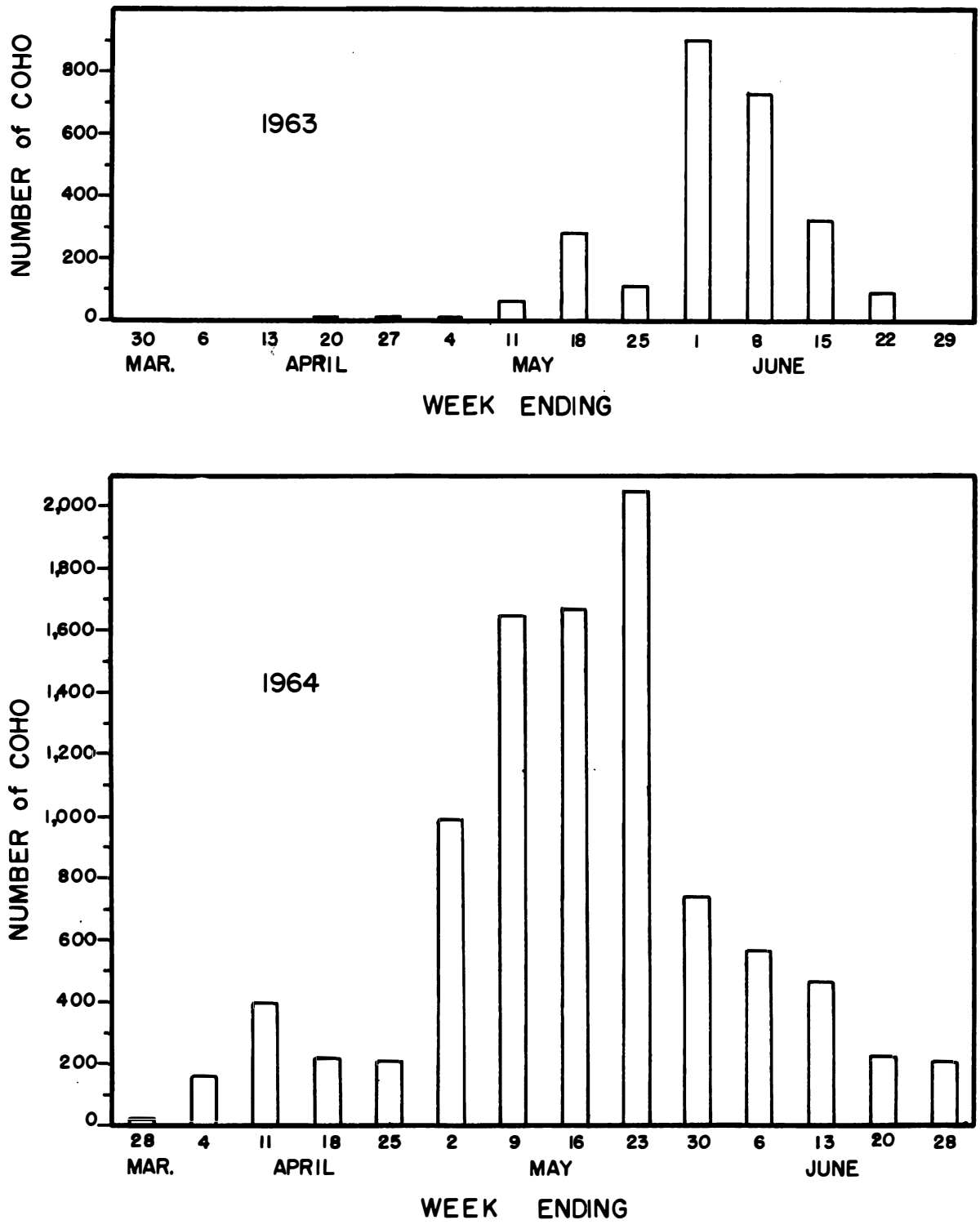

Figure 5.--Weekly catches in the Lake Merwin juvenile fish collector, 1963 and 1964.

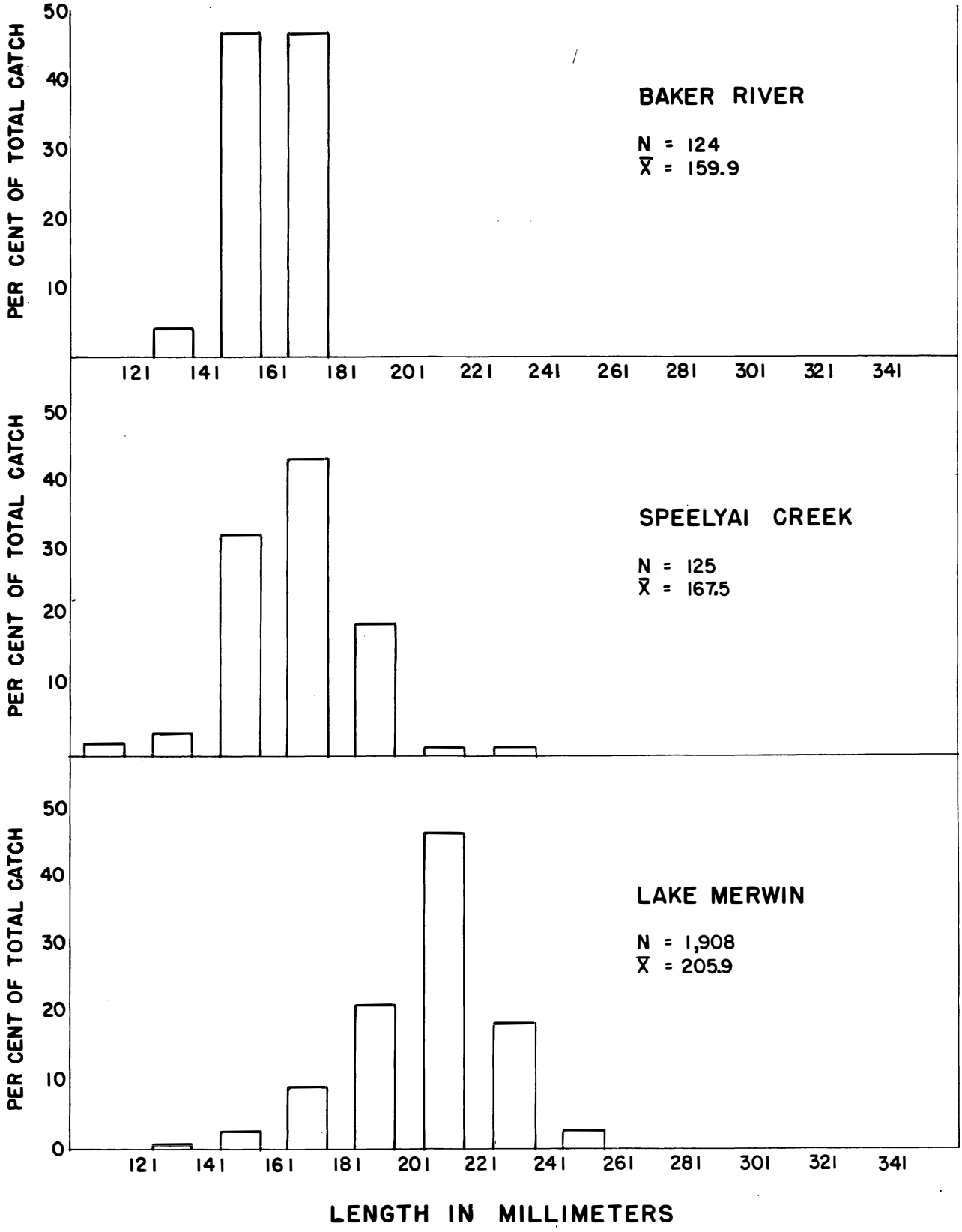

Figure 6.--Length frequencies of yearling coho salmon obtained in the Lake Merwin juvenile fish collector, 1963.

a few two-year-old coho in the lake in 1963 but their numbers were considered insignificant and no attempt was made to separate them from the yearling catch.

