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Author

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Introduction

The life cycle of the sockeye salmon usually involves at least one year of lake residence. It is during this lacustrine stage that the young sockeye suffer their greatest mortality. Studies at Cultus Lake suggest that a large part of this loss is due to the activities of predaceous fish, principally squawfish (Ptychocheilus oregonensis) and cut-throat trout (Salmo clarki) (Foerster, 1938). Recent studies at Lakelse Lake also suggest that a large part of the high mortality in the young sockeye is due to piscivorous fish, particularly the squawfish (Brett, 1950). Since 1949, more intensive studies of the predator populations in Lakelse Lake suggest that the dolly varden (Salvelinus malma) and the cut-throat are also important predators of the young lake-dwelling sockeye salmon. In recent years an active sport fishery for the cut-throat trout has developed at Lakelse. In 1950 it was decided that the anglers' catches would be useful to obtain pertinent information on the cut-throat population. Since 1950, creel census studies have been conducted as a part of the program of sockeye salmon research at Lakelse. To gain a greater understanding of the cut-throat population and its relationship to the survival of young sockeye pertinent information was obtained on the annual removal of cut-throat from the lake and the river by the fishery and on the age composition, growth, abundance and distribution of the cut-throat population.

Location and Morphometry of Lakelse Lake

Lakelse Lake is a temperate eutrophic lake situated in the Skeena River watershed, among the coast range mountains. It lies in a broad valley at an elevation of 220 feet, 15 miles from the town of Terrace. It has a length of 5.4 miles, varies in width from .7 to 1.5 miles, and has an area of 5.47 square miles (Brett, 1950). It has a regular shoreline characterized by many reed beds. The mean depth is 24 feet. The lake has one major inlet, Williams Creek, which arises in the mountains to the east and enters the lake at the northern end. There is only one outlet, the Lakelse River, at the southern end of the lake.

Methods

An intensive creel census, covering all or nearly all of the fishing, has been conducted at Lakelse Lake from 1950 to 1953.

The sport fishery at Lakelse derives most of its support from the nearby village of Terrace, and to a much lesser extent from Prince Rupert. There is one highway from Terrace to Lakelse with two main branches, one leading to the

lakeshore at the north end, and the other approximately 2.5 miles to the south (Fig. 1). With the exception of several small privately owned branch roads, most of the anglers use the main branch to the south.

Nearly all the fishermen who fish on the lake or on the Lakelse River, angle from boats.

The methods of contacting the fishermen varied with the season. In May when the fishing effort was concentrated on the Lakelse River, most of the anglers were contacted after they had returned from fishing. Later on in June and July, when most of the fishing effort was concentrated on the lake, the anglers were either contacted at the time of fishing or after they had returned to their cabins or automobiles. It was difficult to obtain a complete record of the catches during this period, because of the widely dispersed fishing effort along the southern and western shores of the lake.

Each year the fishing season commenced on May first, the legal opening date, and usually continued till the end of August. During that period, anglers fishing on the lake and on the river were contacted and the following information was obtained and recorded: name, residence, time spent fishing, time contacted, number of cut-throat and other species of fish caught, weather, area in which the fish were caught, method of fishing. When anglers were willing catches were examined. The fish in these catches were measured, and scales and stomach samples taken. In appreciation of the anglers' co-operation the fish were cleaned before they were returned.

Results

(a) Assessment of the Catch per Hour as the Index of Abundance

In this study the number of cut-throat caught per hour was used as a relative measure of the abundance of the cut-throat population. The validity of any conclusions based upon catch-per-hour data is dependent upon the precision of the index of abundance. Whether or not catch per effort accurately reflects the abundance of fish depends in part on the extent to which factors other than abundance affect the catch figures. Mottley (1949) and Eschmeyer (1937) found that the catch per hour was affected by several factors. Mottley described the relationship between catch per unit of effort and abundance as curvilinear due to differences in the skill of the participating anglers. He found that, when fishing was good or weather conditions were favourable, the catch per hour declined, due to a higher proportion of unskilled anglers in the angling population on those days.

An effort was made to determine the relationships of weather, time of day, and the methods of fishing to the catch per hour at Lakelse. Chi-square tests of association were applied to the general catch data, but no significant relationships were found.

Examination of the catch-per-hour data obtained by the Lakelse creel census indicates that there were considerable variations in the catch per hour between the individual anglers. To determine whether or not variation in skill

was a factor contributing to the variability in the catch statistics, a group of fishermen, well known to the investigator were rated with respect to their proficiency as anglers. Each angler (according to the estimate of his skill) was placed in one of three categories, good, medium, or poor. These estimates were based almost entirely upon the length of time the anglers had fished at the lake. In other words, good anglers were fishermen who had fished at the lake over a period of years. They had a good knowledge of the seasonal distribution of the trout and of their food habits. They fished frequently at the lake with appropriate gear. The medium fishermen were generally new residents with little previous fishing experience, who fished quite frequently at the lake. The poor fishermen were usually transients with little knowledge of suitable gear or of fishing. It should be emphasized that classification was set up with no specific references to the catches. (The graphs given in Figure 2 shows the frequency distributions of the catch-per-hour values obtained by the anglers in each of the categories from 1950-1952.)

The mean catch per hour attained by the good anglers was fairly constant over the three years of study, suggesting that there has been little change in the size of the cut-throat population during the three-year period. At the same time the mean catch per hour of the poor anglers increased, suggesting that this group of fishermen became more skillful each year. Catches of the medium anglers do not show a consistent trend.

Unfortunately in 1953 the names of the anglers were not recorded. As a result the fourth graph only shows the frequency distribution of catch-per-hour values obtained by all the anglers.

In conclusion the analysis of the data has shown that the catch per hour is extremely variable. It is felt that most of the variability arose from differences in the skill of the individual fishermen. Whereas the skill of the medium to poor fishermen may have changed from year to year, it is probable that the skill of the good fishermen did not. For this reason, the mean catch per hour of the good fishermen probably represents a better index of relative abundance than catch-per-effort figures derived from the angling of the other groups.

(b) Seasonal Distribution of the Fishery

The major fishing effort in May of all years concentrated on the Lakelse River (see Fig. 3) coincident to the emigration of young sockeye, coho and pink salmon down the Lakelse River. Qualitative analysis of the trout stomachs indicates that the consumption of the young migrants is quite high during this period.

From June to August the fishing effort was distributed between the lake and the river, with a greater effort expended on the lake. In all years a major part of the fishing effort on the lake in June and July concentrated along the reed beds on the west shore, coincident with the hatching of large numbers of mayflies. Analyses of the trout stomachs indicate that they feed almost entirely upon mayflies at this time.

In August the major fishing effort on the lake usually moved from the west shore to the mouths of inflowing streams, coincident with the appearance of

the adult sockeye salmon. Stomach analysis indicates that the trout feed upon the eggs of the adult salmon during this period.

(c) Age Composition of the Cut-throat in the Anglers' Catches

The ages of the cut-throat in the anglers' catches were determined by examining the scales of the trout sampled by the creel census. The age composition of catches from the lake and from the river have been considered separately, because of seasonal changes in the fishing intensity at the two locations, and to examine the possibility that the river and lake populations might be distinct.

