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REPORT ON THE 1936 LAKE TROUT INVESTIGATION, LAKE OPEONGO, ONTARIO

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STUDIES ON ALGONQUIN PARK, NO. 1

REPORT ON THE 1936 LAKE TROUT INVESTIGATION, LAKE OPEONGO, ONTARIO

ABSTRACT

The data collected in a creel census are analysed and discussed in relation to the lake trout, *Cristivomer namaycush* (Walbaum), fishery of lake Opeongo. The lake trout taken varied from 8 to over 32 inches. Half the fish taken had not reproduced. The proportion of small fish in the catch was lowest in July and was very high in August and September.

Examination of the gonads of lake trout taken by gill nets in September indicated that lake trout over 22 inches long could not spawn normally in 1936.

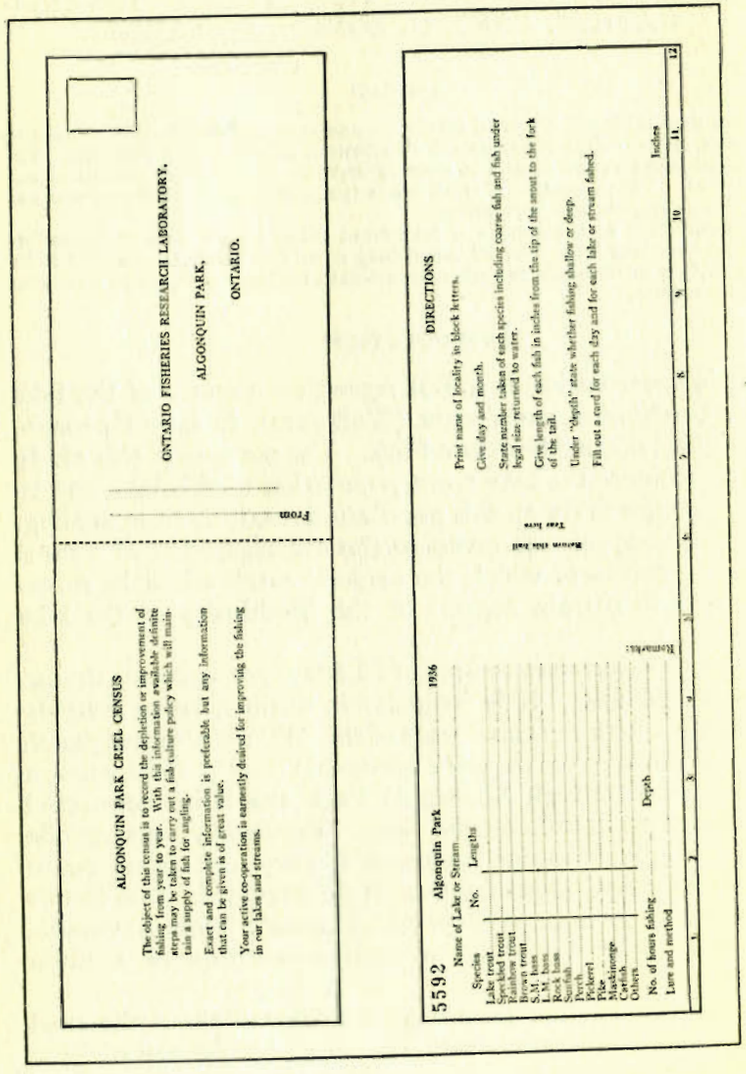
A table is given which describes the stomach contents of Opeongo lake trout taken by anglers.

INTRODUCTION

This contribution is a first report on a study of the lake trout, *Cristivomer namaycush* (Walbaum), in lake Opeongo, the largest lake in Algonquin Park. The purpose of this study is to investigate the lake trout population of this lake and to determine the drain on this population resulting from angling. In 1936 attention was given to the establishment of a creel census by means of which the anglers' catch might be measured, and to certain aspects of the life-history of the lake trout.

Lake Opeongo has an area of 13,400 acres and a maximum depth of 135 feet. It is irregular in outline, being roughly "Y" shaped with the three arms of the "Y" more or less equal. The lake became much more accessible during 1936 when a new highway through Algonquin Park was built, connected with the motor roads to the west. Previously, automobile traffic to lake Opeongo followed a very circuitous route through a sparsely settled section of the province. Due to this recent change in accessibility, lake Opeongo offers a remarkable opportunity for study of the exploitation of a game fishery.