In 1964 scale readings and length frequencies were examined to determine the year class of coho obtained in the collector. These findings indicated that an overlap in lengths of the 2-year classes occurred in the size range from 240-280 mm during the season. It appeared that 260 mm could be effectively utilized as the separation point of the two-year classes (Hamilton et al ibid). On this basis the 1961 year class formed the bulk of the coho catch during the first four weeks of operation (March 23 to April 18, 1964), but the catch was primarily yearling (1962 brood) fish during the remainder of the season (Figure 7).

The Speelyai Creek tagged fish began appearing in the collector catch in fairly large numbers during the last week of May 1964. These fish averaged 161 mm in fork length when obtained in the unit. A large number of untagged coho of the approximate size of the Speelyai tagged fish was also obtained in the collector in June, and it is believed that some of these fish might have been escapees from Speelyai Creek.

Efficiency of the collector.

In order to determine the 1963 efficiency of the juvenile collector on lake reared coho, the number of fish captured in the two Lake Merwin Program recovery traps must be deducted from the population estimate to obtain the actual number of lake yearlings available to the collector. Trap 1-A fished throughout the season and captured 2,898 unmarked yearling coho. Trap 1 fished for approximately two weeks and captured 3,386 unmarked yearlings. The number of yearling coho available to the collector was 28,452 minus 6,284 or 22,168. Of this number the collector captured 2,268 or 10.2% (Table 4).

The efficiency of the collector slightly improved upon the Speelyai Creek fish. Of 949 migrants released into the lake over a period of approximately three months, the collector captured 120 fish (13.7%).

Of the 682 yearling Baker River coho released into the lake, 66 were removed by the two traps, leaving a total of 616 available to the collector. The collector captured 126 Baker yearlings for a recovery rate of 20.5%.

It should be noted that the results of live box tests to determine handling mortality and tag loss for the Lake Merwin fish involved in the population enumeration and the Speelyai Creek migrants were unavailable during the preparation of this report. The application of a correction factor for mortality and tag loss would undoubtedly decrease the number of fish available to the collector and increase the efficiency. Similarly, live box tests to determine the effects of transporting and handling the Baker River fish were not conducted, and the physical condition of these fish was judged to be poor at the time of their release into the lake.

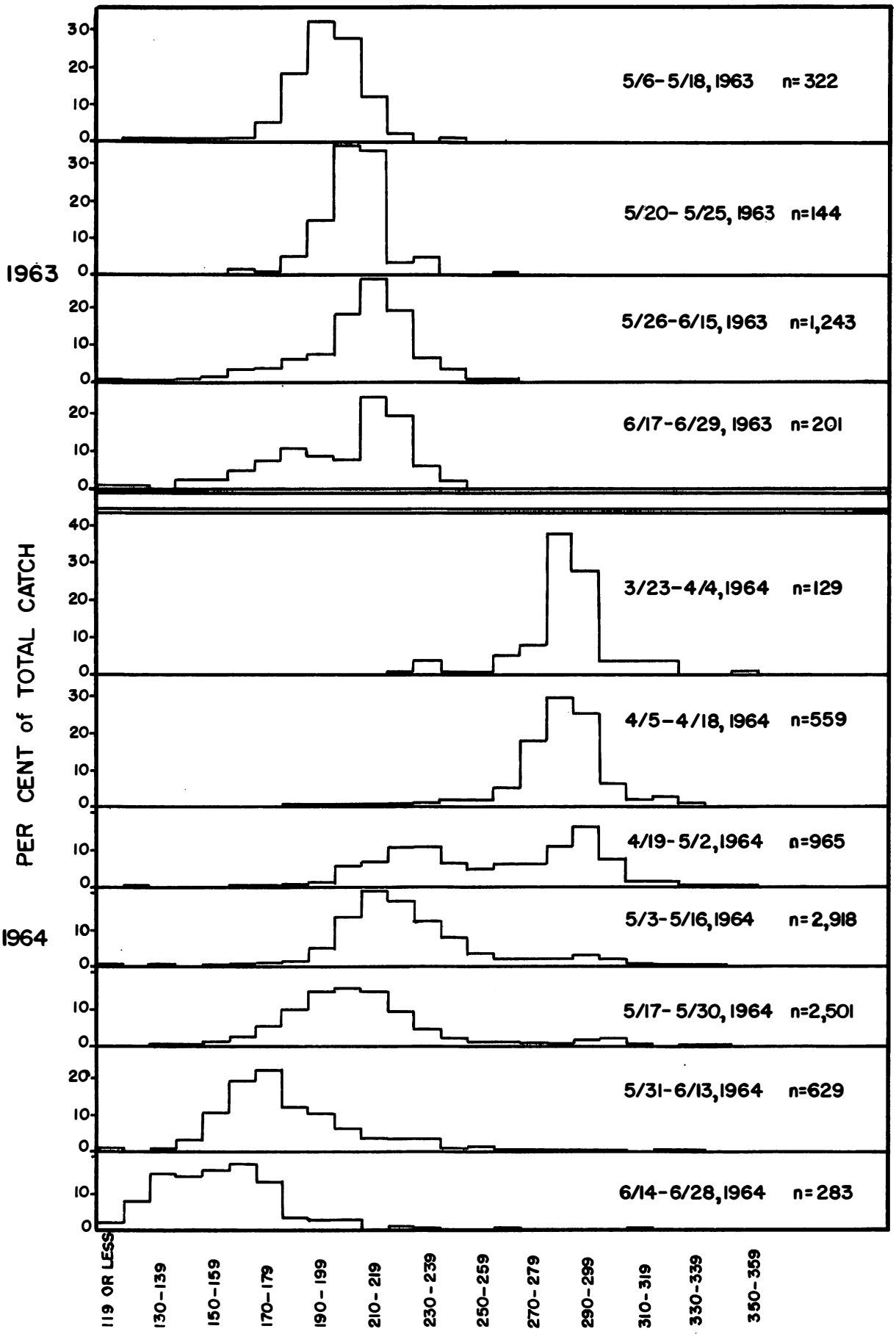

Figure 7.--Coho salmon length frequencies by two week fishing intervals, Lake Merwin juvenile fish collector, 1963 and 1964.

Table 4. Yearling coho salmon recovery rates, Lake Merwin juvenile fish collector, 1963.

