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MAINE DEPARTMENT OF INLAND FISHERIES AND GAME

Fish Survey Report No. 6

A Biological Survey of Moosehead Lake and Haymock Lake, Maine

BY

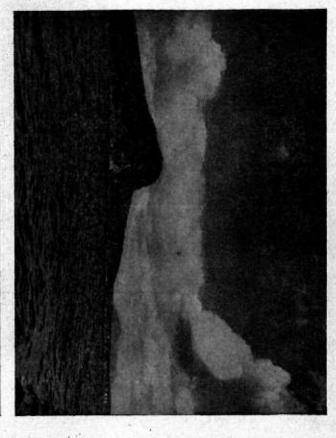
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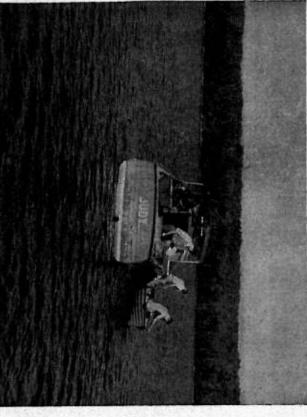
MAINE DEPARTMENT OF INLAND FISHERIES AND GAME

W. EARLE BRADBURY, Acting Deputy Commissioner GEORGE J. STOBIE, Commissioner

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Upper: Mount Kineo on Moosehead Lake, as seen from the west. The mountain rises 778 feet above the lake and is a mile from the camera. The Spencer Mountains are seen in the right background.

Lower: Part of the survey personnel at work on Lily Bay of Moosehead Lake. A gill net is being hauled into the larger boat.

MAINE DEVELOPMENT COMMISSION PHOTOS.

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A BIOLOGICAL SURVEY OF MOOSEHEAD LAKE AND HAYMOCK LAKE, MAINE

Fish Survey Report No. 6

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INTRODUCTION

This is the sixth in a series of reports on the lakes of Maine. The survey program has been conducted by the Department of Inland Fisheries and Game in cooperation with the Department of Zoology at the University of Maine. Previous surveys have covered coastal stream drainage areas as far east as the Penobscot River and as far north and west as the Rangeley Lakes region. The field work for the lakes of Hancock County has been done, and a seventh report on these bodies of water is in preparation. The present survey is unique as compared to the other Maine lake surveys since it is an intensive study of only two lakes, in the Allagash drainage system.

Moosehead Lake is one of the most famous fishing grounds of the State. This region has been a sporting resort for a century and has been visited by people from all parts of the United States. It is of particular interest, therefore, to learn how the fish population has been affected by the intensive fishing pressure. Although the lake is large, fears have been expressed that overfishing was injuring the angler's sport.

Haymock Lake is much smaller, but it is deep enough to contain native togue as well as trout. It differs from Moosehead

in containing no salmon, nor is there any record of fish stocking at any period. Moosehead Lake, on the other hand, has been extensively stocked since 1895. Haymock Lake is fished only occasionally because of its isolated location. It is perhaps as near a lake in a primitive condition as could be found today in Maine. For the purposes of lake survey work in the northern part of the State, it may serve as a yardstick of natural conditions by which we can measure the effect of human interference.

The field work of the survey was carried out from headquarters at Rockwood on the west shore of Moosehead Lake. The personnel of the survey party included three members of the Zoology Department at the University of Maine: Dr. Gerald P. Cooper, Survey Director; Dr. John L. Fuller and Dr. Carl M. Flynn. Five students were employed as technical assistants: Peter J. Bradshaw, Clarke J. Church, Paul J. Dowe, John A. Roberts, and Samuel W. Stuart. Warden Charles Nelson of Rockwood was assigned as guide and boat operator for the survey party. Warden Nelson's knowledge of the lake aided greatly in planning operations.

All materials and personnel were transported to Haymock Lake by planes of the Fish and Game Department. The cooperation of Pilots William H. Turgeon, Merton A. Alexander, and Wilfred Atkins is gratefully acknowledged. A camp site was established on the north shore of the lake, and a boat constructed from materials brought in by plane. It was possible to carry out a complete survey even in the heart of the Maine wilderness. The use of planes will be essential if other lakes in northern Maine are to be surveyed.

The major objectives of the survey at both lakes may be summarized under the following headings.

- (1) To make collections of fish in order to learn the relative proportions of different species, and to obtain material for a study of food habits, and growth by the scale method.
- (2) To make physical and chemical observations, including a complete sounding map. From this data to calculate the amount of water and its suitability for fish.
- (3) To observe the types of food organisms present and to estimate their abundance by quantitative measurements.
- (4) To summarize past stocking records and to collect material on the history of angling in the lake.

- (5) To survey tributaries with special reference to their value for spawning grounds and as feeder streams for trout and salmon production.
- (6) Finally, to analyse this data in order to assist in the formulation of stocking and management policies.

These objectives have been achieved, at least in part. A lake, however, does not remain static biologically, and our results will not be good for all time. They should provide a reference for future work on these and similar lakes by other fisheries biologists. We hope also that this report may be read in part by the sportsman who has an interest in the scientific basis of good fishing.

The major part of this report deals with the results of the study of Moosehead Lake, since this lake received most of our attention during the summer. A summary of our findings on Haymock Lake is given in a section at the end of the report.

CHEMICAL AND PHYSICAL FEATURES OF MOOSEHEAD LAKE

maximum, but it is unlikely that any large pocket of deeper water party was 246 feet. No claim is made that this is the absolute east of Farm Island. Although Moosehead Lake has been reputed remains undiscovered. to be over 500 feet deep, the maximum depth found by the survey the lake is found to the east and west of Kineo, and in a basin few interesting points may be mentioned. The deepest water in on the inside of back cover). This map is self explanatory, but a shown on the large insert map accompanying this report (folded soundings of the entire lake. The results of these soundings are The first step of our survey was, therefore, to make systematic edge of depths is also essential for studies of fish distribution. degree by the size, depth and form of the lake basin. A knowlgame fish are based upon the temperature and chemical composition of the lake waters. These in turn are determined to a high The biological productivity and the suitability of a lake for

Extensive areas of shoal water are not common. The largest continuous area is Spencer Bay, and there are other extensive shallow waters in North Bay, Lily Bay and near West Outlet. The average depth of the lake was computed as 54.5 feet. Table I

summarizes the physical characteristics of the different geographical divisions of the lake.

TABLE I. The areas and average depths of the geographical divisions of Moosehead Lake

Total	North Bay	Geographical divisions
	NB TF TF RS RS SS SS SS SS SS SS SS SS SS SS SS	Symbol
74,890	16,900 7,000 4,807 5,827 13,520 4,626 12,535 4,808	Area:
54.5	55.4 77.8 47.8 47.8 26.9 36.9	Average depth: feet

The soundings were made with graduated lines (of nonstretching tiller rope or brass chain) and are accurate to the nearest foot. The location of the soundings on the map is somewhat approximate since the lines were run in small boats under various conditions of weather, and it was sometimes impossible to steer a straight course between landmarks. It should nevertheless prove useful to the sportsman who seeks water of a particular depth for his fishing effort.

Physical Features of Lakes. Not all the water in a lake is a suitable habitat for game fish. In many of the smaller lakes in the southern part of our State the surface waters become much warmer than the 70° F. limit usually set for trout and salmon. At the same time in certain of these lakes the deep, cold water is often so deficient in oxygen that no fish, and very few other forms of life can survive in the lower levels. One purpose of the survey was to determine whether such conditions were found in any part of Moosehead Lake. A brief description of the annual changes in lakes of temperate regions will serve as a background to the survey studies.

During the winter the waters of a lake are covered by a layer of ice and snow. Some light may penetrate to maintain plant life, but low temperature combined with low illumination reduces life activity to a minimum. Although food production is slight, the energy needs of fish are also reduced. At the lower surface of the ice the water temperature is 32° F. Below this the temperature rises gradually to 39.2° F. at the bottom. At

this temperature water attains its greatest density, and forms a heavy layer beneath the lighter surface water.

In the spring the breaking up of ice allows the sun to heat the surface water. This slightly warmed surface water is thus made heavier than the deeper layers and sinks thereby displacing the colder water. The continuation of this process aided by wind action results in a stirring of the lake from top to bottom and a redistribution of nutrients. This period is commonly known as the spring overturn.

and is known as the hypolimnion. This cold deep water receives nounced. (3) A deep layer which is not stirred by wind action in the report, the oxygen content never falls to a critical point. salmon and trout. In Moosehead Lake, as will be shown later the 5 p.p.m. which is generally considered to be necessary for at and near the bottom often reduces the oxygen content below biologically active lakes the decomposition of aquatic organisms that its oxygen content must necessarily decrease. changing temperatures, the thermocline. Within this section air temperature of the region. (2) A middle stratum of rapidly which is constantly stirred by wind action, has abundant oxygen are eventually formed. (1) An upper stratum, the epilimnion, no access of oxygen during the summer stagnation period, so large lakes where the mixing action of the wind is more proeven between parts of a single lake. It tends to be deeper in The depth range of the thermocline differs between lakes, and dissolved from the air, and has a temperature close to the mean warm water. As a result of these processes three water layers cooler water underneath and gradually works down the layer of few inches. Wind action, however, stirs the warm water into the since the sun's radiation is largely absorbed in the uppermost there is a rapid change in physical conditions from top to bottom. while the deeper water changes only slightly in temperature Throughout the summer the surface water becomes warmer heating makes them lighter and circulation gradually ceases. Once the surface waters are warmed above 39.2° F., further

In the late summer and fall the mean air temperature again falls and the surface water is cooled. As soon as it becomes cooler than the hypolimnion, the surface water sinks and a new mixing process, the fall overturn, is initiated. This process is greatly aided by the strong winds characteristic of the autumn months in

New England. Winter finally brings the temperature below 39.2° F. and a reverse stratification is set up with the colder water at the surface. Since the temperature difference is small this stratification is not as pronounced as in the summer period. A few additional degrees of cooling cause ice formation and the cycle is completed for the year.

The above outline is true for lakes of moderate depth in Maine, but should not be applied to all lakes. For a more complete description of seasonal changes in Maine lakes, the reader is referred to the earlier reports of this series, particularly Survey Report No. 2, published in 1939, and to Welch's Textbook of Limnology.

Chemical Features of Lakes. Natural waters contain a large variety of substances dissolved from the soil and air. From the viewpoint of the fisheries investigator three classes of materials are deserving of attention. (1) Oxygen is needed by practically all organisms to maintain life. The amount of oxygen dissolved by a given amount of water depends upon temperature and pressure. For example the surface waters of Moosehead Lake will take 8.6 parts per million of oxygen from the air at 70° F., and 12.7 parts per million at 40° F. Investigations in Maine have shown that oxygen in good trout and salmon waters never falls below 5 parts per million. In many lakes which have been surveyed, the oxygen content of the hypolimnion is much less than 5 p.p.m. at the end of the summer stagnation period. Trout and salmon are thus forced upward into the epilimnion which is too warm for them.

(2) A second class of substances includes plant nutrients. In water as on land plant growth is the basis of the food cycle for all animal life. Some types of aquatic plants are found in shallow protected spots, but the most important from the fisheries viewpoint are the minute floating plants found in the plankton. A section of this report deals with the plankton of Moosehead Lake. To make a thorough study of plant nutrients would require a more extensive chemical analysis than could be carried out by the present survey party. A few determinations were made on

total phosphorus and on alkalinity. Both of these are important factors in determining productivity. As a general thing clear glacial lakes like Moosehead are very low in dissolved solids, and are thus more limited in productivity than shallow lakes. Clarke (1924) reports the following composition for the dissolved solids of Moosehead Lake: CO_s, 5.4 p.p.m.; SO_s, 2.1 p.p.m.; Cl, 2.0 p.p.m.; NO_s, Trace; Ca, 2.2 p.p.m.; Mg, 0.3 p.p.m.; Na, 1.8 p.p.m.; K, 0.6 p.p.m.; Fe₂O_s, 0.2 p.p.m.; SiO_s, 1.4 p.p.m.—Total, 16.0 p.p.m.

(3) Some substances are known which are directly detrimental to fish or to food organisms. Pollution in Moosehead Lake is too small to cause injurious conditions and no evidence of industrial contamination was found. Decomposition of natural substances may produce large quantities of carbon dioxide which is injurious in high concentration. The measurement of acidity or pH will detect this condition. A pH of 7.0 is neutral; lower values are more acid; higher ones more alkaline.

Methods. The methods employed during the summer were the same as those of previous surveys. Temperatures were taken with reversing thermometers manufactured by Negretti and Zambra. Water samples from various depths were collected in a Kemmerer water bottle. All oxygen analyses were made by the Winkler method as outlined in Standard Methods for the Examination of Water and Sewage (1936). Per cent saturation of oxygen was calculated using the nomogram of Rawson (1944). Lamotte indicators and liquid color standards were used for pH measurements. Alkalinity was measured by titration with normal alkali using the mixed indicator of Cooper (1941). Phosphorus was determined by the method of Robinson and Kemmerer (1930), with perchloric acid oxidation according to Robinson (1941).

Morphometry of Moosehead Lake. As in previous surveys calculations have been made to determine the volume of water at different temperatures, and the bottom area in contact with suitable water which is available to trout and salmon for foraging. These calculations are based upon the late summer period when conditions of temperature are least favorable for trout and salmon. The first step was the outlining of selected contours on the sounding map and the measurement of the enclosed areas by a planimeter. For convenience the lake was divided into nine areas which are more or less distinct take basins. These areas

¹ See Literature Cited, page 122.
2 McGraw Hill Co., N. Y. (1935).

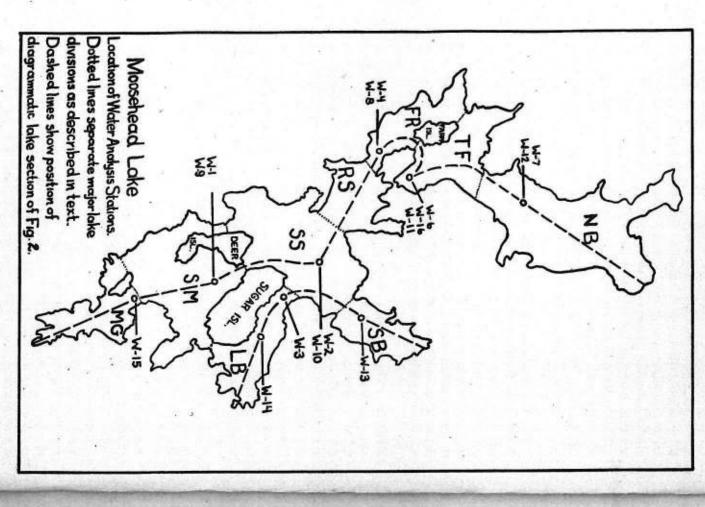


Figure. 1. Reference map of Moosehead Lake showing water analysis stations and lake divisions.

are shown on Figure 1, with symbols used to designate each. Table I summarizes certain data concerning these areas.

The contours chosen were 15 feet, 35 feet, 75 feet, 100 feet, 150 feet, and 200 feet. Fifteen feet represents the lower extent of 70° F. water during the hot period of summer when the lake is calm. This water may be forced down nearly to 35 feet during severe storms. In August the thermocline is best developed between 35 and 50 feet. Below 50 feet conditions in the different basins are variable and are discussed individually. The calculation of water volumes between the several contours was made according to the following formula assuming the form to be a frustrum of a cone. The volume (V) is in acre-feet (the amount of water which will cover one acre to a depth of one foot); A, is the area in acres of the plane of the upper contour; A, is the area in acres of the plane of the lower contour; h is the distance in feet between contour planes.

$$V=h/8 (A_1+A_2+VA_1A_2)$$

There are various inaccuracies in this method which are discussed in Survey Report No. 2, page 143, but the technique yields figures of sufficient precision for the purposes of fish management.

The data used in judging the suitability of water for game fish is summarized in Table II, which gives temperature, oxygen, and pH values for 15 separate stations. In tabulations, the results during early August were used, since the lake temperature was at its maximum at that time.

TABLE II. Summary of water analyses at selected stations on Moosehead Lake. The water analysis stations (WI, W2, etc.) are given on Figure 1

										No wind or waves, Secchi disc disappeared at 18 ft.		W1. July 5, 1944. 8:00-4:00 P.M. M mile west of Birch Island.	Description of station
140	120	110	100	98	70	660	40	220	201	200	10	0.0	Depth in feet
45.9	46.00	47.0	2.00	7.00	51.1	21 53 5 20 60 6	500	57.6	59.4	63.0	6.33	68.7	Temper- ature:
10.5	10.1		***	:	10.5	10.4		10.0	44.4	10.0	****	9.4	Oxygen: p.p.m.
91	89		•••	***	97	99	***	101	***	106	****	106	Oxygen: per cent saturation
6.7	6.8	6.8			6.8	7.0		7.0		7.0		7.0	pH Bromthymol blue

W6. July 11, 1944. 2:80-4:80 P.M. 15 mile east of Kineo Mtn. Depth of water 222 ft. Southeast wind, waves 8 in.	W4. July 6, 1944. 9:00 A.M. to 12:00 M. M. Way between mouth of Moose River and hotel on Kineo Depth of water: 178 ft. N.N.W. breeze, waves 8 in.	W8. July 6, 1944. 8:00-4:00 P.M. 1 mile southeast of mouth of Lily Bay. Depth of water: 76 ft. North wind, waves 2 ft.	W2. July 6, 1944. 1:00-2:00 P.M. Midway between Hogback Island and Spencer Bay narrows Depth of water: 104 ft. East wind, waves 1 ft.	Description of station
100 100 100 100 100 100 100 100 100 100	1100 880 880 880 880 880 880 880 880 880	7654888288115.0	1098785858551150	Depth in feet
66666777777777777777777777777777777777	44544455555555555555555555555555555555	58.5 58.5 58.5 56.5 56.5 56.5 56.5	5011660445666666666666666666666666666666	Temper- ature: F.
9.8 9.8 10.5 10.5 11.6 11.6	9.5 9.8 9.8 10.3 10.3 10.3 10.3 10.3 10.3	9.3 9.4 10.0 10.0	10: 1 10: 10: 10: 10: 10: 10: 10: 10: 10	Oxygen: p.p.m.
106 106 107 108 109 98	1006 1006 1006 1006 1006 1006 1006 1006	106 101 101 102	91 93 94 95 104 86 91 98 96 96 96 96 96 96 96 96 96 96 96 96 96	Oxygen: per cent saturation
6: 9: 9: 9: 9: 9: 9: 10: 10: 10: 10: 10: 10: 10: 10: 10: 10	: 55 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	7.0 7.0 7.0 8.8 8.8	6: : 6: : 6: : 7: : 7: 0 6: : 8: : 6: : 6: : 7: 0	pH Bromthymol blue

W10. Aug. 7, 1944. 2:15-3:80 P.M. Midway between Hogback Island and Spencer Bay Narrows. Same as W2 Depth of water: 99 ft. Northeast breeze, waves 6 in.	W9. Aug. 7, 1944. 11:00 A.M. to 1:00 P.M. Mills west of Birch Is. Senne as W1. Depth of water: 154 ft. North breeze, 4 in. waves. Seechi dize disappeared at 20 ft. Note: total phosphorus at surface 14 p.p.b.; at 55 ft. 16 p.p.b. Alsalinity in p.p.m. Surface 9.0 35 ft. 7.5	W8. Aug. 2, 1944. 8:30-5:30 P.M. I mile northeast of mouth of Moose River, % mile off Kinco diff. Depth of water: 178 ft. Southeast breeze, waves 2 in.	W7. July 13, 1944. 1:30-3:15 P.M. In North Bay half way between Big Duck Cove and Moose Brook Cove. Depth of water: 110 ft. West wind, waves 2 ft.	Description of station
29876565888855560 29876565888855560	150 110 110 110 110 110 110 110 110 110	1150 1150 1150	119838884488885560	Depth in feet
72.7 70.9 70.9 69.8 69.8 69.8 69.8 69.8 69.8 69.8 69	47380 5544	71. 66.6.6.6.6.6.6.6.6.6.6.6.6.6.6.6.6.6.	66.22 66.22 66.22 66.23 66.23 66.23 66.23 66.23 66.23 66.23	Temper- ature:
200: 10: 00: : : 00: : 00: : -3 200: 00: 00: : : 50: : 50: : 10: :	9: 9: 9: 8: 9: 8: 8: 8: 8: 8: 8: 8: 8: 8: 8: 8: 8: 8:	9.4 9.4 10.4 10.4	99: : : : : : : : : : : : 9: : : 9: : 9: : 17: : : : : : : : : : : : : : : : :	Oxygen: p.p.m.
800: 00: 00: :: 00: : 00	8: 8: 8: 8: 8: 8: 8: 10: 10:	99 99 99 99 99 99 99 99 99 99 99 99 99	100 7988:	Oxygen: per cent saturation
66. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6.	6 6 6 6 6 7 7 8 1 6 1 6 1 6 1 6 1 6 1 6 1 6 1 6 1 6 1	::: 6: 6: 6: 6: 6: 6: 1: 7 6: 6: 6: 6: 6: 6: 7	6.6.6.9.10.10.00.00.00.00.00.00.00.00.00.00.00.	pH Bromthymol blue

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W14. Aug. 10, 1944. 1:30-3:00 P.M. In Lily Bay 1½ miles south of Dough- nut Cove. Dopth of water: 90 ft. Northwest wind, waves 8 in. Secchi disc disappeared at 17 ft. *pH checked with phenol red.	W13. Aug. 10, 1944. 11:00 A.M. to 12:00 M. In Spencer Bay 1 mile northeast of Stevens Point. Depth of Water: 24 ft. West breeze, waves 4 in. Seechi disc disappeared at 18 ft.	W11. Aug. 8, 1944. 9:15-11:30 A.M. 35 mile east of Kineo Mountain. Berne a W6. Depth of water: 206 ft. North breeze, waves 3 in. Secchi disc disappeared at 18 ft. Sechi disc disappeared at 18 ft. W12. Aug. 8, 1944. 1:00-2:30 P.M. In North Bay midway between Moose Brook Cove and Big Duck Cove. Depth of water: 140 ft. West breeze. Ripples.	Description of station
8833555555555555	100 200 240	100 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Depth in feet
72.2 71.0 71.0 71.0 71.0 71.0 71.0 71.0 71.0	72.5 72.5 72.0 71.4 66.7	######################################	Temper- ature: *F.
p: -1; p: : : p: : p: : p: : p:	7: 7: : 8	8.7 8.6 9.6 9.6 10.6 10.6 10.6 8.8 8.8 10.2	Oxygen: p.p.m.
100 88 78	81 95	100 88 96 96 91 92 100 100 96 88 88 87 100 94 100 96 88 88 88 87 100 96	Oxygen: per cent saturation
6:	7.0	6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6	pH Bromthymol blue

TABLE II. Water analyses—Concluded

Wif. Aug. 16, 1944. 4:30-5:30 P.M. % mile east of Kineo Mountain. % Same as Wg and Wil. Depth of water: 200 feet. Southwest breeze, waves 6 in.	W15. Aug. 11, 1944, 12:30-3:30 P.M. % mile east of northern above of Moose Island. Depth of water, 130 ft. Strong northwest wind, waves 2½ ft.	Description of station
11110 1110 110 10	1120 1120 1120 1120 1120 1120 1120 1120	Depth in feet
44444444444444444444444444444444444444	71.9 71.9 71.9 71.9 71.9 71.9 71.9 68.7 68.7 68.7 68.7 68.7 68.7 68.7 68.7	Temper- ature: F.
		Oxygen: p.p.m.
	100 86 86 87	Oxygen: per cent saturation
	7.1 7.1 6.6 6.6	pH Bromthymol blue

trout and salmon, and the entire bottom may be utilized as a entire 4,084,241 acre feet of Moosehead water are available for zone of food hunting. contents. It may be concluded that for all practical purposes the ing midsummer, and this is borne out by a study of stomach vey party observed salmon and trout feeding on the surface durcase the water five feet below was 71.4° F. Members of the surfrom the surface during the summer was 73.4° F., and in this white perch. when they need not compete with such species as black bass and even the surface waters as "non-trout" is probably erroneous. surveys, the water layer which attains a temperature above Brook Trout and salmon can tolerate temperatures above 70° F. deficient water in Moosehead Lake. Actually the designation of 70° F. has been designated as "non-trout." There is no oxygen bottom area for the nine sections of the lake. As in previous Tables III and IV summarize the data on water volume and Furthermore, the highest temperature recorded

TABLE III. The volumes of water in acre feet, and by per cent (in parentheses), in specified depth zones of the different geographical divisions of Moosehead Lake.

	-			Depth	of water in feet				
Lake Division	0-15	15-35	85-55	55-75	75-100	100-150	150-200	200-250	Total
North Bay	282,600 (25)	244,700 (26)	205,100 (22)	139,700 (15)	81,100 (8)	38,820 (4)	198 (1)		987,218
Toe of Boot to	98,680 (13)	128,700 (17)	105,100 (14)	92,480 (18)	99,490 (14)	140,900 (20)	59,600 (8)	6,150 (1)	726,050
Farm Island to Rockwood	66,130 (18)	71,860 (20)	59,780 (16)	50,470 (18)	51,710 (14)	62,010 (16)	12,160 (8)		374,120
Rockwood to Sandbar	70,990	74,850 (80)	54,500 (22)	33,300 (18)	16,090 (6)	812 (1)			250,542
Sandbar to Sugar Island	189,200 (29)	209,600	146,500 (22)	75,110 (12)	28,980 (4)	844 (1)			650,284
Spencer Bay	55,310 (73)	20,730 (27)	(1)40						76,080
Lily Bay	68,230 (47)	43,650 (29)	14,430 (10)	10,100	9,450 (6)	206 (1)	**********		146,066
Sugar Island to Moose Island	178,500 (24)	205,400 (28)	157,200 (21)	100,900 (13)	66,740 (9)	39,170 (5)	157 (1)		748,067
Mose Island to Greenville	64,490 (38)	61,350 (85)	30,840 (17)	11,060 (6)	6,224	1,900 (1)			175,864
Total	1,024,180	1,055,840 (26)	773,490 (19)	513,070 (12)	359,784 (9)	279,662 (7)	72,115 (2)	6,150 (1)	4,084,241
	1,024,130 (25) Above 70° Too warm for trout		Tr	8,060,111 (75) out and salmor	water.		No layer oxygen de cient wate	fi-	

TABLE IV. The area of lake bottom in acres, and by per cent (in parentheses), between specified depth contours in the different geographical divisions of Moose-head Lake.

		- 1		Depth of	water in feet		-		
Lake Division	0-15	15-85	35-55	55-75	75-100	100-150	150-200	200-250	Total
North Bay	2,750 . (16)	3,730 (22)	2,705 (16)	2,687 (16)	3,284 ° (20)	1,693 (10)	51 (1)		16,900
Toe of Boot to Farm Island	858 (12)	574 (8)	631 (9)	626 (9)	655 (9)	1,440 (20)	1,755 (26)	461 (7)	7,000
Farm Island to	849 (17)	718 (15)	497 (10)	434 (9)	472 (10)	1,044 (23)	798 (16)		. 4,807
Rockwood to Sandbar	969 (19)	966 (19)	1,059 (20)	1,075 (20)	912 (17)	244 (5)	*******		5,225
Sandbar to Sugar Island	1,790 (13)	2,455 (18)	3,738 (28)	3,311 (24)	1,867 (14)	359 (3)			13,520
Spencer Bay	1,886 (40)	2,753 (59)	81 (1)	,,,,,,,,,,,					4,670
Lily Bay	1,703 (31)	1,820 (24)	1,229 (23)	596 (11)	546 (10)	81 (1)			5,425
Sugar Island to Moose Island	1,265 (10)	1,957 (15)	2,822 (22)	2,771 (22)	1,976 (16)	1,587 (14)	157 (1)		12,535
Moose Island to Greenville	1,129 (24)	1,179 (24)	1,747 (36)	379 (8)	231 (5)	148 (3)			4,808
Total	18,199 (17)	15,652 (21)	14,459 (19)	11,879 (16)	9,943 (13)	6,541 (9)	2,756 (4)	461 (1)	74,890
	13,199 (17) Above 70° F. Too warm for trout in mid- summer			Tro	oxy	layer of yeen defi- nt water			

each temperature range is shown by a characteristic pattern. It will be observed that 70° F. water goes down to 30 feet in North Bay and only to 10 feet between Deer Island and Sugar Island.

nearly as great as would be judged from the figure.

is cautioned that the barriers between different regions are not

line are plotted on an extremely exaggerated scale.

so as to intersect all water analysis stations.