In this report, discussion has been centred about the creel census. The creel census was conducted by the use of form cards (figure 1). These cards were issued to the anglers by the Park officers, by members of the laboratory, or through the medium of two measuring stations. The measuring stations consisted of simple measuring boards with signs indicating



ALGONQUIN PARK CREEL CENSUS

The object of this census is to record the depletion or improvement of fishing from year to year. With this information available definite steps may be taken to carry out a fish culture policy which will maintain a supply of fish for angling.

Exact and complete information is preferable, but any information that can be given is of great value.

Your active co-operation is earnestly desired for improving the fishing in our lakes and streams.

From

ONTARIO FISHERIES RESEARCH LABORATORY,
ALGONQUIN PARK,
ONTARIO.

DIRECTIONS

Print name of locality in block letters.
Give day and month.
State number taken of each species including coarse fish and fish under legal size returned to water.
Give length of each fish in inches from the tip of the snout to the fork of the tail.
Under "depth" state whether fishing shallow or deep.
Fill out a card for each day and for each lake or stream fished.

5592 Algonquin Park 1936

Name of Lake or Stream

Species	No.	Length
Lake trout		
Speckled trout		
Rainbow trout		
Brown trout		
S.M. bass		
L.M. bass		
Rock bass		
Sunfish		
Perch		
Pickerel		
Pike		
Maskinonge		
Catfish		
Others		

Depth

No. of hours fishing

Lure and method

Inches 1 2 3 4 5 6 7 8 9 10 11 12

FIGURE 1.—Creel census cards used in Algonquin Park in 1936.

their use, and provided with a supply of cards and a pencil. The result aimed at was not merely a simple numerical return of absolutely all the fish captured, but rather a reliable measurement of the size composition of the catch and an estimate of the fishing effort. In all, returns were sent in for 1,092 lake trout, taken from lake Opeongo. For 711 of these fish the total length was recorded to the nearest inch, and in most other cases an estimate of the average size of the fish taken was given. The anglers also gave very satisfactory returns concerning the lure, method of fishing, depth, and the length of time required to make their catch.

ACKNOWLEDGEMENTS

This work is being carried out by the Ontario Fisheries Research Laboratory of the Department of Biology, the University of Toronto. The Laboratory is fortunate in enjoying the support and the co-operation of the Departments of Game and Fisheries and of Lands and Forests of the province of Ontario.

Finally, above all, we wish to express our appreciation of the co-operation we have received from anglers visiting lake Opeongo. Without this help it would have been impossible to carry on this investigation. Not only was this co-operation given us willingly but it was also performed in a very able manner.

NUMBER OF FISH CAPTURED IN 1936

The number of lake trout taken in the past season is estimated at between two and three thousand. In May, census returns were made for 78 fish while inquiry gave a figure of something over 200. In June, September, and October, it is probable that returns were made for better than 75 per cent. of the catch. In July and August, when camping parties were scattered all around the lake, returns probably covered only 30 per cent. of the catch. A monthly estimate based on these considerations is given in table 1.

About 75 per cent. of the season's catch was taken during July and August. The rest of the catch was divided fairly