Source of fish	Number available to collector	Number recovered	Per cent recovered
Lake Merwin	22,168	2,269	10.2
Speelyai Creek	949	130	13.7
Baker River	616	126	20.5

In addition to the coho obtained in the collection baskets, fish removed from the lake population by four other types of recovery gear during the period of operation of the collector must be considered when computing the efficiency of the unit for 1964. These other gear are (1) the nets over the discharge from the collector, which recovered fish passing through the louvers in the main flume, (2) the previously mentioned recovery Trap 1-A which was fished at the dam from March 30 through June 11, (3) the gill net vertical distribution study which coincided with the operation of the collector, and (4) the sport fishery in the lake, April through June 1964.

Most of the fish recovered in the discharge nets and in the gill nets were either dead or injured too badly to be returned to the lake population and all coho recovered in Trap 1-A were released into the river with the collector fish. Consequently, the affect of these three units of gear upon the total population is a known factor. An evaluation of the sport fishery was not made, and its effect on the total coho population, particularly on 2-year-old fish, is known. The fishery was monitored on a few occasions and voluntary tag returns were incurred, but the unknown sport tag recoveries would in effect reduce the population estimates and increase the calculated collector efficiency.

The known number of yearling coho removed from the lake population by the discharge nets, gill nets, Trap 1-A, and the sport fishery was 1,445. Deducting these fish from the population estimate resulted in a total of 10,784 yearlings available to the collector in 1964 and the efficiency rate was $\frac{7054}{10784}$ or 65.4%.

The known number of 2-year-old coho removed from the lake population was 953 and the efficiency of the collector on these fish was $\frac{2088}{3941}$ or 53%.

The efficiency of the collector was also computed on the basis of tag recoveries only. In Table 5 the recoveries of all tags in all types of recovery gear are listed by year class and origin of the fish. The combined results (Table 6) show a recovery rate in the collector of 65.6% of the tagged lake yearlings, 53.1% of the tagged 2-year olds and 66.2% of the tagged Speelyai Creek yearlings. The 1964 efficiency figures again are minimal values only, as a tagging mortality factor was unavailable at the time of preparation of this report.

Table 5. 1964 Lake Merwin coho tag recoveries by type of gear and origin of the fish.

Origin of fish	Brood year	Number tagged	Recoveries				
			Collection baskets	Discharge nets	Trap 1-A	Gill nets	Sport fishery
Lake Merwin	1961	497	204	3	64	11	35
Lake Merwin	1962	1,345	795	15	86	22	10
Speelyai Cr.	1962	742	456	12	30	11	0

Table 6. Combined 1964 Lake Merwin tag recoveries by year class.

Coho year class	Number tagged	Discharge nets, Trap 1-A, gill net and sport fishery recoveries	Available to collector	Collector recoveries	Collector per cent recovery
1961 Lake Merwin	497	113	384	204	53.1
1962 Lake Merwin	1,345	133	1,212	795	65.6
1962 Speelyai Cr.	742	53	689	456	66.2

Pump discharge net tests.

Nets were fished in 1963 and 1964 in the discharges from the two main pumps of the collector to determine the number of fish passing through the louvers of the main flume. The net frames raise and lower in metal guides which position them exactly over the egress from the primary sump, and the entire discharge from the pumps passes through the nets. In 1963 the nets were fished May 14 - June 29, while in 1964 they were fished continuously from April 3 through the remainder of the 1964 season and captured 249 coho, 2 chinook, and 142 trout (Table 7).

The total coho catch in the collection baskets from April 3 to June 28 was 9,566. Therefore the number of coho passing through the louvers was 2.6% of the number entering the baskets. This figure is almost exactly the same as was obtained during the shorter 1963 test (Table 8). The percentage of trout passing through the louvers in 1964 as compared with the collection basket catch was much higher at 19.8% (Table 7).

Table 7. Pump discharge net catches for the Lake Merwin juvenile fish collector, 1964.

Period	Coho salmon catch			Trout catch			Other species	
	Collection baskets	Discharge nets	Nets/ baskets	Collection baskets	Discharge nets	Nets/ baskets	Chinook salmon	Sculpins
April 3-18	774	16	2.1%	11	4	36.4%	0	2
April 19-May 2	1,203	13	1.1%	12	1	8.3%	1	0
May 3-16	3,320	111	3.3%	54	10	18.5%	1	0
May 17-30	2,787	71	2.5%	168	21	12.5%	0	0
May 31-June 13	1,043	31	3.0%	222	54	24.3%	0	0
June 14-28	439	7	1.6%	250	52	20.8%	0	4
Totals	9,566	249	2.6%	717	142	19.8%	2	6

Table 8. Pump discharge net catches for the Lake Merwin juvenile fish collector, 1963.

Week	1961 Brood coho		Net/ baskets	1962 Brood coho	1962 Brood chinook	Trout	Sculpins	Suckers
	Collection baskets	Side nets						
May 14-24	333	7	2.0 %	1	0	2	0	0
June 1-7	900	11	1.0 %	0	0	3	1	1
June 8-14	724	15	2.0 %	0	0	8	1	1
June 15-21	318	8	3.0 %	7	3	15	0	1
June 22-29	86	15	17.0 %	7	0	8	0	0
Total	2,358	56	2.4 %	15	3	36	2	3

The year class was obtained for 197 of the 249 coho captured in the discharge nets in 1964; the other 52 fish were mutilated too badly for accurate measurement. Those measured included 28 of the 1961 brood and 169 of the combined 1962 lake and Speelyai Creek broods. Of the 9,566 coho obtained in the collection baskets (1964) during the period the nets were also fished, 2,057 were 1961 brood and 7,509 were 1962 brood. Therefore, the ratios of net catches to basket catches for the identified coho were 1.36% for the 1961 brood and 2.25% for the 1962 brood, indicating the louvers were slightly more efficient in guiding the larger coho.

Catch in the collector as related to flow.

The original intent during the 1963 season was to test the four basic attraction flows into the collector and the wide range of internal water velocities and depths, with the view of determining which combination provided optimum operating conditions. Tests were set up when the collector first began operating in mid-April, but all combinations tried were equally unsuccessful, although catches in Trap 1-A indicated that there were yearling coho in the area. For this reason the emphasis was shifted to increasing the catch, rather than testing, with the assumption testing could be resumed when the catch increased. The addition of net leads was one part of the attempt to increase catches and the movement of the collector was another. However, even during the period of greatest catches in the collector in 1963, June 1-16, the schools of fish entering the main flume were small and scattered and adequate testing conditions were not met. Therefore the original operating criteria, as adopted from the Baker collectors, were utilized throughout most of the season. As a general rule, the two primary pumps were operated singly and the initial depth of water in the secondary flume was 20-24 inches. Table 9 presents the catch in the collector by flow, but these results are misleading because 86 and 305 cfs were not tried during the periods of greatest fish abundance.

Observations on fish behavior were hampered early in the season by the turbidity of the water. However, all indications suggested fish behavior to be most satisfactory at 190 cubic feet per second. This amount of inflow apparently produced smoothly accelerating velocities from the main flume into the collection baskets. At 86 cfs there did not appear to be a sufficient attraction flow. Head differences on either side of the vertical louvers were experienced at 254 and 305 cfs. (The above rates of flow do not include the additional 10-15 cfs which is normally contributed to the inflow by the two secondary pumps.)

Table 9. Yearling coho salmon catch by flow, Lake Merwin downstream migrant collector, 1963. (Weir crest set at 20-24 inches).