A separate line was Depths along this

The reader

Water of

Figure 2. A line was drawn from Northeast Carry to Greenville

the lake. The stratification. regularly shaped lakes, the several sections of the lake may possess distinct individuality. Our water analysis stations were so

The Individual Lake Basins.

It is well known that in large ir-

located that each would be representative of a major division of

The chief difference between areas was in temperature

This is shown in the diagrammatic section of

drawn through Lily Bay and Spencer Bay.

17

Special mention may be made here concerning the suitability of the water for Togue. This is a deep water species whose preference for the lower levels is presumably based largely upon temperature. Most of the Togue taken by the survey party came from water below 60° F. It may be that Togue prefer even colder water, for the best catches were made near Farm Island, the only part of the lake where large volumes of water below 50° F. are found.

this region. tial plankton producing capacity as compared with other lakes of We may conclude that Moosehead Lake is about average in poten-Hancock County, this value is neither exceptionally high nor low. As compared with Connecticut lakes and with Maine lakes in per billion with no significant differences between depth layers. phorus made by survey personnel in August averaged 14 parts the summer when minimum values would be expected. nitrate in Moosehead, but his analysis may have been made in midwestern lakes. above show a very low concentration of salts when compared to total nitrogen and phosphorus. plankton productivity of the lakes studied was correlated with Connecticut lakes Deevey and Bishop (1941) New England lakes which have been studied. substances dissolved in the lake water. Only brief consideration was given to the amount of nutrient is a more reliable value. This condition is typical of other large deep Clarke reports only a trace of Measurement of total phos-Clarke's analyses given report that the In a survey of Winter

Scale in Miles Over 70' 65-70° F. 60-65°F Greenville Bay Spence Bay Sugar Is Bay ıly Rockwood Ridge Moose Isl. Depression North Bay Sugar Isl. Deer Isl. Aoose River Trough Deep 200 Hardscrabble Form Island Ridge Kineo Deep

Figure 2. Diagrammatic section of Moosehead Lake showing temperature distribution in individual lake basins. See

This is not important, but is caused by the fact that the North Bay observations were made during a heavy wind. The thermocline where the bands are narrow and crowded is between 35 and 55 feet. It is very definite above the Farm Island-Kineo Deep, but is wide and less definite in the southern half of the lake. Below the thermocline the different divisions show the greatest individuality. Near Farm Island and off Moose River, 40-50° F. water is found at all depths below 65 feet. The only other 40-50° F. water found was in a small pocket between Deer and Sugar islands. Here it occurs only below 105 feet. This great bulk of cold water in the Kineo region is not found elsewhere. It influences the surface waters to some extent when storms cause a mixing of the two, and it may be expected to have an influence on the distribution of the fish in the lake.

Conclusions. No lake studied by the survey has offered better water for salmon, trout and Togue. The limitations on the game fish of Moosehead will be due to food supply and angling pressure. The sections of this report immediately following deal with the problem of food organisms.

PLANKTON OF MOOSEHEAD LAKE

almost exclusively upon plankton. A few Togue from Haymock plankter, Leptodora. In general the food cycle is not as direct Lake and from Moosehead Lake contained hundreds of a large matter of fact some fresh-water game fishes may feed at times the Greenland whale is able to subsist upon the larger plankters which feed directly upon plankton. Even so large an animal as The mackerel and herring are species of commercial importance a basic link in the food chain which leads to game and food but are not strong enough to enable them to swim in a directed ments which aid them in holding their position against gravity, bubbles or oil droplets. Others execute weak swimming moveplankton. They may float passively in the water, held up by gas of small size and transparency. These small floating organisms, (plankton organisms) which it strains out in its mouth. belonging to both plant and animal kingdoms, are known as support an abundant population which escapes detection because bloom" occur which may discolor the water or make it appear to appear unpopulated. Only at certain seasons does a "waterbe filled with small dust-like particles. Actually these waters To the casual observer the open waters of a large lake often In certain marine fishes this connection is very close. To the fisheries investigator plankton is important as

and may be represented by the accompanying diagram (Figure 8).

This diagram shows the plankton plants as the basic food producers, deriving materials from the dissolved solids of the water,

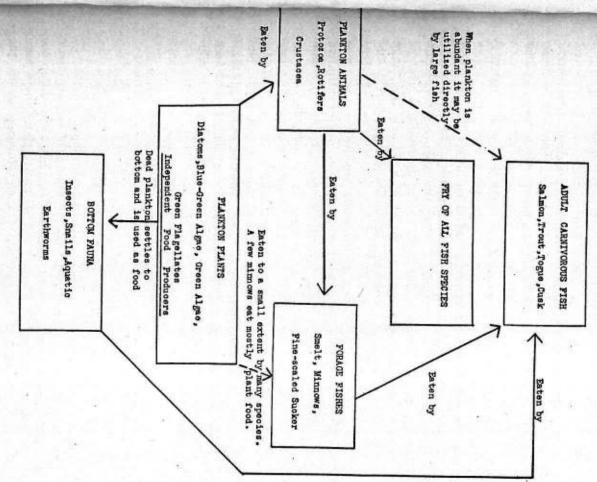


Figure 3. Flankton in the Food Cycle of Moosehend Lake

and energy from sunlight. So important are these plants that the measurement of the chlorophyll (green coloring material) which they contain is probably the best single index of biological productivity. Fish, however, feed directly upon plankton animals to a much greater extent than upon plants. This is because the animals are larger and can be more efficiently strained out by the fishes' gill-rakers. Small fish in shallow water may be observed to capture plankton animals individually. In deep water where there is less light, plankton feeders presumably strain large quantities of water and retain the organisms of suitable size which happen to be caught.

made at three times during the summer, the collections of each summer shows a minimum. Since our plankton collections were parison were as follows: group were averaged and compared. The results of this comsonal changes in plankton abundance. Almost universally, late dant in one section on a given day. Finally there are great seaamount in different parts of the same lake. Currents, wind action and other factors may cause plankton to be especially abunresults is possible. Plankton also differs in composition and used by previous surveys, so that a comparison of quantitative of the hypolimnion. These depth ranges are the same as those 15 feet to the surface. This includes the upper warm layer of water which reached a temperature of 70° F. The middle range ranges were generally taken. The upper range extended from thermocline. A haul from 75 to 35 feet sampled the cool water extended from 35 to 15 feet and includes the upper part of the do the lower layers. In our studies samples from three depth layers contain more organisms, and often different types, than they are not uniformly distributed. Everywhere the upper Although plankton organisms are found throughout the lake,

ections 5	Group Dates Number of 15 ft. to 15 f	0.44
octions 5	nber of ections 5	0 4
ctions	iber of ections 5	
ctions	ber of	
	ber of	

Because of the high variability of the samples taken in Group II, no significance can be attached to the difference between these samples and those of Groups I and III. Since the difference between the means of Group I and III is five times the square root of the sum of the squares of their standard errors, the difference is probably significant. The average volume of plankton increased in the lake between early July and mid-August.

Types of Plankton Found. In the tabulation of plankton counts (Table V) all organisms are classed under ten headings. One of these headings, Copepoda, is subdivided into two groups as explained below. In many instances the choice of classification group for a species is arbitrary since authorities do not agree. In general the grouping follows Ward and Whipple (1918) with some changes according to Smith (1933).

Crustacea. Two groups of Crustacea were prominent in the plankton. A popular name for this group is "water-fleas." The Copepoda were most numerous in individuals. Common species were Cyclops leukartii and a species of Diaptomus. Copepod eggs develop into free-swimming individuals called nauplii which bear little resemblance to the adult species. Both young and adults were most abundant in the upper fifteen feet, but proportionally more nauplii were found at greater depths. Cladocera were much less abundant particularly below fifteen feet, but presented more variety. Common species were Daphnia retrocurva, Daphnia pulex, Bosmina longirostris, and Holopedium gibberum. Also observed were Leptodora kindtii, and Diaphanosoma brachyura. Females of this group carry their young in a brood pouch until they have attained substantially adult form.

Protozoa. These are one-celled animals which are sometimes aggregated in colonies. An abundant colonial form was *Dinobryon*, found in almost every sample. Other genera represented were *Mallomonas*, *Actinosphaerium*, and *Synura*.

Rotifers. These are a group of small worm-like animals of microscopic size. Feeding is accomplished by drawing in a current of water by the action of cilia around the mouth. Although not as abundant as in many lakes, a large variety of rotifers was identified, and they were present in all samples. Genera listed include: Notholca, Polyarthra (most common), Anuraea, Conochilus, Gastropus, Rattulus, and Asplanchna.

The algae collected were classified into four major groups following Smith (1933). One of these, the Chlorophyceae was further subdivided for purposes of tabulation. The organisms found are listed below.

Myxophyceae. These algae are characterized by a blue-green color. They are primitively organized cells, often covered with a gelatinous sheath and grouped into filaments or irregular masses. Among the genera identified were Coelosphaerium (very common), Anabena, Nostoc, Clathrocystis, and Aphanocapsa.

decreasing abundance. of food for the micro-crustacea listed above. ton form in practically every sample, and are an important source Rhizosolenia, Diatoma, Fragillaria, and Navicula, in order of Asterionella were extremely common. Other genera included box-like shell of silica. Diatoms were the most abundant planktoms. It includes minute plants which are encased in a delicate This assemblage is commonly known as the dia-Tabellaria and

Penium, and Spondylosium. found less often were: Arthrodesmus, Xanthidium, Cosmarium, The most common genus was Staurastrum. Others which were teresting forms with the cell partially divided into two semi-cells. green algae were counted separately. The Desmidaceae are in-Pediastrum, Botryococcus, and Actinastrum. Two groups of tified: Dictyosphaerium, Ulothria, Chlorobotrys, Micratinium, more delicate in construction. The following genera were idenin pools and roadside ditches. The planktonic forms are much Chlorophyceae. These are the green algae which are often seen

species were identified. Volvox, was unusually prevalent in Moosehead Lake. Another family of green algae is the Volvocales. One genus, No other

as algae, but they are often regarded as protozoa. One large Dinophyceae. species of Ceratium was consistently found in the upper fifteen Smith treats this group of flagellated organisms

filtering efficiency of 0.83 for the net. Results of individua Rangeley Lakes in 1939, and with those of 61 lakes and ponds averaging all results on Moosehead Lake with those of the samples are given in Table V. Table VI is a composite table using a compound microscope. Counts were converted to numscope. All other species were counted in 20 fields of 1 cu. mm. bers of organisms per cubic foot of water filtered assuming a counts were made for two 1 cc. samples using a binocular microcell. For the larger plankters such as crustacea and rotifers, diluted to 100 ml. and observed in a Sedgwick-Rafter counting this method see Ward and Whipple (1918). All samples were measured after twenty-four hours settling. For a criticism of placed in graduated sedimentation tubes and the plankton volume a Birge closing net of #20 silk bolting cloth. The samples were samples were collected from definite depth ranges by means of Quantitative Plankton Study. As described above plankton

98				31			Av	erage nu	mber of per cu	lankton or ft, of lak	ganisms e water			
Description of station	Depth range of net haul in feet	Volume of sample	Average volume per cu. ft. of lake water in c. c.	Copepoda (juv. to adulta)	Copepoda (nauplii)	Cladocera	Protozoa	Rotifera	Мухорһуевае	Volvocales	Desmidiaceae	Other Chlorophyceae	Bacillariese	Dinophyeese
W2. July 6, 1944. 2:00 P.M. Midway between Hogback Is- land and Spencer Bay Narrows	15- 0 85-15 75-85 100-75	0.60 0.40 0.30 0.20	0.27 0.14 0.05 0.05	320 210 34	115 260 76 55	161 `17	4,600 850	400 500 51 69	6,900 1,700	4,600	6,900 5,100	9,200 3,400 2,600	20,600 29,000 22,000	69 110 43
W3. July 6, 1944. 3:00 P.M. One mile southeast of mouth of Lily Bay.	15- 0 35-15	0.85 0.25	0.16 0.09	430 69	69 17	69 140	***	390 140	2,800	6,900 3,400	2,300 5,200	1,400	9,200 32,600	206
W5. July 7, 1944. 4:30 P.M. One-balf mile east of face of Kineo Mountain.	15- 0	0.60	0.27	320	69	180	2,390	985	2,300	4,600	4,600		11,500	920
W6. July 11, 1944. 4:00 P.M. ½ mile east of face of Kineo Mountain	15- 0 35-15 75-35	0,55 0,22 0,12	0.25 0.08 0.02	820 52 17	250 206 43	23 17 60	5,200 860	320 214 34	4,600 1,700	6,900 1,700	8,400	4,600	16,000 13,800 2,600	460 17 17
W7. July 13, 1944. 3:00 P.M. In North Bay midway between Moose Brook Cove and Big Duck Cove.	15- 0 85-15 75-35	0.65 0.80 0.22	0.30 0.10 0.04	183 172 26	229 69 60	160 34	9,200 5,200 2,600	580 390 26	367 138 8	1,000 620 17	2,300 2,300	4,600 2,600	18,300 9,200	138 34 8
W9. Aug. 7, 1944. 1:00 P.M. My mile west of Birch Island	15- 0	1.30	0.60	252	206	28	6,900	46		32,000	4,600	6,900	64,000	780
W11. Aug. 8, 1944. 11:30 A.M. 's mile east of face of Kineo Mountain.	15- 0 85-15 75-35 200-75	0.42 0.60 0.25 0.30	0.19 0.21 0.04 0.02	229 189 69	298 258 172 8	182 0 17 8	14,000 1,700 550	710 52 9 3	9,100 8,800 1,700 550	4,600 945 350 239	4,600 5,200 1,700	6,800 860 820	52,600 20,600 4,300 275	780 34

of the central coastal area surveyed in 1941.

Part of the							Av	erage nu	mber of p	lankton or f lake wat	ganisma er	20		
Description of station	Depth range of net haul in feet	Volume of sample	Average volume per cu. ft. of lake water in c. c.	Copepoda (juv. to adults)	Copepoda (nauplii)	Cladocera	Protozoa	Rotifera	Myxophycene	Volvocales	Desmidiaceae	Other Chlorophyceae	Bacmariese	Dinophyceae
W12. Aug. 8, 1944. 2:00 P.M. In North Bay midway between Moose Brook Cove and Big Duck Cove.	15- 0 15-85 75-85	0.90 0.45 0.37	0.41 0.15 0.06	390 258 8	183 189 26	115 17 129	18,700 10,600 800	69 34 8	6,900 '46	6,900 720	2,300 1,700	5,200 800	9,200 5,200 800	850
W18. Aug. 10, 1944. 12:00 M. In Spencer Bay 1 mile northeast of Stevens Point	12- 0 22-12	0.85 0.07	0.49 0.004	601 103	343 34	343 0	17,100 8,400	200 241	42,900 3,400	22,900 84,400	2,800	22,900 3,400	42,900 44,700	3,400 138
W14. Aug. 10, 1944. 8:00 P.M. In Lily Bay, 1½ miles south of Doughnut Cove.	15-0 85-15 75-85	2.00 0.45 0.10	0.92 0.15 0.02	481 344 52	252 482 69	137 52 8	25,200 3,400	92 17 8	20,600 5,160 4,300	45,700 1,070 361	27,500 860	29,800 5,160 860	119,000 17,200 12,900	1,050 17 26
W15. Aug. 11, 1944. 3:00 P.M. 1/2 mile east of northern end of Moose Island	15- 0 85-15	1.15 0.82	0.53 0.11	298 52	206 17	69 69	25,200 3,400	69 17	6,900 5,200	36,600 3,400	2,800	2,800 3,400	73,300 53,500	2,060 896
Sp 1. Aug. 16, 1944. 2 stations. 2 hauls in each depth range at each station. 1 station in NB 1 station in TF	15- 0 35-15 75-85	2.00 0.30 0.10	0.46 0.05 0.01	526 86 34	526 224 120	435 17	20,700 3,400 1,700	92 52 26	8,400	860	5,750 1,720 430	10,400 4,300 860	98,000 18,900 3,400	1,150 108 9
Sp 2. Aug. 21, 1944. 7 stations. 2 hauls in each depth range at each station. 1 station in R8 1 station in LB 5 stations in SM	15- 0 35-15 75-85	7,50 5,00 2,80	0.49 0.24 0.06	538 162 112	238 59 258	100 37 18	4,270 8,900 2,200	69 44 22	4,600 2,200 1,500	2,300 740 610	6,500 1,700 1,700	12,400 5,200 2,600	88,500 62,300 21,500	3,600 490 120
Sp 3. Aug. 22, 1944. 3 stations. 2 hauls in each depth range at each station. 2 stations in FR 1 station in RS	15- 0 85-15 75-35	2.30 1.10 0.37	0.86 0.13 0.02	766 57 87	69 68 146	0 23 3	9,200 5,200 1,700	58 143	8,400 7,400 1,200	2,300	6,100 6,300 1,700	25,200 10,900 8,100	168,000 88,300 18,900	760 570

^{*}Present, but too scarce for an accurate count.

TABLE VI. A comparison of the numbers of various types of plankters found in Moosehead Lake (1944), the Rangeley Lakes (1939), and 61 lakes and ponds of the central constal area (1941).

				A	verage num	ber of plank	ton organism	ns per cubic	foot of lake	water		
Location and date	Depth range in feet	Average volume of plankton per cu. ft. of lake water in c.c.	Copepoda	Cladocera	Rotifera	Protozoa	Zoophyta (Yolvocales and Dinophyceae)	Desmidiacese	Other Chlorophyceae	Bacillariese	Myxophycese	All plankters to nearest thousand—add 000
Moosehead (1944) Rangeleys (1939) Central Coastal (1941).	15- 0 15- 0 15- 0	0.41 0.66 0.81	622 168 699	147 145 264	288 8,000 14,000	10,900 37,000 49,000	13,800 5,000 2,000	5,600 13,000 3,000	9,650 7,000 83,000	56,500 53,000 85,000	7,900 10,000 154,000	10: 13: 84:
Moosehead (1944) Rangeleys (1989) Central Coastal (1941).	85-15 85-15 85-15	0.13 0.19 0.15	302 42 243	32 31 74	2,000 3,000	3,500 15,000 14,000	4,100 1,000	2,700 3,000 1,000	3,400 10,000 9,000	32,900 26,000 50,000	3,000 4,000 3,000	50 61 80
Moosehead (1944) Rangeleys (1989) Central Coastal (1941).	75-15 75-15 75-15	0.03 0.09 0.08	150 26 347	30 18 22	36 1,000 2,000	1,180 7,000 3,000	450 2,000 2,000	710 1,000	1,600 8,000	9,600 11,000 11,000	970 1,000	15 26 18

abundant than in other lakes. The extremely high average for this species about August 10. the upper fifteen feet was caused by a remarkable increase of consistently far below both of the other two series, while Volvox important to the welfare of forage fish and young game fish in that this difference would exist at all seasons, but it may be the central coastal lakes. It would require further study to prove important group, Copepods, it is much higher, and approaches which are also important trout and salmon waters, is of especia Moosehead Lake. The rotifer population of Moosehead Lake is interest. Moosehead plankton is consistently lower, but in one these low plankton waters. A comparison with the Rangeleys. ponds in the coastal area were, however, much lower than Moose-Lake is poorest in plankton volume at all depths. Individua (listed under Zoophyta in the comparison table) was more Several facts are evident in this comparison. First, Moosehead Other more productive lakes more than compensated for

of food for fish in large deep lakes like Moosehead. titative grounds that plankton must be the most important source fraction cannot yet be determined. is only a fraction of the total seasonal productivity. Just what ment of plankton organisms is so great that the standing crop smaller plankters which pass through the net were included and midsummer is about 29,200 tons. This averages approxiin the lake. Furthermore, the rate of reproduction and develop-This quantity is over 150 times the standing crop of bottom fauna mately 778 pounds per acre. This value would be higher if the total standing crop of plankton in Moosehead Lake during late from 75 to 35 feet, 1,800 tons; and below 75 feet, 700 tons. sidered as unity. The results for the total lake area as short standing plankton crop in Moosehead Lake during late summer. feet to the surface, 20,100 tons; from 35 to 15 feet, 6,600 tons tons of plankton in the designated depth ranges are: gravity of the plankters is slightly over 1.0, but has been conthe amount of water in each depth range. The average specific We multiply the average volume of plankton per cubic foot by By making certain assumptions it is possible to calculate the It appears obvious on quan-From 15

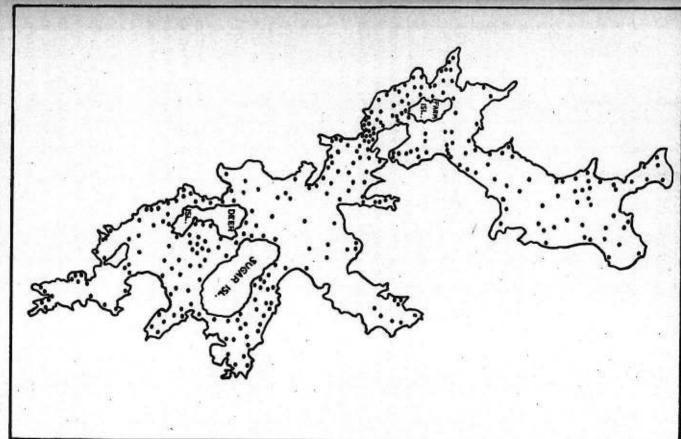


Figure 4. An outline map of Moosehead Lake showing the distribution of the 228 bottom samples plus the 80 unsuccessful attempts at bottom sampling which encountered rocky bottom. Each dot is one sample station.

BOTTOM SOIL AND BOTTOM FAUNA OF MOOSEHEAD LAKE

on the grounds that they were of no interest from the standpoint from the screen were preserved in 70 per cent alcohol, except depth of water, and type of bottom soil were recorded. All masamples were from localities distributed fairly uniformly over that a few large bivalve molluscs were excluded from the samples Tables IV and VIII). For each sample, the location on the lake, samples according to depth was approximately in proportion to the depth distribution of lake bottom area (compare data in the area of the lake (see Figure 4), and the distribution of the during the daylight hours of 8:00 A. M. to 5:30 P. M. The area, during the period of July 18 to August 29, and entirely a hard or rocky bottom was encountered. The samples were col-(i. e., 20 openings to the linear inch). The organisms recovered terial collected by the dredges was screened with #20 sieves plus an additional 80 unsuccessful sampling attempts in which Moosehead Lake is based on the collection of 228 bottom samples lected with Ekman dredges, having a 9-inch by 9-inch bottom The present account of the bottom soil and bottom fauna of

The organisms in the samples were identified mostly to classes, orders, or families. The number of each type of organism was counted, and the volume of each type was measured by displacement in alcohol. The volumes of very small organisms were most frequently estimated, and these estimates were based on a knowledge of the average size of each type of organism obtained by volume measurements on several specimens collectively.

Summary tabulations of the data on bottom soil and bottom fauna have been based on water-depth intervals of 30 feet, in Tables VII, VIII, and IX; and the uppermost, 30-foot zone has been further subdivided to show the nature of the bottom fauna in the very shallow water (0 to 10 feet).

The collection of samples, especially from water depths of from 0 to 30 feet, and to a lesser extent at depths of from 30 to 60 feet, was to a considerable extent selective, on the basis of types of bottom soil, because the Ekman dredges are designed to operate only on a soft bottom. The frequent attempts at sampling which encountered a gravel, rubble, or boulder bottom, at depths of 0 to 60 feet, were mostly unsuccessful (the sampler would not operate); except that most of the 19 samples, in the

TABLE VII. Frequency of each type of bottom soil material in the 228 successful attempts at bottom sampling, and in the 80 unsuccessful attempts, according to depth of water.

All depths	181-210	151-180	121-150	91-120	61-90	81-60	11-30	0-10	Depth of water, in feet
80	:	:	:	2	20	14	50	14	Rock or boulder bot- tom, sampling attempt unsuccessful
16	:	:	:		:	60	4	10	Gravel
14	:	:				00	20	9	Gravel, sand
28	:	1	:	:	4	80	7	9	Sand
•	:			:		4			Mineral concretions
00	:	*	1	1	66	10	1	:	Clay
66	1	:		:		***	1	6	Sand, wood debris
23	:	1		1	1	۵	15	,	Mud with sand or clay
14	:	:	:	:	÷	4	9		Mud, wood debris
6	:		:	:	0	8	1		Mud, mineral concretions
112	00	Ot	13	15	82	27	12	1	Mud

31

TABLE VIII. The volumes in cubic centimeters and numbers (in parentheses) of the different types of organisms in the 228 bottom samples from Moosehead Lake, tabulated according to depth of water.

Depth of water in feet	Number of samples	Leeches (Hirudinea)	Aquatic earth- worms (Oligochaeta)	Fresh-water shrimp (Amphipods)	Alderffy larvae (Sialis)	Mayfly nymphs (Ephemerida)	Dragonfly nymphs (Anisoptera)	Caddisty larvae (Trichoptera)	Midge larvae (Chironomidae)	Meequito larvae (Corethra)	Snails (Amnicolidae)	Other snails (Gastropoda)	Pill clams (Sphaeridae)	Miscellaneous organisms*	All organisms
0-10	36	0.21 (3)	0.093 (12)	0.088 (18)		0.91 (66)	0.72 (5)	0.025	0.133 (31)	0.002	0.055	0.15 (5)	0.065	0.041	2.487 (164
11-30	51	****	0.07 (10)	****	0.098 (7)	1.192 (38)		0.01 (1)	0.176 (32)	0.002 (1)	0.6	0.43	0.02	0.005 (1)	2.608
31-60	51	0.09 (2)	0.108 (10)	****	0.055 (4)	0.03 (2)		0.08	0.547 (44)	0.049	****	0.08	0.098	0.012	1.039
61-90	43	13010	0.01 (1)	****	****	****		0.08 (1)	0.26 (32)	0.105	****	****	0.04	0.032	0.477
91-120	17		0.094 (6)	••••		0.01		0.08 (1)	0.248 (34)	0.02			0.055	0.005	0.457
121-150	14		0.01 (1)	****		****			0.156 (18)	0.01		,	0.03		0.206
151-180	7	Exer.	0.01						0.06				0.01	0,002	0.082
181-210	9	****	0.084 (6)		****				0.054 (6)				0.005 (1)		0.143 (13)
All depths	228	0.30 (5)	0.474 (47)	0.088	0.153 (11)	2.142	0.72 (5)	0.125 (8)	1.629 (205)	0.188 (84)	0,655 (8),	0.61 (17)	0.318 (40)	0.097 (24)	7.494 (529)

^{*}Miscellaneous organisms included: 9 Stonefly nymphs with a volume of 0.04 c.c.; 10 Dixa pupas, 0.088 c.c.; 3 Cladocera, 0.012 c.c.; 1 Lepidoptera larva, 0.002 c.c. and 1 Roundworm, 0.005 c.c.