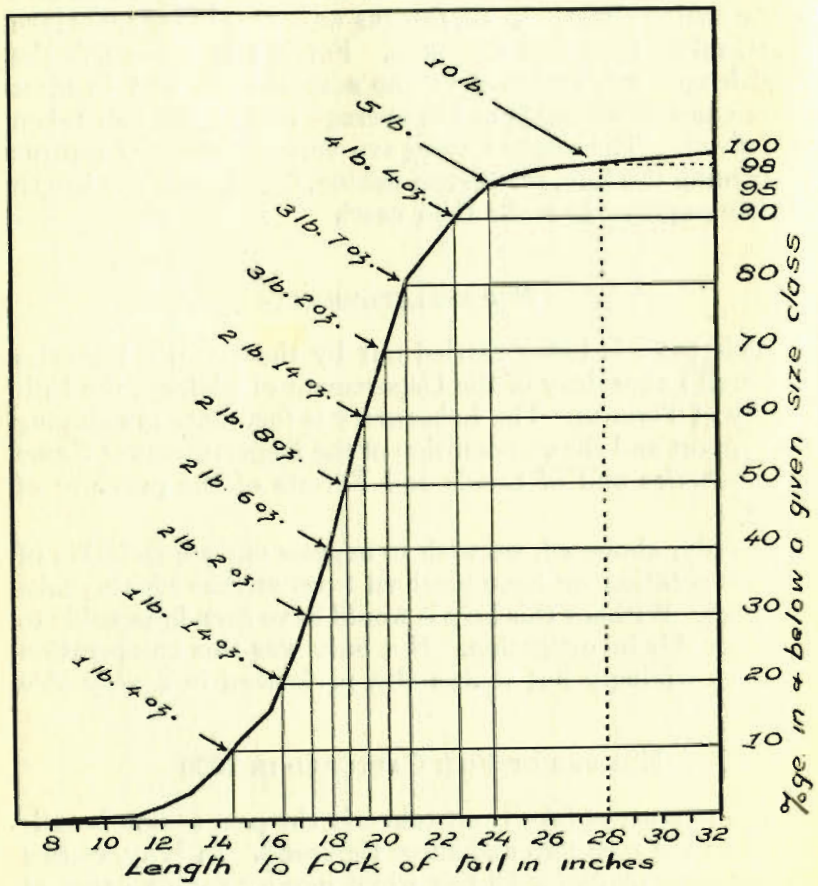


FIGURE 2.—Cumulative frequency polygon of the size composition of the anglers' catch of lake trout in lake Opeongo, 1936. The weights given at the boundaries of the deciles are taken from the weight-length graph, figure 3.

TABLE 1.—An estimate of the catch of lake trout taken in lake Opeongo in 1936.

Month	Number reported	Number estimated	Percentage of season's catch per month
May	78	250	9
June	157	200	7
July	368	1,000	38
August	326	1,000	38
September	160	200	7
October	3	10	1
Total	1,092	2,660	100

equally over the months of May, June, and September, with slightly more fish taken in May. In October practically no fish were taken.

SIZE COMPOSITION OF THE CATCH

The large number of returns in which the lengths of the fish were given made possible a reliable estimate of the size composition of the anglers' catch. The results are compiled in table 2, which gives the number of fish in each inch-group reported each month. The values given in the bottom line of table 2 have been used to plot the cumulative frequency diagram, figure 2.

The area under the curve has been marked off into ten equal parts and the weight corresponding to the length at the boundaries of these deciles was read off from the graph showing the relation between weight and length given in figure 3.

Considering the total catch in this way (figure 2), it will be seen that 10 per cent. of the lake trout taken were less than 14½ inches long or weighed less than 1 lb. 4 oz. Another 10 per cent. were between 14½ and 16¼ inches long, or between 1 lb. 4 oz. and 1 lb. 14 oz., and so on. Similarly it will be seen that only 10 per cent. of the fish captured were over 22¾ inches long or 4¼ lbs. in weight. This upper decile has been subdivided further to emphasize the actual proportion of very large fish in the catch. Only 5 per cent. weighed more than 5 lbs., and a mere 2 per cent. were heavier than 10 lbs.

The cumulative frequency curve is better suited for the purposes of calculation than for demonstration; therefore the

TABLE 2.—A compilation of the returns from anglers concerning the capture of lake trout in lake Opeongo, 1936. The table gives the number of fish in each inch-group reported each month plus the unmeasured fish which are grouped under the heading "no length".

Month	Length in inches to fork of tail																								No length	Monthly total
	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32		
May								2	4	7	4	7	1	1		1							1	1	49	78
June			1		2		3	1	4	11	7	10	4	3	1	3		1						2	104	157
July				1	1	9	8	8	18	28	43	40	36	22	24	16	6	2	1		1	4		2	98	368
August	1	1	2	7	6	10	11	11	21	27	36	29	26	12	9	6	1	2	1	1	2	1		1	102	326
September				2	5	6	6	13	15	18	20	17	15	7	3	1	1	2	1						28	160
October						1					1		1													3
Total	1	1	3	10	14	26	28	35	62	91	111	103	83	45	37	27	8	7	3	1	3	5	1	6	381	1092
Percentages	0.1	0.1	0.5	1.4	2.0	3.5	4.4	5.0	8.7	12.7	15.8	13.9	11.9	5.9	5.1	4.2	1.1	1.0	0.5	0.1	0.4	0.7	0.1	0.9		
Cumulative percentages	0.1	0.2	0.7	2.1	4.1	7.6	12.0	17.0	25.7	38.4	54.2	68.1	80.0	85.9	91.0	95.2	96.3	97.3	97.8	97.9	98.3	99.0	99.1	100		

data in table 2 have been plotted also as a simple frequency polygon, figure 5, page 11.