	Flow in cubic feet per second							
	86		190		254		305	
Month	Hours run	Catch	Hours run	Catch	Hours run	Catch	Hours run	Catch
April	22	0	211	7	48	0	20	0
May	0	0	465	459	51	27	0	0
June	14	5	440	1,508	181	520	30	14
Totals	36	5	1,116	1,974	280	547	50	14
Pct. of totals for season	2.4	0.2	75.3	77.7	18.9	21.5	3.4	0.6

Catches during daylight and dark hours.

Mercury vapor lights were used at night during both seasons to attract fish since catches made during hours of darkness in 1963 with all lights off were negligible. Most of the yearling coho caught prior to May 12, 1963 and all of the 1962 brood coho caught during the period July 10-19, 1963 were taken at night with the lights on. However, 76.6% of the yearlings captured over the entire 1963 season were taken during daylight hours (Table 10).

The 1964 results found the catch spread more uniformly over a 24-hour period with only 58.6% occurring during daylight hours (Table 10). However, 1200-1600 hours was the most productive period in both years.

Table 10. Coho salmon catches in the Lake Merwin juvenile fish collector by four hour intervals, 1963 and 1964.

	Hourly time periods						
	0000-0400	0400-0800	0800-1200	1200-1600	1600-2000	2000-2400	Totals
1963 catch	322	229	511	724	575	175	2,536
Per cent of total	12.7	9.0	20.2	28.5	22.7	6.9	100.0
1964 catch	1,605	1,164	1,429	2,310	1,454	1,636	9,598
Per cent of total	16.7	12.1	14.9	24.1	15.2	17.0	100.0

Tests of the well addition to the collector.

Testing of the well on the collector began in late April and was continued through June 16, 1964. This consisted of comparing catches in the collector with panels in the front end of the addition set at 0, 14, and 28 feet in depth. (Throughout the tests the side panels were in place to a depth of 28 feet.) With the panels removed from the front, fish in the surface layers of the lake could enter directly into the well. Under this condition the inflow into the collector was very similar to that of 1963. With the front panels set at 14 or 28 feet in depth, however, fish in the surface water layers were required to sound and enter the well from below. Under these conditions the collector was drawing water from greater depths than in 1963.

During the testing the panels were generally set at the desired depth for 72 or 96 hours before being changed. Longer testing periods were prevented by the shortness of the migratory season and shorter periods were undesirable because of the sporadic pattern of catches in the collector. All tests began and ended at 1600 hours except for May 13 when the unit was shut down earlier for repairs.

Since catches in the gill net distribution study indicated the fish were concentrated in the surface layers (Erho, 1964) the panels were left out of the front section until April 27. However, the installation of all panels on this date (28 foot depth) resulted in an immediate increased catch in the collector, although the Trap 1-A catch did not indicate an increase in abundance of fish (Figure 8). In the 96-hour period preceding the installation of the panels, the

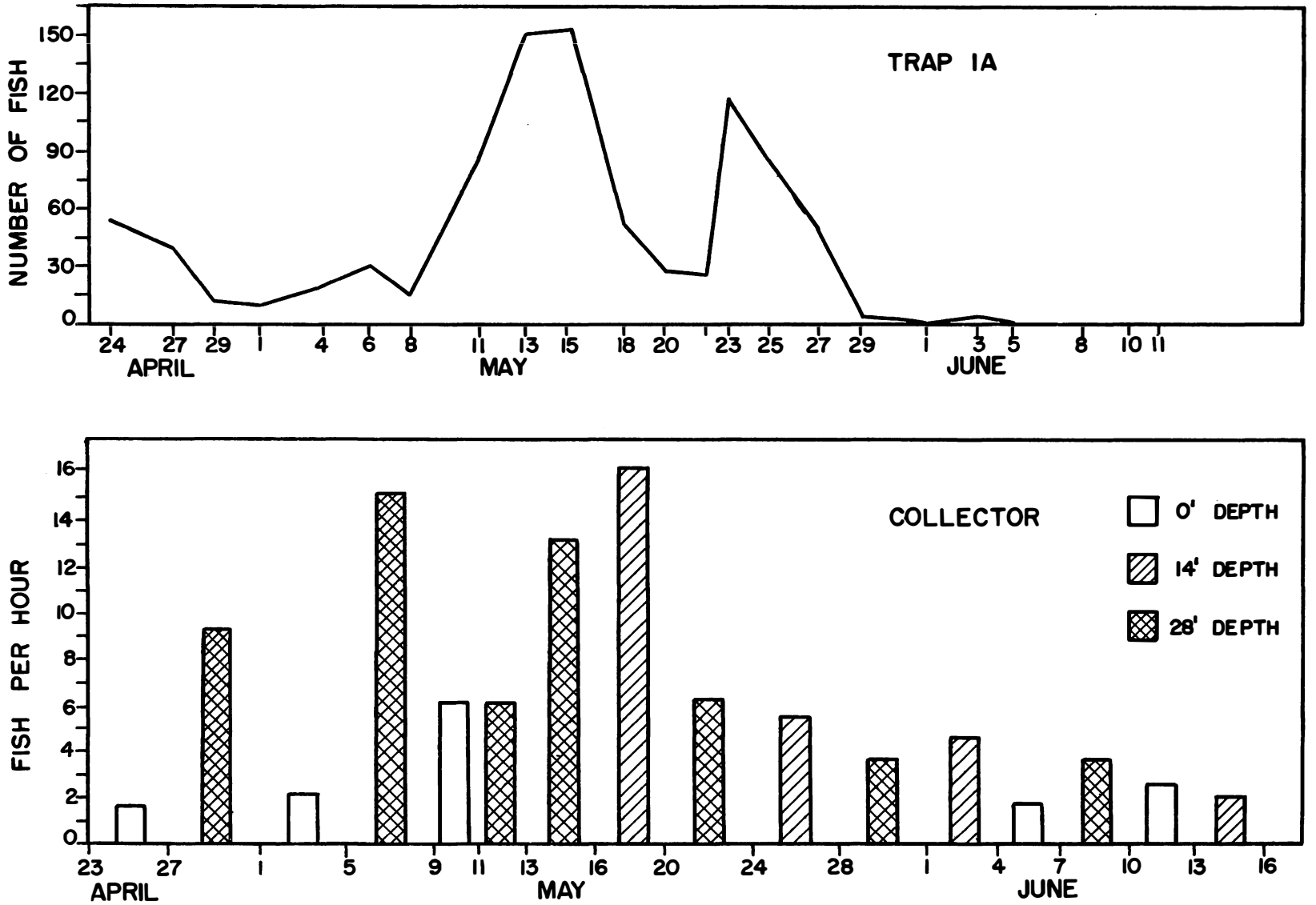

Figure 8.--Coho salmon catches in the juvenile fish collector and in trap I-A during the testing of the 1964 addition to the collector.

collector recovered 147 coho. After the panels were installed the catch was 887 coho in 93 fishing hours.

When the front panels were removed on May 1, the collector caught 232 coho in 94 fishing hours; and the installation of all panels on May 5 resulted in a catch of 1,454 fish in the following 96 hours. During the period May 9-13, the recovery rates were 296 coho in 48 fishing hours with the front panels removed and 252 coho in 41 fishing hours with all panels installed. These latter results were possibly affected by mechanical failure of the collector on the 13th.