(1) Seasonal representation of the age groups in the anglers' catches. The cut-throat first make their appearance in the fishery at Lakelse at age II. Usually a few II-year-olds enter the fishery on both the lake and the river in May, and as the season progresses the number caught increases (Tables I and II and Fig. 4). Comparison of the mean lengths of Age II trout caught in May of 1950 to those caught in August showed that no significant differences (8.56 and 8.64 inches) existed, suggesting that there were some faster growing Age II trout that became vulnerable to the fishery early in the season. The fact that these fish are just on the minimum size limit (8 inches) partially accounts for their low representation in the anglers' catches. It is likely that more were caught but were either released or not declared. It is also possible that fish of that size are not vulnerable to the gear used by many of the sports fishermen.

Throughout the four years of the creel census Age III trout have been the most abundant age class in the anglers' catches (approximately 43.0%). The proportion of these fish in the catches remains almost constant throughout the season.

Age IV and V trout are most abundant in the spring of each year, their numbers tending to decline as the season progresses. This decline may be due to an emigration of mature or maturing fish from the lake and the upper Lakelse River in the spring of the year, as deduced from data on the lengths of fish migrating down the Lakelse River (taken from samples of trout trapped at the Lakelse River weir in 1953 (Fig. 5).

Age VI trout appeared in the anglers' catches from the lake and the river in 1952. The proportion was very small amounting to 4 percent. No conclusions can be drawn on seasonal variations and the availability of fish of this age class.

(2) Annual representation of the age groups in the anglers' catches. The age composition of the lake catches tends to be less subject to variability than the river catches.

In 1952 the installation of a sockeye smolt counting weir in the Lakelse River (Fig. 3) restricted the emigration, and in 1952 and 1953 the fishermen tended to confine their efforts to the area above the weir and did not sample the area as widely as in previous years.

From year to year, variations in the time of downstream movement of the trout occur, owing to differences in weather, time of ice break-up, etc. The

angling fishery commencing May, therefore, tends to exploit a different part of the run each year. As most of the fishing on the lake generally begins in June after the spring emigration is complete, the age composition of samples of fish taken in the lake are more comparable from year to year than that of samples taken in the river.

Examination of samples of trout taken in the lake indicate that the age composition of the catches has remained fairly constant over the past four years (Fig. 6). There was a tendency for the proportions of Age IV and Age V fish to increase during the four years. This trend indicates that the brood years of 1947 and 1948 were relatively more abundant in the catches than either that of the preceding or succeeding brood years. However, the numerical superiority of these brood years over the others is not great as is shown by data on the catch per unit of effort.

If the abundance of the 1947 and 1948 brood years were very much higher than in other years, the catch per effort would be expected to decline after these fish had moved through the fishery. For example, in June, 1951, when fish of two brood years were three and four years old and hence would constitute most of the catch, the catch per effort might be expected to be greater than in later years when these fish were older and formed a smaller proportion of the catch. However, as mentioned earlier, the catch per hour of the good fishermen (i.e., those that fished in a consistent manner from year to year) showed that the catch per hour did not change appreciably. In 1953 when classification of the anglers according to skill was not carried out the catch per hour of all the fishermen was even better than in 1951. Thus the apparent superiority of the 1947 and 1948 brood years is not reflected in an increase in availability of the fish to the anglers.

Data on the catch per hour of the various age classes supports the view that the contributions of the various brood years to the catch have been quite constant over the years. In Figure 7 it is seen that the catch per hour of the various age groups does not change markedly. In the four-year period of study the catch per hour of III- and IV-year-olds, the main contributing age classes, has remained within narrow limits (the III-year-olds, 0.451-0.523 fish per hour; IV-year-olds, 0.326-0.451 fish per hour).

In conclusion the data do not indicate that there has been a marked change in either the abundance or age composition of the lake resident popula- of cut-throat at Lakelse.

(d) Growth

The mean sizes attained by cut-throat trout of different ages in the anglers' catches in the years from 1950 to 1953 have been used as the indices of the rates of growth. Table V. gives the mean fork lengths, the standard deviations and the standard errors for each of the age classes. Table VI compares statistically the mean lengths of cut-throat in each age group throughout the four years.

During the four-year period of study significant changes in the mean sizes of the cut-throat occurred. As is indicated in Figure 8 there was a

decline in the size of cut-throat of each age class from 1950 to 1952. In 1953 there was a significant increase in the size of the fish (Table VI).

As discussed previously there is little evidence from the catch-per-hour data to suggest that the abundance of the cut-throat increased during those years. Larkin (1950) found an inverse relationship between the mean lengths of Kamloops trout of various ages and their corresponding standard deviations. He found that a slow rate of growth was associated with a higher variation in individual size, suggesting that when there was a strong competition for food, the individuals were unequally affected. This does not appear to be the case for the cut-throat at Lakelse. The smaller the mean size of the fish of a specific age-class, the smaller the standard deviation of the lengths tends to be (Table VII). There is no evidence that the observed changes in growth are associated with changes in population size.

The increase in growth of the cut-throat in 1953 may have been related to a higher consumption of food, during the fall of 1952 and the spring of 1953. Warmer lake temperatures during the fall of 1952 (as indicated by scanty water temperature records and air temperatures, see Figure 9) and an earlier break-up in the spring of 1953 (April 9 in 1953 as compared to May 1 in 1952 and April 25 in 1951) suggest the possibility that these conditions may have increased the rate of growth and extended the active feeding period of the trout.

(e) Rates of Exploitation

Marking (fin excision (Shepard, 1953)) during the spring and summer showed no migration between the lake and the river suggesting that after the downstream movement begins there is little or no interchange. Thus, for the purpose of examining the effect of the fishery on the population the river population can be considered separately from that of the lake. From the results of a mark-recapture program, the proportion of the cut-throat population taken by the anglers can be approximated.

(1) River population. Shepard estimated the river population of cut-throat in 1952 to be approximately 4,000 at the time of angling (some fish had moved out of the fishing area before the season had opened; the total population before the opening of the fishing season may have thus been approximately 5,000). The angling fishery takes only the smaller fish (Fig. 5). In 1952 the total catch was estimated to be approximately 1,100 and no lower than 900 (the number of trout examined). Therefore, of the population of cut-throat, excluding a few II-year-old fish which move downstream in the spring, the angling fishery took about 20 percent.

In 1953, when a major part of the emigration had occurred before the angling season began, the total catch decreased. A higher than ever rate of exploitation was observed. The population was estimated to be slightly more than half that available in 1952 (i.e., about 2,200). Of these, the angling fishery removed about 700, and no fewer than 600, representing a rate of exploitation of about 30 percent. Again the angling fishery did not sample the large fish as thoroughly as the smaller ones. The higher rate of exploitation was associated with a marked increase in the intensity of fishing (Table I).

(2) Summer lake population. The summer lake population is probably stable during the time of most of the fishing effort. By the time the fishing

begins, the emigration of cut-thro down the Lakelse River is complete.

Shepard (1953a) estimated th 1952 lake population to be approximately 15,000 fish, above 8 inches in length. The removal of trout in 1952 by anglers was approximately 1,300 and in 19 the removal was about 1,100. This represents an approximate rate of exploitation of about 8 percent in both years.