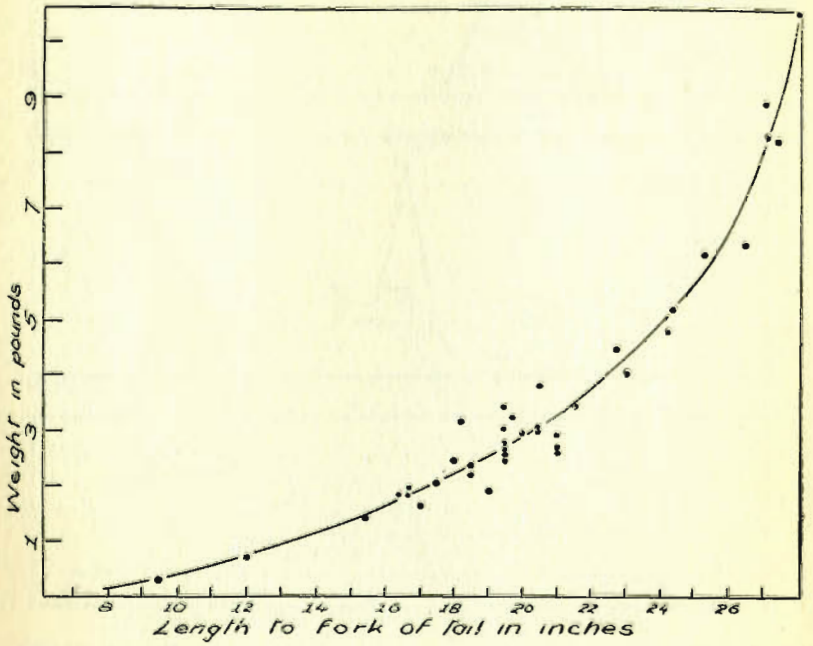


FIGURE 3.—The relation between length and weight in a sample of lake trout from lake Opeongo.

In figure 5 the size of the fish has been related to their reproductive potentiality. This requires some explanation before figure 5 is discussed. In late September and early October the lake trout population was sampled by the use of a graded series of gill nets.[1] During the course of the examination of these fish, three types of reproductive organs were noted:

1. Immature. The typical immature gonad of the Salmonoids.
2. Mature. The typical mature gonad of this group.
3. "Infertile". Ovaries which appeared spent except that they were not so loose in structure. The ova were small and somewhat irregular in shape and size. The

[1]Five nets each 150 feet long of 1½-5 inches inclusive stretched mesh.