TABLE IX. Average volumes in cubic centimeters and numbers (in parentheses) of all bottom organisms per 9" x 9" sample, tabulated according to depth of water and type of bottom soil, based on 228 samples from Moosehead Lake. Averages based on five or more samples are given in heavy type.

The numbers of samples, on which the averages are based, are given in Table VII.

4		93	lo ma		T	ype of botto	m soil				
Depth of water in feet	Gravel	Gravel, sand	Sand	Mineral concretions	Clay	Sand, wood debris	Mud with sand or clay	Mud, wood debris	Mud, mineral concretions	Mud	All bottom types
0-10	9.071 (3.2)	0.039 (2.4)	0.045 (4.1)	*****	*****	0.068 (4.3)	0.060 (5.0)	0,560 (42.0)			0.069
11-80	0.005 (0.5)	0.0	0.063 (2.6)		0.005 (1)	0.002	0.050 (2.8)	0.058 (2,1)		0.071 (2.1)	0.051 (2.1)
81-60	0.008 (1)	0.003 (0.3)	0.015 (0.5)	0.011 (1.8)	0.005 (0.5)		0.024 (2.5)	0.018 (1.8)	0.020 (2.7)	0.026 (2.0)	0.020 (1.8)
61-90		****	0.003	****	0.0	*****	0.080		0.0	0.014	0.011 (1.6)
91-120				****	0.0		0,030 (1)	****		0.028 (3.3)	0.027 (2.9)
121-150	••••	****			0.0				101	0.016 (1.7)	0.015
151-180	*****		0.0	****	****	****	0.030 (5)		****	0.010 (1.4)	0.012
181-210		,		****	****	- 0.0 (0)	3223	*****		0.018 (1.6)	0.016 (1.4)
All samples all depths	0.047 (2.3)	0.026 (1.6)	0.038 (2.5)	0.011 (1.8)	0.002 (0.3)	0.051 (3.4)	0.044 (3.0)	0.083 (4.9)	0.010 (1.3)	0.025 (2.1)	0.033 (2.3)

sentative data for organisms in the very shallow water at depths of 0 to 3 feet within the 0-10-foot zone. (not rocky) bottom at depths of 11 to 60 feet, and fairly reprefor depths of over 60 feet, selective data for organisms of soft then, provides representative data on the summer bottom fauna of 60 feet, practically all sampling attempts encountered a soft sentative on the basis of depth, there is a definite lack of data bottom and were successful. The entire group of 228 samples, in the sampling for organisms on rocky bottom. Below a depth responding depths; so that, while the data remain quite repreclosing the jaws of the sampler by hand. The frequent unsuccompensated for by additional samples on soft bottom at corcessful sampling on hard bottom at depths of 11 to 60 feet was they were taken in water from 1 to 3 feet deep with the operator bottom (Table VII), were successful sampling attempts because depth category of 0-10 feet, taken on gravel, and gravel and sand

in the deeper of these two zones, 46 samples contained mud and rocky in character and below which it is mostly muddy mately a transition line above which the lake bottom is mostly and organic material. The 30-foot depth contour is approxigreater than 60 feet contained mostly mud, i. e., fine-grained silt encountered rock or gravel bottom. The samples from depths other soft materials while only 19 samples and sampling attempts other soft materials. From the 11-30 zone to the 30-60 zone within this depth range included 56 on a bottom of rock and there is a considerable change in the character of the bottom; gravel as compared to 45 samples on a bottom of mud, sand, and 11-to-30-foot zone; for the 101 samples and sampling attempts countering various bottom soil types are given in Table VII.) soil throughout its depth range. (The number of samples en-The rocky character of the shore extends into much of the be indicative of the relative amounts of different types of bottom lake basin below a depth of 10 feet, the sampling is believed to bottom for the operation of the sampler by hand; but for the choosing a soft bottom for the sampling, or of choosing a gravel sampling in shallow water was quite selective, as the result of The limited areas of sand, mud, and other fine materials in shalprotected stream mouths. The distribution of the bottom low water are confined mostly to small and protected bays and very limited in extent, and sand beaches are almost non-existent. several feet in diameter. Shallow-water areas of small gravel are of rocks and boulders ranging in size from several inches to Bottom Soil. The shoreline of Moosehead Lake is almost entirely

> water. The aquatic earthworms, midges, and pill clams were of bottom organisms reveals definite depth preferences by some organisms; not by others. The fresh-water shrimp, Mayflies, uniformly from a wide range in depth. The Corethra larvae dragonflies, stoneflies, and snails were mostly from very shallow were mostly from water of a moderate depth (30 to 90 feet). water. An analysis of the depth distribution of the various types total number, and greater volume in shallow water than in deep dragonfly nymphs, amnicolid snails, aquatic earthworms, and quency of occurrence. The organisms which represented the greatest volume were, in order, Mayfly nymphs, midge larvae, pill clams. The bottom fauna was of greater variety, greater a whole; aquatic earthworms and pill clams were next in frenymphs were the most numerous organisms in the samples as are summarized in Table VIII. The midge larvae and Mayfly types of organisms in the samples, according to water depth, and other snails. The volumes and numbers of these different mosquitoes; and the molluscs, by sphaerid clams and amnicolid stages of alderflies, Mayflies, dragonflies, caddisflies, midges, and fresh-water shrimp; the insects, by the aquatic larval or nymph aquatic earthworms; the crustacea were represented by the taceans, insects, and molluscs. The worms included leeches and samples represent four major types of animals: worms, crus-Bottom Fauna. The organisms collected by the 228 bottom

In terms of quantity of organisms, the bottom fauna of the lake is a very scanty one, and quite uniformly so throughout all depths of the lake (Table IX), on all types of bottom (Table IX), and in almost all geographical regions of the lake (Table X); the few averages, in the tables, which would tend to refute this conclusion are based on a small number of samples and are therefore of least significance to the point in question. The average of 4.6 organisms, of 0.069 c.c., for the samples from 0 to 10 feet (Table IX), even though twice the average for all depths, still signifies a scanty fauna.

The bottom fauna of Moosehead Lake is considered to be scanty, on the basis of a calculated average of 4.1 organisms, of 0.059 cubic centimeters in volume, per square foot for the entire lake bottom. Corresponding averages for the bottom faunas of other Maine lakes are available from previous reports in this series (Cooper, 1939, pp. 50 and 137; 1940, pp. 63 and 182; 1941, p. 93; and 1942, p. 75), and provide the following compari-

TABLE X. The volumes and numbers of bottom organisms in the samples from Moosehead Lake, and the calculated volumes and numbers foot of lake bottom, according to geographical divisions of the lake.

Geographical	Number of 9" x 9"	All organisms in a	ill samples	Organisms per samp	le (average)	Organisms per sq. foo	t (calculated
divisions of the lake*	bottom samples	Volume in cubic centimeters	Number	Volume in cubic centimeters	Number	Volume in cubic centimeters	Number
North Bay, from Seboemook to Toe of Boot (NB)	48	1.137	146	0.026	3.4	0.046	6.0
Toe of Boot to Farm Island (TF)	24	0.657	37	0.027	1.5	0.048	2.7
Farm Island to Rockwood (FR)	87	1.138	103	0.081	2.8	0.058	5.0
Rockwood to Sandbar (RS)	17	0.351	18	0.021	0.8	0.087	1.4
Sandbar to Sugar Island (SS)	19	0.514	- 31	0.027	1.6	0.048	2.8
Spencer Bay (SB)	5	1.230	55	0.246	11.0	0.437	19.6
Lily Bay (LB)	21	0.562	42	0.027	2.0	0.048	3.6
Sugar Island to Moose Island (SM)	42	0.623	53	0.015	1.8	0.027	2.3
Moose Island to Greenville (MG)	20	1.282	49	0.064	2.5	0.114	4.4
Entire Lake	228	7.494	529	0.088	2.3	0.059	4.1

se geographical divisions of the lake are shown on page 8, Figure 1, where they are identified by the letter symbols given in this table.

son of the calculated average numbers and volumes ganisms per square foot of lake bottom: of all or-

Forty-four lakes of Androscoggin and Kennebec River drainages	Quimby and Horseshoe Ponds	scot River drainages	Six Rangeley Lakes (average)	Moosehead Lake
81.1	165.4	6.1		4.1 0
		u		organisms
•	•	-	•	ţ,
0.34	0.624	0.099	0.070	0.059 c.
	2	2	2	0.0

Seventeen lakes of Central Coastal

0.28

factor in the economy of the lake, for the bottom fauna conscarcity of bottom organisms in Moosehead Lake is an important a rule, the very poorest in quantity of bottom organisms. The meagre data on the latter lake); but these largest and deepest gree of oxygen depletion of their waters during the summer. above for a comparison with Moosehead, are much smaller and The great majority of the 73 lakes and ponds, considered in the tion on Food Habits of Fishes, page 56). tributes relatively little to the food of fishes in the lake (see sec-Rangeley Lakes and with Sebago Lake (judging from quite in organic material than Moosehead, judging from a greater deshallower than Moosehead. lakes in Maine, which have been studied thus far, have been, as Moosehead compares more favorably with the larger of the Also, they are mostly much richer 59.0

FISHES OF MOOSEHEAD LAKE AND TRIBUTARIES

net was left in one position for two days, in which event the net nets were suspended from additional floats so that the nets were of the nets they sat on the lake bottom; for certain net sets the net was brown. The 150 x 12-foot net was white. The gill nets used. In two of these nets the thread was white in color, and one mesh (stretched measure). of 4, 2, 6, 3, and 5 inches (stretched measure), with the five units 375 x 6-foot net made up of five 75-foot sections with mesh sizes taries were made by seines. The gill nets were of two types: a nets and seines, and collections from most of the larger tribufish removed, on the following morning. during the morning, and was lifted from that position, and the operation of the nets, each net was usually set in one position fished at a desired depth level above the bottom. were rigged with floats and weights so that in the usual operation tied together in that sequence; and a 150 x 12-foot net of 5-inch Collections of fishes from Moosehead Lake were made by gill Three of the 375 x 6-foot nets were In a few instances the

show that the depth distribution of the net sets was approximately in quantitative proportion to the depth distribution of the and a comparison of this figure with the data in Table IV will types of gill nets used in Moosehead Lake are shown in Figure 5, water to the bottom of the nets for the various sets of the two of 36 over-one-night net sets, for a total of 7671/2 hours, during bottom area of the lake. the period from June 20 to August 25. The ranges in depth of ferent depth zones. The 150 x 12-foot net was fished for a total proportion to relative amounts of lake bottom area within diffrom June 20 to September 9. An attempt was made to apportion the number of net sets, according to depth of the net set, in sets, for a total of 2,152 net-fishing-hours, during the period were fished in Moosehead Lake for a total of 98 over-one-night night period, as well as the second. The three 375-foot nets was examined and the fish removed, at the end of the first over-

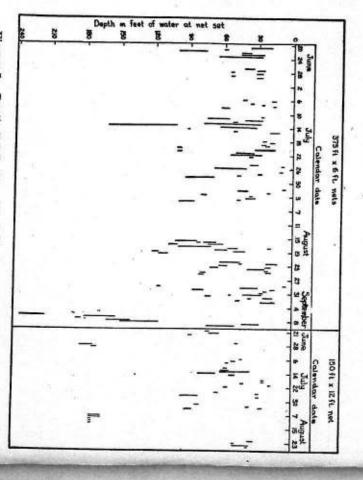


Figure 5. Depth distribution of individual, over-night gill net sets in Moose-head Lake.

Seining collections in both the lake and its tributaries were made with Common Sense minnow seines of 6, 12, and 20 foot lengths. As a general policy, all fish collected by seines were preserved, or recorded as a part of the collections. The rocky character and steep slope of most of the shoal areas of the lake made seining quite difficult, and this fact, together with the fact of an inexperienced seining crew, was probably responsible for the comparatively small numbers of fish in the seine collections. Seining collections were made at 39 stations on the lake and at 12 stations on streams tributary to the lake. All seining was done during the daytime. Seining in the lake was done entirely along shore in shallow water mostly less than five feet deep. The 89 lake seining collections represented a total of 29¼ hours of actual seining; the 12 stream collections, 7½ hours of seining.

The locations of all gill net and seining collections on Moosehead Lake and its tributaries are shown in Figure 6.

Distributional List of Fishes and Notes on the Species

The fishes collected from Moosehead Lake and its tributaries included 21 species. By taxonomic groups they were: 1 species of smelt, 2 whitefishes, 3 salmonids, 2 suckers, 9 minnows, 1 bull-head, 1 sculpin, 1 stickleback, and 1 cusk. A fourth salmonid, the Chinook Salmon, has been planted in Second Roach Pond, a tributary of Moosehead Lake. At least two other species, the eel and a sunfish, may be present. Notes on the occurrence and abundance of the species are given in the following list.

size:—mostly less than four inches long (see Table XVI). found in the collections and game fish stomachs were of a small surveys (see previous Fish Survey Reports). All of the smelt results of seining collections of this and previous Maine lake species of the smaller fishes. From the scarcity of the Smelt except probably on the shoals along the shore, than any other of fish in the contents of stomachs of Brook Trout, Land-locked throughout Maine lakes in general, may be surmised from the the principal habitat of the Smelt is the open and deep water, head Lake lives mostly in open water and in deep water. That in the seining collections, it is concluded that the Smelt in Mooseis believed to be very abundant in the lake and more abundant, its appearance in the stomachs of these larger fishes, the Smelt Salmon, Togue, and Cusk collected from the lake. Judging from the other hand, the Smelt was, by far, the most abundant type the seining collections. None was taken by the gill nets. Smelt. Osmerus mordax. Two small individuals were taken in

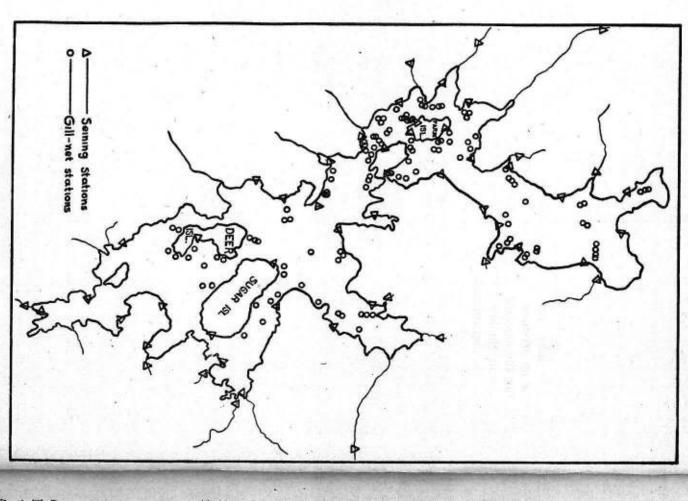


Figure 6. The location of fish collections by gill net and seine on Moosehead Lake made by the 1944 survey.

fact, together with the failure of the gill nets to catch even a single smelt, is strong evidence that there are no large-sized smelt in Moosehead Lake, or else they are very rare. Frequently in the past, these same gill nets have caught numerous large-sized smelt in Maine lakes, even in waters where the Smelt was not especially abundant.

Menominee Whitefish. Prosopium cylindraceum quadrilaterale. This is the more abundant of the two species of whitefishes found in Moosehead Lake. The gill nets collected 64 individuals of this species as compared to 9 Common Whitefish. It is readily distinguished from the Common Whitefish because it is less deep-bodied and more chub-like in outline than the Common Whitefish. The Menominee Whitefish caught by our nets were mostly about 8 to 14 inches long, and generally much smaller than the Common Whitefish which were taken. This size difference between the two species is reported among individuals of the two species taken by anglers. In our fish collections, the specimens of Common Whitefish were mostly much older than individuals of the Menominee Whitefish.

Common Whitefish. Coregonus clupeaformis neo-hantoniensis. Nine individuals of the Common Whitefish were collected by the 98 over-night sets of the 375-foot gill nets; in addition, one specimen was obtained by an unrecorded collection. Nine of these ten specimens were preserved, and have been used in an attempt to determine their subspecific status. Counts and measurements of gill-rakers, lateral line scales, body depth, head length, etc. were made according to the methods used by Koelz (1929; pp. 305-307). The counts and measurements on these nine fish (8 females, 1 male) are summarized as follows:

length of pectoral fin (PV/P) ", 1.6-2.0; ", 1.6	body (L/D)	head (L/H)	Lateral line scales	Gill-rakers on first left arch	Standard length in millimeters (L)
R		2			Range
1.6- 2.0;	, 3.9-4.4;	, 4.1-4.8;	, 79- 98;	24- 28;	, 319-398;
	2	a	a	"	Average
, 1.8	4.1	, 4.5	, 85.3	26.2	352

On the basis of the number of gill-rakers and number of lateral line scales, the Moosehead Lake specimens resemble more closely the subspecies *C. c. neo-hantoniensis* than they resemble *C. c. stanleyi*, as these two forms are characterized by Koelz (1931; p. 371); the measurements of head length, fin length, and body

depth were of little aid in identification. The possibility of the Moosehead fish being C. c. gulliveri is precluded by their low gill-raker count. Kendall (1914) recognized two forms of the Common Whitefish in Maine, namely: Coregonus stanleyi, confined to the Fish River chain of lakes, and C. labradoricus, as of more general distribution in lakes throughout the State. Koelz (1931; p. 380) recorded a third form, C. c. gulliveri from the Allagash River. It is pointed out by Koelz (ibid.; p. 374) that Richardson's labradoricus may be the same form as neo-hantoniensis. It might therefore be inferred that Kendall's records for labradoricus apply mostly, if not entirely, to the form which Koelz considered to be neo-hantoniensis, which form is of general distribution in Maine and is the Common Whitefish of Moosehead Lake.

The Common Whitefish taken by the nets ranged in length from 13 to 16 inches. The species is reported to reach a weight of 3 to 4 pounds in the lake.

predominantly an open-water, or pelagic, species. Thus the relamer, all tend to substantiate the conclusion that the salmon is salmon are seen jumping at the surface during most of the sumtively low number of salmon caught in the gill nets, which were cessful method of catching salmon, and the frequency with which when fishing considerably above the bottom, the fact that surreports by fishermen that they catch salmon more frequently on the bottom, than the Brook Trout and Togue. face fly-fishing during spring and early summer is the most sucfished at depth levels above the bottom (see page 47) indicate that this is the case, but not to the extent shown by these figures. salmon is greatly outnumbered by these species. We believe that the salmon is more of an open-water fish, and less a dweller The results of three series of net sets, in which the gill net was Togue, taken in the gill nets would appear to indicate that the has frequently exceeded the numbers of Brook Trout planted. stocking during recent years has been about 200,000 fish, and heavily and quite consistently since 1900; the annual rate of the Moosehead Lake region. The salmon has been stocked ceived a considerable portion of the State's fish-cultural efforts in Commissioners Reports and other records, the salmon has re-A total of 34 salmon, as compared to 120 Brook Trout and 191 the lake about 1896. According to the State Fish and Game Salmon, not native to Moosehead Lake, was first introduced into Land-locked Salmon, Salmo salar sebago. The Land-locked Numerous

fished mostly on the bottom, is probably to a considerable extent misleading. That is, the salmon is probably more abundant, in relation to the abundance of Brook Trout and Togue, than the figures 34, 120, and 191, respectively, would indicate. The question is considered in more detail later on in this report.

Chinook Salmon. Oncorhynchus tshawytscha. During 1937 and 1938, a total of 31,280 Chinook Salmon fingerlings was planted in Second Roach Pond. This pond drains into the Roach River, a tributary of Moosehead Lake. These Chinooks have had access to Moosehead Lake, and there are reports that anglers have caught Chinooks from Moosehead, subsequent to these plantings. It is probable that most, if not all, of the survivors of these plantings had reached sexual maturity and died during the seven seasons previous to 1944. Recent plantings of Chinooks in numerous lakes in Maine have resulted in a rapid growth to large-sized fish which have reached maturity, spawned (probably without producing a second generation), and all died, the entire cycle involving about 5 or 6 years. The Chinook Salmon certainly was not present in large numbers in Moosehead Lake during 1944, for none was taken in the survey collections.

Brook Trout. Salvelinus f. fontinalis. The Brook Trout or "Square-tail," native to Moosehead Lake, is abundant in the lake and in many of the lake's tributaries. In the lake it commonly attains a weight of 3 to 5 pounds. Since the beginning of intensive fish plantings in the lake, about 1900, a greater number of Brook Trout has been planted in the lake and its tributaries than of any other species.

Togue or Lake Trout. Cristivomer n. namaycush. The Togue, more properly called Lake Trout, is native to the lake. It is the most abundant species of game fish in the lake, and, according to year-around reports by fishermen, it is taken more frequently by anglers than is the Land-locked Salmon and possibly more frequently than the Brook Trout. Judging from our records, the Togue commonly attains a weight of 5 to 12 pounds in the lake. There are a few records of individuals weighing 20 to 22 pounds taken by anglers.

Common Sucker. Catostomus c. commersonnii. The Common Sucker, judging from our gill net catches, is the most abundant of the larger fishes in the lake. It was taken commonly in the seining collections from the lake and from many of the tributary streams. The species does not grow to a very large size in the

lake, for very few of the 340 Common Suckers taken by the nets were more than two pounds in weight. Most of the fish were from 7 to 15 inches in length. The small average size of this sucker in Moosehead is probably the result of the fact that bottom food organisms (the natural food of the sucker) are generally rare (see page 33).

Fine-scaled Sucker. Catostomus c. catostomus. The Fine-scaled Sucker is nearly as abundant in the lake as is the Common Sucker, and is the second most abundant of the larger species. The two species of suckers together comprised more than half of all fish caught in the gill nets. Though the Fine-scaled Sucker is poorly known, and seldom recognized by fishermen as a species distinct from the Common Sucker, the two species can be distinguished readily by the smaller scales, more inferior mouth, thicker lips, and triangular shape of the head (in side view) of the Fine-scaled Sucker. The two species of suckers were the chief food items found in the stomachs of Togue over five pounds in weight.

Fallfish. Leucosomus corporalis. This species is Maine's largest minnow, and is one of the most abundant minnows in streams throughout the State. It is not a common species in Moosehead Lake, from which only two small specimens were taken in the gill nets and very few were taken by seining collections. It was one of the most abundant species in the seining collections from the tributaries of the lake.

Creek Chub. Semotilus a. atromaculatus. The Creek Chub was not collected from the lake, but was collected from several of the tributaries.

Northern Dace. Margariscus margarita nachtriebi. A large series of young individuals in one collection from Moosehead Lake are tentatively identified as of this species. This being our only record for the species, it is presumably rare in the Moosehead region.

Lake Chub. Couesius p. plumbeus. The Lake Chub is the most abundant minnow in the lake, but was not encountered in any of the tributaries. It was found to be an important food item in the stomachs of the game species.

Black-nosed Dace. Rhinichthys a. atratulus. Not collected at all from the lake, it was found to be one of the most abundant minnows in the tributary streams.

Fine-scaled Dace. Pfrille neogaea. Not found in the lake, but was found to be common in two of the tributaries.

Red-bellied Dace. Chrosomus eos. One specimen was collected from the lake, and several were taken in three of the tributaries of the lake. Two specimens of the hybrid, Pfrille neogaea X Chrosomus eos, were obtained, one from each of two tributaries from which Chrosomus eos, but not Pfrille neogaea, were collected.

Golden Shiner. Notemigomus c. orysoleucas. One specimen from the lake and several specimens from two tributaries are our records. However, sight records in the field indicated that the species is common in the still-water sections of some of the tributaries of the lake.

Common Shiner, or Red-fin Shiner. Notropis c. cornutus. The species was taken in three seining collections from the lake, and it was found to be the most abundant species of fish in the tributary streams.

Bullhead or Horned Pout. Ameiurus n. nebulosus. One young individual in a seining collection from Mud Pond Brook is our only record for this species. Whether or not the species is native to the Moosehead region is unknown to the authors.

and many Togue and Cusk from depths of 40 to 100 feet contained one or more Cottus each. feet had 2 Cottus; three Togue from 58-71 feet had 16 Cottus; from 116-122 feet contained 3 Cottus; one Cusk from 108-116 feet and one record for a tributary stream (Moose Brook), would sug-Togue from 116-122 feet had 1 Cottus; one Togue from 97-101 contained 2 Cottus; 2 Cusk from 101-162 feet had 4 Cottus; one Cusk from a depth of 184-187 feet contained 2 Cottus; two Cusk as seen in the following examples of fish stomach records: One abundantly from shallow water down to depths of over 100 feet, two game species indicate that the Slimy Muddler occurs quite from the lake. Our records for the occurrence of Cottus in these was found very commonly in the stomachs of Togue and Cusk gest that the species is quite rare in the area. But the species records for the Slimy Muddler in seining collections from the lake Fresh-water Sculpin or Slimy Muddler. Cottus cognatus.

Three-spined Stickleback. Gasterosteus aculeatus cuvieri. This species was found to be the most abundant and most widespread of the smaller species on the shore shallows of the lake. It was of rare occurrence in the streams. In the lake it was found in

8

gest that the stickleback is of rare occurrence at this depth few records for sticklebacks from depths of 50 to 100 feet sugwere caught at depths ranging down to about 50 feet; the very fish and Cusk which contained sticklebacks in their stomachs in the Togue, and very frequently in the Cusk. Most of the game the stomachs of a few Brook Trout and salmon, quite frequently

our net sets averaged fairly small, with few individuals exceeding 3 pounds in weight. parts of the lake and at all depths. The size of the Cusk from in any one set, they caught this species quite consistently in all most abundant and most widespread of the larger fishes in the lake. Though the gill nets seldom caught more than 4 or 5 Cusk Cusk or Burbot. Lota lota maculosa. The Cusk is one of the

ably the Pumpkinseed Sunfish (Lepomis gibbosus), although in the lake just above the East Outlet dam. residents at East Outlet reported that they have caught sunfish any eels suggests that the species is no more than rare. have been seen by the authors. reported to be fairly common. local residents to be present in Moosehead Lake, namely: the Lepomis auritus is a possibility; no specimens from this locality Common Eel (Anguilla bostoniensis) and a sunfish. Two species, in addition to those cited above, are reported by The failure of the nets to catch The species is prob-The eel is Local

of the warm-water game fishes, particularly the pickerel, perches, the fish fauna of the lake is noteworthy in the complete absence With the exception of the possible rare occurrence of sunfish,

collections in which each species was taken (Table XI).

three species, with the Brook Trout second in abundance, and the ting records indicate that the Togue is the most abundant of the the lake, but from the standpoint of relative abundance, our netare the Land-locked Salmon, Brook Trout, and Togue or Lake Land-locked Salmon third; the total numbers of the three species caught, and the numbers of over-night gill net sets and seining fishes caught by the 134 over-one-night gill net sets (the two three abundant and important game species of Moosehead Lake been summarized according to total number of each species types of gill nets combined) and by all seining collections have Abundance and Distribution of Fish Species. The records of We have no basis for estimating the total population of The

Species	Record	s of occurrence in M	foosehead Lake		Records	of occurrence in tri	butaries of Moosehead Lake
opedes		net sets	39 seine	collections	Number of fish	Number of stream	
	Number of fish	Number of net sets	Number of fish	Number of seine collections	in all (12) seine collections	collections in which species was found	Names of streams or brooks in which species was found
Smelt Osmerus mordar	**	1	2	2			
Menominee Whitefish Prosopium eplindraceum quadrilaterale	64	28		-			
Cammon Whitefish Caregonus clupeaformis neo-kantonieneis	9	6	**	7			*****
Land-looked Salmon Salme salar sebage	34	17	12			**	******
Brook Trout Salselinus f. fontinalis	120	37		2	- "		orar .
Cristisomer n. namayoush	191	62	1	1	34	2	West Cove, Scentean
Common Sucker Catostomus c. commerconnii	340	53		- "		A+	Police P. L. D. L. D. L. D.
ine-scaled Sucker Catostomus c. catostomus	247	52	25	8	25	7	Baker, Lucky, Roach, South, Mud Pond, Beaver, Moose
allfish Loucosomus corporalis			2	1	**	· .:	
reck Chub Semotilus a, atromaculatus	2	1	27	2	58		Lucky, Spencer, South, Mud Pend, Beaver, Moose
orthern Dage				5	15	4	Baker, Mud Pond, Beaver, West Cove
Margariscus margarita nachtriebi ako Chub	- 11		56	1			
Coussins p. plumbeus			303	11	1		

TABLE XI. Records of frequency of occurrence of different species of fishes in Moosehead Lake and its tributaries (Concluded).