The total Lakelse system stock (over 8 inches in length) was estimated to have been about 20,000 trout i 1952 and 1953, the angling fishery removed about 2,400 (or 12%) in 1952, and about 1,900 (or 9.5%) in 1953. The availability of V- and VI-year-old fish is probably lower than that of IV-year-olds and younger fish, most likely du to the fact that these fish are exposed to the fishery primarily during the spawning run when they do not really take [illegible] lure. The [illegible] probably [illegible] comprised a large portion [illegible] spawning [illegible] 1953 [illegible] 1952.

References

Bilton, T. H. 1953. Fish. Res. B. Canada, Ann. Rept. Pac. Biol. Sta., p. 32.

Brett, J. R. 1950. Lakelse Lake sockeye survival. J. Fish. Res. Bd. Canada, 8(2): 103-110.

Eschmeyer, R. W. 1937. The Michgan creel census. Trans. Second N. American Wildlife Conf., pp. 625-63.

Foerster, R. E. 1938a. An investigation of the relative efficiencies of natural and artificial propagation of sockeye salmon (Oncorhynchus nerka) at Cultus Lake, British Columbia. J. Fish. Res. Bd. Canada, 4(3): 151-161.

Larkin, P. A. 1950. The producion of Kamloops trout (Salmo gairdneri kamloops, Jordan) in Paul Lake, British Columbia. Univ. of B. C. and B. C. Game Dept.

McDonal[illegible] 1954. The prodetion of sockeye salmon fry and the factors [illegible] survival. Ms. unpublished.

Mottley, M. C. 1949. The statitical analysis of creel census data. Reprint Trans. Amer. Fish. Soc. [illegible].

Ricker, W. E. 1948. Methods of estimating vital statistics of fish populations. Indiana Univ. Pub., Scien. Series, 15.

Snedecor, G. W. 1946. Statistical methods. Iowa State College Press, Ames, Iowa.

(1) Shepard, M. P. 1953a. Fish. Rs. Bd. Canada, Ann. Rept. Pac. Biol. Sta., p. 27 (No. 5).

(2) 1953b. Fish. Rs. Bd. Canada, Ann. Rept. Pac. Biol. Sta., p. 27 (No. 6).

(8) Shepard, M. P., and T. H. Bilton 1953. Fish. Res. Bd. Canada, Ann. Rept. Pac. Biol. Sta., pp. 27-3 (No. 7).

Table I. Monthly catch per hour of cut-throat trout of various ages caught by anglers fishing on the Lakelse River, 1950-1953.

		Hours	II No. fish	II C/hr.	III No. fish	III C/hr.	IV No. fish	IV C/hr.	V No. fish	V C/hr.
May	1950	105	210 14	.133	55	.523	125	1.190	5	.047
	1951	88	166 3	.034	42	.477	47	.534	24	.272
	1952	497.5	-	-	178	.357	244	.490	157	.315
	1953	743.0	27	-	214	.288	224	.301	76	.102
Jun	1950	113.5	16	.140	80	.704	48	.422	7	.061
	1951	119	-	-	29	.243	53	.445	33	.277
	1952	227	-	-	68	.299	141	.621	62	.273
	1953	110	5	-	21	.190	26	.236	7	.063
Jul	1950	123	42	.341	100	.813	14	.113	-	-
	1951	121	15	.123	77	.636	57	.471	4	.033
	1952	49								
	1953	30								
Aug	1950	68	2	.029	40	.588	22	.323	2	.029
	1951	52	7	.134	17	.326	11	.211	-	-
	1952									
	1953	8								

estimated for 50 and 51 = 2x

Table II. Monthly catch per hour of cut-throat trout of various ages caught by anglers fishing on Lakelse Lake, 1950-1953.

			II		III		IV		V	
		Hours	No. fish	C/hr.	No. fish	C/hr.	No. fish	C/hr.	No. fish	C/hr.
May	1950	47			15	.319	49	1.042	2	.042
	1951	25.5			13	.509	16	.627	3	.117
	1952									
	1953	15								
Jun	1950	278.5	41	.147	163	.585	85	.305	3	.010
	1951	161.5	2	.012	70	.433	58	.359	7	.043
	1952	107	3	.028	35	.327	47	.439	7	.065
	1953	271	14	.051	181	.667	199	.734	65	.239
Jul	1950	277	39	.140	138	.498	70	.252	10	.036
	1951	179.5	10	.055	94	.523	43	.239	6	.033
	1952	395	13	.032	153	.387	140	.354	126	.318
	1953	129	37	.286	41	.317	20	.155	3	.023
Aug	1950	43.5	15	.344	22	.505	11	.252	-	-
	1951	76.0	9	.118	26	.342	22	.289	1	.013
	1952	118	13	.110	61	.516	58	.491	8	.067
	1953									

Table III. Comparison of annual catch per hour of cut-throat trout of various ages caught by anglers fishing on (a) Lakelse River and (b) Lakelse Lake, 1950-1953.

			II		III		IV		V	
	Year	Hours	No. fish	C/hr.	No. fish	C/hr.	No. fish	C/hr.	No. fish	C/hr.
River										
	1950	409.5	73	.178	303	.739	186	.454	12	.029
	1951	382.0	27	.070	163	.426	169	.442	59	.154
	1952	821.5			267	.325	422	.513	223	.271
	1953	883			284	.321	239	.270	102	.115
Lake										
	1950	647	99	.153	345	.523	211	.326	13	.02
	1951	442.5	21	.047	201	.454	143	.323	18	.04
	1952	620	51	.082	280	.451	280	.451	58	.093
	1953	415	73	.175	204	.492	184	.444	73	.175

Table IV. Catch per hour of cut-throat trout of various ages, caug
anglers on Lakelse Lake and Lakelse River, 1950-1953.

		II	III	IV	V	VI	II	III	IV	V
1950	No.	17	70	43	3		66	229	140	
	%	12.7	52.6	32.3	2.2		14.8	51.5	31.5	2.2
1951	No.	13	78	81	30		15	142	101	12
	%	6.43	38.6	40.0	14.0		5.5	52.3	37.2	4.4
1952	No.		43	68	36	12	23	125	125	2
	%	29	29.2	46.2	24.4		7.6	41.8	41.8	8
1953	No.		64	54	23		18	60	48	1
	%		45.3	38.2	16.3		12.5	41.6	33.3	12

Table V. Means and standard deviations of fork lengths (inches) of different ages of cut-throat trout in anglers' catches, 1950-1953.

Age	1950	1951	1952	1953
II	212 ~~8.38~~	208 8.02	201 7.90	203 8.08 ~~9.21~~
	± 1.452	± 1.350	± 1.03	± .892
	= .155	= .270	= .230	= .216
III	274 10.79	259 10.20	250 9.86	10.09 10.99
	± 1.192	± 1.220	± .847	± 1.272
	= .068	= .088	= .066	= .115
IV	310 ~~12.17~~	292 11.48	281 11.16	11.80 11.92
	± 1.440	± 1.360	± .934	± 1.303
	= .101	= .1005	= .067	= .115
V	367 14.45	328 ~~12.91~~	312 12.29	333 13.13 13.300
	± 1.212	± 1.290	± .981	± 1.471
	= .203	= .206	= .101	= .235

Anglers catches sampled May - Sept

Table VI. "t" tests at probable level of .05 of mean lengths of cut-throat trout in each age group.