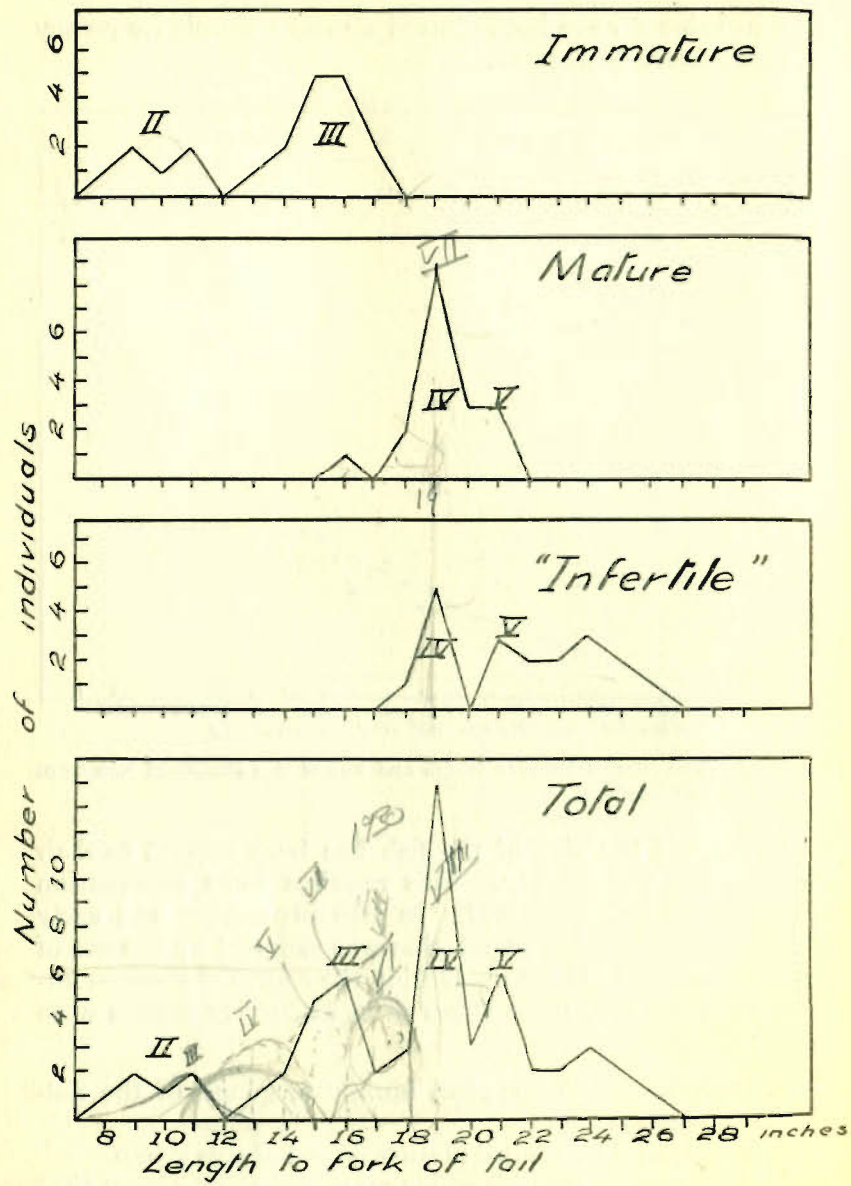


FIGURE 4.—The relation between size and the state of the gonads in a gill-net sample of the Opeongo lake trout. The numbers at the modes which suggest the age of the individuals must be considered provisional pending an examination of the scales.

testes were small and immature in appearance although the fish were large.

When fish with gonads of the type classified as "infertile" were first noticed in the samples, the females were considered to be spent fish and the males immature. However, when no spent, or even ripe males were taken it was felt that even if these females had developed eggs, the eggs had not been shed

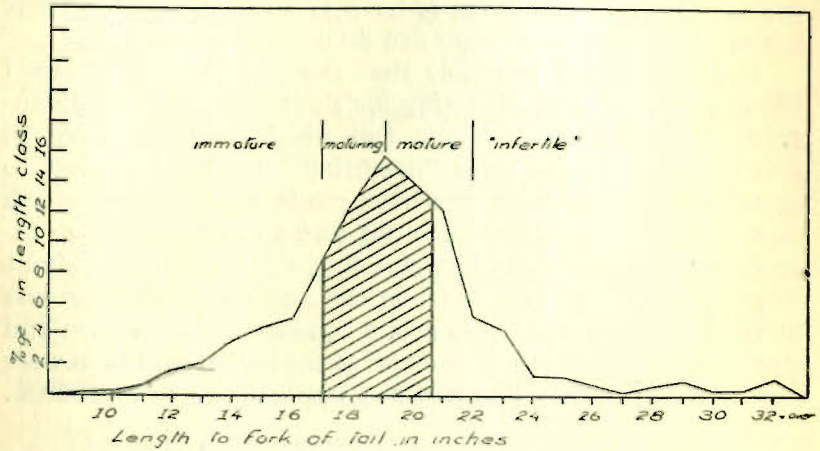


FIGURE 5.—The size distribution of lake trout taken by angling in 1936. This diagram shows the percentage of fish of different lengths making up the catch. The central hatched portion is 50 per cent. of the area and indicates that one-half of the fish taken were between 17 and 20½ inches long. The two areas to the left and right of the hatched area are each 25 per cent. of the total. One-quarter of the fish taken were less than 17 inches long. The state of the reproductive organs of the fish is indicated above the diagram.

during the course of normal spawning. After this the interpretation of immaturity placed on small testes in large fish was also questioned, since the proportion of fish with small testes did not progressively diminish in larger size classes.

When the fish in the samples were sorted into the three groups mentioned above, it was found that each classification corresponded to a definite size range (figure 4). The lower panel of figure 4 shows the length composition of the total sample. There are four pronounced modes (numbered II, III, IV, and V in the graph) which probably represent consecutive age classes. The fish grouped about the modes II and III are

immature. Most of the fish about mode IV and approximately half of those about mode V are mature. The fish classed as "infertile" make up part of mode IV and include the majority of fish larger than those in this group; in fact, the state of the gonads would seem to indicate that no fish over 22 inches long would be able to spawn normally in 1936. It would seem, then, that the reproductive activity of the Opeongo population of lake trout is bound up in individuals confined to the very limited size range of from 17 to 22 inches. Smaller fish are immature and larger fish do not spawn normally.