	Record	s of occurrence in M	foosehead Lake		Records of occurrence in tributaries of Moosehead Lake				
Species *	134 gill	net sets	39 sein	collections +	Number of fish in all (12)	Number of stream collections in	Names of streams or brooks		
Telling the second	Number of fish	Number of net sets	Number of fish	Number of seine collections	seine collections	which species was found	in which species was found		
Black-need Dace Rhinichthys a. atratulus					51	7 .	Baker, Lucky, Spencer, Mud Pond Beaver, West Cove, Duck Pond		
Fine-scaled Dace Pfrille neogaea					33	3	Lucky, Mud Pend, Moose		
Red-bellied Dace Chrosomus sos			1	1	25	3	Mud Pond, Beaver, Duck Pond		
Hybrid Pfrille neogueu X Chrosomus cos					2	2	Beaver, Duck Pond		
Golden Shiner Natamigonue c. crysoleucas			1	1	21	2	Lucky, Beaver		
Common Shiner Notropia c. cornutus			15	3	98	5	Spencer, South, Mud Pond, West Cove, Duck Pond		
Bullhead or Horned Pout Ameiurus n. nebulosus					1	1	Mud Pond		
Fresh-water Sculpin Cottus cognatus			3	2	5	1	Moose		
Three-spined Stickleback Gasterosteus aculeatus cuvieri		٠	418	27	4	2	Baker, Tombegan		
Dask or Burbot Lota lota maculosa	146	_ 61							

4	East of July 24- Farm 26- Island July 31- Lily Bay Aug. 1-2	Location D	
1 1 2 2 2	24-25 26-27 27-28 31-Aug. 1 1-2 2-3 3-4 28-29 29-30 30-31 31-Sept. 1	Date	
12 net sets	8-8 28-28 46-46 7-7 21-21 36-36 46-46 6-6 16-16 26-26 36-36	Depth in feet to bottom of suspended net	
2		Common White- fish	
14		Land- locked Salmon	
cn .	1 2 11	Brook Trout	
9		Togue	

one-night sets, comprising the three series of suspended net sets a water depth of 76 to 85 feet; and the third, from August 28 to net sets were made as follows: The first series, from July 24 to out the ropes of the accessory floats, where it was fished for a with the float-line of the net at or near the surface. were as follows: depth of 146 to 150 feet. The fish caught in each of the 12 over-September 2, about one mile west of Birch Island, over a water 200 feet; the second, from July 31 to August 4, in Lily Bay, over 28, in the area east of Farm Island, over a water depth of 150 to 24-hour period; and so on. The three series of these suspended then lowered uniformly to the next selected depth, by letting of the net was fitted with numerous accessory floats each atwere made with the 375 x 6-foot gill net, in which the float-line depth level considerably above the bottom. Three series of sets In each series of sets the net was fished for one over-night period page 40), and is substantiated by the numbers of salmon caught sixth as abundant as Togue. That this low figure representing is only about one-fourth as abundant as Brook Trout and onesets. The total of 34 for salmon would indicate that this species tached to the net by a rope of adjustable length (see Plate IV). in the gill nets when these nets were fished while suspended at a tative of the actual situation, has been mentioned previously (see the abundance of salmon is probably too low, and not represenin 62, 37, and 17, respectively, of the 134 over-one-night gill net collected were 191, 120, and 34 respectively, and they were caught The net was

2:1:1 for the three species) in the open-water zone, which zone salmon to a total of 2 Brook Trout and Togue (or a ratio of Since the suspended gill nets took salmonids at the ratio of 2 feet does not invalidate the 51/2 to 1 ratio of open water to botexclusion, in this calculation, of water of depths greater than 75 Brook Trout and Togue are more abundant than salmon. The extensive than the volume of water in the bottom zone in which tom water, for this ratio is applicable to the lake as a whole. water zone of the lake down to a depth of 75 feet, is far more of water, in which salmon are frequently found, in the open-This calculation is for the purpose of showing that the volume mately 51/2 times as great as the volume of (2) the bottom zone. By this rough calculation the lake is divisible into two zones: 2,800,000 acre feet of open water including all water down to a (1) An open-water, or pelagic zone with a water volume approxidepth of 75 feet and exclusive of the 10-foot layer defined in (1). 500,000 acre feet of water restricted to a 10-foot layer immediately above the bottom at depths of less than 75 feet, and (2) then this 3,300,000 acre feet can be divided into two parts (1) be most subject to capture by six-foot gill nets set on the bottom, clude the principal habitat of bottom-dwelling fishes which would 10-foot layer of water immediately above the bottom would insalmon (see Figure 7), and, furthermore, if it is assumed that a 75 feet is taken as the lower depth limit of water inhabited by water, of which 3,300,000 is less than 75 feet deep. If a depth of of water and area of lake bottom within different depth consults of these sets do indicate that salmon are at least as abun-The entire lake contains approximately 4,000,000 acre feet of Togue. From figures, given earlier in this report, on the volume tours, the following approximate figures have been computed. dant, if not more so, in the open water as are Brook Trout and the number of suspended net sets was relatively few, the re-Brook Trout, and 9 Togue from suspended nets. Even though and 169 Togue from bottom nets as compared to 14 salmon, 5 above the bottom, the totals are 20 salmon, 110 Brook Trout, the bottom with catches of nets fishing at a level considerably nets are used for a comparison of the catches of nets fishing on Trout, and 13 Togue. If only the data for the 375 x 6-foot gill sets of the 150 x 12-foot net which contained no salmon, 5 Brook tained 20 salmon, 110 Brook Trout, and 169 Togue, and the 36 along with 86 bottom sets of the 875 x 6-foot gill nets which consuspended net sets with 14 salmon, 5 Brook Trout, and 9 Togue, The data given in Table XI are summary figures for the 12

represents four-fifths of the lake; whereas the gill nets fished on the bottom took 20 salmon, 110 Brook Trout, and 169 Togue, or these three species at an approximate ratio of 1:7:7, in a zone which represents one-fifth of the lake:—it can be calculated, by weighting the above ratios in proportion to the relative volumes of the two zones concerned, that, in the lake as a whole, the abundance of salmon is in the ratio of 9 to an average of 11 for Brook Trout or Togue. In spite of numerous inaccuracies in this method of calculation, and in the arbitrary assumptions of conditions involved in the calculation, the data obtained by the net sets do indicate that the ratio of salmon to Brook Trout and Togue was greater in the open water of the lake than in bottom water, and that the proportion of salmon to Brook Trout and Togue in the lake is greater than the figures from the gill net sets (34, 120, and 191, respectively) would indicate.

In addition to the three species of salmonids, the lake has abundant populations of the Common Sucker, the Fine-scaled Sucker, and the Cusk or Burbot (see Table XI). Together, the two species of suckers outnumbered all other species in the gill net collections. The Cusk was taken quite consistently in all parts of the lake and at all depths. Of the two species of white-fishes, the Menominee Whitefish (64 fish) considerably outnumbered the the Common Whitefish (9 fish) in the collections.

contents of salmonids and Cusk indicate that the Fresh-water observations during the summer. Our records from stomach scanty in the lake, judging from our collections and from direct Sculpin, the Three-spined Stickleback, and, to some extent, the rock-bottomed, wave-swept, and almost void of aquatic vegetasuitable habitat for the species; the shore shallows are narrow, tion. In general, the population of these smaller shore fishes is Lake is attributed to the fact that the lake shallows are not a the Golden Shiner, which is typically a lake form, in Moosehead of lakes shortly after hatching in the Spring. The scarcity of to the fact that young Togue probably retire to the deep waters sence of young Togue in the lake seining collections we attribute salmon are planted each year. Thus almost no young salmon or seining collections. Most of the young salmon were taken at Brook Trout were collected from typically lake waters. The abthe mouth of the Moose River in which hatchery-reared young water. Young salmonids were notably rare or absent in our back and the Lake Chub are, by far, the most abundant in shallow Of the smaller shore fishes of the lake the Three-spined Stickle-

Lake Chub are common to abundant in the deeper water or in the open water of the lake. The seining records and stomach records, together, reveal that the Smelt is confined largely to the open and deep waters of the lake where it is at least fairly abundant.

In the streams, tributary to Moosehead Lake, the Common Sucker, Black-nosed Dace, Fallfish, Common Shiner, and Creek Chub are among the most abundant species. Many of the tributaries are known to have large populations of Brook Trout. Only one of our seining collections encountered a large trout population, in the upper waters of Socatean Stream, while most of the stream seining collections were made in the quiet-water sections in the lower reaches of the tributaries presumably downstream from the preferred habitat of the Brook Trout.

There is some interest in the question as to whether most fishes are to be found near the bottom, or in open water above the bottom; and some information on this question is available from our gill net records. The 12 suspended sets (see page 47) of the 375 x 6-foot net, fishing in water from the surface down to a depth of 46 feet, and fishing over water depths ranging from 76 to 200 feet, took 28 salmonids, or 2 1/8 per over-night set; while the 86 bottom sets of the same type of gill net, in water ranging from 9 to 237 feet deep, took 299 salmonids, or 3½ salmonids per set.

TABLE XII. The vertical distribution and abundance of fishes taken by gill note from Mooschead Lake, as indicated by the average number of fish caught (in parentheses), the number of hours fished by the note.

For not not not not shown should be the note.

For not not not which overlapped two or more depth zones, the records were apportioned to the depth zones involved (see boot).

Type of net	Depth range of net sets in feet	Number of over-one night net sets	Total hours of net sets	Common Whitefish	Menominee Whitefish	Land- locked Salmon	Brook Trout	Togue	Common Sucker	Fine- scaled Sucker	Cusk	Fallfish	All fish
	0-15	5	109¾		1.5 (6½)		1.2 (5½)	0.1 (½)	4.6 (21)	****	0.8 (135)		7.7
- 27	15-80	231/2	52456	0.05 (1)	(163 <u>4</u>)	0.8 (18)	3.4 (743/2)	1.0 (22½)	8.6 (188½)	0.85 (7)	1.6 (35½)	0.1 (2)	16.6 (36534)
	80-46	211/6	460%	0.1 (2)	(2134)	0.3 (6)	(211/2)	2.4 (46)	4.9 (93)	2.5 (47)()	1.9 (37½)		14.2 (27436)
I nets	45-60	1696	368	0.2 (3)	0.9 (18½)	0.6 (9½)	0.9 (13½)	3.8 - (67½)	1.8 (28)	5.5 (8834)	(2236)	,	14.8 (28056)
6-ft. gill	60-75	73%	156	0.3 (2)	0.9	0.1 (34)		1.8 (11½)	0.2 (1½)	5.6 (861-6)	1.5 (9%)		10.1 (7514)
34	75-90	8	1783/2	0.1 (½)	****	****	****	2.6 (19)	0.4	5.4 (40¾)	(1232)		10.0 (7516)
375-ft.	90-120	834	197	0.1 (3/2)		377.0	****	(1734)	0.5 (4)	(30%)	(14%)		8.1 (6734)
	120-150	21/2	471/4	****	****	****		1.0 (2)		0.5 (1)	2.3 (4½)		3.8 (73/2)
	150-200	834	871/4	****			****	0.1 (¾)		0.2	1.8 (634)	,	2.2 (7%)
	200-240	1	23%		****	****		1.0					1.0 (1)

depth intervals, are given separately for the two types of gill nets ber of net sets, the hours fished, and the fish caught, by waterbasis to the depth ranges involved. The tabulations of the numhours of the set, and the fish caught, were apportioned on an equal two or more depth ranges approximately to an equal extent, the set was attributed to that range; but if the net set overlapped set was more than 75 per cent within one depth range, the entire depth ranges given in Table XII, if the depth range of a given net corded, and the catch per net has been tabulated on a per-24 hour over-one-night set of a gill net has been tabulated as one unit; basis. In this tabulation of the catch per net, according to the but, also, the actual number of hours fished by the nets was reapplies only to fishes of a size larger than 6 to 9 inches. etc. caught by the gill nets was approximately 6 to 9 inches, depending on the species, so that the analysis of depth distribution XII, and Figure 7). The minimum length of salmonids, suckers, the depth distribution of the larger fishes in the lake (Table The catch records of the gill net sets have furnished data on

ype of net	Depth range of net sets in feet	Number of over-one night net sets	Total hours of net sets	Common Whitefish	Menominee Whitefish	Land- locked Salmon	Brook Trout	Togue	Common Sucker	Fine- scaled Sucker	Cusk	Fallfish	All fish
	0-15		****							-	-	-	19
- 1	15-30	6	129%				****	****		****		****	
1	30-45				1,11.4	****	0.3 (2)	****	0.2	****	0.2		0.
	3753309.	6	13134			****	0.5	0.2	****		0.2	****	0,:
ner	45-60	9	1891/4	2221	****	1111		0.4			(1)		-
B -	60-75	914			-			(3)		1111		****	0.4
X 12-11.	00.10	81/2	7034	****	****		****	(314)		****	****		(81/4)
-	75-90	4	85	****				1.3		-			-
	00 100							(41/2)		****	3101	2333	(414)
-	90-120	36	10%	****		****		****					(479)
	120-150						-			****	****	****	
	150-200	7	151					****	****	****	****		
-	200-240						****	0.2 (1)	****	777.E.	****		0.2
1		****	****	****	****		****	* ****					1111

IN FEET	COMMON WHITEFISH	WHITEFISH	LAND-LOCKED SALMON	BROOK	TOGUE	COMMON SUCKER	FINE-SCALED SUCKER	CUSK	FALLFISH
0 - 15					-	Cent	JOCKER	42	19
15-30	0.00	0.0×	0.	0	6.5	Charles and the same of the sa	. eta	03	0
30-45	@			0	0	0.0	0.33		•1
45-60		-	O	0		CE.	O.		
60-78		0	**			404	Care		A SIL
75-90	•					0.2 CS:24	Oe.	@ >	A SA
90-120	0				a		- M	<i>a</i>	
	0,1				2.2	0.8	3.7	1.7	
120-160			g Test C		-		-	0	
					1.0		0.5	2.3	
150-200					-		63-	0	
					. 6.1	100	0.2	1.0	
200-240					42 *	11/12			
A. F.					1.0	10.00			

Figure 7. Comparative abundance of the larger fishes of Moosehead Lake in various depth zones. Data based entirely upon records of the 375-foot experimental gill nets. The number below each figure is the average number of fish caught per 24 hours per one net. Size of fish outline is proportional to numbers of fish caught—not to size of fish caught,

caught. Rather, the areas of the outline drawings in the figure comparable between species in most instances. caught per 24 hours, with the size of the drawings not being are approximately proportional to the figures on numbers of fish on Figure 7 have no relation to the size of the fish which were within different depth zones of the lake. The fish outlines drawn numbers of fish of each species caught per 24 hours per net terially the content of the figure except to give a general reducfor this net were included in Figure 7, it would not change mafor large fish, that it catches relatively few fish; if the records The 150 x 12-foot gill net, because of the large size of its mesh x 6-foot, experimental type of gill net with various sizes of mesh The figures given in Table XII and Figure 7 are the average in Table XII. Figure 7 is based solely on the records of the 375 tion in the value on catch per-24-hours for the various species (5 inches, stretched measure), has been found to be so selective

record of Togue for the 200-to-240 foot zone was a single fish lake, from surface waters down to depths of over 200 feet. taken by a net set on the bottom in 215 to 237 feet of water. Togue were found throughout the entire depth range of the pecially abundant between 45 and 60 feet. It is noteworthy that was abundant throughout the range of 30 to 90 feet, and essalmonids, the Togue was definitely the deep-water species. its abundance in the 15-to-30 and 45-to-60 zones. Of the three depth of 60 feet. The Land-locked Salmon was found within the than either the salmon or Togue; its greatest abundance occurred The Brook Trout was found to be more of a surface-water form depth range of 15 to 75 feet, with relatively little difference in in the 15-to-30 foot depth zone, and it was collected down to a in the depth distribution of the different species of game fishes. some striking differences, which will be of interest to fishermen, or not collected at all in the upper 15 feet of water. There are whereas a majority of these larger species were relatively rare are abundant over, most of the lake basin. This generalization a study of Figure 7. The major part of the fish population in is applicable especially to the depth range of 15 to 75 feet, that the majority of the fishes of the lake have access to, and wide range in depth within this upper 75-foot layer, it follows fishes during the summer months can be readily verified from (see page 15), and since most of the larger species occupy a Since over 70 per cent of the lake basin is less than 75 feet deep Moosehead Lake is to be found in the upper 75 feet of water Certain conclusions on the vertical distribution of the larger

> sumably the species occurs commonly in the 0-to-15 foot zone. water, and 4 fish from a depth of 184 to 187 feet. The record of the Cusk were of 2 individuals in a net set in 153 to 180 feet of to the 150-to-200 foot zone, and its abundance was remarkably tribution of the Cusk was an extensive one, from the surface fine-scaled form is the most abundant species. ference between the two suckers is important from the standabundant between 45 and 120 feet. A recognition of the difabundant from the surface to 45 feet, while the Fine-scale suckers. While both species occupied an extensive depth range, ing difference in the depth distribution of the two species of abundance from the surface to 75 feet. There was a very strikthan the Menominee Whitefish which occurred in fairly uniform at depths of 15 to 120 feet, was definitely a deeper-water form Of the two species of whitefishes, the Common Whitefish, found the Fallfish in Figure 7 is based on only 2 fish from one net; preuniform over this wide depth range. Our deepest records for feeding mostly on suckers, and at depths of over 60 feet, the found frequently at depths of over 60 feet, were found to be point of the Togue population, for the larger Togue, which were Sucker, not encountered within the 0-to-15 foot zone, was most the Common Sucker was definitely a shallow - water form The depth dis-

It should be emphasized that the preceding account of the depth distribution of the larger fishes in Moosehead Lake applies only to the summer months. (Our netting records were for the period from June 20 to September 9.) A quite different picture of the depth distribution of these species, especially the salmonids, probably would be obtained by comparable netting during early spring or late fall, for, as most fishermen know by experience, trout, togue, and salmon are found frequently near the surface during the spring, but by mid-summer these species are more abundant in deeper water to which they have descended, presumably to avoid the warmer surface water.

FOOD HABITS OF FISHES IN MOOSEHEAD LAKE

these fishes were collected.

Óver-all dates: 1944

July 6-Aug. \$1 June 20-Sept. 6 June 27-Sept. 1 June 21-Sept. 8 June 20-Aug. 31 Aug. 18

Over-all range in depth of water: in feet

16-67 12-237 7-68 12-187 9-75 56-67

estimates of length. corresponding parts of entire specimens, as a basis for these bones, vertebral columns, and fin rays with the measurements of quent comparisons were made of the measurements of individual stances where only part of a fish was left, as the result of partial digestion, the total length of the fish was estimated. the stomach contents were measured for total length. of Menominee Whitefish), the volume of the material of the cases was included as "caddisfly" in the tabulation. "stickleback" along with food organisms. Where caddisfly larvae were found within their cases (frequently in the stomachs in the body cavities of the sticklebacks, they were tabulated as be demonstrated that these tape-worm larvae had been parasites been feeding on the Three-spined Stickleback; and since it could Ligula were encounted in the stomachs of a few fish which had frequently encountered, were not tabulated as food. Larval volume. All volumes of food material present were measured and the total number was calculated from the measured total siderable quantity of cladocerans, a one-c.c. sample was counted by water displacement. type of food organism was counted; but in the case of a conthree hours after the fish were taken from the nets; were pretheir contents identified and tabulated. The number of each served in 10% formalin; and were subsequently opened and stomachs were removed from the fish, usually within one to scaled Suckers the salmonids, Cusk, and Menominee Whitefish taken by gill nets from the lake. Examinations were made of the stomach contents of most of In addition, the stomach contents of the Finein one net collection were examined. The Stones, pebbles, and pieces of wood, All fishes in In in-

3 - 2	4				5
TABLE XIII. The numbers a	nd lengths of fishes examined	for stomach contents, together w	rith data on the m	et mete ha aut the c	

Number

stomachs containing food

Number of over-one-night gill net collections

Number of stomachs examined

57

56

results of this study represent the feeding habits of fishes in

depths, and dates of the net sets by which these fish were colthe number of stomachs containing food, and the number, water

habits, together with data on the lengths of the fish examined,

The fishes which were examined for this study of feeding

lected are cited in Table XIII. The question as to how well the

Species of fish, stomachs examined

Land-locked Salmon Togue. Brook Trout. Cusk. Menominee Whitefish. Fine-scaled Sucker.

Range in total length in inches, of fish examined

8.7-22.4 8.7-34.9 8.1-23.5 9.8-25.8 9.5-16.1 10.5-14.8

sizes of fish involved, and on the extent of the sampling involved the lake may be considered on the basis of the numbers and

59

a percentage basis in Table XV) show that these large-sized viewpoint of total volume of food, the figures (summarized on

suckers, salmonids, and Cusk were the principal food of the very

were all of frequent occurrence; and large-sized (8- to 18-inch) Fresh-water Sculpin, Three-spined Stickleback, and Lake Chub

and homopterans. Among the fishes, the Smelt was by far the most important type of food of the game fishes and Cusk; the

portant type, but there was also quite a variety of beetles, bugs, mostly to surface-feeding fishes, the ants were the most imthe air onto the surface of the water and thus are available of the midges, Mayflies, dragonflies, and caddisflies were the more

Among the aquatic insects, the larval or nymph stages

important types. Among the terrestrial insects, which fall from

fishes, aquatic insects, and terrestrial insects were the important organisms on which these larger fishes of the lake had fed, the aquatic and terrestrial. From the viewpoint of variety of food mal classification, and with the insects divided into two groups: organisms are listed in sequence according to the system of ani-

examined is given in Table XIV. In this table the types of food ferent types of food organisms found in the stomachs of the fish

large Cusk and especially of the large Togue.

Moosehead Lake as a whole. summer, of Land-locked Salmon, Togue, Brook Trout, Cusk, and to be fairly representative of the feeding habits, during the 8 to 9 inches. Thus the results of the present study are believed Menominee Whitefish, of lengths greater than 8 to 9 inches, in lengths of the different species examined were approximately scattered over the lake, and from most depths at which the sepadate intervals throughout most of the summer. The minimum rate species were found to occur in the lake, and at frequent fairly large numbers of specimens collected from many localities these suckers could not be regarded as necessarily representaand on one date, and, therefore, the information obtained from were all from one net set, at one station, at a limited depth range, sample; while, on the other hand, the 20 Fine-scaled Suckers 51 Menominee Whitefish from 22 net sets represent a fairly good sampling; the 30 Land-locked Salmon from 15 net sets and the sets at separate stations in the lake, represent an extensive over-night net sets, respectively, and with most of the over-night and Cusk, the 185, 117, and 138 specimens taken by 61, 87, and 58 in the process of collection. In the case of Togue, Brook Trout, A summary tabulation of the volumes and numbers of dif-The salmonids, cusk, and whitefish are represented by

Fish examined	Land-locked Salmon 80		Togue 185		Brook Trout		Cusk 138		Menominee Whitefish 51		Fine-scaled Sucker 20	
Food organisms in stomachs	Volume in e.c.	Number	Volume in c.c.	Number	Volume in c.c.	Number	Volume in e.c.	Number	Volume in c.c.	Number	Volume in c.c.	Number
Hair-worm (Gordius) Leeches		::::	0.68	····ż	0.48		0.37	<u>ż</u>	0.1 0.42	1 2		
Leptodora Cladocera (other than Leptodora)	****	****	8.63	2,230	4.6	909	::::		****		0.028 4.227	
Alderfly larvas (Sialis) Mayfly nymphs (burrowing type) Mayfly nymphs (non-burrowing) Dragonfly nymphs. Stonetly nymphs. Stonetly nymphs. Water-beatmen (Corixidae). Beetle larvas (aquatie). Gyrinidae adult. Dytiscidae adult. Caddisfly larvas (including cases) Caddisfly pupae. Midge larvae and pupae (Chironomidae). Mosquito larvae (Corethra).	0.15	1 2	4.02 0.08 0.36 0.08 0.01 0.212	30 1 1 1 1 1 1 1 1 1 1 2 3 6 1 124	0.58 2.18 0.7 0.1 0.02 0.03 0.02	5 55 1 1 1 1 1	0.06 2.58 0.23 4.7 0.13 0.05 0.05	1 25 9 11 2 8 1 	1.2 0.22 0.6 0.02 0.03 0.06 28.89	25 16 2 3 5 2 347	0.i 0.01 0.02 0.125	6,49
Grasshopper Mayfly adult Dragonfly adult Leaf-hoppers, etc. (Homoptera) sphids stink-bugs (Pentatomidae) Geetles (adult and terrestrial) Laddisfly adult Luts (winged forms) discellaneous and unidentified terrestrial insects	0.1	1 2 3	5.9	98	1.0 1.02 0.1 0.42 4.33 1.25 10.24 8.08	59 18 10 70 18 188 188	0.4 0.16	···i			20.0	
pider nails (Planorbidae) nails (Amnicolidae)	****	::::	::::	::::	0.04		::::	::::	0.02	3 71		***

Table concluded next page

60

A tabulation of the

Fish examined	Land-locked Salmon 30		Togue 185			Brook Trout		Cusk 138		minee tefish 1	Fine-scaled Sucker 20	
Food organisms in stomachs	Volume in e.c.	Number	Volume in e.e.	Number	Volume in e.e.	Number	Volume in c.c.	Number	Volume in c.c.	Number	Volume in e.e.	Number
Smelt Land-locked Salmon	86.71	279	292.77 7.0	353	199.41	415	57.67	83		****		
l'ogue	1000		5.5	î	****	*****		****	****			***
ogue or Brook Trout		10.00	21.7	8	****	****	****	****	****	****	****	***
ine-scaled Sucker		****	26.6	1 1			****	****	****		****	***
Common Sucker	****		190.0	2		1	3100		****	****	****	***
ucker sp ish (probably sucker)		****	354.8	9			46.0	· · · · · · · · · · · · · · · · · · ·		****		
ake Chub (Couesius)	7.8	*****	2.1	3	22.24	****			1111			565
linnow sp	1000000	5	11.4	4	58.0	23	19.1	8				200
culpin (Cottus comptus)	****	****	5.2 24.3	50	2.3	2	0.9	2	****		2222	100
eulpin (Cottus cognatus) hree-spined Stickleback.	1.9	3	29.7	39	23.85	*44	18.96	34	4990		****	111
usk (Lots)			40.5	0.0		W	17.05	22		****	****	
ish sn.	2.1	2	4.14	4	2.38	****	52.0 2.92	1	2.4.	****		
ish cleanings			****		2.00		85.4	8 2	8.0	2	****	***
	1.1.0	2000		1111	****	****	00.4	-	****		****	
Total	99.0	299	1,088.48	2,992	321.11	2,202	808.93	227	33.72	489	4.53	6,64

TABLE XV. A summary of the volume percentages of the major types of food organisms in the contents of stomaches of the fish examined for the present study.