Following repair work on the unit, testing was continued at the 28 foot depth until May 16 when the front section was set at 14 feet. Because of a time limitation on the testing, this series of tests was considered to commence on May 12, and in the following 89 hours the collector recovered 1,296 coho. From May 16-20, with the front section at 14 feet, the recovery was 1,540 coho in 96 fishing hours. On May 20 the panels were reset at maximum depth and a catch of 588 fish occurred in 94 hours. During the 96-hour period of May 24-28 with panels at 14 feet, the catch was 531 coho. From May 29 - June 4 the collector recovered 264 coho in 72 hours at maximum fishing depth and 337 coho in 72 hours with the front section at intermediate depth.

During June it was planned to conduct tests comparing all three depths, but this was curtailed by a decrease in abundance of fish. By combining the results of tests at 14 and 28 feet, however, a measure of the effect of panel installation can be obtained.

From June 4-7 the catch was 124 coho in 72 fishing hours with all front panels removed. On June 7 fishing was resumed at the 28 foot depth and 266 coho were obtained in the following 72 hours. All front panels were again removed on June 10 and 190 coho were recovered in another 72-hour test. On June 13 the panels were set at 14 feet and a catch of 133 coho occurred in the ensuing 68-hour test period.

The results of the three series of tests indicated that the panel installation to a depth of 28 feet during the period April 23 - May 13 effectively increased the catch in the collector. With all front panels removed from the addition the collector recovery rate was 2.84 fish per hour; with these panels set at 28 feet in depth, the recovery rate was 11.27 fish per hour (Table 11). During the period of May 12 through June 4, catches at the 14 and 28 foot panel depths were somewhat similar. With the panels set at 14 feet in depth, the coho recovery rate was 9.12 fish per hour and at the 28 foot depth the recovery rate was 8.42 fish per hour.

During June the presence of the panels did not appear to greatly increase the catches. The recovery rate with all front panels removed was 2.18 fish per hour, while 2.85 fish per hour was obtained with the panels at 14 or 28 feet in depth.

Table 11. Coho salmon catches in the Lake Merwin juvenile fish collector with the front section of panels in the well set at 0, 14, and 28 feet.

Period	Panel depth	Fishing hours	Coho catch	Period	Panel depth	Fishing hours	Coho catch
April 23-27	0	96	147	April 27-May 1	28	93	887
May 1-5	0	94	232	May 5-9	28	96	1,454
May 9-11	0	48	296	May 11-13	28	41	252
		238	675			230	2,593
Fish per hour = 2.84				Fish per hour = 11.27			
May 12-16	28	89	1,296	May 16-20	14	96	1,540
May 20-24	28	94	588	May 24-28	14	96	531
May 29-June 1	28	72	264	June 1-4	14	72	337
		255	2,148			264	2,408
Fish per hour = 8.42				Fish per hour = 9.12			
June 4-7	0	72	124	June 7-10	28	72	266
June 10-13	0	72	190	June 13-16	14	68	133
		144	314			140	399
Fish per hour = 2.18				Fish per hour = 2.85			

It should be noted that the Trap 1-A catches presented in Figure 8 are used only as an indicator of the relative abundance of coho near the dam. Although this trap was located approximately 300 yards uplake from the collector, all indications were that the latter had the more preferable fishing site and fish moving to the dam were more likely to encounter the collector first. Therefore daily fluctuations in the trap catches could have been partly influenced by the catches in the collector.

It should also be noted that the testing periods per each panel depth were not selected randomly, but followed one another in orderly sequence. Extreme fluctuations in catches occurred within the individual testing periods at one particular depth and the apparent increase in catch due to panel position might have been primarily due to fish abundance. To determine if the observed differences in catches at the three panel depths were significant, a statistical analysis was performed on the catch data.

The first step in the analysis was the calculation of fish per hour values for each 24-hour fishing interval within the various testing periods listed in Table 11. These values were summed to obtain one fish per hour total for the entire period (Table 12). The combined results produced six periods of comparisons of catches with the panels set at depths of 0 feet and 28 feet, six comparisons at 28 feet and 14 feet, and four comparisons of panels "in" versus panels "out" in June.

Table 12. Coho catches in fish per hour during the 1964 testing of the well addition to the Lake Merwin juvenile fish collector.

Testing Period	Panel 0 ft	Depths 28 ft	Testing period	Panel 28 ft	Depths 14 ft
April 23 to May 1	2.6	9.3	May 12 to May 20	10.4	5.4
	1.7	6.1		13.8	35.3
	0.1	16.1		16.8	16.4
	1.8	6.6		16.0	7.1
Subtotals	6.2	38.1		57.0	64.2
May 1 to May 9	1.0	16.6	May 20 to May 28	3.9	3.7
	4.4	11.4		12.0	2.7
	1.4	11.7		5.7	10.4
	2.9	21.0		3.4	5.3
Subtotals	9.7	60.7		25.0	22.1
May 9 to May 13	3.7	3.1	May 29 to June 4	4.3	7.5
	8.7	10.4		3.3	6.1
				3.5	0.5
Subtotals	12.4	13.5		11.1	14.1

Testing Period	Panel 0 ft	Depth 14 or 28
June 4	1.9	1.5
June 10	2.8	7.0
	0.5	2.6
Subtotals	5.2	11.1
June 10	0.5	3.3
June 16	1.5	2.3
	5.9	0.4
Subtotals	7.9	6.0

The testing periods for the computed panel depths were arranged in a one way analysis of variance design and the hypothesis that catches were equally as good at each depth was tested at the 95% level of significance. The hypothesis was rejected for the series of tests with the panels at 0 feet and 28 feet, but it was accepted for the other two types of comparisons (Table 13). [The tabled distribution of F is from Snedecor (1956) Table 10.5.3, p. 246.]

Table 13. Analysis of variance table for comparisons of catches with the panels set at 0, 14, and 28 feet.

A. Analysis of variance table for 0 versus 28 feet in depth, April 23-May 13, 1964

Source	Sum of squares	Degrees of freedom	Mean square	F value	Tabled distribution of F
Between classes	496.74	5	99.35	7.92	2.96
Within classes	175.50	14	12.54		

B. Analysis of variance table for 28 versus 14 feet in depth, May 12-June 4, 1964

Source	Sum of squares	Degrees of freedom	Mean square	F value	Tabled distribution of F
Between classes	526.43	5	105.29	2.41	2.85
Within classes	698.94	16	43.68		

C. Analysis of variance table for 0 versus 14 or 28 feet in depth, June 4-16, 1964

Source	Sum of squares	Degrees of freedom	Mean square	F value	Tabled distribution of F
Between classes	6.88	3	2.29	0.45	4.07
Within classes	40.48	8	5.06		

To further define the source of variability in the catches at 0 feet versus 28 feet, a two-way analysis of variance test was performed. When the observations were arranged as in Table 14 below, it can be seen that the proportional numbers model is appropriate (Snedecor, 1956). The analysis of variance for these observations is given in Table 15.

Table 14. Observation table obtained from the totals of each testing period in Table 12.