It is considered probable that most of the fish grouped about mode IV were maturing for the first time. To distinguish these fish from fertile fish which have spawned in previous seasons the term "maturing" has been applied to them. This distinction has been made since maturing fish captured before October have not had an opportunity to reproduce. Referring now to figure 5, it will be seen that about 50 per cent. of the lake trout in the anglers' catch were less than 19 inches long. This group consisted of immature and maturing fish. Therefore one-half of the lake trout taken were captured before they had had any opportunity to reproduce.

RELATION OF SIZE OF FISH TAKEN, TO SEASON, METHOD OF CAPTURE, AND LOCALITY FISHED

A further analysis of the catch shows considerable differences in the results yielded by fishing in different months and by different methods, or at different depths. For instance, the two very large fish taken in June were taken in deep water, the greatest number of large fish were taken in July, and still-fishing resulted in catches of larger average size than did trolling.

Table 3 shows the percentage of fish of different sizes taken in each month from May to September.

If the extreme right-hand column is considered, it will be seen that in May, only 14 per cent. of the fish taken were over 22 inches long; that is, about one fish in every seven. In June there was a greater proportion of these large fish in the catch, and in July the proportion reached 30 per cent., a frequency of almost one fish in every three. Subsequently fish of this

size became rarer in the captures until in September only a little better than one fish in ten was as large as this. Accordingly the angler fishing in July secured a greater percentage of large fish than the angler fishing in other months. On the other hand, the column on the extreme left, which shows the proportions of very small fish in the catches, makes it clear that the relative number of these small fish taken was least in July, and ran up to a very high percentage in September when more than one fish in every three was less than 18 inches long.

TABLE 3.—Monthly variations in the size composition of the lake trout catch taken in lake Opeongo, expressed as percentages of the monthly catch falling into various size classes.

Month	Length class				
	Less than 18″	18″-19″	19″-20″	20″-22″	Greater than 22″
May	21	24	14	27	14
June	21	21	13	26	19
July	17	10	16	28	29
August	32	12	16	24	16
September	36	14	15	24	11

The method of fishing also influenced the expectancy of large fish in the catch. In July 50 per cent. of the fish taken by still-fishing were 22 inches and over while only 21 per cent. of the fish taken by trolling were as large as this.[2] Further, when the time necessary to catch these fish is taken into consideration, still-fishing may have had a yet greater advantage, for two men in a boat using this method took their limit in an average fishing time of 6.5 hours while two men trolling required almost an hour longer to catch the same number, their time being 7.3 hours.[3] However, this shorter fishing time may be due only to the good luck of these particular anglers since mathematical treatment indicates that this difference is not great enough to be statistically significant.

The advantage of deep fishing over shallow in producing

[2]Difference is 0.28 per cent. ±0.085 (σ). Calculated by method given in Tippett (1931), p. 57, from a sample of 149 lake trout taken by trolling and 52 taken by still-fishing.

[3]This difference is not statistically significant. The difference is 0.8 hours ±0.77 (σ), based on samples of 52 fish taken by still-fishing and 149 taken by trolling.

large fish was not so marked. Of the fish taken in July below fifty feet, 40 per cent. were 22 inches or longer, while in catches made at depths of less than this only 27 per cent. had reached this size, but this may also have been due only to chance.[4]

THE RELATION OF MONTHLY VARIATIONS TO THE TOTAL CATCH OF 1936

The purpose of table 3, page 13, was to show the proportions of different size classes in the monthly catch, divorced from any reference to the actual number of fish taken in that month. This was done to point out differences in the drain upon the stock caused by the removal of a given number of fish in a given month.

To calculate the actual number of individuals in each size group taken in the different months of the season of 1936, the percentages in table 3 are multiplied by the monthly estimated catches in table 1. This has been done and the results are given in table 4, below.

TABLE 4.—Estimated monthly catches of lake trout of different size classes taken in lake Opeongo in 1936, calculated from tables 3 and 1. The final digits are not significant.

Month	Length class				
	Less than 18"	18"-19"	19"-20"	20"-22"	Greater than 22"
May	52	60	35	68	35
June	42	42	23	52	38
July	170	100	160	280	290
August	320	120	160	240	160
September	72	28	30	48	22
October		negligible			
Total	656	350	408	688	545

This table further emphasizes the excellence of the fishing in July since more than half the large fish over 22 inches long, taken throughout the season, were captured in this month. It also points out the great drain on the young stock for which fishing in August is responsible, since it shows that about 300

[4]Difference is 0.13 per cent. ±0.074 (σ). Calculated from a sample of 134 lake trout taken below 50 feet and 58 taken above 50 feet.

of the 600 odd fish under 18 inches, taken in 1936, were removed during the single month of August.