The figures are a summary of the data given in Table XIV

Water-fleas (Cladocera)
Aquatic Insects.
Terrestrial Insects.
Ottor Invertebrates (Worms,
Leeches, Spider, Snalls) ...

0.00

28.8

8.2 8.2 62.1

0.1

92.4 92.4 92.4 92.4

Type of food organism

Land-locked Salmon

Togue

Brook

Cusk

Menomines Whitefish

Fine-scaled Sucker

nows, Scurpum,

Game Fish (Salmon, Togue

(over 8 to 9 inches long) salmon trout toons and cust in Moose	All Fish
	99.6
	98.2
	89.1
1	97.1
	22.4
	-
	0.0

9.39 3,8

27.0

78.4

2.4

00

chunks of fish scraps (thrown into the lake by persons cleaning ever, represented a small volume percentage (18.7) as comwhich presumably were eaten at the surface of the lake. cent coarse fishes which were mostly Lake Chubs and sticklesmall per cent (3.3) of the food of the Togue. The food of the ers eaten by the large Togue. fish) represented a large part of the volume. most frequent, while a few large suckers, minnows, cusk, and pared to the volume percentage (78.4) of coarse fishes; among Cusk contained a considerable number of smelts which, howto an appreciable extent (8.2 per cent) on terrestrial insects, backs; also, the Brook Trout was the only species which had fed Brook Trout was 62.1 per cent smelts as compared to 27.0 per in proportion to the volume percentage (66.6) of the large suckof smelt, but the volume by per cent of smelt (28.3) was small sculpins, and sticklebacks. The Togue had fed on large numbers small extent on the so-called coarse fishes,—suckers, minnows, spectively. An analysis of the types of fishes consumed by these these coarse fishes, sculpins and sticklebacks were by far the game species and Cusk reveal some very striking differences. The salmon had fed mostly on smelt, and to a comparatively fish in their stomach contents were 99.5, 89.1, 98.2, and 97.1, rehead Lake had fed almost entirely on fish; the percentages of Game fishes represented only a

records" for the smaller fishes are especially valuable because abundance of the smaller fishes of the lake. and cusk has provided information on the distribution and The present study on stomach contents of the larger salmonids These "stomach

of predators had fed on the different species of smaller fishes. cipal predatory species, the abundance and distribution of the smaller food fishes, and the extent to which the different species net and seining records of water depths and fish caught, and tionships between the abundance and distribution of the prin-Figure 7), it is possible to give a general summary of the relation of the larger salmonids and other predatory species (see formation, together with the information on the depth distribustated probably with a fair degree of accuracy. With this innows, sculpins, sticklebacks, and suckers) in Moosehead can be summer distribution of the smaller species of fishes (smelt, minwith some of the principal and generally known habitat adaptathe lake. On the basis of these stomach records, and the gill tions and requirements of the different fish species in mind, the records for the smaller fishes in the open and deep waters of the shore line shoals are a very limited habitat as compared to very limited extent by the shore line seining collections (since they represent information which could be duplicated only to a the lake as a whole), and because this was our only source of

bottom food by also feeding on plankton. That this is a possior pelagic in habit, in order to supplement the scanty supply of abundant suckers might have become, to some extent, open-water from the shallow water down to depths of over 100 feet. Moosedwelling forms; and the collections by gill nets fished on the considerable distance above the bottom (see page 47) contained head Lake has a very scanty bottom fauna (see page 33), and the bottom indicated that suckers (the two species) were abundant no sculpins. Suckers are also bottom-feeding, and hence bottombottom, while the 28 salmonids caught in nets suspended at a pins were from stomachs of fish caught in nets fished on the feet, as well as from shallower water. In all instances the sculstomachs of Togue and Cusk from water depths of 60 to 200 Moosehead Lake. The sculpin was found commonly in dicated that this is the principal distribution of the sculpin in found to be in the low seventies, Fahrenheit). Our results inlower water (maximum surface temperatures in the lake were tom, in the cold, deep water, but also commonly in the shalthat the species occurs over much of the lake basin, on the botwater. On the basis of these requirements, it might be expected for a bottom-dwelling existence; it is also known to require cold lows: The Fresh-water Sculpin (Cottus cognatus) is adapted these smaller fishes in Moosehead Lake may be stated, as fol-The probable depth distributions and preferred habitats of

> seining collections in shallow water along the shore contained open water than in water immediately above the bottom. Our almost no smelt. 75 to 100 feet, and was possibly somewhat more abundant in smelt was fairly abundant from the surface down to a depth of from different depth zones of the lake (see Table XVI), the that the Smelt is relatively abundant in the lake. Judging from tents of all the predatory species indicates quite conclusively preponderance of smelt over all other fishes in the stomach conor not at all from depths greater than 60 feet. The numerical shallow water, by the seining collections. Both types occurred and the Three-spined Stickleback were found to be abundant in the average number of smelt per stomach of game fish taken to 30 feet, less frequently from depths of 30 to 60 feet, and rarely frequently in the stomachs of salmonids from water depths down to be mostly a bottom form. Minnows, especially the Lake Chub, Judging from the results of our net sets, the Cusk is believed depth levels considerably above the bottom took no suckers. 586 suckers, while the 12 sets of the same nets fished at various for the 86 sets of the 375-foot gill nets fished on the bottom took that both species of suckers are predominantly bottom forms; p. 71), the results of our net sets in Moosehead Lake indicated be pelagic in habit in some Maine lakes (see also Cooper, 1940, forms (Table XIV). But, even though suckers occasionally may Suckers which were examined; these had fed mostly on plankton bility is indicated by the stomach contents of the 20 Fine-scaled

bottom. Although the feeding records have been used, in part, fairly uniformly abundant down to a depth of 200 feet, on the more abundant on the bottom than in open water; and the Cusk, most abundant at depths of from 30 to 120 feet, and possibly face water, both over open water and near the shore; the Togue, abundant throughout the upper 60 feet of water, including surabundant in open water than on the bottom; the Brook Trout, abundance of the larger predatory species in the lake during the From a previous discussion (see page 54, and Figure 7), the to be found mostly at depths of from 15 to 60 feet, and more summer may be summarily stated. The Land-locked Salmon is throughout the upper 100 feet of water, except very near shore. 30 feet), and most abundant near shore; and the Smelt, abundant minnows and sticklebacks, mostly in shallow water (the upper cusk are to be found on the bottom in shallow to deep water; the lake may be summarized as follows: Sculpins, suckers, and Thus the principal summer habitats of these smaller fishes in

Fish exa	mined for ch conten	ta								Fish in	the	ston	ach conte	enta									_
		-		Smelt			Three-spi Stickleba	ned ck	T	Fresh-wa Sculpin	ter	M	innows, n Couesis	nostly	1	Sucker	5	I	Salmonio	de	Ι	Cusl	
Species	Depth of water in feet	Number of fish	Number	Range in length in inches	Average length	Number	Range in length in inches	Average length	Number	Range in length in inches	Average length	Number	Range in length in inches	Average length	Number	Range in length in inches	Average length	Number	Range in length in inches	Average length	Number	Range in length in inches	Average length
Land-locked	0-30	16	88	1.1-3.8	1.4	3	1.7-2.0	1.9			1.	2	2,9-3,2	3.0							1	THE REAL PROPERTY.	-
Salmon	80-60	14	191	0.9-3.5	1.6			-	1		-	3	3.0-3.1	3.0	1:	****		-	****			***	- ++
	0-80	29	160	1.4-5.8	2.3	31	1.1-2.5	1.9	12	1.1-2.6	1.6	4	2.6-3.9	8.2	÷	****	-		****		1	***	
13	30-60	101	142	1.3-4.9	2.5	7	0.9-2.2	1.6	17	0.9-2.0	1.4	8	2.2-3.3	-	1	7.9	7.9	1	3.5	8.5		***	
	60-90	40	29	1.6-3.8	2.6	H		-	18	1.3-2.0	1.6	0		2.7	3	7.9-9.8	8,5	1	5.9	5.9		***	
Togue	90-120	12	22	2.6-3.8	3.0	1	1.9	1.9	3	1.6-1.8	1.7	·	****	1	11	8.8-15.6	11.3	3	6.8-15.9	9.6	1	7.8	7.8
1011010	120-180	2	-	****	0.0	Ĥ	-	1.5	-	-	1.7		****	-:	-	****				٠			
	180-240	1	- 00		-	-	ceri	-			-	-:	1111						****				
1854	0-80	80	169	0.9-3.9	2.5	26	1.8-2.2	1.8	-	****	-	-	****	-		****	× (*					
Brook Trout	30-60	37	246	0.9-3.6		18	1.4-2.0	1.7		****		25	2.5-4.6	8.8		****	•	•	1314			***	
	0-30	39	19	1.0-3.4	2.5	5	0.7-2.8	1.9	4	1.5-2.2		•	****			****							
	30-60	54	28	1.0-3.0	2.2	16	1.1-2.0	1.7	8	0.9-2.8	1.9	8	2.9-4.1	3.4	1	6.2	6.2						
	60-90	19	18	1.2-3.5	2.1	1	1.9	1.9	-		1.6	2	2.0-2.4	2.2	1	3.5	3.5				1	8.9	8.9
Cusic	90-120	15	13	1.1-3.3	2.0	-		1.9	8	0.7-2.0	1.5		****			****							
	120-180	7	5	2.0-2.4	2.2		1777	•	8	1.4-2.6	1.9	•	****										
	180-240	4	-				****		4	0.9-1.9	1.3		****										
	230-240			****	*		****		2	1.8-2.2	2.0		****				. 1						

^{*}Longths of fish were measured to the nearest millimeter, and the figures have been converted to inches for this table.

attribute to the belief that the Cusk is a less efficient predator

extent on sticklebacks and minnows. The fact that the Cusk

had fed to a lesser extent on smelt, than had the salmonids, we

while individuals from shallow water had fed to a considerable

large extent on bottom forms (sculpins, suckers, and cusk) abundant on the bottom in shallow to deep water, had fed to a

greatest range in habitat conditions in the lake.

The Cusk,

cusk; but the relatively few Togue from shallow water had fed

to a large extent on the bottom-dwelling sculpins, suckers, and

large extent, a bottom-dwelling form, had fed mostly on smelt,

The Togue, being mostly a deep-water, and, to a

sticklebacks.

centages of surface insects and shallow-water minnows and

in the upper 30 feet of water, and it contained the greatest perthat the Brook Trout was the only salmonid found abundantly on the bottom fishes (sculpins and suckers). It is noteworthy and to an appreciable extent on surface insects, but not at all on smelt, but also to a large extent on sticklebacks and minnows, of the lake, both in open water and near shore, had fed mostly

and minnows, and not at all on the bottom-dwelling sculpin, suckers, and cusk. The Brook Trout, living in the upper waters

water Smelt, to a slight extent on the shallow-water stickleback

in the upper layers of open water, had fed mostly on the openspecies and the habitats of their prey. The salmon, abundant

relationships between the principal habitats of the predatory

there still remains much of significance in pointing out the close as the basis for stating the distribution of the smaller fishes,

greater variety in the fish-diet of the Togue is in agreement with on numerous smelt and sticklebacks and a few minnows. The

the fact that, of the three salmonids, the Togue occupies the

and less able to capture the fast-swimming smelt.

In summary,

the present study has indicated that these predatory species in

Moosehead feed mostly on whatever fishes of an eatable size are

monids because these three species of salmonids tend to occupy of food, there is much less competition among the three salextent that these fishes supplement a smelt diet by other types Lake, in that they all eat smelt to a large extent. the salmonids and cusk (especially the salmonids) in Moosehead cumstantial, data.

been supported by the accumulation of actual, even though cirwhich is frequently taken for granted, but which has seldom present in the same habitat with them. This is a conclusion

three distinct zones of the lake: the togue in deep water; the There is a considerable degree of competition for food, among But to the

salmon in shallow, open water; and the trout in shallow water especially near shore. The lake is sufficiently large and deep to provide these three zones; whereas, in a much smaller lake, the three species probably would not have sufficient space to exist under a comparable degree of segregation.

smaller than those eaten by the Togue. The larger fishes in the stomachs of the large Cusk were much stomach contents. Apparently the suckers in Moosehead Lake stomachs of the larger Togue, but they made up most of their large Togue which the lake produces. (For data, see Table XIV.) are very valuable in that they are the chief food of the many Not only were these large-sized food fishes confined to the inches long. One 21.2-inch Togue contained a 7.3-inch Cusk. and it contained the remains of a salmonid estimated to be 15.9 to 31.2 inches, and the suckers which they contained, from 7.9 including most of the largest ones collected, ranged from 22.8 tents, 15 from Togue and 2 from Cusk; the 10 Togue in question, on large suckers. There were 17 suckers in the stomach conto 15.6 inches. The largest Togue collected was 34.9 inches long, that the large-sized Togue in Moosehead had fed almost entirely In a previous paragraph, reference has been made to the fact

The 51 Menominee Whitefish stomachs contained mostly caddisfly larvae, and also considerable numbers of other aquatic insects and of snails, but no terrestrial insects and practically no fish (Table XIV). The caddisfly larvae, mostly of types with cases made of sand, had been swallowed "case and all." No doubt the sand aids the gizzard-like stomach to grind up insects and snails and other hard foods.

The 20 Fine-scaled Suckers (the first U-shaped loop of the stomach-intestine was examined) contained mostly plankton water-fleas and a few midge pupae (probably also plankters), and practically nothing else. These 20 suckers ranged in length from 10.5 to 14.8 inches long, and were collected from one overnight net set on August 18, from a water depth of 56 to 67 feet. This small and single collection of suckers may not afford results typical of the feeding habits of the suckers in the lake. But it should be stated that the contents of these fish represent an unusual type of food for suckers. Neither the Fine-scaled nor the Common Sucker have the long gill rakers typical of plankton-feeders, and both have the inferior, thick-lipped mouth typical of bottom-feeders. If it is generally true that suckers in Moosehead feed extensively on plankton, it is probably the result of the fact that their normal bottom food is quite scanty.

AGE AND GROWTH OF GAME FISHES IN - MOOSEHEAD LAKE

Most of the game fish in the survey gill net collections were used for studies of age and growth. As each net collection was made, the fish were brought to the survey laboratory at Rockwood; each fish was weighed and measured, and a sample of its scales was saved. For almost all fish, the sex and stage of sexual maturity were determined. Subsequently, the age of each fish was determined by an examination of its scales.

allow certain valid conclusions on the general trend of age and collected a fairly representative sample of all game species of of life, so that we have almost no records of fish younger than Most of the 9- to 10-inch salmonids were in their third summer catch game fishes less than about 9 to 10 inches in total length. summer (of 1944). The gill nets which were used are selective over-night gill net sets scattered throughout all parts of the lake collected by the gill nets. Details concerning the collection of growth of Moosehead Lake game fishes above 10 inches in length. lengths above 9 to 10 inches, and that the present study does three growing seasons. However, it is believed that the nets fish. Our records for Moosehead indicate that the nets failed to in catching fish, to the extent that they catch almost no small These collections were made almost continuously throughout the and from representative depth ranges throughout the lake. these fish are given in a previous section of this report. It may or Lake Trout, 64 Menominee Whitefish, and 9 Common Whiteis as follows: 34 Land-locked Salmon, 120 Brook Trout, 191 Togue be re-stated here that these fish were collected by a total of 134 The number of fish of each species used for the present study This includes all individuals of these species which were

In the examination of the scales of these fishes, it has been concluded previously that salmon scales can be "read" with complete confidence that most, if not all, readings are correct. This is because salmon scales grow rapidly to a large size, and the spacing of the numerous circuli varies greatly with the seasons. The scales of Brook Trout from Moosehead Lake are quite easy to read, and there has been little question as to the validity of the readings with the exception of a few of the oldest individuals. The scales of the whitefishes were likewise read with confidence,

about 3 to 31/2 pounds.

fish in their third summer; so that the

inches; and the V-fish,

rapid growth, presumably in the lake.

is an estimate; scale measurements were not made).

son, and the oldest fish were in their seventh.

different species.

in error to the extent of plus or minus one or two years. fident that most of the scale readings for the younger Togue angle of the scale, are helpful characters. The writers are conare correct, but the readings for some of the older fish may be posed field, and the circuli pattern along the posterio-lateral continuity of the circuli. given by Van Oosten (1923 and 1929). In the case of Togue or Lake Trout, many of the scales were more difficult to read than that most winter marks are discernible only by a slight disare laid down with little seasonal differentiation in spacing, so the older Togue. were the scales of other salmonids. This was especially true of (like those of Brook Trout), but in older years the few circuli especially with the aid of the photographs of whitefish scales Not only are Togue scales relatively small A definite "wear line" across the ex-

Photographs of scales of salmonids from Moosehead Lake are These

and weight are summarized by age group for each species fish are given in Table XVII, and part of the data on total length scales were selected on the basis of being relatively easy to read. given on Plates XV to XXVI at the end of this report. Data on the lengths, weight, age, sex, and maturity of these

our salmon was approximately one pound per year, starting with during the third and fourth years, or the first two years in the the lake. The most rapid increase in length of the salmon occurs one or three years of apparently stream growth before entering fish, the third-year scale area was very large, indicating a very at the end of which most fish were about 5 to 8 inches long (this slow growth, presumably in a stream tributary or a fish hatchery, these salmon showed the first two years of life as being of very were collected during their third summer or third growing seatributed among age groups III to VII; that is, the younger fish tate an easy comparison of the relative rates of growth of the The 34 Land-locked Salmon from Moosehead Lake were dis-The III-fish averaged 9.1 inches; the IV-fish averaged 15.2 In Table XVIII the data are presented to facili-17.8 inches. The increase in weight of We have data on the growth of salmon VI- and VII-fish were A few fish had either The scales of in most in by grouping the data according to early Species and Date of collection (1944) range in lengths and weight Ratio of males to females* Number seasons, including 1944 as a com-pleted year of fish Body or standard length in inches Total length in inches Maturity†, and growth history‡ of salmon Weight in ounces Land-locked Salmon ш 2 7.1 (7.9-8.7) (2.8-3.5) 1 to 0 Both fish immature. Both fish, 2-I. July 6-28 TV 11 13.0 (11.5-15.2) 15.3 (12.8-17.7) All fish immature. 9 fish, 2-II. 1 fish, 2-IS-I. 1 fish, 1-III. 20.4 (13.5-31.0) 5 to 5 V 5 15,1 (12.6-16.8) 17.6 (15.1-19.6) 35.0 (15.8-49.7) Four fish mature, one not. 2 fish, 2-III. 1 fish, 2-IIS-I. 1 fish, 2-IS-IS-I. 1 fish, 3-II. 1 to 4 VI 4 17.9 (17.1-19.1) 20.6 (19.8-21.8) 49.8 (35.0-68.8) All fish mature. 3 fish, 2-IIIS-I. 1 fish, 2-IV. 1 to 3 VII 2 18.9 (18.1-19.6) 21.5 (20.6-22.4) 54.5 (52.0-56.9) All fish mature. 1 fish, 3-IIIS-I. 1 fish, 2-IIIS-IS-I 0 to 2 Land-locked Salmon III 3 8.8 (7.2-10.0) 9.7 (8.8-11.7) (3.6-8.4) 1 to 2 All immature. 3 fish, 2-I. Aug. 2-Sept. 1 IV 3 12.6 (11.1-13.5) 14.8 (18.3-15.7) 22.2 (14.2-29.7) 2 to 1 One mature, two immature, 3 fish, 2-II v 1 15.9 18.5 40.7 Fish mature. Growth history, 2-III. 0 to 1 VI 3 18.0 (17.0-18.8) 20.5 (19.6-21.8) 58.7 (49.5-72.2) 0 to 3 All mature. 2 fish, 3-III. 1 fish, 2-IV.

*For a very few fish, the sex was not determined. Hence there are a few discrepancies between the total number of fish and the numbers included by some of the above nex ratios.

† Where fish are indicated as mature, it was judged from the stage of development of their reproductive organs that they would have spawned during the fall

of 1944.

In the growth history for salmon, a formula is used to distinguish between stream growth and lake growth. The salmon spends its first few (usually two) years in a stream, growing very slowly, and then enters the lake where it grows very rapidly. A 2-III fish is one which lived its first few (usually two) years in the lake. A 2-IIIS-IS-I fish is one which lived for two years in a stream, then three years in the lake, spawning at the end of this third lake year, then another year in the lake, then spawning, then one more season in the lake during which it was captured.

TABLE XVII. Lengths, weight and age of game fishes-Continued

Species and	Age in growing	Number	Average ar	nd range in length	s and weight	Ratio	
Date of collection (1944)	seasons, including 1944 as a com- pleted year	of fish	Body or standard length in inches	Total length in inches	Weight in ounces	males to females*	Maturity†, and growth history‡ of salmon
Togue or Lake Trout	VI	16	13.5 (11.5-15.9)	15.8 (13.5-18.4)	20.2 (10.9-33.0)	9 to 7	Eleven immature, five mature
June 20-29	VII	13	15,9 (12.8-18.3)	18.5 (15.4-21.4)	34.6 (16.4-63.0)	11 to 2	Eight fish mature, the five smaller ones immature.
(Concluded)	VIII	15	18.2 (15.5-21.6)	21.2 (18.4-25.1)	55.9 (39.4-102.3)	9 to 6	All mature.
	IX	6	19.9 (17.9-24.6)	23.2 (20.9-28.1)	76.8 (50.0-159.5)	4 to 2	All mature.
	x	2	22.0 (19.8-24.1)	25.4 (23.3-27.6)	91.2 (70.3-112.0)	1 to 1	Both fish mature.
	XI	1	23.1	26.7	188.0	1 to 0	Fish mature.
	XII	1	26.2	29.8	208.0	1 to 0	Fish mature.
Togue or Lake Trout	ш	1	12.3	14.6	14.0	1 to 0	Fish immature.
July 6-28	· IV	2	11.4 (10.1-12.6)	13.5 (12.2-14.8)	12.2 (8.5-15.8)	2 to 0	Both fish immature.
	ν.	14	12.8 (11.0-14.0)	14.5 (12.9-16.4)	15.0 (10.2-21.3)	8 to 6	All immature.
	VI	. 16	13.9 (12.0-18.7)	16.3 (18.9-21.7)	22.8 (18.9-58.0)	14 to 2	Three fish mature, others mostly immature.
	VII	12	15.2 (12.9-18.8)	17.8 (15.1-20.2)	28.2 (15.7-43.3)	8 to 4	Three fish immature, most of others mature,
	AIII	9	18.4 (16.7-19.9)	21.4 (19.8-23.0)	54.7 (40.5-72.0)	5 to 4	All mature.
	IX	5	18.5 (17.8-20.5)	21.7 (20.0-23.6)	55.6 (44.9-74.0)	0 to 5	All mature.
	x	1	19.9	23.8	72.0	0 to 1	Fish mature.
. 1	ıx	0		2000			
	XII -	2	28,5 (26.8-30.2)	33.0 (31.2-34.9)	209.8 (187.5-232.0)	1 to 1	Both fish mature,

TABLE XVII. Lengths, weight and age of game fishes-Continued

Species	Age in growing	Number	Average an	d range in lengths	and weight	Ratio	PERMIT BATTO EX
Date of collection (1944)	seasons, including 1944 as a com- pleted year	of fish	Body or standard length in inches	Total length in inches	Weight in ounces	males to females*	Maturity†, and growth history‡ of salmon
Togue or Lake Trout	ım	2	7.8 (7.3-8.2)	8.9 (7.9-9.8)	(3.6-4.6)	2 to 0	Both immature.
Aug. 16- Sept. 6	IV	4	8.0 (7.2-9.3)	9.6 (8.7-10.9)	(3.7-6.5)	3 to 1	All immature.
	v	8	12.0 (10.9-13.2)	14.3 (12.8-15.8)	18.9 (10.1-17.7)	3 to 5_	All immature.
ν.	. VI	11	13.7 (11.9-16.9)	16.1 (14.2-19.8)	20.4 (13.8-37.4)	4 to 5	All immature except one.
	VII	8	16.2 (12.2-18.9)	19.1 (14.5-22.2)	34.6 (13.9-54.9)	2 to 6	Five fish mature, three females immature.
	VIII	9	17.6 (15.9-20.2)	20.6 (18.8-23.2)	45.4 (84.7-65.7)	2 to 7	All mature.
	IX	4	18.9 (16.7-21.8)	22.0 (19.7-24.8)	· 60.3 (34.1-90.0)	1 to 3	All mature.
	x	0			****		
	XI	1	23.4	26.8	142.0	1 to 0	Fish mature.
	XII .	1	28.7	27.2	157.0	1 to 0	Fish mature.
Menominee Whitefish (Presopium)	IV	15	8.8 (8.1-9.7)	10.3 (9.5-11.2)	(4.0-6.6)	7 to 6	Most fish immature, the larges fish was a mature female.
June 20- July 27	v	5	9.5 (8.4-10.6)	11.0 (9.7-12.2)	6.5 (4.1-8.8)	5 to 0	All immature.
	VI	12	9.9 (8.2-11.5)	11.5 (9.5-18.2)	7.3 (3.5-10.9)	6 to 6	Five mature, seven immature
	AII	7 -	10.5 (9.3-12.3)	12.2 (11.0-14.3)	8.2 (5.9-12.8)	5 to 2	All mature.

TABLE XVII.	Lengths.	weight	and	 -		

Species and	Age in growing	Number	Average an	d range in length	and weight	Ratio	
Date of collection (1944)	seasons, including 1944 as a com- pleted year	of fish	Body or standard length in inches	Total length in inches	Weight in ounces	males to females*	Maturity†, and growth history‡ of salmon
Menominee Whitefish	VIII	2	10.5 (10.4-10.6)	12.0 (12.0-12.1)	7.9	2 to 0	Both fish mature.
June 20- July 27	IX	5	12.2 (11.5-13.0)	14.0 (13.0-15.0)	12.9 (9.6-16.8)	3 to 2	All fish mature.
(Concluded)	х	2	12.4 (12.0-12.8)	14.2 (18.9-14.5)	15.1 (13.9-16.3)	2 to 0	Both fish mature.
	.XI	2	13.9 (13.8-14.0)	15.9 (15.7-16.1)	21.0 (20.6-21.4)	0 to 2	Both fish mature.
Menominee Whitefish (Prosopium)	IV	5	8.6 (8.4-9.1)	10.0 (9.8-10.4)	4.4 (4.2-5.3)	1 to 4	All immature.
Aug. 1- Sept. 1	v ,	4	9.1 (8.7-9.7)	10.6 (10.1-11.8)	5.2 (4.4-6.0)	1 to 3	Two mature, two immature,
1905000	VI	0	****				
	AII	2	11.1 (10.5-11.7)	12.8 (12.2-13.3)	10.8 (9.2-12.3)	2 to 0	Both mature.
	VIII	1	11.2	13.0	9.2	1 to 0	Fish mature.
	IX	1	13.6	15.7	16.8	0 to 1	Fish mature.
	x	1	14.0	15.9	21.1	0 to 1	Fish mature.
Ommon Whitefish	VIII	1	13.3	- 15.4	21.1	1 to 0	Fish mature.
(Coregonus)	IX	0	****	4444			
uly 11- Aug. 22	x	1	14.1	16.6	23,5	0 to 1	Fish mature.
	XI	1	14.0	16.3	23.0	0 to 1	Fish mature,
	хи	2	14.3 (12.8-15.9)	17.1 (15.2-19.0)	24.0 (18.8-34.2)	0 to 2	Both fish mature.
	XIII	2	14.1 (13.5-14.7)	16.9 (16.3-17.5)	25.7 (22.3-29.0)	1 to 1	Both fish mature.
	XIV	1	14.0	16.3	26.6	0 to 1	Fish mature.
	xv	1	14.0	16.5	21.0	0 to 1	Fish mature.