Testing period	Observations at 0 ft	Observations at 28 ft	Totals for testing periods
April 23 to May 1	n = 4 + = 6.2	n = 4 + = 38.1	n = 8 + = 44.3
May 1 to May 9	n = 4 + = 9.7	n = 4 + = 60.7	n = 8 + = 70.4
May 9 to May 13	n = 2 + = 12.4	n = 2 + = 13.5	n = 4 + = 25.9
Subtotals	n = 10 + = 28.3	n = 10 + = 112.3	n = 20 T = 140.6

Table 15. Analysis of variance table (proportionate analysis)

Source	Sum of squares	Degrees of freedom	Mean square
Testing period	44.11	2	22.06
Panel depth	352.80	1	352.80
Interaction	99.83	2	49.92
Error	175.50	14	12.54

The hypotheses tested were (1) no significant differences in catches due to testing periods, (2) no significant differences in catches due to panel positions, and (3) no interaction between the panel positions and testing periods.

For (1) $F = \frac{22.06}{12.64} = 1.76$ Since F (d.f. 2.14) = 3.74, this hypothesis is accepted.

For (2) $F = \frac{352.80}{12.54} = 28.13$ Since F (d.f. 1.14) = 4.60, this hypothesis is rejected.

For (3) $F = \frac{49.92}{12.54} = 3.98$ Since F (d.f. 2.14) = 3.74, this hypothesis is rejected.

The interpretation of the interaction between panel positions and testing periods is that catches with the panels at 28 feet were significantly greater for the periods April 23 to May 1 and May 1 to May 9, but not for the period May 9 to May 13 (Table 7). It is suspected that this latter is at least partly due to mechanical malfunctioning of the collector during this period.

Water temperature.

The temperature of the inflow to the collector was monitored by a recording thermometer throughout the 1963 and 1964 seasons. Also, from late April through the remainder of the 1964 season, daily surface to bottom water temperature readings were taken inside the addition and off the stern of the collector. The spring of 1964 was extremely cool and water stratification in the vicinity of the collector was minor throughout the entire migration season (Figure 9). In 1963 stratification was evident in the vicinity of the collector in June (Figure 10). The temperature of the inflow to the collector did not reach 60 F until the last day of the 1964 operation, and during the period of highest catches it was 45-50 F. These later values compare with a temperature of about 58 F during the period of highest catches in 1963. In the latter part of the 1964 season the surface water temperature was slightly warmer off the stern of the collector than inside the well addition, probably due to the upwelling of water inside the addition.

Observations on fish behavior in and around the collector.

In 1963 the fish were generally observed entering the main flume in small groups (10-20 fish). Once inside the flume they would normally drift slowly backwards, working laterally just above the horizontal louvers, until reaching a point approximately five feet in front of the weir crest. Here they apparently became disturbed and would swim out towards the entrance again. This maneuver would often be repeated several times before some or all of the fish crossed the weir crest and entered the secondary channel, or else the entire group would leave the collector. A few larger groups of fish (50-70) entered during the first two weeks in June and these fish appeared more willing to accept the collector. Also, the 1962 brood coho which were captured in July, averaging 129 mm in length, appeared more willing to accept the collector than had the smaller groups of yearlings.

Fish which crossed the weir crest and entered the secondary channel would normally pass on into the collection baskets. However, they would often remain in the channel several minutes before passing through the drawdown from the secondary separator.

In general the behavior of the fish inside the primary flume of the collector in 1964 was similar to that observed during the 1963 season. The one behavior difference noted between the two years was that in 1964 the fish appeared less hesitant to cross the weir crest and enter into the secondary separation channel, although it was not unusual for them to make repeated passes through this area before entering the baskets. On several occasions during the season large groups of coho (50-70 fish) were observed to pass over the crest and drift back in the secondary channel until reaching the louvered area. Here they would congregate for a short period of time, with perhaps a few entering the collection baskets. The remaining fish eventually swam entirely out of the collector and momentarily disappeared from view inside the well addition before re-entering the primary flume and repeating the cycle. This maneuver would often be repeated several times before the majority of the originally sighted group entered the baskets.

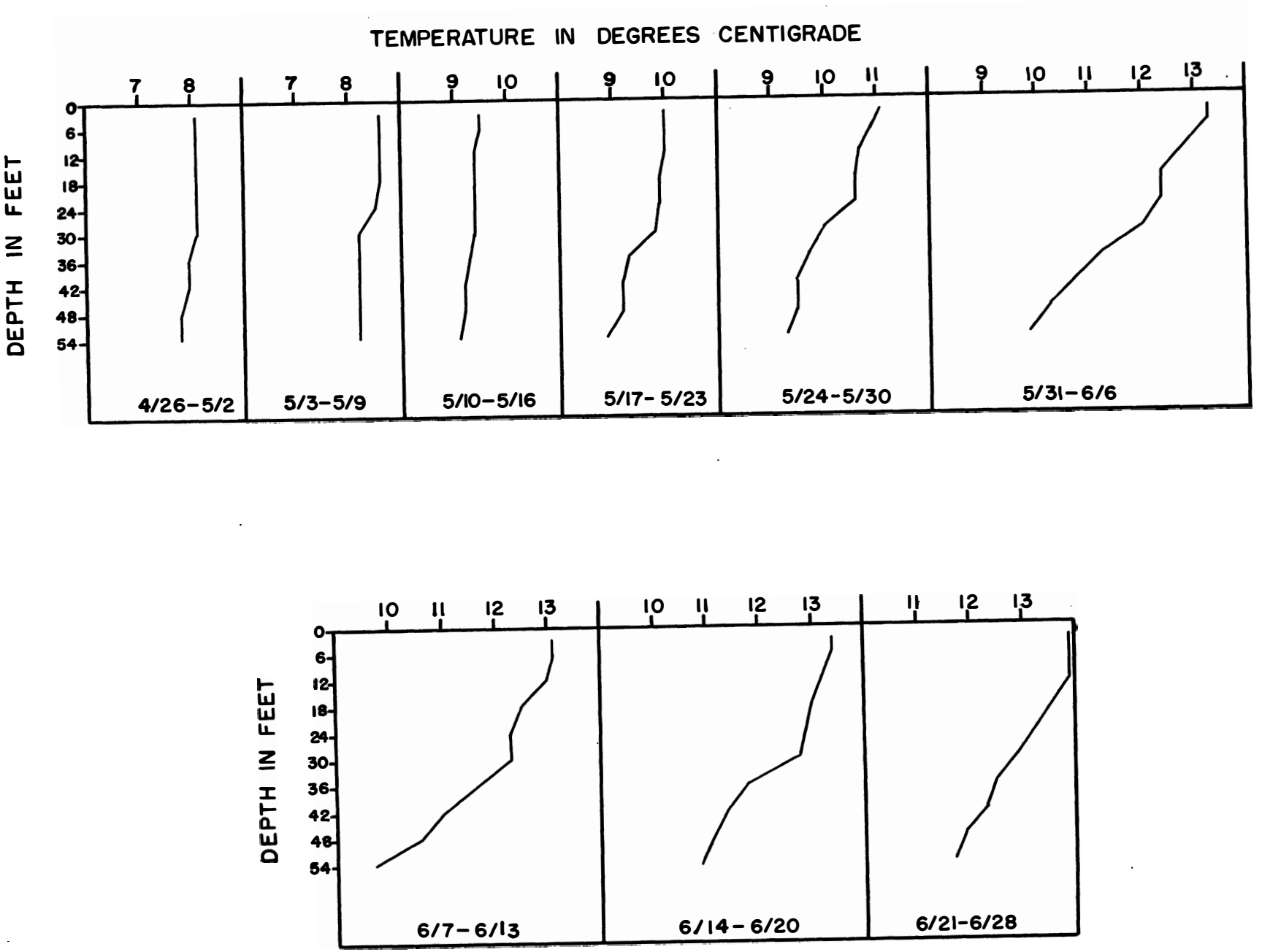

Figure 9.--Average weekly water temperatures at six foot intervals in depth inside the well addition to the juvenile fish collector.