In table 4 it will also be seen that the May, June, and September fishing in 1936 caused a relatively unimportant drain on the population since fishing activity in these months was not great. Herein lies the difference in significance between this table and table 3. Table 4 records as an historical fact that the number of fish taken in these months in 1936 was low. Table 3 emphasizes the fact that fishing in these months removes a proportionally larger number of immature fish, and for that reason the future fishing activity over these periods should be watched as a possible source of danger to the breeding stock.

MONTHLY VARIATION IN FISHING EFFORT

Table 5 gives the average fishing effort by months from June to October, expressed as the length of time required for two men in one boat to catch their limit of five trout each. The effort for May has been omitted since it could not be calculated on this basis.

TABLE 5.—Monthly averages of the effort expended in the capture of lake trout in lake Opeongo. Effort is expressed as the number of hours required by two men in one boat to capture ten lake trout when no other game fish were taken.

Month	Effort[5]
June	8.7 hours
July	7.1 "
August	8.6 "
September	6.3 "
October	days

It will be seen that, neglecting May which has good fishing but for which the effort was not measured, fish were captured most easily in September. Next in order of success was July. In June and August the fishing was fair but definitely poorer, while in the early part of October, when the fish were return-

[5]The numbers of fish in the samples used for the calculations of fishing effort and the standard deviations of the averages are as follows:

	No. of fish	σM
June	161	±0.33
July	201	±0.29
August	190	±0.49
September	131	±0.65

ing to shallow water, people could fish all day and catch nothing. If size is taken into consideration, then on the whole, July yielded the best fishing, for in that month many more large fish were taken than were captured in September.

INTERPRETATION OF SEASONAL DIFFERENCES IN THE CATCH

The lake trout in Opeongo participate in a summer migration from shallow to deep water similar to that found in the case of the cisco, *Leucichthys artedi* (Le Sueur), in lake Nipissing (Fry, 1937), and in other lakes. If the details of events in the lake trout migration parallel those of the cisco migration, then the observations concerning the capture of lake trout by angling are quite understandable.

As the upper waters of a lake become warmer the ciscoes, like the lake trout, swim deeper and deeper. Large ciscoes are more sensitive to high temperatures and go deep earlier. Just before the ciscoes leave the warm water, they stop feeding and they do not resume feeding immediately on entering the colder deeper water. The later the ciscoes leave the warm water the longer they fast in the cold water. This leads to a condition wherein most of the ciscoes that are feeding in July are large. In late summer practically all the ciscoes have begun to feed again. In October the ciscoes leave the deep water, which is still cold, and return to the shallow water, which, while it has cooled considerably, is still warmer than the deep water. At this time they again stop feeding.

The capture of a lake trout by angling arises out of circumstances in which the concentration of trout in the neighbourhood of the bait, their willingness to take the bait, and the chances of their being accidentally snagged all play a part. The largest trout went to deep water early and for that reason were not generally taken except there. In July, after the whole population had entered deep water, only the large trout were feeding, and therefore, in general, only large ones were taken by still-fishing. When fish are taken by trolling some may be accidentally snagged without having seized the bait in their mouths at all. Of course feeding fish will co-operate by seizing the bait and consequently will be likely to predominate in catches taken by trolling, but the non-feeding

fish that are snagged will make the average size of troll-caught fish smaller.

It will be remembered that in August more time was required to catch a given number of fish than in July. This may be because more dependence had to be placed on accident owing to a large percentage of the feeding fish having been captured. In September the smaller fish had nearly all resumed feeding and fish were again more easily taken.

The great difficulty experienced in taking fish in October is probably an indication of a second fast which the fish begin on their return to shallow water.

RELATION OF THE 1936 FINDINGS TO THE PROBLEM OF CONSERVATION OF THE OPEONGO FISHERY

The findings pertinent to this problem may be summarized as follows:

1. It has been found possible to follow the fishery by means of a creel census.
2. About 3,000 lake trout were taken, 2,000 of these in July and August.
3. Fifty per cent. of these fish had not reproduced even once.
4. The proportion of immature fish in the catch was much higher in August and September.

Findings 2 and 3 would seem to indicate that if the fishery is exploited without control it is very likely to be faced with the prospect of depletion. In 1936 the highway to Opeongo was very bad; with its improvement the fishing activity will probably be greatly increased, and since the fishery seems to draw so heavily from the breeding stock some control would be advisable as early as 1937.