Age	1950/1951	1950/1952	1950/1953	1951/1952	1951/1953	1952/1953
II	NS	NS	S	NS	S	S
	→	→	←	→	←	←
III	S	S	NS	S	S	S
	→	→	←	→	←	←
IV	S	S	NS	S	S	S
	→	→	←	→	←	←
V	S	S	S	S	NS	S
	→	→	←	→	←	←

Increase ←

Decrease →

Significant S

Not significant NS

Table VII. F test for significance at .05 probability level of standard deviations of mean lengths of cut-throat trout in each age group.

Age	1950/1951	1950/1952	1950/1953	1951/1952	1951/1953	1952/1953
II	NS	NS	S	NS	S	NS
	→	→	→	→	→	→
III	NS	S	NS	S	NS	S
	←	→	←	→	←	←
IV	NS	S	NS	S	NS	S
	→	→	→	→	→	←
V	NS	S	NS	S	NS	S
	←	→	←	→	←	←

Increase ←

Decrease →

Significant S

Not significant NS

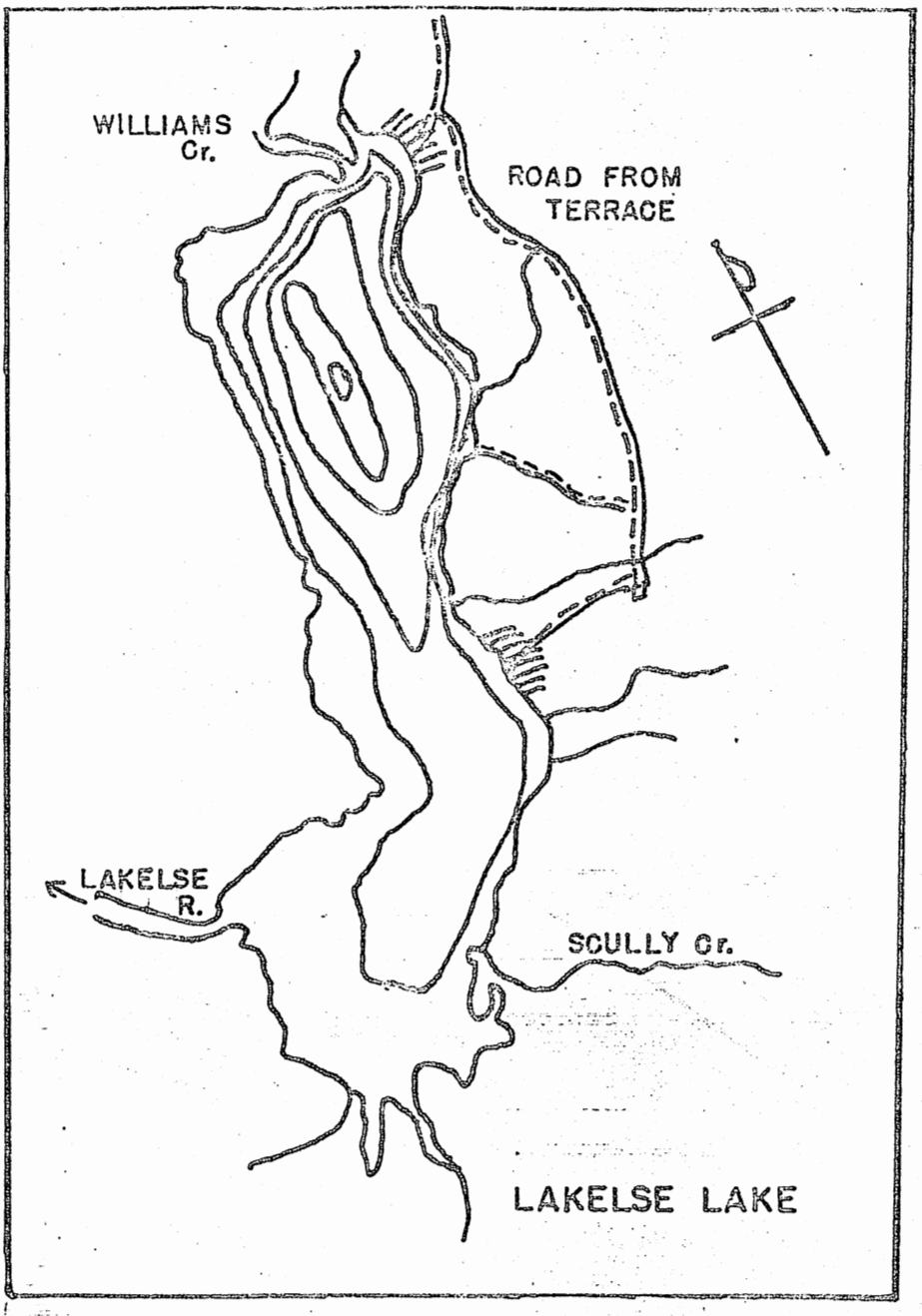


Figure 1. Map of Lakelse Lake showing bottom configuration, and roads giving access to lakeshore.