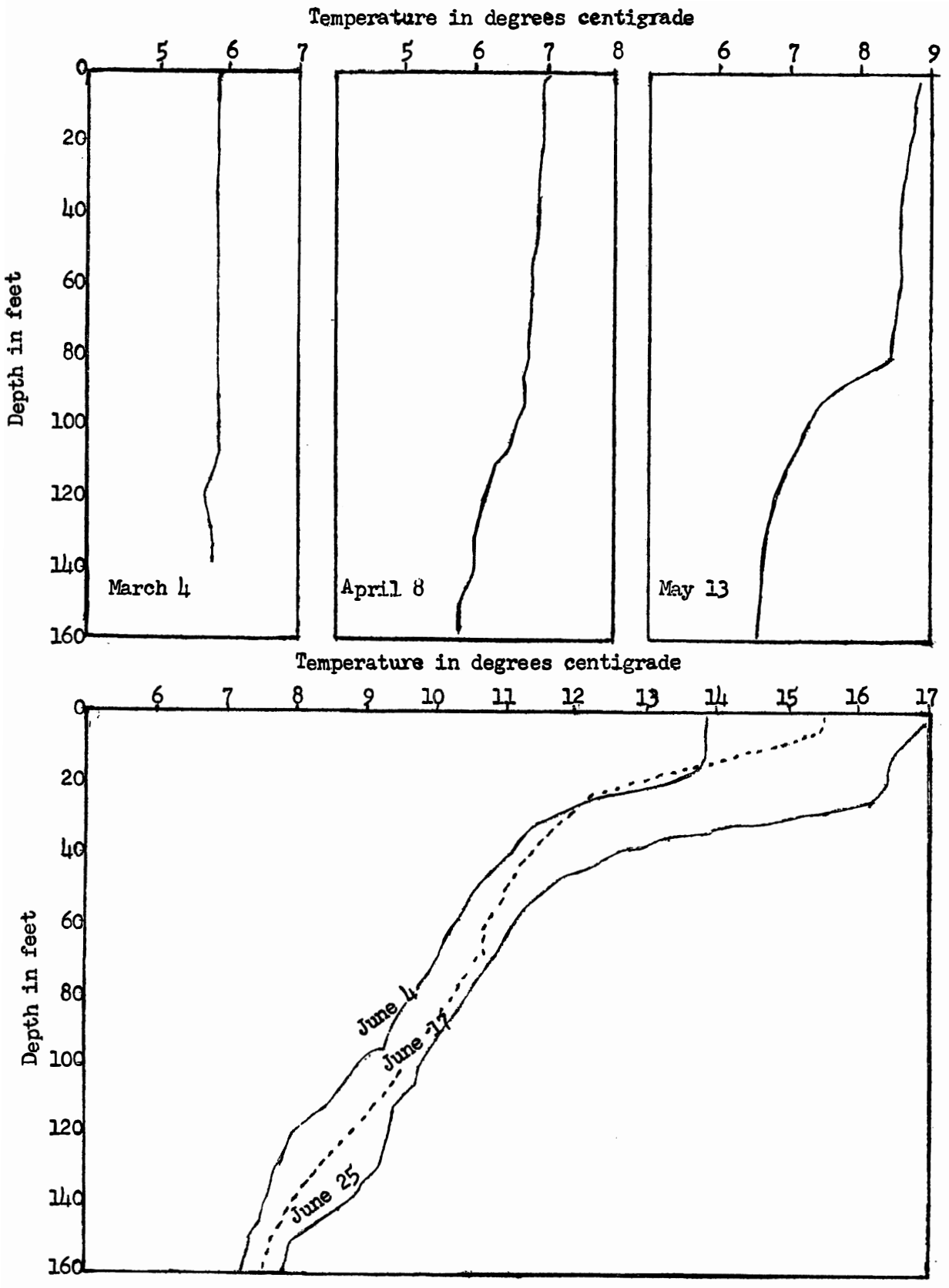

Figure 10 - Temperature profiles at Merwin Dam, 1963. (Unpublished data obtained from the Reservoir Limnological Study Program).

DISCUSSION

The results of the 1963 operation of the juvenile collector were extremely poor and the reason or reasons for this were thought to be related to the vertical distribution of the coho due to size of fish, water stratification, or other unknown factors. Of three stocks of fish available to the collector, the recovery rate was highest on the smaller fish (the Baker River and Speelyai Creek groups). Significant numbers of the larger lake-reared coho were approaching the floating Lake Merwin traps, as evidenced by the catches, and these traps were fishing to a depth of 30 feet as compared with 10 feet for the collector (Allen, ibid). Consequently, in 1964 a well addition to the collector was created which changed the maximum fishing depth from 10 to 28 feet.

The catch in the collector in 1964 improved appreciably despite the fact that the coho population was smaller than in the previous season. Based on the population estimate, the 1964 efficiency of the collector on yearling coho was calculated at 65.4%, as compared with 10.2% in 1963. Recoveries of coho tagged and released throughout the season uplake from the collector were 65.6% for Lake Merwin yearlings, 53.1% for lake two year olds, and 66.2% for Speelyai Creek migrant yearlings. The fish per hour value for 1964 over the entire season was 4.8 as compared with 1.7 fish per hour for 1963. During the five weeks of highest catches in the collector in each of the two seasons, the coho catch was 8.6 fish per hour in 1964 and 3.0 fish per hour in 1963.

The reason or reasons why the collector was more efficient in 1964 was not entirely due to the construction of the well addition. Tests of this structure were conducted during the season to determine its effect on the coho catch. With the front panels removed, inflow to the collector was considered to be drawn from the surface water layers similar to that in depth distribution of 1963. The 1963 catch during the period of highest recovery in the collector was 3.0 fish per hour. The 1964 catch during the period of highest recovery, April 23 - May 11, was 2.84 fish per hour with all panels removed from the front end (Table 11). When the panels were set at their maximum depth of 28 feet the catch increased to 11.27 fish per hour. Subsequent tests in May indicated it made little difference whether the panels were set at 14 or 28 feet in depth. During June the testing indicated no significant difference in catches, regardless of whether the front panels were in or out.

The panel testing was limited due to the shortness of the migratory season. In particular, 14 feet, or some other intermediate depth, should have been tried during the early testing period and all panels should have been removed during the mid-May incidence of highest catches in the collector. Although it does appear that the well addition in itself was an important contributor to the more successful 1964 catch, particularly in the early part of the season, the June panel testing results suggest some other factor was also important in the improved 1964 catch.