Findings 4 and 1 are suggested as pointing the way to the control of exploitation. A lower limit to the size of lake trout landed is very likely impracticable but immature fish could be protected to a large extent by limiting the fishing activity in months when they are most susceptible to capture. Since no one is in a position to state the maximum of exploitation that may be desirable in lake Opeongo, it is desirable to feel the way

to the peak of production by watching the catch from year to year through the medium of the creel census.

It seems quite probable, due to the apparently restricted reproductive capacity of the population, that hatchery operations might materially augment the natural production of lake trout in lake Opeongo. The findings reported would further indicate, then, that a planting policy for this lake might well be inaugurated.

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TABLE 6.—Stomach contents of lake trout taken by anglers in lake Opeongo, 1936. The first number in a column indicates the number of stomachs containing the organism; the number in brackets is the average numbers of the organism in question in these stomachs. (†) indicates a trace. The surface food recorded consisted of the remains of winged insects.

		No. of stomachs examined	No. of stomachs with contents	Surface Food	Bottom Organisms						Fish			Trash	
					Crayfish	Mayfly nymphs	Dragonfly nymphs	Alder fly larvae	Phantom larvae	Midge larvae (blood-worms)	Whitefish	Perch	Ling	Fish remains	
May	24	9	8	2(†)		4(1)	1(2)	3(1)	1(1)		3(1)	5(2)		3(10)	
June	2–3	14	12			5(††)	1(1)				2(1)	5(6)		4(2)	
"	8–11	5	4		2(2)	1(3)				1(1)	1(2)			3(††)	sponge (†)
"	14	8	6							1(10)	5(2)	1(1)		12(1.2)	sponge (†)
"	28–30	15	13								4(1)			1 (1)	
July	6	5	5								5(1)	6(6.6)			
"	16–17	16	6			1(†)					4(2)	3(2)		4(1)	reed (††)
"	18	14	11			1(2)					1(1)	6(3.3)	2(1)	6(1.3)	sponge (†)
"	20–21	27	17								4(1)	5(2.2)		5(1.8)	
"	28–30	17	12		1(†)						6(1.3)	12(6.5)		2(1.5)	
August	2–3	31	18								1(3)	4(4.8)		3(1)	
"	12–13	15	8								2(2)	5(6.4)		8(1.5)	
"	20–24	16	14		1(1)						1(1)	3(17)		3(1.3)	
"	31	13	6								2(1.5)	4(1.8)		3(1)	
September	5–6	25	11	2(†)							2(1)	12(6.8)		8(1.4)	
"	13	18	16												

APPENDIX

THE FOOD OF OPEONGO LAKE TROUT TAKEN BY ANGLERS

The stomach contents of a number of lake trout taken by anglers were examined at different dates throughout the summer of 1936. The results of this examination are summarized in table 6. It was not possible to relate the stomach contents to the size of the fish since often the viscera only were received, nor was it possible to measure the volumes of the food organisms.

In the table the food has been classified according to whether it consisted of organisms living out of the water, organisms living on the bottom of the lake, or fish. The group of minute floating organisms, the plankton, which is so important a source of food for many fish and often for lake trout, was not found in the sample of Opeongo stomachs examined.

Surface food, which consisted of the remains of winged insects, was found in four stomachs. Two of these were examined in May and the remaining two in September. These indicate that lake trout feed at the surface, at least to some extent, during the spring and the fall.

Bottom food was found in appreciable amounts during only May and June although crayfish and mayfly nymphs were found in stomachs in July and August.

By far the most important article in the diet of the Opeongo lake trout is fish. The species of fish eaten are principally two, the whitefish, *Coregonus clupeaformis* (Mitchill), and the perch, *Perca flavescens* (Mitchill), although ling, *Lota maculosa* (Le Sueur), and suckers, *Catostomus* spp. (not recorded in the table)[6] are occasionally taken by the larger trout. Most of the perch and whitefish taken were small, being usually no more than two years old. In length the whitefish varied from 3 to 6 inches and the perch were considerably smaller. Perch of the year appeared in the stomachs as early as July 17, when they were only about 1½ inches long. It is difficult to assess the relative importance of the perch and the whitefish as food for the lake trout. Perch are taken more frequently and in greater numbers but they are not as large as the whitefish.

[6]Both the northern, *C. catostomus* Fors, and the common sucker, *C. commersonii* (Lacépède), occur in the lake. We have not identified any suckers found in trout stomachs but they have been reported to us.