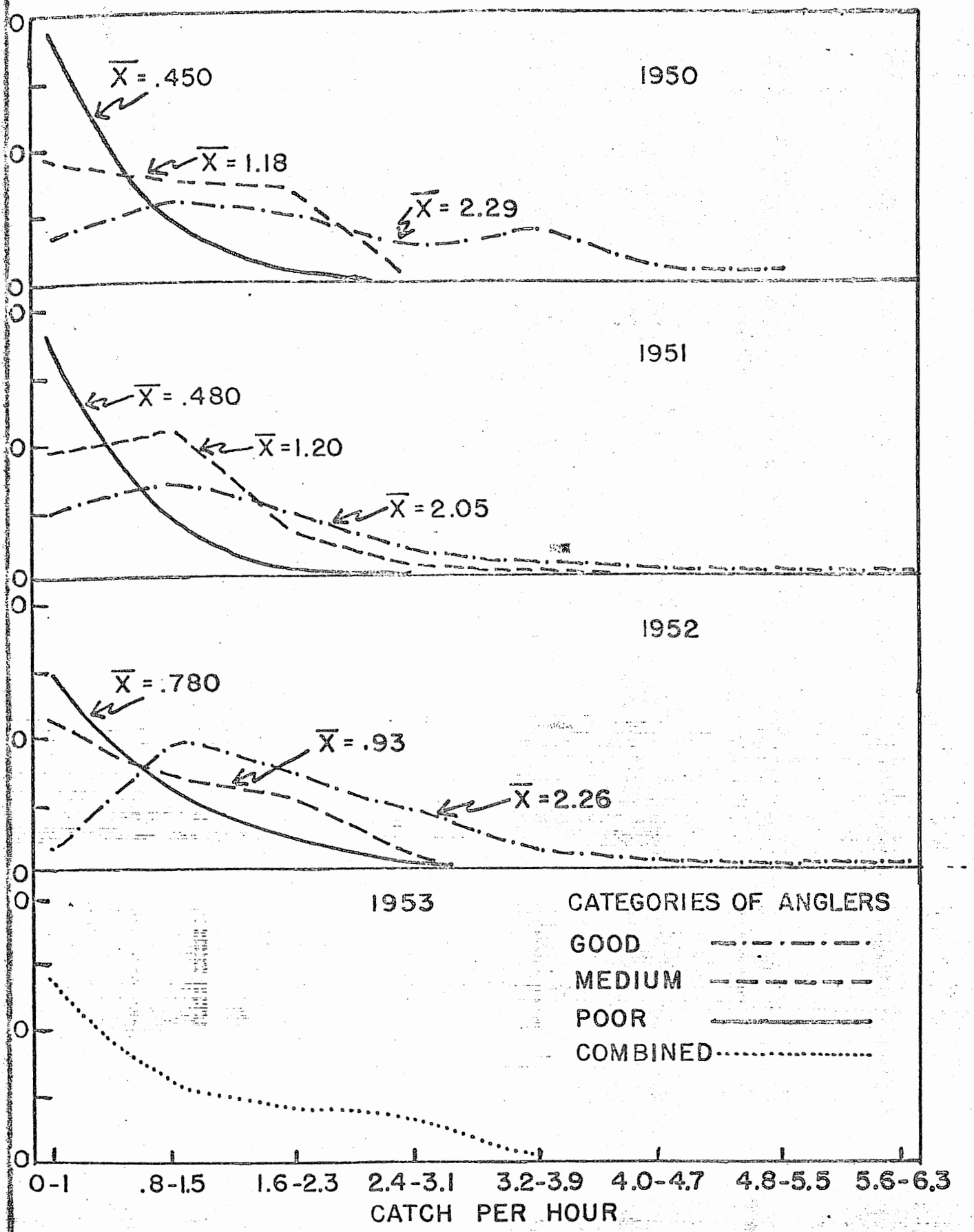


Figure 2. Frequency distributions of the catch per hour values obtained by the anglers in each of the categories.

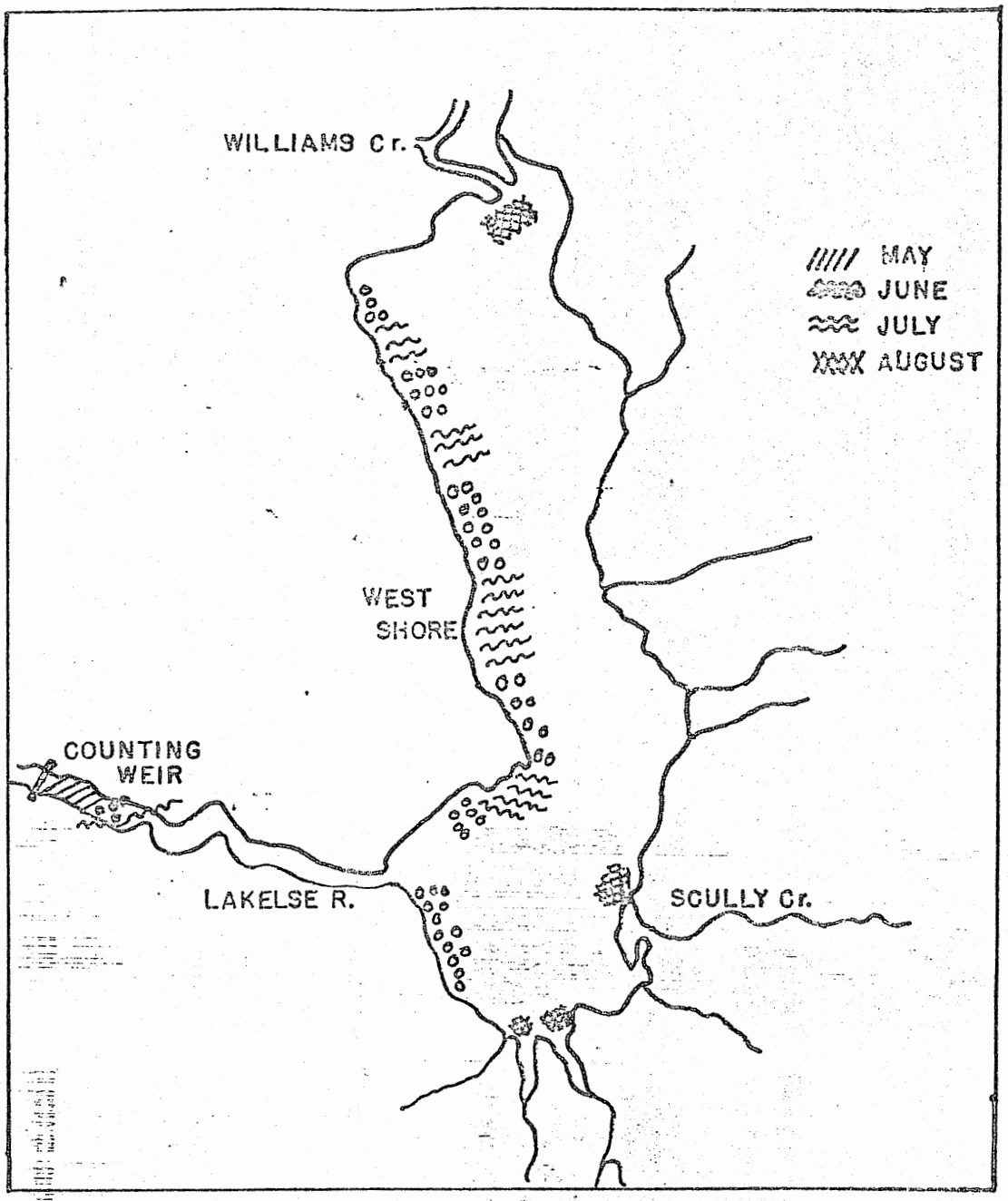


Figure 3. Distribution of fishing effort on the Lakelse River and on Lakelse Lake.