TABLE XVIII. Average lengths and weights of different age groups of game fishes collected from Moosehead Lake by the survey during the summer of 1944.

Averages based on five or more specimens are given in heavy type. This table is a summary of part of the data given in Table XVII.

Species					Age in g	growing seas	sons (incl. 19	944)				
		II	III	IV	V	VI	VII	VIII	IX	x	XI	XII
g Land-locked Salmon .	.,,,		9.1	15.2	17.8	20.6	21.5		4444.7			
Brook Trout	253	8.3	9.3	12.1	14.3	19.5	20.7		1.111		****	***
Togue or Lake Trout			10.0	11.0	14.6	16,1	18.4	21.1	22.4	24.7	26.8	30.
		****	1996	10.2	10.8	11.5	12.4	12.3	14.3	14.8	15.9	-
Land-locked Salmon		****	4.6	20.9	36.0	53.6	54.5				-	
Brook Trout.		3.7	5.0	11.6	19.6	48.7	59,3				****	
Togue or Lake Trout		****	5.1	6.7	15.2	21.2	32.2	52.7	65.1	84.8	140	19
Menominee Whitefish				4.8	5.9	7.3	8.8	8.8	13.6	17.1	21.0	

year, while a few spawn first in their fourth year. data that most salmon in Moosehead spawn first in their fifth of capture. year, judging from the condition of their sex organs at the time without an accompanying scale erosion. It is concluded from our preting scale wear and the possibility that spawning may occur ing marks on the scales, because of the possibility of misinterdetermining age at maturity than is the appearance of spawngans during late summer or early fall is a better criterion for Sons. previous falls at the end of their third or fourth growing seascales indicated that some of these fish probably had spawned in all older fish were maturing to spawn in the fall. In other words spawned in the fall of 1944. All except one of the V-fish, and in their fourth, were all found to be immature; their reproducthese salmon were reaching maturity first during their fifth tive organs were so small as to indicate that they would not have The 5 salmon in their third summer, and 13 of the 14 salmon But observation on the condition of the reproductive or The presence of apparent spawning marks on the

able to the Moosehead fish. The 7 VI-year salmon from Moosehead averaged about a half pound heavier than VI-fish from the

in the Rangeleys and other Maine lakes (Cooper, 1940) for com-

parison with these Moosehead fish. The comparison is favor-

mostly the smaller individuals of the age group. fish, about half were judged to be immature, and these were of the third-summer Brook Trout were immature; and most of ounces, and several others were from 3 to 5 pounds each. sentatives of its age group. Age groups III to VII were well larger fish were in their sixth or seventh summer of life. single fish of the II-group obviously was one of the larger reprefrom 9.3 inches for the III-fish to 20.7 inches for the VII-fish increase in average lengths for these groups was quite uniform represented in the collections, especially groups III and IV. he fifth-summer fish were mature. The largest Brook Trout in our collections weighed 5 pounds The 120 Brook Trout included fish in age groups II to VII. Among the fourth-summer Most These

The 191 Togue or Lake Trout represented age groups III to XII, the oldest fish being in their twelfth summer of life. Age groups V to VIII had a large number of fish as compared to groups III and IV. The fact of fewer fish in group III may have resulted from size selectivity of the nets, for the age-length growth curve for the togue suggests that the III-fish were larger,

these very large fish are necessarily older than twelve years. For one of our larger fish (9 lbs., 15½ ozs.) was in its ninth ing approximately half a pound a year; the VII- to IX-fish, a size, it could have approached the 20-pound mark by its twelfth summer, and, at the prevailing rate of growth for Togue of its 20-pound class. Furthermore, it should not be concluded that would take only a few additional years for a Togue to reach the might well represent a low point in the abundance of Togue of At the rate of increase in growth of fish in our collections, it sented a steady increase with age: the IV- to VI-fish were addto 30.8 inches for the XII-group. The growth in weight reprea very uniform rate of increase from 11.0 inches for the IV-group this age group. The figures on average lengths of Togue reveal of fewer fish in the IV-group, as compared to groups V to VIII, Lake occasionally catch Togue weighing up to 20 to 22 pounds. long and was in its twelfth summer. Fishermen on Moosehead heaviest Togue, weighing 14 pounds, 8 ounces was 34.9 inches pound a year; and the X- to XII-fish, three pounds a year. Our as compared to the IV-fish, than would be expected. The fact

Almost all of the third-summer, fourth-summer, and fifth-summer Togue were found to be immature, as well as the smaller individuals among the sixth-summer fish. The few largest VI-fish, and most of the older ones, were maturing to spawn. Most Togue in Moosehead Lake, then, first reach maturity when they are six or seven years old.

the seventh year, the increase in size of togue was more rapid fifth years, and more rapidly during the sixth and seventh years, The trout increased in size less rapidly during the fourth and togue by about three inches in length and a pound in weight trout or salmon is the explanation for the larger size of the but the fact that togue in Moosehead live much longer than de and about 11/2 pounds lighter, than salmon or trout. Beyond resulting in seventh-summer togue about 2 to 3 inches smaller groups III to VII was slower than of either salmon or trout seventh summer. The increase in size of togue among ago to be about equal to the salmon in length and weight by the mon in their fourth and fifth summers had exceeded trout and the same average length during their third summer of life. Salmonids in Moosehead Lake, from the available data (Table XVIII), indicates that the three species are of approximately A comparison of rate of growth of the three species of sal-

> the suckers extensively. reach a sufficient size, during their shorter life span, to utilize in the same habitat with the suckers, or because they never salmon do not feed extensively on the suckers, or on any other growth. Furthermore, the togue is most abundant on the botsuckers, to utilize the large suckers for several years of rapid large-sized forage fish in Moosehead, either because they are not tom of the lake in the same habitat with the suckers. Trout and lives long enough, after becoming large enough to feed on the growth or to reach a very large size. The togue in Moosehead need a large-sized forage fish in order to maintain a rapid larger forage fish in the lake. We assume that large-sized fish vealed that suckers were by far the most abundant type of feed extensively on large suckers, and our netting records rethese salmonids (see page 66). The large togue were found to togue. There is a reasonable explanation for the larger size of the togue in the results of our study on the feeding habits of

and immature fish, the mature fish were the larger individuals. generally true that, within an age group containing both mature est life span matures at the latest age. The sizes at first maspan matures at the earliest age, while the Togue with the longyears. In other words the Brook Trout with the shortest life for togue. Among all three salmonids it was observed to be inches or one pound for trout, and 15 to 17 inches or 13/4 pounds mate figures: 15 to 17 inches or 2 pounds for salmon, 11 to 12 turity of salmonids in Moosehead Lake can be given as approxi-Salmon to be about nine years, and that of Togue about twelve of Brook Trout to be about seven years, that of Land-locked lakes in Maine (Cooper, 1940), we have found the maximum age our scale studies on salmonids in Moosehead Lake, and in other at first maturity and the length of life span of the species. may be summarily stated as follows: most Brook Trout mature years. There is a significant relationship between these ages mon in their fifth year; and most Togue, in their sixth or seventh first in their fourth or fifth years of life; most Land-locked Sal-The age at sexual maturity of the salmonids in our collections

The Moosehead salmonids were distributed according to sex as follows: the salmon included 11 males and 21 females; the trout, 57 males to 63 females; and the togue, 110 males to 79 females (the sexes of 2 salmon and 2 togue were not determined). The aberrant ratios for salmon and togue might be due to some selective factor in the collecting. That there might have been a

seasonal selective factor is indicated by the data for togue. The togue collected in June included 52 males and 29 females; for July, 39 males and 23 females; but for August 1 to September 6, there were 19 males and 27 females.

pounds, and the V- to VII-year trout averaged 11/2 to 31/2 pounds present Survey, the IV- to VII-year salmon averaged 11/2 to 31 lected for the comparison (which would be comparable to But if only the few largest fish collected by the survey are In comparison, among salmonids collected during 1944 by th pounds; and V- to VII-year trout weighed three to five pounds Wilson's records, IV- to VIII-year salmon weighed four to eigh parently beginning its eighth summer. Among these fish from their seventh summer; but one trout, 21 inches long, was ap was about 7 years, for most of the VII-fish were at the end o from them were obtained. The maximum age among the trou 6-pound trout were cited in Wilson's record book, but no scale 4 ozs., with most of the fish between 4 and 5 pounds. A few for this fish. The maximum weight among the trout was 5 lbs cited one salmon of 9 lbs., 8 ozs., but no scales were obtained were beginning their ninth summer). Wilson's record book 8 pounds and a maximum age of about 9 years (the 2 VIII-fisl The records indicate for salmon a maximum weight of about 6 to be given consideration in any conclusions drawn from the records a period of about 40 years. This fact of a selected sample should sent a selected group of the larger fish taken by fishermen over senting the correct fish. that there are few if any errors remaining in the records used minations have been made on those fish for which normal scales obtained along with their corresponding records. Age deterat the time the fish outlines were traced, and these scales were notes on species, date of capture, length, and weight. From a Land-locked Salmon and 15 Brook Trout (Table XIX), reprehere, which errors might have resulted from scales not repreinstances of obvious scale sample contamination, and we believe few of these fish, scales had obviously become stuck to the paper a record book has been maintained since 1884, in which fisherhave included outline tracings of individual fish, together with men have recorded some of their larger fish. from Wilson's Camp at West Outlet on the lake. have fortunately become available. These records were obtained (not regenerated ones) were obtained. We recognized only two Brook Trout collected from Moosehead Lake during former years Some records and scale samples of Land-locked Salmon and These age and growth records, for 16 These records At this camp,

TABLE XIX. Length, weight, age, and growth history of individual Land-locked Salmon and Brook Trout collected from Moosehead Lake during former years.

The data on lengths and weights, and the fish scales on which the age determinations have been made, were obtained from the Fish Record Book of Wilson's Camp. These were some of the larger fish caught by fishermen over a period of forty years.

Species	Date caught by fisherman	Total length of fish	Weight	Age in growing seasons*	Growth history† and remarks
Land- locked	About 1897	21 inches	3 lbs., 8 ozs.	IV	3-I-14; scale shows 414 growing seasons.
Salmon	About 1905	223/9 "	5 lbs., 4 ozs.	IV	2-II; early summer fish, slight growth in 5th summer.
	July 2, 1907	281/2 "	4 lbs., 12 ozs.	v	1-IV plus small growth in summer of 1907.
	June 9, 1908	251/2 "	6 lbs., 8 ozs.	VI	2-IIIS-I plus small growth in 1908.
	May 5, 1915	261/9 "	7 lbs., 12 ozs.	VII	2-IVS-I plus no growth in 1915.
	Probably 1917	22 "		m	1-IIS plus some growth in summer collected.
	May 5, 1918	24 "	6 lbs., 12 ozs.	VI	2-IIIS-I plus a very small growth in 1918.
	June 8, 1918	22 "	4 lbs., 8 ozs.	VI	2-IV plus no growth in 1918.
	May 26, 1919	24 "	6 lbs., 4 ozs.	v	2-III plus some growth in spring of 1919.
	June 27, 1920	24 "	6 lbs.	VII	2-HIS-IS-I plus some growth in 1920.
	May 14, 1922	2734 "	8 lbs.	VIII	3-IVS-I plus no growth in 1922.
139	June 7, 1923	23 "	5 lba., 8 ozs.	IV	2-II plus small growth in 1923.
23	June 14, 1923	24 "	5 lbs.	VIII	2-VI plus small growth in 1923.
	Aug. 24, 1923	221/2 "	6 lbs.	VI	
	June 19, 1926	24 "	5 lbs., 4 ozs.	VI	2-IV plus about 1/2 a season's growth for 1923.
	May 25, 1929	253/2 "	6 lbs., 8 ozs.	VII	2-IV plus small growth for 1926. 2-IVS-I plus no growth in 1929.

TABLE XIX. (Concluded) Length, weight, age, and growth history of individual Land-locked Salmon and Brook Trout collected from Mohead Lake during former years.

The data on lengths and weights, and the fish scales on which the age determinations have been made, were obtained from the Fish Record Book of Wilson's Camp. These were some of the larger fish caught by fishermen over a period of forty years.

Species	Date caught by fisherman	Total length of fish	Weight	Age in growing seasons*	Growth history† and remarks
Brook Trout	May 30, 1887	21 inches	*****	VII	Fish was in its 8th calendar year, but no growth yet in 1887.
Arout	Probably 1888	221/2 "	4 lbs., 12 ozs.	v	Five growing seasons completed, or nearly so.
	Sept. 29, 1888	221/2 "	4 lbs., 8 ozs.	VII	Fish at end of its 7th summer.
1	May 14, 1889	21 "	3 lbs., 8 ozs.	VI	No scale growth for 1889.
. [Probably 1889	223/2 "	5 lbs., 4 ozs.	v	Small growth in 1889, its 6th summer.
- 1	June 9, 1892	21 "	4 lbs.	v .	Small growth in 1892, its 6th summer.
ĺ	July, 1892	211/4 "	4 lbs.	v	Small growth in 1892, its 6th summer.
ſ	Sept. 28, 1892	1934 "	3 lbs., 12 ozs.	v	Fifth growing season nearly completed.
Ī	Probably 1896	23 "	*****	VI	Six completed growing seasons.
Ī	Probably 1897	21 "		VII	The 7th growing season partially or nearly completed.
	Sept. 4, 1904	191/4 "	3 lbs., 6 czs.	VII	Seventh growing season nearly completed.
	June 14, 1915	211/2 "	4 lbs.	VI	Fish in seventh growing season.
	June 25, 1917	201/2 "	4 lbs.	VI	Fish in its seventh summer.
	Sept. 28, 1921	1934 "	4 lbs.	VII	Seventh growing season nearly completed.
	June 24, 1922	22 "	5 lbs.	v .	Fish in its 6th summer.

*"Age in growing seasone" is comparable to age in years, except that a fish is considered to be a year older after it has lived through most of a summer's growing season. Thus, with a fish caught in apring or early summer, the calendar year in which it was caught is not added to its age. But, with fish caught during late summer, the year of capture is considered as a completed year of age.

In the growth history for salmon, a formula is used to distinguish between stream growth and lake growth. The salmon spends its first few (usually two) years in a stream, growing very slowly, and then enters the lake where it grows very rapidly. A 2-III fish is one which lived its first two years in a stream and its last three years in the lake. A 2-IVS-I fish is one which lived for two years in a stream, then four years in the lake, then spawned, and then lived another year in the lake before its capture.

mature.

VI-fish, were immature, while all fish older than six years were viduals in their fourth and fifth years, and about half of the

summer fish. averaged 10.2 inches long and 4.8 ounces in weight, and our slower than it has been over the past 50 years on the average. survey fish, the VI- to VII-year salmon were 31/2 to 41/2 pounds selectivity represented by Wilson's records), then, among the is very slow as compared to that of the salmonids. groups IV to XI. The youngest fish (in their fourth summer) is about the same as in these former years. With Brook Trout, on the other hand, the present rate of growth that the growth of salmon, at the present time, is somewhat length and weight to 15.9 inches and 21.0 ounces for the eleventhfigures represent a fairly steady rate of increase in average in weight. On this latter basis, the comparison would indicate in weight, and the VI- to VII-year trout were over 4 to 5 pounds The 64 Menominee Whitefish (Prosopium) The rate of growth of this whitefish in Moosehead represented age Most indi-

many smaller Menominee Whitefish which were taken, suggests mon Whitefishes in our collections, especially in view of the represented age groups VIII to XV. All of these fish were mawere from 15 to 19 inches long, 21 to 34 ounces in weight, and that the abundance of age groups of Common Whitefish may ture. The complete absence of any younger and smaller Comrun in cycles. Our few (9) specimens of the Common Whitefish (Coregonus)

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TRIBUTARIES OF MOOSEHEAD LAKE

The tributaries of Moosehead Lake include two rivers, about twenty moderate to large brooks, and a considerable number of small streams with small or intermittent flow. Most of the larger streams were visited during the hot dry period of July and August, since this is the most critical time of year for young trout and salmon. The tributaries which were accessible by road were studied at the road crossings. Others were entered by canoe, and followed as far as possible. This difference in method is reflected in the survey results. The lower reaches of the streams have a slower current, afford less cover, and may be warmer. During the summer months trout are less abundant than minnows and suckers in this type of habitat. Beaver favor such streams for their activities, and were commonly found on

absence of salmon and trout in the seining collections, though on the observed physical characters of the stream, than on the indication of suitable conditions in that particular tributary. the presence of such fish in the collections is the most positive ficult for seining operations. The writers place more reliance fish during the hot summer months, while others were very difthat so few trout and salmon were collected from the streams readily and escape predatory fishes. It is perhaps unexpected near the mouths of streams, so that they might leave the lake by plane. Care has been taken by the pilots to liberate such fish salmon have been transported from the hatcheries to the lake ing collections in the lake, support this belief. In recent years spawning, and the absence of small trout and salmon in the seinknown congregation of trout and salmon in the streams for grounds that they serve as feeder streams to the lake. The (see page 50). Some of the brooks appear unsuitable for these The tributaries of the lake are closed to all fishing on the

Moose River. Seining collections at the mouth of the river included a considerable number of young salmon. No temperature readings were taken on the river.

Baker Brook. Lower 3% mile examined. Discharge 6300 g.p.m. (gallons per minute). Riffles and pools begin 3% mile from lake. Temperatures: water 70° F.; air 83° F. 1:00 P. M. July 14.

Cover good. Food grade II. Beaver dam obstructs stream Large spawning areas. Fair trout water.

Tomhegan Stream. (1) Lower mile examined. Discharge 13,500 g.p.m. Riffles begin one mile from lake. Temperatures: water 63° F.; air 80° F. 4:00 P. M. July 14. Food grade III. Beaver active. Good spawning grounds in second ½ mile. Good trout water in this section. Flows into main outlet of Tomhegan Pond.

- (2) At road crossing just below Tomhegan Pond. Pools fair. Temperatures: water 73° F.; air 77° F. 5:30 P. M. Aug. 15.
- (3) One-half mile below Tomhegan Pond. Temperatures: water 79° F.; air 84° F. Little flow. Not good salmon or trout water in this section.

Socatean Stream. At crossing of Rockwood-Seboomook road. Discharge 750 g.p.m. Pools good. Temperatures: water 64° F.; air 83° F. 4:00 P. M. Aug. 15. Cover good. Food grade II. Many trout seined. An excellent trout stream. Used for pulp drive.

Moose Brook. Examined 300 yards above mouth of stream. No flow. Temperatures: water 77° F.; air 78° F. 3:00 P. M. Aug. 8. Unsuitable for trout or salmon.

Williams Stream. Lower one-half mile examined. Flow 375 g.p.m. Cover and food poor except near lake. Temperatures: water 65° F.; air 75° F. 1:15 P. M. Aug. 9. Beaver active. Trout reported to spawn on gravel bed 300 yards from mouth of stream.

Norcross Brook. Lower 1/4 mile examined. Flow 600 g.p.m. Pools and food fair. Many minnows. Temperatures: water 66° F.; air 79° F. 11:00 A. M. Aug. 9. Trout reported to spawn on gravel bed near mouth. Appears suitable for trout.

Duck Pond Brook. Examined at trail crossing about ½ mile below pond. Discharge 900 g.p.m. Food scanty. Temperatures: water 80° F.; air 81° F. Trout seen, but not caught. Appears too warm for good trout water.

Lucky Brook. Examined from mouth of brook up to Lucky Pond. Discharge 3000 g.p.m. Food good. Cover scant. Temperatures: water 75° F.; air 61° F. 2:15 P. M. July 17. Beaver have patched up old dam at foot of pond. No suitable spawning grounds. Too warm for good trout water.

Spencer Stream. Lower 3% mile of stream examined. Discharge 23,000 g.p.m. Food fair to good. Temperatures: water 75° F.; air 74° F. 2:15 P. M. July 18. Fallfish redds in lower section. Should be suitable spawning ground for trout, but too warm to carry fish through summer.

Roach River. Examined on township line between T. 1, R. 14 and T. 1, R. 13. Discharge 31,500 g.p.m. Temperatures: water 75° F., air 77° F. 11:30 A. M. Aug. 9. Reported to be important salmon spawning stream. Warm for trout during midsummer.

North Brook. Examined at mouth of stream. Discharge 1000 g.p.m. Temperatures: water 60° F.; air 74° F. 1:00 P. M. Aug. 9. Fish hatchery on upper waters of stream. Good trout water.

Tussle Brook. Examined on line between Lily Bay township and T. A2, R. 13 & 14. Dried to pools. August 9.

South Brook. Examined at bridge on Greenville-Kokadjo road. Discharge 1200 g.p.m. Temperatures: water 69° F.; air 76° F. 1:30 P. M. Aug. 9. Cover and pools good. Fair trout water, but heavy competition from suckers and fallfish.

Mud Pond Brook. Examined above bridge on Greenville-Kokadjo road. Practically no current. Temperatures: water 74° F.; air 79° F. 2:30 P. M. Aug. 9. Unsuitable for trout.

Beaver Brook. Examined at bridge on Greenville-Kokadjo road. Discharge 450 g.p.m. Temperatures: water 77° F.; air 84° F. 3:00 P. M. Aug. 9. Too warm for trout.

West Cove Brook. Examined one mile above Greenville Junction at union with tributary. Discharge 900 g.p.m. Temperatures: water 81° F.; air 79° F. 4:30 P. M. Aug. 9. Trout seined, but only fair trout water.

Big Squaw Brook. Not studied, but is site of fish hatchery and well adapted to trout and salmon. Trout and salmon spawn in this stream according to hatchery superintendent.

Of the streams surveyed: Socatean, Tomhegan, Norcross, North, Big Squaw, Williams, and Baker appear to provide the best trout water; although some trout undoubtedly live in the other streams during at least part of the year. The present policy of closing these streams to fishing is probably justified. To maintain these streams at their greatest productivity it is recommended that beaver control be intensified on these streams.

There are many streams where beaver can multiply without damaging fishing to any appreciable extent. The economics of the situation indicates that beaver should not be allowed to damage the not too extensive natural rearing grounds for small trout. The use of streams for log drives damages them for fish, because of the necessary clearing away of cover such as rocks and logs. While such uses cannot be prevented, steps should be taken to repair the damage whenever possible.

The spawning grounds of the salmon are a disputed question. The survey party failed to capture young salmon from any stream. Many guides stated that salmon entered only Moose River and Roach River. The opinion of Mr. A. O. Bolduc, hatchery superintendent at Squaw Brook, was that they entered all large streams such as Tomhegan and Socatean. It would be worth while to study the tributaries throughout an entire season, to properly evaluate them as feeders to the lake.

SUMMARY OF WARDEN CENSUS REPORTS

are taken outside of the lakes and ponds. of Moosehead Lake are closed to fishing, few trout in this area of the wilderness country to the north. Since the tributaries been taken from Moosehead Lake, but it is believed that the is almost certain that many of this species came from small figures for Brook Trout are so high for certain months that it great majority of salmon and togue were caught there. The to 1941. District 86 (formerly 85) covers the remainder of the East Outlet to Ronco Cove. This district was No. 80 previous 75 includes the portion of the lake south of a line running from of fish found in their possession. No record is kept of the source of the fish, nor of their size. Moosehead Lake is divided for fishermen checked each month, and the numbers of each species ponds in the vicinity or were checked on fishermen coming out lake. Fish checked in these two districts have not necessarily administrative purposes between two warden districts. District land Fisheries and Game have filed reports on the number of For a number of years all wardens of the Department of In-

The records summarized below cover the period from 1935 to 1944, although no data was available for 1942 and the early part of 1943. The monthly averages given in the summary table are based upon reports for each month of from 3 to 8 years. For most months seven annual reports were averaged to obtain the final figures. Within the period covered by these reports the two wardens checked 14,895 fishermen. Game fish possessed by these fishermen added up to 6,577 salmon, 14,895 Brook Trout and 9,748 Togue.

It must be admitted that the census data are too crude to show anything other than major changes. The wardens probably check a random sample of fishermen, but some are checked as they start out with no fish, while others are checked as they return with their total catch. Sportsmen checked on the lake may be just starting or on their way home. Possibly it would be fair to estimate that on the average each man had completed half his fishing. Thus the figures for fish per fisherman should be multiplied by two to give a fairer estimate of the average catch. At times a warden devotes most of his time to enforcement work, while at others he is occupied by management duties

or special work. In June, 1941, an especially intensive check was made on fishermen leaving after the Memorial Day weekend. In this month 1284 sportsmen were checked. The average of fish per fisherman was very high, since so many had complete catches. In fact the average for this one month was slightly over twice the average for all Junes. This tends to substantiate the argument above that the number of fish should be multiplied by two to give more accurate figures on total catch. With reservations in mind concerning the precision of our data, we may now turn to the evidence concerning the questions stated below.

(1) What are the relative numbers of the three game species taken and is this in proportion to their relative abundance as deduced from our net collections?

If we add together all fish we can calculate that out of every one hundred fish caught there were 48 Brook Trout, 31 Togue and 21 salmon. Based on our gill net collections, with correction for the preponderance of bottom sets, each one hundred salmonids in the lake would include approximately 35 Brook Trout, 35 Togue and 30 salmon. Since many of the Brook Trout reported by the wardens came from other waters, the agreement between these two sets of figures is as good as might be expected. If we assume that equal fishing effort has gone into the attempts to catch each species, it is probable that Brook Trout slightly outnumber Togue, and that salmon are measurably less abundant than the other two species. The present situation may be a balance with no advantage to any one species.

(2) How does the yield of fish vary seasonally during any one year, and how does it change from year to year?

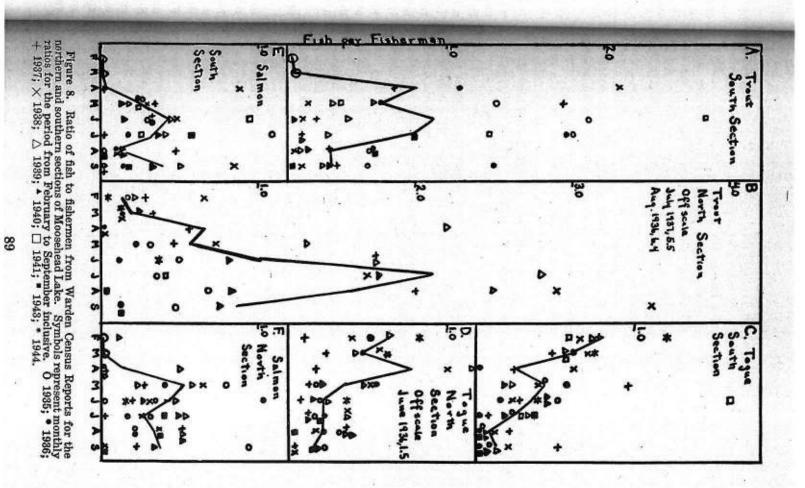
Because of variations in the amount of time which the wardens devote to inspecting fishermen, the total numbers of fish reported would be of no value in answering this question. The number of fish per fisherman might be expected to show seasonal differences if such exist. The total catch of each of the three species was totaled for each month over the census period. From these figures the average monthly values for fish per fisherman (F/Fm) were calculated for the months from February to September. These figures are summarized in Table XX, and shown graphically as the heavy lines in Figure 8. Three figures were not used in making up these averages; one because it was apparently a clerical error, and the other two because they represent special checking of fishermen and unduly affect the average values.