As mentioned previously a system of nets designed to concentrate the fish near the collector was also installed prior to the 1964 season. This system consisted of a net lead, extending from the water surface to the lake bottom,

from the front of the addition into shore, and net walls which extended to the lake bottom from the floor of the primary flume of the collector and the two sides of the well addition. Fish sounding or following the lead below the 28 foot maximum depth of the addition were thus still entering a three-sided enclosure formed by the nets. Net leads were used to some extent in 1963 but they were not designed to concentrate the fish near the collector and the fish could sound below the unit. The 1964 net complex was in place during the entire season and its individual effect on the catch is unknown, but it could have been a very important factor.

The 1964 fishing site, the most successful location for Lake Merwin traps previously, may also have contributed to the improved catch. Although catches in 1963 did not materially improve when the collector was moved into this position, the move was not made until late in the migratory season when fish abundance was decreasing.

In 1963 the average length of 1,908 untagged yearling coho obtained in the collector was 205.9 mm. The following season the unit recovered 6,259 untagged yearlings and their average length was 210.1 mm. The average length of Speelyai Creek fish recovered during the two seasons was 167.5 mm in 1963 and 161.0 mm in 1964. Although in 1963 the size of fish was considered as a possible contributor to the low catch, there was no major difference in average size of coho in the two seasons. Size of fish alone did not appear to be an important factor in the 1964 catch. The recovery rates for tagged coho in the collector were 65.6% for lake-reared yearlings and 66.2% for the smaller Speelyai Creek fish. The recovery rate on tagged two-year-old coho was only 53%, but this could have been due to a large number of these fish being taken in the lake sport fishery during the season.

The average size of the recovered coho was also compared with the fishing depth of the collector. During the series of tests with the panels at either 0 or 28 feet in depth, the average size of the recovered coho was 233.0 mm at 0 feet and 244.1 mm at 28 feet. When the catches at 14 feet versus 28 feet are compared the average coho size at 14 feet was 211.6 mm in length and at 28 feet, 217.6 mm in length. The average size of the coho recovered in June was 169.7 mm in the catches with all panels removed and 176.9 mm with the panels at either 14 or 28 feet. Although a slight increase in average size occurred with increased fishing depth (Table 16) this difference may be too minor to be of significance.

Table 16. Average size of coho recovered during the 1964 tests of the Lake Merwin juvenile fish collector addition.

Period	Panel depth (feet)	Total coho	Average size (mm)
April 23 - May 11	0	675	233.9
April 27 - May 13	28	2,593	244.1
May 16 - June 4	14	2,408	211.6
May 12 - June 1	28	2,148	217.6
June 4 - June 13	0	316	169.7
June 7 - June 16	14 or 28	399	176.9

Since catches earlier in the season improved with the fishing depth of the collector, it might be assumed that the coho at the dam were initially at greater depths and then appeared in the surface layers more frequently later in the season. However, the 1964 gill net distribution study indicated that the majority of the fish were present in the 0-20 layer during the entire season (Erho, 1964).

It is proposed that part of the success of the 1964 addition was due to an "imprisonment" of the fish inside the well addition which kept them concentrated near the collector for a period of time. If the majority of the fish were in the surface layers, as the gill net study indicated, they were required to sound to enter the well addition when all panels were in place. In theory then they followed rising inflow to the collector and became concentrated inside the walls of the addition, in front of the main flume of the collector. It has been previously noted that fish were observed entering the collector almost to the collection baskets, then swimming back out into the addition to be lost from view, before eventually being captured. If these fish had become frightened upon their initial entree into the collector and retreated into the addition, they might have been turned by the panels and again returned to the primary flume. With the front panels removed they could have departed the vicinity of the collector without again sounding below the well addition.

Hamilton and Rothfus (1963) in their tagging studies found that the interval between time of tagging of coho uplake and time of their initial recovery at the dam increased as the migration season progressed. If this is an indication of increased speed of migration, then it might be assumed that they would accept the collector more readily as the season progressed. The "imprisoning" effect of the addition could then have become less important in the recovery rate later in the season, resulting in the almost equal catches in June during the "in" versus "out" panel tests.

During the 1963 season it did not appear that the low coho catch was directly attributable to water temperature. However, it appeared possible that vertical distribution of fish, particularly late in the season, could have been influenced by water stratification.

Lake Merwin is under limnological study under a separate contract with the Bureau of Commercial Fisheries Accelerated Research Program, and an intensified sampling of the forebay area was conducted during the 1964 migration season to determine the possible effect of stratification. A complete analysis of the results is not yet available but it is known that stratification was weaker in 1964 than during the previous season. If stratification is an important factor in the vertical distribution of fish near the dam, then its effect on the efficiency of the collector in 1964 was less than in 1963.

SCUBA observations upon the behavior of fish entering the well addition were hampered by the murkiness of the water and the relatively small numbers of fish in the area at one time. It was unfortunate that time did not allow the testing of the well without the net lead and walls to determine the effect of the latter upon the catches. Of primary importance, however, was the determination that the juvenile collector could be successfully utilized for fish passage at a reservoir other than those on the Baker River system, although some modifications or additions to the basic structure may be necessary.

SUMMARY

1. The Lake Merwin juvenile fish collector was constructed at the lake in early 1963 and operated during the normal spring downstream migration period for yearling coho salmon.

2. The catch during the 1963 season was very low, possibly due to the size and/or the vertical distribution of the lake-reared yearling coho.

3. A well addition structure designed to increase the fishing depth of the Lake Merwin juvenile fish collector, was constructed prior to the operation of the unit during the 1964 spring downstream migration season. A system of nets, designed to lead and concentrate the fish near the primary flume of the collector, was also installed.

4. The collector recovered 9,598 coho in 2000 hours of operating the catch amounting to 4.80 fish per hour over the entire 1964 season. This was an increase from 2,525 total coho and 1.7 fish per hour in 1963.

5. On the basis of the population estimate obtained by a tagging study conducted under a separate research program, the 1964 efficiency of the collector was calculated at 65.4% for the lake reared yearling coho population. In 1963 this efficiency value was 10.2%.

6. Recoveries of tagged coho in the collector in 1964 amounted to 53.2% of the 2-year-old lake reared fish, 65.6% of the lake reared yearlings, and 66.2% of the Speelyai Creek yearlings.

7. The percentage of fish passing through the louver guidance system in 1964, as compared with the collection basket catch, 2.6%, was very similar to that obtained in 1963.

8. Less than 60% of the total 1964 coho catch occurred during daylight hours, as compared with a 76% daylight catch in 1963. This change was apparently due to improved catches during the earlier part of the migration season.

9. Catches in the collector early in the 1964 season significantly improved when the well addition was set at the maximum fishing depth of 28 feet. Later in the season however, the fishing depth of the collector did not appear in itself to be the only reason for the increase in the efficiency in 1964.

10. Water stratification in the Merwin Dam forebay was weaker in 1964 than in 1963, which could have contributed to the improved catch.

11. The primary reasons for the improved catch were probably due to the 1964 fishing site and concentrating the fish in front of the collector by the well addition and the net leads.

12. It is concluded that the juvenile collector could be successfully utilized for fish passage at reservoirs other than those on the Baker River system, although some modifications or additions to the basic structure may be necessary and the fishing site could be critical.

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