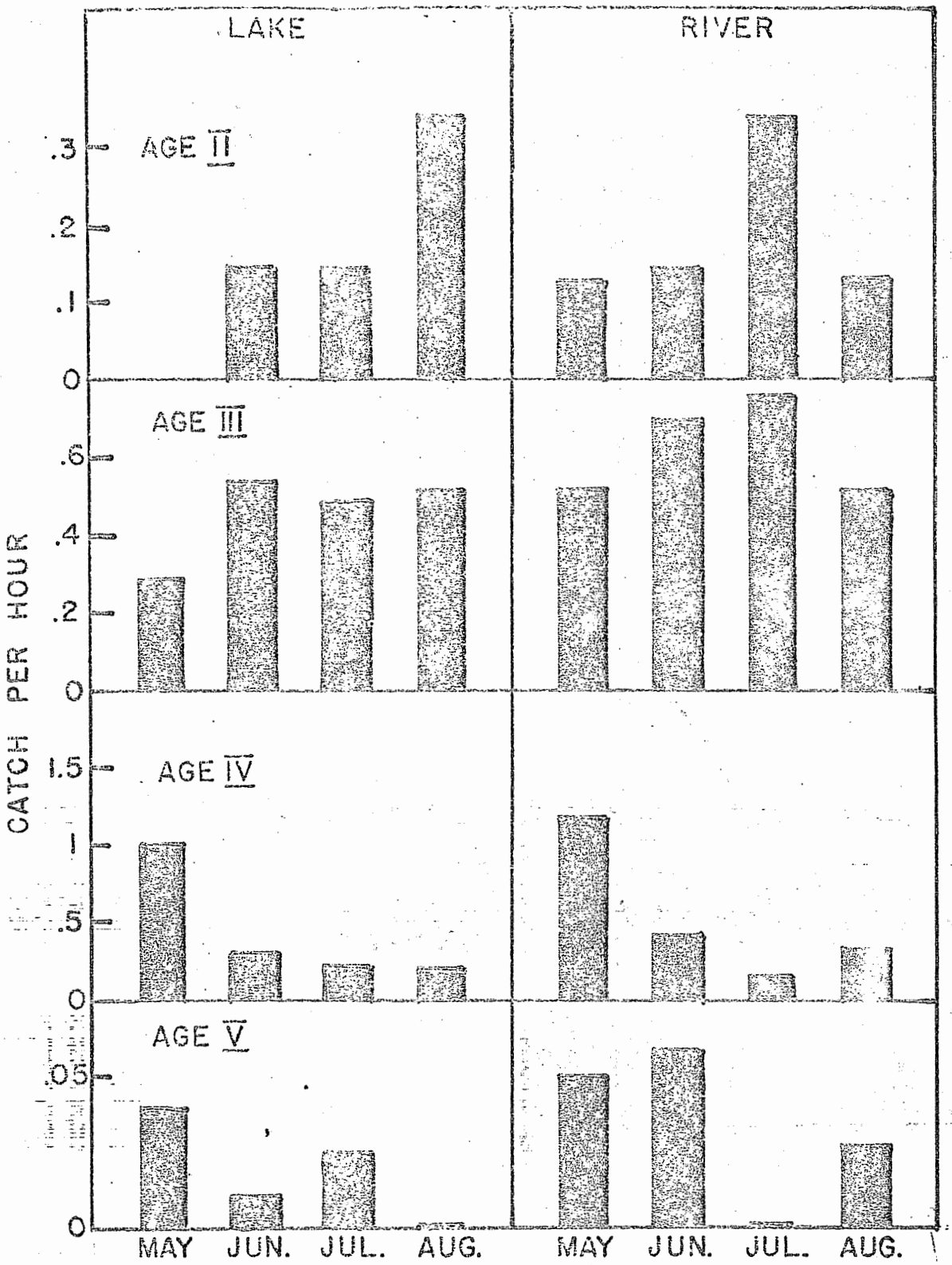
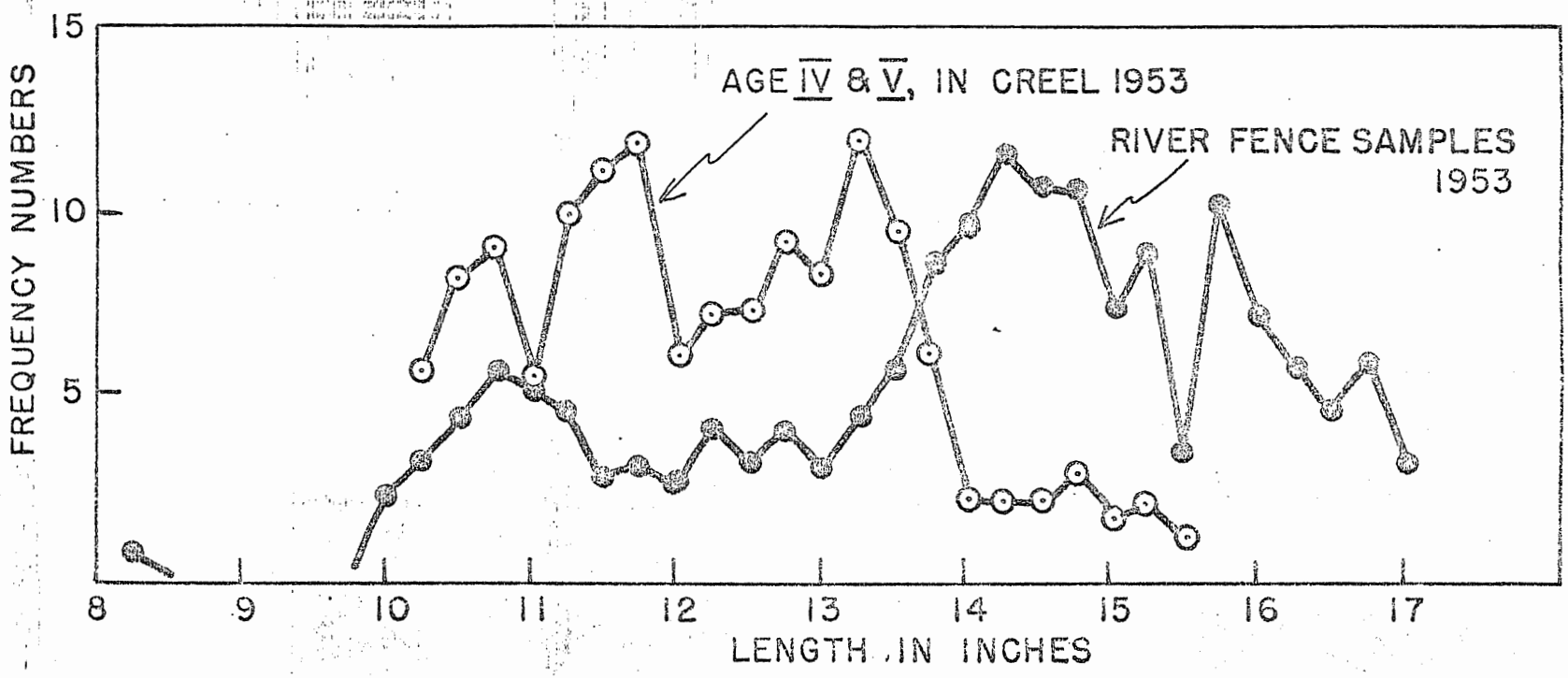


Figure 4. Monthly representation of the age groups in the anglers' catches from the lake and the lakelse River in 1950.

Figure 5. Length frequency distribution of Age IV and V cut-throat in creel 1953, and river fence samples 1953, smoothed by threes.