TABLE XX. A summary of Warden Census Reports from Mooschead Lake area for the years 1935-1944

		Souther	n Division						Northern I	Division		
Month	No. months	Total fishermen checked	Tr/FM	To/FM	Sa/FM	AF/FM	No. months	Total fishermen checked	Tr/FM	To/FM	Sa/FM	AF/FM
Feb. Mar. Apr. May June July Aug. Sept.	5 6 3 7 8 7	759 143 3852 4567 1979 917 545	0.08 0.05 0.80 0.59 0.93 0.77 0.25 0.28	0.80 0.62 0.25 0.42 0.37 0.23 0.08 0.11	0.005 0.004 0.05 0.23 0.43 0.84 0.10	0.88 0.67 1.10 1.24 2.06 1.34 0.43 0.77	55467885	689 451 115 2313 1763 634 468 316	0.14* 0.20 0.69 0.57 1.00 2.14 1.63 0.86	0.64 0.49 0.78 0.36 0.25† 0.22 0.24	0.02 0.03 0.15 0.53 0.47 0.28 0.34 0.38	0.80 0.72 1.62 1.46 2.01 2.64 2.21

Tr/FM=Trout per fisherman.
To/FM=Togue per fisherman.
Sa/FM=Salmon per fisherman.
Sa/FM=All fish per fisherman.
AF/FM=All fish per fisherman.
*Error suspected in figure for trout for 1938. Only 4 years used in calculating trout per fisherman. If 1938 were included this figure would be 0.30. †Based on 6 year totals. Figure for 1937 not included since they are exceptionally high. Would be 0.54 if 1937 were included.

Based on 7 year total. -Figure for 1941 not included. Would be 0.70 if 1941 were included.



no definite trend apparent. trout fishing varies widely both seasonally and annually, with year, and 1936 as a low year. It may be safely asserted that southern portion of the lake (Fig. 8 b) shows 1938 as a high definite conclusions from this data, however, especially since the figure are consistently above average. It is unsafe to draw ently below the average. Other years such as 1936 in the same ages. Certain years, for example 1938 in Fig. 8 a, are consistdoes not necessarily coincide at all with the graph of the averall except the winter months. The graph for an individual year which the averages were compiled shows great variability in Moosehead Lake. A glance at the points on the graph from and August is attributed to fishing in ponds rather than in and July. The sharp peak in the northern section during July March. The catch rises during the months of April, May, June that few Brook Trout are taken through the ice in February and In the case of Brook Trout (Fig. 8, a and b) the figures show

The records for Togue (Fig. 8 c and d) are much more consistent. If we eliminate two figures which represent special census effort, the average shows a consistent gradual decline in F/Fm from a high during the ice fishing season to a low in August and September. The April rise shown in Fig. 8 d is based upon a small number of fishermen. It may indicate that ice fishing is practiced more in the northern section during April.

The salmon figures are depicted in Fig. 8 e and f. An insignificant number are taken through the ice. The number (F/Fm) rises sharply in May, falls off in late summer, and shows a slight or sometimes marked rise in September. The spread of points is greater than that for togue, but less than that for trout. This agrees with the fishermen's observation that there are good and bad salmon years. According to the census reports, 1939 and 1938 were slightly above average, while 1935 and 1936 were below. The more recent records fall close to the average.

We may summarize these data by saying that they agree fairly well with the results of the survey. No definite trend in the type of fishing is evident over the ten year period, but there are wide annual fluctuations in the catch of fish. These are so great that they probably represent either actual variations in abundance or special conditions which affect angling. It would be desirable to make periodic checks in somewhat more detail in order to follow up these studies.

STOCKING RECORDS FOR MOOSEHEAD LAKE AND TRIBUTARIES, 1867-1943

These records of game fishes stocked in Moosehead Lake were obtained from the reports of the Commissioners of Inland Fisheries and Game starting with the first report (for 1867). For the past ten years the Department's fish planting records have been given in detail in the form of a mimeographed, annual report.

There were two main difficulties to assembling a complete record. Some of the Commissioner's reports were not available, particularly for the period during the 1920's. Also, although in many cases there was a Commissioner's Report for a particular year, very often these reports contained no record of where or when fish were planted, or of the species planted. All of the Commissioners' Reports that were examined are listed in the following account.

The three principal species of game fishes stocked in the waters of Moosehead Lake (or in waters having access to the lake) are:

- 1. The Brook or Squaretail Trout (Salvelinus f. fontinalis)
- The Togue or Lake Trout (Cristivomer n. namaycush)
- The Land-locked Salmon (Salmo salar sebago)

The heaviest plantings of the three over this period of years has undoubtedly been composed of the Brook Trout. The salmon runs a fairly close second, with the Togue third in importance in stocking. So far as can be told from the records, the only other species of game fish planted in the Moosehead area was the Chinook Salmon (Oncorhyncus tshawytscha) introduced into Moosehead Lake in 1897 and into Second Roach Pond in 1937-38. However, we had a verbal report that Rainbow Trout were planted in the lake about 1918, and there may have been plantings of other species in the lake or its tributaries, which are not recorded.

Stocking Records by Year. 1867-1943.

Reports of Commissioner of Fisheries (State of Maine) for the years 1867, 1868, 1869, 1870, 1871, (not 1872, 1873, 1874), 1875, (not 1876), 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1884, (not 1885), 1886, (not 1887), 1888, 1889-90, 1891-92, (not 1893) or 1894) were examined. No records of fish stocking in Moosehead or its tributaries.

Report for 1895

Trout, no number or date, Moosehead Lake.

Report for 1896

not given) during October 1896. Moosehead Lake stocked with 5-months-old Land-locked Salmon (number

Chinook Salmon, no number, Moosehead Lake. Trout, no number, Moosehead Lake. Report for 1898 Report for 1897

No records this year,

Report for 1900

Report for 1902

No records this year.

Squaw Brook, Big Squaw Mt. Twp. Roach River, Kokadjo Twp. Squaw Brook, Big Squaw Mt. Twp. Moosehead Lake Lily Bay, Lily Bay Twp. 257,000 trout 25,000 15,000 salmon 35,000 "

Report for 1904

Report for 1906

No records this year.

Salvelinus fontinalis

Salmo sebugo Roach Pond, Kokadjo Twp. Moosehead Lake, Piscataquis Co. Squaw Brook, Big Squaw Mt. Twp. Roach Pond, Kokadjo Twp. Moosehead Lake, Piscataquis Co. 45,000 2,000 5,000

No records this year

Report for 1907

3,000

Report for 1908

Salmon, in Moosehead Lake, Lily Bay Squaw Brook Greenville

3,000

Nov.

15,776

East Brook
West Brook
Hospital Cove
Howard's Cove

East Brook Whitcomb Brook N. E. Carry N. W. Carry

No records for trout stocking.

Report for 1909 not seen

Report for 1910

35,000 4,000 Number Salmon Species

Nov. 16, 17, Apr. 30, May 27,

1910

Roach Pond and Roach River Squaw Brook

Date

June 17, 1910 Aug. 20, " Date Squaw Brook Place

Number 80,000 Species Trout. Mature Ad. fry

Report for 1911 not seen

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20,00							
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250		11 the	-0	1	""	=	18
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10		adjo	Kok	River	Roach	1912	12,
Nun	0	ownski	Township	33	Place	Date	Date
	21	for 19	Report				

Oct Jun

739	Moosehead Lake	1913		Oct.
Kokadjo	Roach Pond	. 2	0	Oct.
Brassua	Brassua Lake	1913	15,	May
	Moosehead Lake	1913		May
Report for				

200,000 10,000 5,000 5,000

Salmon Trout

Trout.

or 1913

	**	:	12,		:	10,	9		ÿ
		:	:				9, 1914		
7	Baker Brook	Moosehead Lake	Masterman Cove	Whitcomb Brook	South Brook	Hunt Brook	North Brook Lily Bay		
1	Trib to M. L.	Rockwood	Moosehead La	Greenville		Sandy Bay	Lily Bay	Report for 1914	

15,000 15,000 15,000 15,000 15,000 15,000

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	Spence	W. Mi	Tomhe	Trib. t

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Jewett Cove Deer Island, Lit-	Spencer Bay and	long s. shore of	In brooks and a-	Socatean Brook	Tomhegan Stream
	*		Spencer	W. Middlesex	Tomhegan
	Jewett Cove Deer Island, Lit-	Spencer Bay and Jewett Cove Deer Island, Lit-	long s. shore of Spencer Bay and Jewett Cove Deer Island, Lit-	In brooks and a- Spencer long s. shore of Spencer Bay and Jewett Cove Deer Island, Lit-	Socatean Brook W. Middlesex In brooks and a-Spencer long s. shore of Spencer Bay and Jewett Cove Deer Island, Lit-

Brassua Lake North Brook South Brook Squaw Brook North Brook	long s. shore of Spencer Bay and Jewett Cove Deer Island, Lit- tle W., Green Is- land and Carry	In brooks and a-
Brassua Lily Bay Big Squaw N		Spencer

35,000

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17,

Big Squaw Mt	Brassua Lily Bay	
	5,000	
	Sal	

	Moosehead	Greenville	Sandy Bay	Lily Bay	Big Squaw I		Lily Bay	Brassua
**	lake	50			Mt.			
200	200	100	250	250	10,000	5,000	5,000	5,000
	:			:			•	Salmon
		****			****		****	****

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5,000 18,000			Actoro	T. S.
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			250	

Sandy Bay Greenville

Near Forest Park Lily Bay Brooks along W. shore of Lake	Howard's Cove Brooks and coves
k Moosehead Lake Lily Bay Somerset Co.	Howard's Cove Moosehead Lake Brooks and coves near N. E. Carry "N. W. Carry
15,000 20,000 40,000	12,000 18,500 20,000
Trout .	

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111

""

:00,00 1915

#"Mature" means over six inches in length. Brooks along W. shore of Lake Brooks along E. shore and Sandy Bay

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98

Moosehead Lab Piscataquis Co.	aters and County
ke, Mo	nty Township

Oct. 17, 1934

Date

e 14, 1915 Hospital Brook Whitcomb Brook Whitcomb Brook Creenville Whitcomb Brook Outlet At head of Deer I. Moosehead Lake Black Sand Island E. side Deer Island Sandy Bay Brook Moosehead Lake Beaver Brook Moosehead Lake Beaver Brook E. Spencer Stream Cowen Brook Spencer Stream Cowen Brook Spencer Stream Cowen Brook Spencer Stream Cowen Brook Moosehead Lake Spencer Stream Cowen Brook Spencer E. sandbar Island Harford's Cove Mill Brook West Branch Br. & Northeast Carry Brook and Northwest Carry Brook and Coves Moosehead Lake Alang w. shore Little Brassua Pd. Brassua 6, Moosehead Lake Piscataquis Co. 8				1010 1020 1021	In the reports for the wears 1017 1010 1020 1021 1020 1021	report	the	In
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ate Place 14, 1915 Hospital Brook Whitcomb Brook 2 brooks near E. Saplin Outlet At head of Deer I. Black Sand Island E. side Deer Island E. side Deer Island E. side Deer Island Center Brook Lily Bay Brook Lily Bay Brook Mosehead Lake Beaver Brook Beaver Brook Beaver Brook Beaver Stream Lucky Brook Spencer Stream Lucky Brook Spencer Stream Cowen Brook Sandbar Island Harford's Cove Mill Brook Sandbar Island Harford's Cove Mill Brook Sandbar Island Harford's Cove Mill Brook Sourth Brook Sandbar Island Mosehead Lake Spencer Spencer Spencer Cowen Brook Sandbar Island Harford's Cove Mill Brook Sandbar Island Harford's Cove Mill Brook Sandbar Island Mosehead Lake Spencer Spencer Cowen Brook Spencer Spencer Cowen Brook Spencer Spencer Mosehead Lake Spencer Spencer Spencer All West Branch Br. & Northeast Carry Carry Brook and Northwest Carry	Trout		41,515	eport for 1916 Moosehead Lake	74	916	30, 1	May
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ute Place Township e 14, 1915 Hospital Brook Greenville Whitcomb Brook Greenville Whitcomb Brook . 25, " 2 brooks near E. Saplin Outlet At head of Deer I. Moosehead Lake E. side Deer Island Lily Burnt Jacket Br. Greenville South Brook Lily Bay Brook Lily Bay Brook Lily Bay Brook Sandy Bay Brook Moosehead Lake Beaver Brook Beaver Brook Beaver Brook Sugar I. Near head of Nosehead Lake Spencer Stream Moosehead Lake Spencer Stream Spencer	: :		5,800	Moosehead Lake	Cowen Brook Sandbar Island	: :	1,	Nov.
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Place Township 1 Hospital Brook Greenville Whitcomb Brook 2 brooks near E. Saplin Outlet			2000	Monsehead I ale	At head of Deer I.		2	:
Place Township 1 Hospital Brook Greenville Whitcomb Brook "	Salmon		7,000	Saplin	2 brooks near E. Outlet	:	25,	Oct.
Place Township	Trout		10,000	Greenville	Hospital Brook Whitcomb Brook	1915	:14	June
	Sheries	*	Numbe	Township	Place		tte	D

no stocking records for Moosehead given, except for a record in the 1920 report of 9,500 salmon which escaped from rearing ponds into Squaw Brook, and presumably into the lake.

Reports for 1918, 1923, 1927, 1929, 1930, 1931 were not seen.

		9,1							-	TVO Cates	1
beaver Creek	Luy Bay Brook	Moosehead Lake th	First Roach Pond	Third Roach Pd.	Monsahand I ale at	Lily Bay Brook	First Roach Pond	Moosehead Lake	Moosehead Lake	Center Pond	
Gore 2-A	Lily Bay	oroughfare	4 4	Kokadio	Gore 2-A	Lily Bay	Kokadio			Big Squaw Mt.	Report for 1932
3,000	87,984	3.000	4,000	4,500	4,000	296,240	3,000	20,000	00,000	55,683	
	=	:	mont.	7 :	:	oguinos.	2 logue	1		Salmon	
	-	1	***	I			****		****	ı	

each fiscal year beginning July 1, 1933. The remaining records are from the mimeographed reports, put out by the Inland Fish and Game Dept., of fish plantings for

Jounty 1 Lake, 5 Co.	Y
Township Moosehead	, 1933-Dec. 30,
Number 4,000	1934
Species Salmon	
Size 2-3"	

Trout mature "" "4-4" Trout " Trout "4-6" Togue fry Salmon 4-6" Trout " Salmon " Togue fry Salmon " Salmon " Salmon " Togue fry		Greenville " " Big Squaw Mt.	read L		
		Greenville " " Big Squaw Mt.	" " Moosehead Lake	20,	
	The state of the s	Greenville " " Big Squaw Mt.		31,	
3		Greenville "" "" "" "" "" "" "" "" "" "" "" "" ""		28,	Į
	The Control of the Co	Greenville "" ""		30	
		Greenville		45, 20,	
3		Greenville	Moosehead Lake	127/10	
3		Greenville	Highlands	+0,	
3		Greenville	Manashand I also	# 200	
3	C. C	ьпу Бау			
3	10,000 10,000 5,000	1939-June 30, 1940	Moosehead Lake Piscataquis Co.	1, 1	
B	10,000	Gore Az	WOODCHEAR TAKE	Sour le sons	
3	10,000	Greenville	Highlands	lune 4 1030	
3	1000	Tax wende for	Moosehead Lake		
3	10,000			17,	
	10,000			Oct. 13,	
	1,200	Big Squaw Mt.			
	1,000	Gore 2A		" " " "	
	1,000	Greenville	Piscataquis Co.	28	
	0	, 1938-June 30, 1939	July I,	Tuly 27 1938	
Salmon 2-4"	10,000	Tomhegan	Somerset Co.		
	2,000		Moosehead Lake	Sept. 25, 1937	
Trout mature	4,000	Greenville	Moosenead Lake Highlands	" 27 "	
	35,000			26,	
non	50,000	Squaw Mt.		25,	
Togue 2-4"	38,000	Creenville	Piscataquis Co.	Sept. 15. "	
		1937-June 30, 1938	July 1, Moosehead Lake	Oct. 14, 1937	
	2,000	Squaw Mt.	ı	" 18, "	
Trout try	2 123	Greenville	=	00.1	
	10,000		Piscataquis Co.	lune 2 1937	
4	7	, 1936-June 30, 1937	Moosehead Lake	Oct. 5, 1936	
	7,000	Big Squaw Mt.		" 12, "	
Salmon 2-3"	6,400	Greenville			
Trout 2-3"	20,000	Big Squaw Mt.	2	June 1, "	
4-6"	4,000	Greenville		" 23 "	
	,,000	Highlands,		May 21, 1936	
::	7,000	Bav		19	
			. Piscataquis Co.	4 =	
Pecies Size Trout mature#	Number Species 1,000 Tr	Little Squaw Mt.	Moosehead Lake	July 20, 1935	
	6	30, 15			

#"Mature" means over 6 inches.

95

		Sept.	Oct.	-			Nov.	Oct.		::			2	Oct.	:	Sept.	2	=	:			2	2 2		Sept.	Aug.	July			::	Oct.
11,	114	çu	ښ	21,	25-27	5.6	10-	22-30,	22,	2,5		17.	5.6	1, 2,	=	30,	30,	ä	= 1	28,		26.	2 2		20				7	19 18	Date ct. 16
=	===	1942	3, 1941		27, "	= -		٥	=	2 2			=	=	2	1941	2	2	:	: :	:	=	::		: :	= =	, 1941		35	19, 21, '40 23, 24, '10 18, '1	, 17, 18
	# # # # # # # # # # # # # # # # # # #	July 1 Moosehead Lake, Piscatamis Co	Moosehead Lake	Somerset Co.		::	:		= :	Moosehead Lake	Moosehead Lake Highlands		::	:		Moosehead Lake	woosenead rake	Highlands	Moosehead Lake			1	::		II III	Mosshand I a	Moosehead Lake Highlands	July Piscataguis Co.	Somerset Co.		ters and Con Moosehead
В	EOU	e, , ,			5	o o				8		_	7			90(1)31					_				228		200	y 1,			ke
Big W (?)	Lily Bay Greenville Lily Bay	July 1, 1942-June 30, 1943 Lake, Bic Samue Mt	Rockwood	Lily Bay	WOCKWOOD			2	: :		Greenville	Lily Bay	Rockwood		Greenville Big Somaw M+	Big Squaw Mt.	Rockwood		Luy Day	Big Squaw Mt.	Rockwood	Rig Sourant M+	Big Squaw Mt.	Rockwood	Seboomook	D:C	Greenville	July 1, 1941-June 30, 1942 s Co.	Rockwood	Gore 2-A Abbot	July 1, 1940-June 30, 1941 unty Township Nu Lake
10,000	35,000 15,000 20,000		6,000	13,000	13,000	7,954	111,694	8,000	8,000	8,000	10,000	10,000	12,000	2005,000	15,000	15,000	16,000		10,000				20,000	5,000		10,000	5 000	1942	5,000	78,000 30,000	Number Species
Salmon	Land-	3	Brook Trout	Togue	::	: :	:	:	: :		=	= :	Trout	Brook	= =	Salmon	Brook	: :	Salmon	Togue	Brook	: :	Salmon	Brook	Salmon	11046	Brook		Salmon	Salmon Togue	pecies
2.2	: :24	1	4-6"	fry	4-6"	2-4"	:	4-6"	"	r		2-4"	4-6"		: :	2-4"				2-4"		: •	2-4"		::	=1	3			2.4"	Size

Nov. 13, "	2	Sept.			. :	: :		Nov.
13,	ça :	3 = 2	21,	20	17,	16	,0	,4 te
:	51	1943	21, "		: :	: =	:	Nov. 4, 1942
	" 5, " Somerset Co.	Moosehead I aka	:	=				Waters and County Moosehead Lake Piscataguis Co.
Greenville	Rockwood Long Pond T.	Gore 2A Lily Bay	:			Greenville Jct.	Big Squaw	Township Lily Bay
12,000	10,000	35,000 35,000	20,000	20,000	20,000	10.000	20,000	Number Species 1
Salmon Brook Trout	Land- locked	Togue	2	::	:	1 nort	Brook	Togue Size
4-6	2.4"	"fy	:	: :	2	= 3	=	2.4"

In the following section are given the stocking records for tributaries of Moosehead Lake, as taken from the mimeographed reports put out by the Inland Fisheries and Game Department of fish plantings by fiscal year beginning July 1, 1933. Data are listed by County.

Stocking Records for Tributaries of Moosehead Lake July 1, 1933-June 30, 1934

理學的語			
" 10, May 28,	Aug. June	Oct.	Date July 14, May 11, May 11, 12, 13, 13, 14, 15, 16, 17, 18, 19, 19, 19, 19, 19, 19, 19, 19, 19, 19
10,	3,		11, 330,000 miles
	21, 1934 3, 1935	4, 1933	Date July 14, 1933 May 11, 1934 May 12, 11, 1934 May 13, 11, 11, 11, 11, 11, 11, 11, 11, 11,
Upper Squaw Brook, Big Squaw Mt. Squaw Brook, Big Squaw T. 2nd Roach Pond, T.A-R. 12 1st Roach Pond, T.A-R. 13	July 1, 1934-June 30, 1935 Piscataguis County Lily Bay Brook, Lily Bay Baker Pond, Kineo	Somerset County Center Pond, Soldiertown	Waters Squaw Brook, Big Squaw T. Lily Bay Brook, Lily Bay T. First Roach Pond, T.A-R. 13 Lily Bay Brook, Lily Bay 2nd Roach Pond, T.A-R. 12 Fitzgerald Pond, Big Squaw T. Lily Bay, Brook, Lily Bay McEachern Brook, Greenville Beaver Creek, Greenville South Brook, Lily Bay Fitzgerald Pond, Big Squaw T. South Brook, Lily Bay Fitzgerald Pond, Big Squaw T. South Brook, Lily Bay Fitzgerald Pond, Big Squaw Mt. Fitzgerald Brook, Squaw Mt. Fitzgerald Brook, Squaw Mt. Squaw Brook, Squaw Mt.
25,000 10,000 3,000 5,000	30,000 5,000	3,000	Number 10,000 50,000 50,000 5,000 27,900 41,800 25,000 25,
Trout	Togue Brook	Salmon	Species Salmon Brook Trout Togue Salmon Trout Togue Trout " " Togue Trout " " Togue Trout " " " " " " " " " " " " " " " " " " "
"fry 4-6" 2-3"	2.3"	4-6"	Size 4-6' 2-3' 4-6' 2-3' 4-6' 1-7'

¢	£	5	
2	:	5	
c	χ	3	

	Sept. 15, " 27, Oct. 12,	May 2 June	******	May 3	185	Oct.	July Oct. May		Date May 30, June 9, 3, 10,
	5, 1937 7,	19, 1936 19, 25, 1937 25, 1937 8, "		57		5, 1935 7, ".	17, 1935 12, 1936 18, 1936 29, 15,	[3, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	30, 1935 9, " 10, "
	North Brook, Lily Bay South Brook, Lily Bay South Brook, Lily Bay Squaw Brook, Big Squaw Mt. 1st Roach Pond, A.R. 13		Prong Pond Brook, Gore 2A Upper Squaw Brook, Big Squaw Mt. Sam Wing Brook, Little Squaw Mt. Squaw Brook, Big Squaw Mt. Squaw Brook, Big Squaw Mt. Squaw Brook, Big Squaw Mt. Upper Squaw Bay, Big Squaw Mt. Somerset County	2nd Roach Pond, A-R. 12 Lily Bay Brook, Lily Bay Lily Bay Brook, Lily Bay South Brook, Lily Bay Lily Bay Brook, Lily Bay	July 1, 1936-June 30, 1937 Piscalaguis County Lily Bay Brook, Lily Bay Squaw Brook, Big Squaw Mt.	Somerset County Center Pond, Soldiertown Moose River, Rockwood	July 1, 1935-June 30, 1936 Piscataquis County Squaw Brook, Big Squaw Mtn. Lily Bay Brook, Lily Bay 2nd Roach Pond, A-R. 12 Lily Bay Brook, Lily Bay Squaw Brook, Big Squaw Mt.	for the second s	
	5,000 5,000 10,000	10,000 5,000 12,500 12,500 2,125	15,000 85,000 20,000	20,282 51,266 15,560 4,100	10,000 7,000 35,000	4,000 1,000	15,000 10,000 5,000 5,526 45,000 38,000	5,000 5,000 5,000 5,000 5,000 5,000 5,000	Number 41,800 35,000 5,000 15,000
	Salmon	Salmon Trout "	Togue	Chinook Salmon Trout	Salmon Togue	Salmon Trout	Salmon Togue Trout Togue Salmon	**************************************	Species Trout Trout "
	= = = 24	2-4" "fry 4-6"			2.4"	nature	2-3" 4-6" 2-3"	23	Size 4-6' fry 2-3''
	SALE TO NOW		1 250						
	June 3, "	0, 2, 1940	25, 1939 22, 1939 23, 11 26, 11 29, 11	1939	" 3, " May 29, 1939 June 2, " 3, "	1111	June 6, 1939	15. 15. 15. 15. 15. 15. 15. 15. 15. 15.	Date Oct. 23, 1937 Apr. 27, 1938 May 20, "
99	"" Sam Wing Brook, Little Squaw Mt. Little Squaw Brook Big Squaw Brook, Big Squaw Mt. Mt. View Pond (Inlet) Big Squaw Mt. 3, "" View Pond (Inlet) Big Squaw Mt.	30, Koach River, Kokadjo "Sandy Bay, Greenville "Squaw Point, Big Squaw Mt. "Roach River, Blake T. 22, 1940 Mud Brook, Gore 2A "Lily Bay Brook	25, 1939 22, 1939 23, 11 26, 11 29, 11	27,	3, " 29, 1939 2, " 3, "	8, Lily Bay Brook 9, South Brook, Lily Bay 11 3rd Roach Pond, T. A-R. 12 12 4th Roach Pond, T. A-R. 12	14, 19, 1939 29, 1939 6, 1939 7,	30, "Farm Brook, Lily Bay 30, "Farm Brook, Big Squaw Mt. 2, Beaver Cove, Gore 2A "I Squaw Point, Big Squaw Mt. Squaw Point, Big Squaw Mt. Somerset County 15, 1937 Moose River, Rockwood 25, "Center Pond, Soldiertown 28, 1938 Tomhegan Stream, Soldiertown "Socatean Stream, Soldiertown Moose River, Rockwood July 1, 1938-June 30, July 1, 1938-July 1, 1938-July 1, July	Waters 23, 1937 Spencer Lake, Spencer 27, 1938 3rd Roach Pond, A-R. 12 4th Roach Pond, A-R. 12 20, "2nd Roach Pond, T. 1, R. 12 23, "Fitzgerald Pond, Big Squaw Mt.
99	" Sam Wing Brook, Little Squaw Mt. Little Squaw Brook Big Squaw Brook, Big Squaw Mt. Big Squaw Brook, Big Squaw Mt. Mt. View Pond (Inlet) Big Squaw Mt. 3, " " " " "	30, Koach River, Kokadjo "Sandy Bay, Greenville 10,000 "Squaw Point, Big Squaw Mt. 10,000 "Roach River, Blake T. 21,676 22, 1940 Mud Brook, Gore 2A 25,000 "Lily Bay Brook 35,000	25, 1939 Roach River, Kokadjo 22, "South Brook, Lily Bay 22, "Roach Lake, south inlet, T.A-R.12 23, "Lily Bay Brook 26, "Squaw Brook, Big Squaw Mt. 29, "3rd Roach Pond, T.A-R.12	5, 1939 Squaw Bro 27, "South Broc "Lily Bay B	3, " 29, 1939 2, " 3, "	on on a	14. "South Brook, Lily Bay 19. Lily Bay Brook 29, 1939 Sam Wing Brook, Big Squaw Mt. Farm Brook, Big Squaw Mt. "" Upper Squaw Brook, Big Squaw Mt. Squaw Brook, Big Squaw Mt. 6, 1939 Fitzgerald Inlet, Farm Brook, Big Squaw Mt. T. "Farm Brook inlets Bio Squaw Mt.	30, "Farm Brook, Lily Bay 30, "Farm Brook, Big Squaw Mt. 2, Beaver Cove, Gore 2A "Squaw Point, Big Squaw Mt. Somerset County 15, 1937 Moose River, Rockwood 25, "Center Pond, Soldiertown 28, 1938 Tomhegan Stream, Soldiertown "Socatean Stream, Soldiertown I, "Moose River, Rockwood July 1, 1938-June 30, 1939 Fiscaloguis County 13, 1038 1st Boach, Boad Victoria	Waters Waters 23, 1937 Spencer Lake, Spencer 27, 1938 3rd Roach Pond, A-R. 12 4th Roach Pond, T. 1, R. 12 20, "2nd Roach Pond, T. 1, R. 12 23, "Fitzgerald Pond, Big Squaw Mt.
99	" " " Little Squaw Brook, Little Squaw Mt. " Little Squaw Brook Big Squaw Mt. Big Squaw Brook, Big Squaw Mt. " Mt. View Pond (Inlet) Big Squaw Mt. " " " " " " " " " " " " " " " " " " "	30, Koach River, Kokadjo "Sandy Bay, Greenville "Squaw Point, Big Squaw Mt. "Roach River, Blake T. 22, 1940 Mud Brook, Gore 2A "Lily Bay Brook	25, 1939 Roach River, Kokadjo 22, South Brook, Lily Bay 23, Roach Lake, south inlet, T.A-R.12 Lily Bay Brook 24, Roach River, Kokadjo 26, Squaw Brook, Big Squaw Mt. 29, 3rd Roach Pond, T.A-R.12	July 1, 1939-June 30, 1940 Piscataguis County 5, 1939 Squaw Brook, Big Squaw Mt. 27, "South Brook, Lily Bay Lily Bay Brook	3, "Highland Brook, Greenville 4,000 29, 1939 Socatean Stream, Soldiertown 50,000 2, Moose River, Rockwood 2,000 3, " 2,000	5,000 5,000 5,000	14. "South Brook, Lily Bay 19. "Lily Bay Brook 29, 1939 Sam Wing Brook, Big Squaw Mt. Farm Brook, Big Squaw Mt. """ Upper Squaw Brook, Big Squaw Mt. Squaw Brook, Big Squaw Mt. 6, 1939 Fitzgerald Inlet, Farm Brook, Big Squaw Mt. T. "Farm Brook inlets Rio Squaw Mt.	30, "Farm Brook, Lily Bay 8,000 20, "Farm Brook, Big Squaw Mt. 15,000 21, Beaver Cove, Gore 2A 11,500 22, "Squaw Point, Big Squaw Mt. 20,000 23, 1937 Moose River, Rockwood 5,000 24, 1938 Tomhegan Stream, Soldiertown 5,000 25, "Center Pond, Soldiertown 10,000 26, 1938 Tomhegan Stream, Soldiertown 10,000 27, "Moose River, Rockwood 20,000 28, 1938 Tomhegan Stream, Soldiertown 10,000 28, 1938 Tomhegan Stream, Soldiertown 20,000 29, 1939 Tomhegan Stream, Soldiertown 10,000 20,000 21, "Moose River, Rockwood 20,000 22, 1939 Tomhegan Stream, Soldiertown 10,000 23, 1939 Tomhegan Stream, Soldiertown 10,000 24, 1938 Tomhegan Stream, Soldiertown 10,000 25, "Moose River, Rockwood 20,000 26, 1938 Tomhegan Stream, Soldiertown 10,000 26, 1938 Tomhegan Stream, Soldiertown 10,000 27, "Moose River, Rockwood 20,000 28, 1938 Tomhegan Stream, Soldiertown 10,000 28, 1938 Tomhegan Stream, Soldiertown 10,000 28, 1938 Tomhegan Stream, Soldiertown 10,000 29, 1939 Tomhegan Stream, Soldiertown 10,000 20,000	Waters Waters 23, 1937 Spencer Lake, Spencer 27, 1938 3rd Roach Pond, A-R. 12 4th Roach Pond, T. 1, R. 12 20, "2nd Roach Pond, T. 1, R. 12 23, "Fitzgerald Pond, Big Squaw Mt.