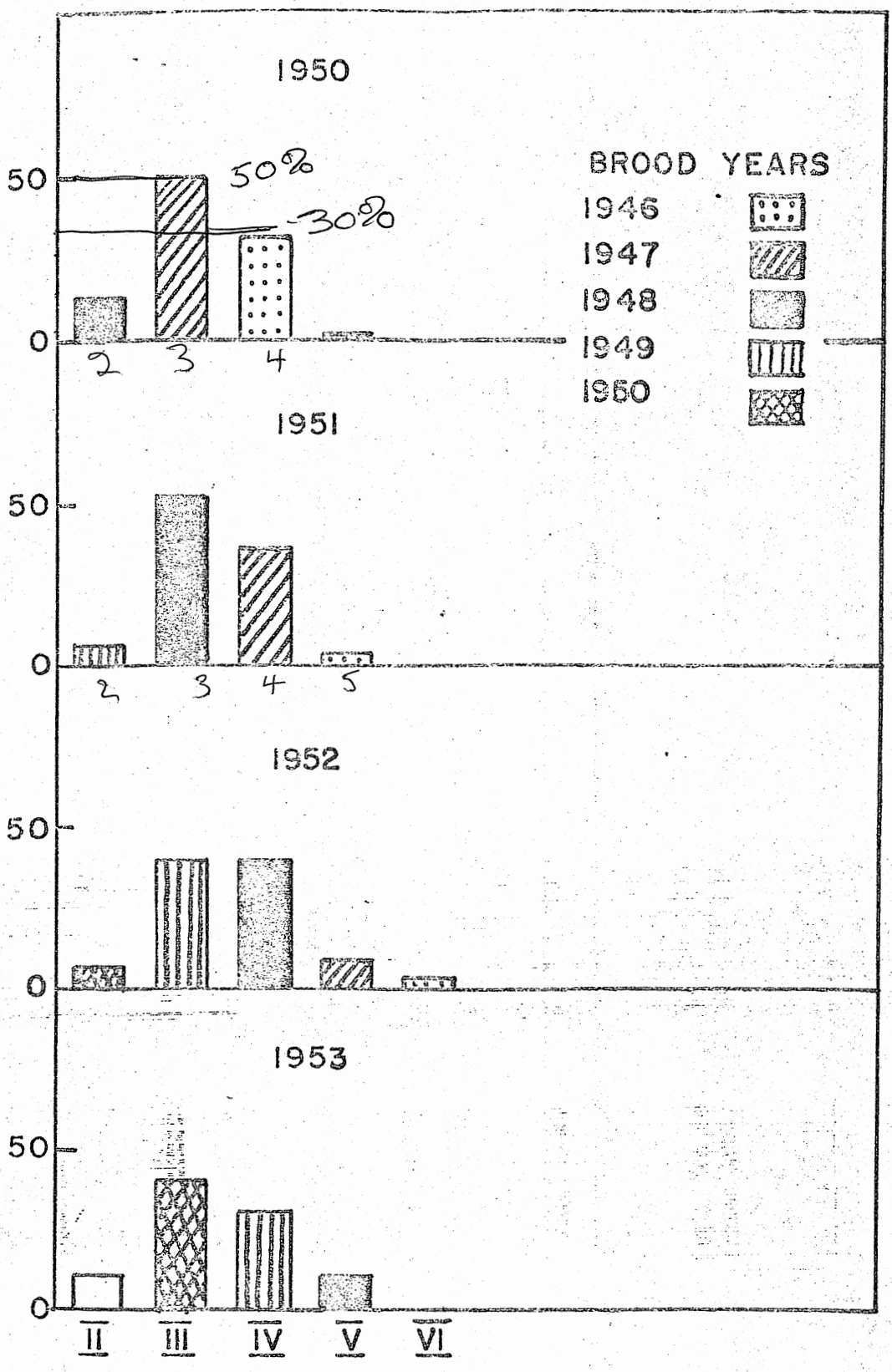


Figure 6. Percent representation of the various age groups in the anglers' catches from the lake, 1950 to 1953.

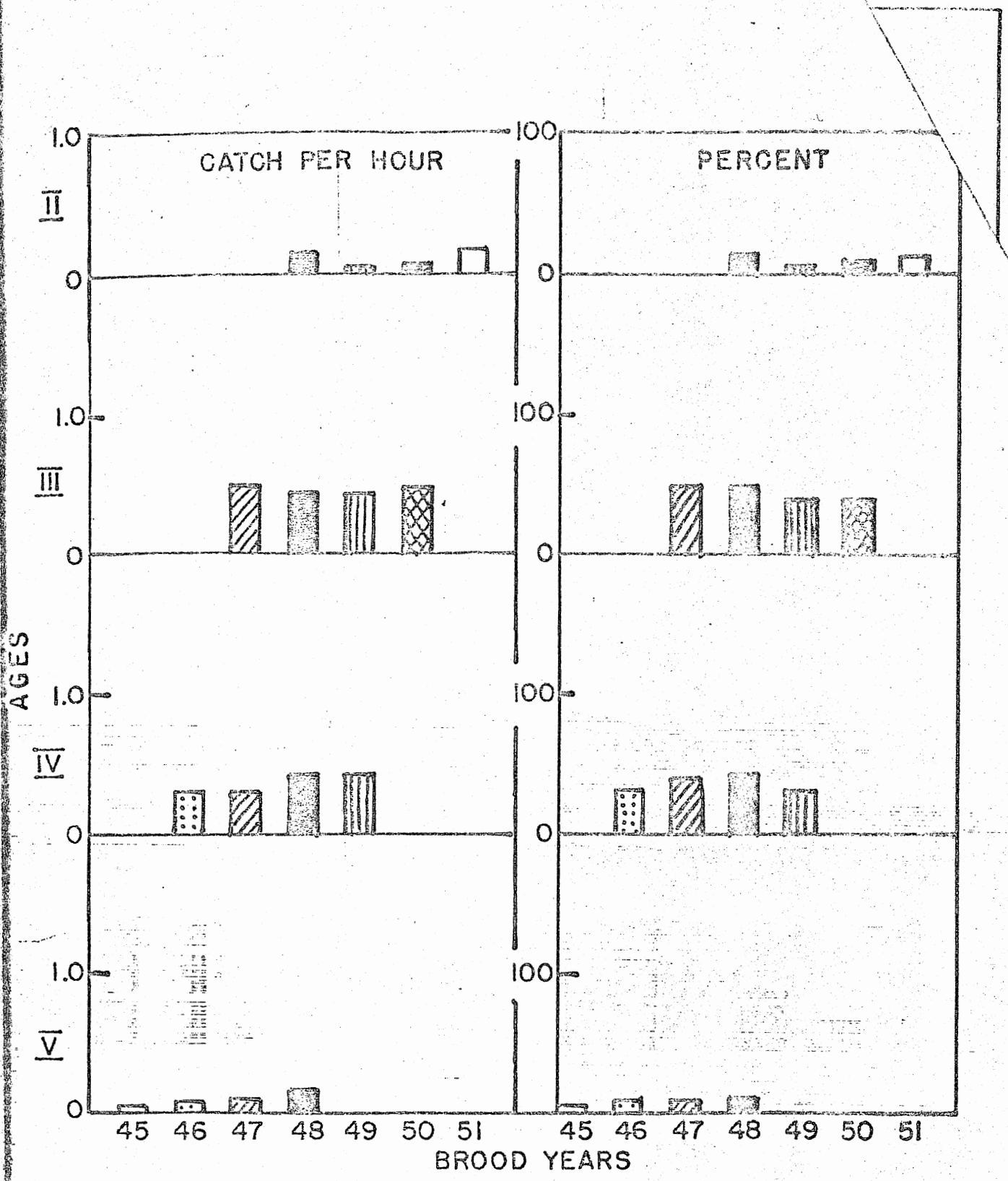

CATCH PER HOUR
PERCENT
AGES
II
III
IV
V
1.0
0
100
45 46 47 48 49 50 51
BROOD YEARS

Figure 7.

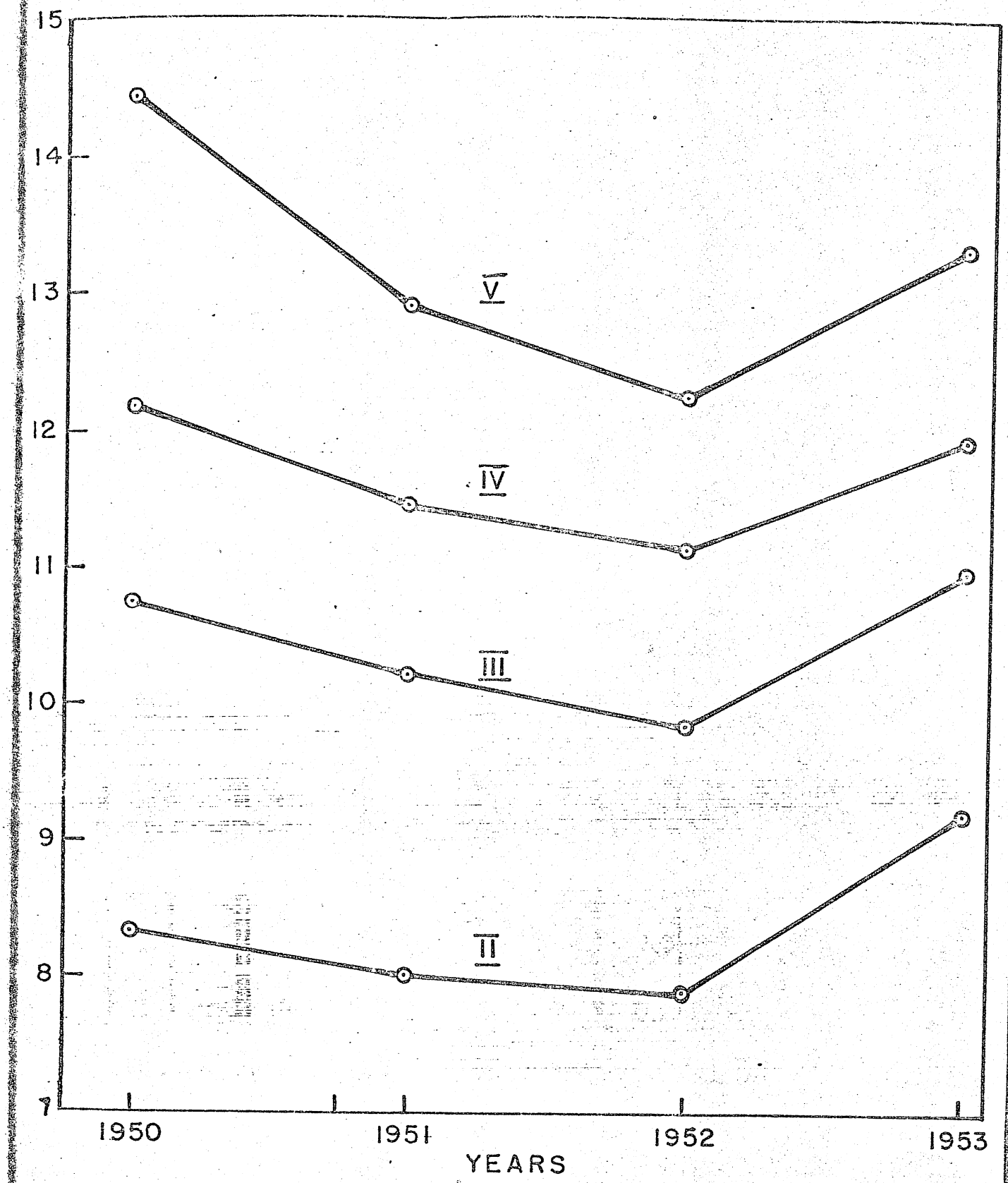


Figure 8.

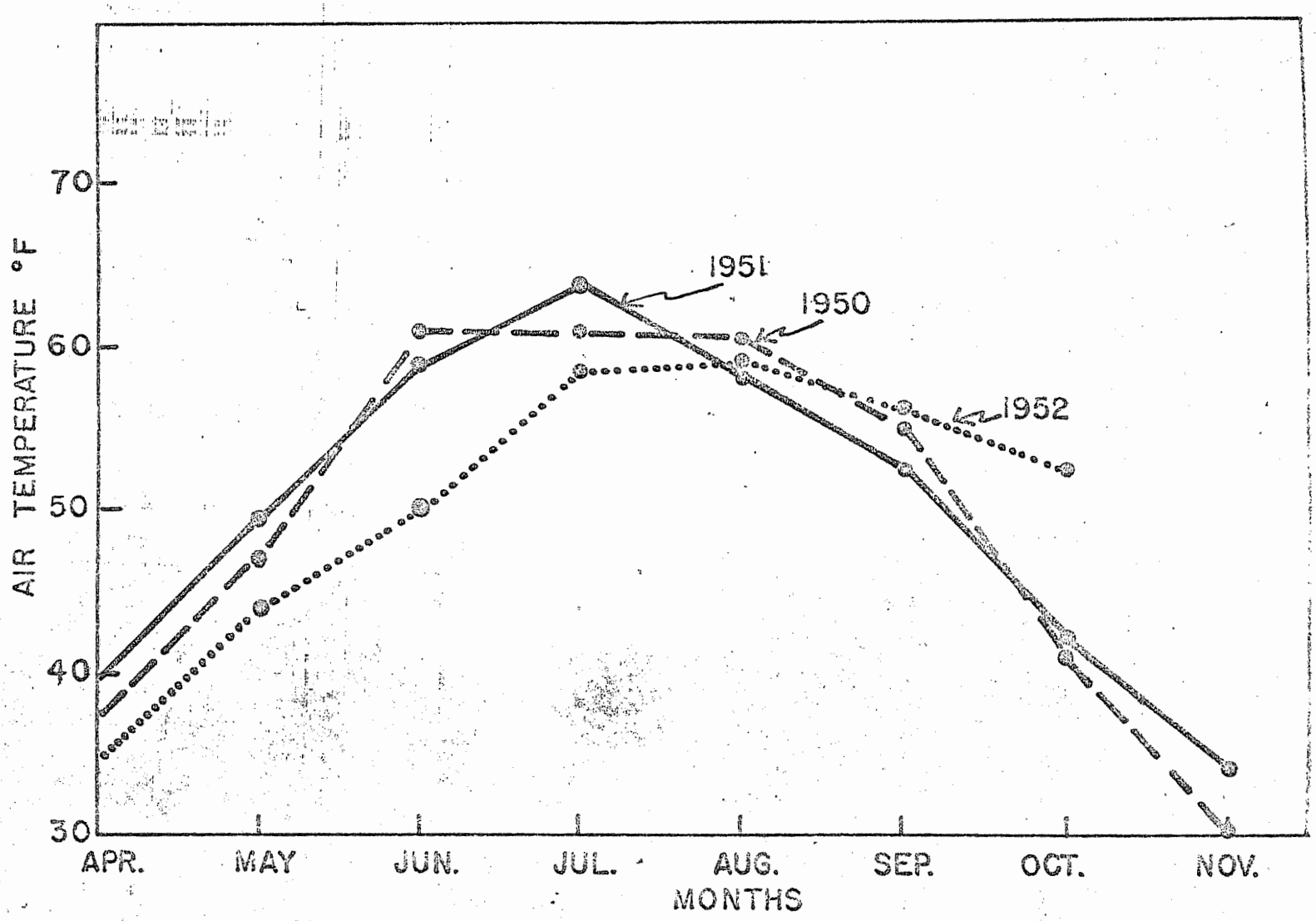


Figure 9. Monthly mean air temperatures at Lakelse Lake.