2.4" 4.6" fry Size
-2-4"
mature
4-6"
"fry
"fry
"fry

2.4" 2.4"

July 1, 1941-June 30, 1942 July 25, 1941 Lily Bay Brook Beaver Brook, Gore 2A South Brook, Lily Bay Spencer Pond, Middlesex T. Lily Bay Brook Lily Bay Brook Sept. 26, "South Brook, Lily Bay Sept. 26, "South Brook, Lily Bay Lily Bay Brook Lily Bay Brook Sept. 26, "South Brook, Lily Bay Lily Bay Brook South Brook, Lily Bay Lily Bay Brook Roach Pond (1st), Kokadjo Roach River, Kokadjo Mt. View Pond, Squaw Mt. May 21, 1942 Beaver Creek, Gore 2A Roach River, Kokadjo Roach River, Kokadjo Roach River, Kokadjo Roach River, Kokadjo Roach Rod, Squaw Roach River, Kokadjo Roach Rod, Squaw Rod, Rod, Squaw Rod, Rod, Rod, Rod, Squaw Rod, Rod, Rod, Rod, Squaw Rod, Rod, Rod, Rod, Rod, Rod, Rod, Rod,	Sept. 25, 1940 Demo Pond, Rockwood 30, "Center Pond, Soldiertown Oct. 8, "Moose River, Rockwood 24, "Moose River, Rockwood Carry Brook, Big W June 2, 1941 Moose River, Rockwood "12, "Carry Brook, Seboomook	June 30, uis Counts town Squaw N Squaw N Squaw I	June 3 & 4, 1940 Mud Brook, Gore 2A June 3 & 4, 1940 Mud Brook, Gore 2A Moosehead Highlands Bk., Greenville 8, "Lily Bay Brook Somerset County July 1, 1939 Moose River, Rockwood 5, """" Sept. 19, """"" May 22, 1940 Tomhegan Stream, Tomhegan Moose River, Rockwood 28, """ Carry Brook, Seboomook June 3, "" Moose River, Rockwood	
10,000 5,000 2,500 5,000 1,250 11,250 11,250 11,250 10,000 8,000 10,000 10,000 10,000	1,000 3,000 10,000 5,000 20,000		Number 2,000 2,000 3,000 5,600 8,000 16,000 2,000 2,000 2,000 2,000 2,000 2,000	
Trout " Salmon Togue Salmon Trout Togue Salmon Trout Togue Salmon Trout	Trout Salmon Togue Salmon Togue Trout	Trout Salmon Togue Salmon Togue Togue Trout	Species Trout " Togue Salmon " Trout " "	
, , , , , , , , , , , , , , , , , , ,	\$.57 " " " " " " " <u>" " " " " " " " " " " "</u>	4.5	Size mature 4-6" mature 4-6" 4-6" 2-4"	
		8, 15, Oct. 28, May 29, 1943 Sept. 4, 1942 May 30, 1943	Date H Sept. 25, 1941 Oct. 13, " Oct. 15, " May 21, 1942 May 21, 1942 June 20, " Sept. 4, 1942	

July 1, 1942-June 30, 1943

Piscataguis County

Roach River, T.1-R.12

20,000

Land-locked Salmon

Carry Brook, Seboomook Moose River, Rockwood Moose River, Rockwood

30,000 10,000 10,000 20,000 20,000

Salmon Togue Trout Trout Togue Trout Salmon

केंद्र के

...24"

Squaw Brook, Big Squaw Mt. Beaver Creek, Gore 2A Spencer Pond, Middlesex Squaw Brook, Big Squaw Mt.

20,000 20,000 2,500 30,000 16,000 8,000 25,000

Trout Salmon

2-4"

Prong Pond, Gore 2A Squaw Brook, Big Squaw Mt. 1st Roach Pond, Frenchtown

Moose River, Rockwood

20,000 10,000 35,000

Salmon Trout Togue

Somerset County

Togue Trout Waters and County Township
Somerset County

Number Species

Size

Moose River, Rockwood

100

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Moosehead Lake is Maine's largest lake, and is one of its most famous lakes in furnishing good fishing for trout, togue, and salmon to a large number of fishermen. The lake was found to be excellent water for salmonid fishes from the standpoints of depth, temperature, and dissolved oxygen; and this applied to each of the several deep basin units of the lake. Bottom organisms which might be used as food by fishes were found to be very scanty in quantity. But the lake has an average abundance of plankton organisms which constitute the chief basic food of small fishes (especially the Smelt) in the lake, which, in turn, are the chief food of the larger game fishes.

The larger fishes of the lake include abundant populations of Togue and Brook Trout and nearly as many Land-locked Salmon, abundant populations of the Cusk and two species of suckers, and a fairly large population of whitefishes (two species). The warden's records of salmonids checked in the Moosehead area substantiate the survey findings that Brook Trout and Togue are of about equal abundance in the lake and that salmon are nearly as abundant as either trout or togue.

monids in Moosehead Lake is above average, as compared to Moosehead. The rate of growth of the three species of salit now has. Comparable survey gill netting within the more samples have been studied—another indication that the lake is Lakes; this comparison does not indicate an over-population in to approximately 3 salmonids in most of the Rangeley Lakes per 375-foot net per 24 hours for Moosehead Lake, as compared suitable lake depth zones yielded approximately 2.5 salmonids should be able to support a larger population of salmonids than on the other hand, some of the results indicate that the lake results of the present study that the lake is over-stocked; while could support a much larger population of salmonids than it now the growth of salmonids in other Maine lakes from which scale discussion, it might be stated that there is no indication in the (1941 survey), and as compared to 12 salmonids in Haymock The question arises at this point as to whether or not the lake Anticipating the general conclusion from the following

in the lake could be sufficiently abundant to support a much is correct, then these small smelts and other small forage fishes of growth in weight increases considerably. If this reasoning a sufficient size to be able to feed on the large suckers, its rate is noteworthy, in this connection, that when the Togue reaches not able to capture enough smelts to make a rapid growth. larger population of salmonids than is now present, and suptrout and salmon, in eating mostly two- to three-inch smelt, are Moosehead salmonids. In other words, the two- to three-pound factor than available numbers in limiting the rate of growth of the writers that the small size of the smelt is a more important would grow much more rapidly than they do at the present time. smelts in Moosehead, is not especially helpful because the Moosehead smelts were smaller. If smelts were especially abundant in Moosehead Lake, it could be maintained that the salmonids But, although this argument might be valid, it is the opinion of parison, even though it might indicate a greater abundance of salmonids from the Rangeleys (1941 survey); but this comper fish, as compared to 0.5 smelt per stomach among 246 monids. The 332 salmonid stomachs had 1,047 smelts, or 3.2 abundant that it would support a greater population of saldirect evidence that this small race of Smelt in Moosehead is so race of Smelt is also present, it must be rare.) We have no small race, seldom exceeding four inches in length. (If a larger taken from 470 salmonids and cusk, the Smelt in the lake is of a monids. Judging from 1,130 smelt (all measured for length) or not the lake could support a much larger population of salthe abundance of the Smelt is the key to the question of whether ters and all the salmonids except the very large togue. pal link in the food cycle of the lake between the animal planklarger togue on) suckers and Cusk. But the Smelt is the princibacks; and togue on sculpins, sticklebacks, and chubs, and (the on other fishes—the salmon on chubs; trout on chubs and sticklewere found to be feeding mostly on smelts, and to a lesser extent food supply than is now being utilized. The three salmonids salmon, it must depend largely on the presence of a much greater Lake can support a much larger population of trout, togue, and to the presence of too many species is avoided. If Moosehead Thus some of the effect of over-population which might be due not over-populated. The three species of salmonids in Moosethat interspecific competition for space is probably not extreme. possible, due to the large size and great depth of the lake), so head occupy somewhat different zones of the lake (which is

³ For results of the study of Haymock Lake, see page 115.

should be able to support a larger population of salmonids than that it is, and on the basis of this comparison, Moosehead Lake head should be much better than in Haymock. It is our opinion tion a large population of smelts, the food situation in Mooseabout the same forage species as does Haymock, and in addiusual or preferred food of salmonids. Since Moosehead has the food cycle of Maine lakes, and which, when present, is the But Haymock Lake lacks the Smelt, which is an efficient link in and mostly on a diet of sticklebacks, sculpins, and plankton. as dense as in Moosehead (judging from the gill net collections), present, supports a population of salmonids about three times comparison of Moosehead with Haymock Lake. Haymock, at ably could) support a larger population of salmonids is from a rate of growth, even though the present forage fish population of the belief that Moosehead Lake should be able to (and probdoes not provide a more rapid growth among salmonids in the port these additional fish without a corresponding decrease in present population. The most conclusive argument in support

eral times by State Fish and Game Wardens that when the large A large Smelt is a predator, and it has been reported to us sevnecessarily follow that such an introduction would be desirable. probably result in an increase in size of salmon, it does not introduction of a large race of Smelt into Moosehead would and others) which produce record-sized salmon and trout mostly in the lake would result in larger salmon and possibly larger that the presence of a larger race of smelts (5 to 10 inches long) by a moderate rate of growth, do not live long enough to utilize or that the trout and salmon, after reaching a fairly large size have populations of a large race of Smelt. Even though the lakes in Maine (Sebago, the Rangeleys, the Fish River lakes, therefore would be in the same habitat with the salmon. Those trout. The Smelt is known to be mostly pelagic in habit and the large suckers extensively. It could reasonably be expected dant in the same ecological zones of the lake with the suckers, possible reasons being that the trout and salmon are not abun-But the trout and salmon do not feed on the suckers extensively, head Lake upon which any of the salmonids feed extensively. suckers are the only abundant, large-sized forage fish in Moose of the togue may be attributed to their feeding on suckers. The record-sized Brook Trout or Land-locked Salmon. The large size 20 pounds and more; but it is not noted for producing many Moosehead Lake is noted for the record size of its Togue, up to

> do more harm than good, that such an introduction is not recomanother potential predator. In fact, there are so many possibilities in which the introduction of a large race of smelt would logical to introduce a strictly plankton feeder than to introduce ductions of forage species were to be made, it would be more which only one is fed on extensively by salmon, if further introof predators as compared to only a few species of plankton converters (smelt, stickleback, chub, and possibly the suckers), of the present fauna. Since the lake now has four abundant species with an ultimate effect of simply adding one more predator to race of smelt and probably deplete their numbers considerably, Also, the larger smelt would feed extensively on the smaller readily as the larger togue would feed on the smaller smelt. largest of the smelt would probably feed on togue fry just as probability that such a decrease would take place. For the for these warden reports, but it is entirely within the realm of decreases. We have no direct evidence that this occurs, except smelt is introduced into a lake, the togue population greatly

inches, or a togue or salmon at 14 inches, the fisherman gets rapidly for several years. The legal length is attained early in the period of rapid growth. So that by taking a trout at 10 at a length of approximately 7 to 9 inches. Mostly they reach their legal length during their third or fourth summer and grow the first two years, and begin their third year of life in the lake the greatest return. Trout, togue, and salmon in Moosehead of the fish. The most reasonable attitude is to consider fish in other aspect of the legal size limit concerns the growth history season's fishing before they become mature for spawning. Anon the average; the Togue, at 15 to 17 inches; and the salmon, at 15 to 17 inches. For each species the legal size limit is in-Lake or its tributaries grow very slowly, on the average, for the sense of a crop to be utilized at the most opportune time for most individuals of each species are subject to capture during a adequate to the extent of about one year's growth. legal limits on trout, togue, and salmon do not accomplish this head Lake first reaches maturity when about 11 to 12 inches long, purpose. According to survey data the Brook Trout in Moosehave had an opportunity to spawn at least once, then the present size limit is to protect most individuals of a species until they it is correctly assumed that one of the purposes of having a legal inches, that for Togue and Land-locked Salmon is 14 inches. If The legal size limit for Brook Trout in Moosehead Lake is 8

only a small part of the benefit of the normal rapid growth of the species. To illustrate the point, since it takes 3 to 5 years (depending on the species) to produce a one-pound fish, it would seem to be entirely sensible to wait one more year and get the two-pound fish. An increase in the legal size limit to 12 inches for Brook Trout, and to 16 inches for Togue and Land-locked Salmon would allow a majority of the fish to reach sexual maturity before being subject to capture, and these increased legal lengths would give the fishermen more benefit from the increased rate of growth of these species during their third, fourth, and fifth years of life.

Of the numerous small tributaries of Moosehead Lake, at least seven streams are good trout feeder streams. But these streams have a limited carrying capacity as compared to that of the lake itself. Any methods which would keep these streams at their highest carrying capacity for small trout would be desirable. Drastic control, and probably a complete elimination, of beaver on these tributaries is entirely justified. The Moose and Roach rivers are the principal rearing grounds for salmon. But the short stretches of these rivers below Brassua Lake and the Roach ponds, respectively, are again of limited carrying capacity as compared to that of the lake. The lake is so large, as compared to the capacity of its tributaries to produce trout and salmon, that artificial propagation and plantings of hatchery fish may always be justified.

sively to Brook Trout, Land-locked Salmon, and Togue. mately 477,000 salmon, 481,000 trout, and 318,000 togue; and year to year, and there has been a gradual change in the species relative numbers of the different species has varied some from waters over the past 70 years has been confined almost excluand 571,000 togue. This represents an average rate of 553,000 721,000 salmon, 517,000 trout, and 253,000 togue; giving a total for the tributary streams and closely adjacent tributary ponds. previous to July, 1943, the plantings in the lake totaled approxiphasis on salmon during recent years. For the five fiscal years trend from an early emphasis on Brook Trout to a greater emest emphasis on propagation of salmon also seems justified in the continued stocking of all three species seems justified. Greatto support abundant populations of all three species of salmonids, salmonids a year. Since the lake has demonstrated a capacity for both lake and tributaries of 1,198,000 salmon, 998,000 trout Stocking of salmonids in Moosehead Lake and its tributary

> view of the fact that salmon rearing grounds on the lake tributaries are the most limited; and, for the same reason, trout should be favored over the togue.

size of the Brook Trout and Land-locked Salmon to 6 to 7 inches principal effort in the Moosehead area should be to increase the are being stocked, Moosehead Lake is not being over-stocked by serve to indicate that, compared to the rate at which small lakes would be economically profitable. But the above estimate does impossible to meet such a quota with present hatchery facilities spawning grounds, and an abundant food supply. It is entirely on the basis of the lake having medium fishing intensity, good acres of water suitable for salmonids during late summer, and per year. This calculation is based on the lake having 61,000 mended rate of stocking would be 3,000,000 six-inch salmonids for smaller lakes in the southern part of the State, the recomwhich has been used as a basis for stocking recommendations to attempt to greatly increase the number of fish planted. a size suitable for planting directly into the lake, rather than taries. As the State's fish-rearing facilities are expanded, the the 553,000 salmonids planted each year in the lake and its tribu-Furthermore it is doubtful that such a heavy rate of stocking On the basis of the stocking table for trout and salmon lakes,

The results of the Fish and Game Wardens' census of fishing in the Moosehead area indicate that the average fisherman obtains good returns for his effort. In their routine checking on fishermen throughout the day, the fishermen were found to have an average of two fish per person on an all-season basis, from which we conclude that the average fisherman has about four fish at the end of each day. The salmonids taken by survey gill nets from Moosehead averaged about two pounds in weight. Making allowances for the fact that many of the salmonids taken in survey collections were of illegal size, it is a conservative estimate that the average fish caught by fishermen from Moosehead is about two pounds in weight. Thus the average catch of salmonids per fisherman per day on Moosehead is conservatively estimated at six to eight pounds.

Our recommendations for management of Moosehead Lake, most of which are discussed in the previous paragraphs, are summarized as follows:

 Do not introduce any species of warm-water game fishes (bass, perch, pickerel, etc.) into the lake.

- Do not introduce a large race of Smelt.
- Increase the legal size limit on fish taken from the lake to 12 inches for Brook Trout, and to 16 inches for Togue and Land-locked Salmon.
- Keep the present law prohibiting all fishing on the immediate tributaries of Moosehead Lake.
- Keep the immediate tributaries of the lake entirely free of beaver.
- 6. Continue stocking the lake and its tributaries with salmon, trout, and togue at the present rate of approximately 500,000 (total for the three species) per year, employing any expansion of fish-hatchery facilities for an increase in size of the salmon and trout to 6 to 7 inches before planting in the lake itself.

SURVEY OF HAYMOCK LAKE

so that the results of the two studies would furnish valuable comparisons. this lake would prove to be sufficiently similar to Moosehead Lake of Maine's relatively inaccessible lakes (Haymock Lake) was sestudy of heavily fished and rarely fished lakes. But very few lected for study by the 1944 survey. It was anticipated that studies have been made of the lakes in inaccessible parts of portant questions which might be elucidated by a comparative hand, are related to the carrying capacity of a given lake. Does Maine, which are rarely fished. As a start in this direction, one increased with good results? These are some of the very imis the reverse true, and the rate of stocking might be greatly heavy as to keep a given lake over-stocked with small fish? Or main in the lake? Is the rate of stocking in some lakes so responding increase in rate of growth among the fish which rebelow the carrying capacity of the lake accompanied by a corthe lake? And if it does, then is this decrease in population mon reduced to only a small fraction of the carrying capacity of an average amount of fishing keep a population of trout or salmonids will thrive, if the warm-water species are absent. the one hand, or the catching of fish by fishermen on the other Secondly, we do not know the extent to which fish plantings on know more about the various conditions under which the salsalmon by eliminating the warm-water species. But we need to question is of utmost importance in connection with the possiof perch, bass, sunfish, pickerel, etc. were not present. almost all lakes in all parts of the State, if the several species of competition by warm-water game fishes. The writers have bility of reclaiming many of these southern lakes for trout and long suspected that our native Brook Trout would thrive in populations are limited by environmental factors other than that difficult to determine the extent to which trout and salmon salmonid plantings in many of the lakes. Therefore it has been and these warm-water species are unquestionably detrimental stocked with one or more species of warm-water game fishes of information. Almost all of these southern lakes have become to populations of trout or salmon to the extent of nullifying management policies for lakes in the southern part of Maine, we have been continually handicapped by the lack of a certain type In making recommendations on stocking and other fish-

Haymock Lake was selected, after consultations with several State Fish and Game Wardens who knew the lake, on the basis of it being an excellent Togue and Brook Trout lake, of fairly large size, probably quite deep, rarely fished, having no warmwater game species, and never artificially stocked.

Haymock Lake is located in the northern part of Piscataquis County, and in the unorganized towns of T. 8, R. 11 and T. 7, R. 11. It is about 35 miles northeast of the northern end of Moosehead Lake. The surrounding country is entirely forested with a mixed growth of hard-woods and soft-woods, and the heavy timber extends to and overhangs much of the shore line (see Plate XIII) except at the two ends of the lake. Most of the overhanging trees are cedars. The lake is slightly over two miles long, with the long axis northwest to southeast, and it is about a mile wide at the widest point. Drainage from Haymock Lake is to the northwest into Smith Brook, Eagle Lake and the Allagash River. The lake has several small inlets, all of which were found to be dry, or dried to pools, during August of 1944.

scanty growth of Pipewort (Eriocaulon septangulare).* and a few White Water Lilies. about 30 acres containing a fairly dense growth of Potamogetons the outlet end of the lake, there is a mud-bottom, shoal area of the northwest end (at the outlet) which has silt and mud. water, except for the southeast end which has a sand beach, and with the shoal areas grading into gravel and sand toward deeper and shoal areas of the lake are mostly of rubble and boulders extending out to a depth of four feet. The immediate shore line a steep shore line rising about five to eight feet above the lake lake the aquatic vegetation is limited almost entirely to a very level, and there is a prominent shoal area about 200 feet wide feet into the lake. there are extensive shoal areas extending for several hundred At the two ends of the lake the shore line is quite flat and Around the remainder of the lake there is Around the remainder of the At

The study of Haymock Lake was made by two parties, each spending a week to 12 days on the lake. The first party was on the lake from July 8 to 15, establishing a camp, building a boat, mapping and sounding the lake, and making seine collections of fishes. The second party was at the lake from August 7 to 18.

Figure 9. Outline map of Haymock Lake, showing depth soundings in feet and depth contours at 10-foot intervals. The diagram in the upper right shows the suitability of the water in the lake for Togue or Brook Trout, on the basis of temperature and dissolved oxygen. The direction arrow indicates true north.

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personnel, this party included Dr. University of Maine.

making gill net and seine collections of fishes, making water analyses, and collecting bottom samples and plankton samples.

Depth and Water Conditions. The outline map of Haymock Lake (Figure 9) is largely the result of direct observations by the survey personnel. A series of 21 flag stations, at approximately equal intervals, was established along each of the two opposing shore lines of the lake. The distances between consecutive flag stations was measured in a few instances, but most stations were spaced by rowing along the shore line and estimating the distance from flag to flag. The shore line direction from flag to flag was determined by compass. Depth soundings were made along lines run between corresponding flags on the two opposing shores, and the spacing of soundings along a given line was again estimated while rowing the boat. The depth soundings were made with a braided tiller rope, marked at one-foot intervals, and the water depths are given in Figure 9 to the nearest foot.

The maximum depth of the lake was found to be 61 feet. The basin of the lake is of a simple, one-depression type, with the deep area in the southeastern third of the lake. Much of the expanded, central portion of the lake is from 20 to 40 feet deep, and the 50-foot water is confined to the southeastern half. The largest shoal area (less than 20 feet deep) is at the outlet end. On the basis of the lake being 2.3 miles long (our estimate), the area of the lake has been calculated to be 704 acres, and the total water volume to be 19,445 acre feet.

spect to the suitability of the water for salmonid fishes during late summer. The volume of water in acre feet within these solved oxygen, the lake has been divided into two zones with resoundings, water volume, temperature stratification, and diserately alkaline (7.4) in the surface waters to moderately acid as 5.6 p.p.m. in the deepest water. The pH ranged from modsaturation, in the upper waters, but had been reduced to as low monids of approximately 60 to 65° F. were found at depths water from 35 to 60 feet. The optimum temperatures for salcline between 20 and 30 feet, and a stratum of uniformly cold (6.5) in the deepest water. On the basis of the data on depth below 25 feet. The dissolved oxygen was about 8 p.p.m., or near down to a depth of approximately 20 feet, a pronounced thermostratification, with water temperatures above 70° F. extending tions on the lake (Table XXI) reveal a typical temperature The results of water analyses during August at the two sta-

TABLE XXI. Results of tests on temperature, dissolved oxygen, and pH at two stations on Haymock Lake

August 12, 1944. 9:30-11:30 A.M. Station: ½ mile from east end of the lake, midway be- tween north and south shores. Depth of water: 60 feet. Southwest breeze, 6 - inch waves. *In the bottom mud.	August 12, 1944. 4:00-5:00 P.M. Station: near the center of the largest portion of the lake. Depth of water: 86 feet. West wind; 10-inch waves	Description of station
95555555555555555555555555555555555555	38888881 15 0 5088888888 0 0 0	Depth in feet
74.5 74.5 74.5 74.5 78.8 78.8 78.8 78.8 78.8 78.8 78.8 78	74.5 74.8 74.1 74.1 69.8 67.6 65.3 65.3 65.3 65.3 65.3 65.3	Temper- ature: °F.
: nowwww. w. w. w. w. w. w.	6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6	Ozygen: p.p.m.
98 94 94 95 95 96 98	100 100 96 64	Oxygen: per cent saturation
566666 72 74 74 74 74 74 74 74 74 74 74 74 74 74	72. 74. 74. 74. 74. 74. 74. 74. 74. 74. 74	pH Bromthy- mol blue
		pH Cresol red

zones, and the area in acres of lake bottom in contact with these water zones, have been calculated as follows:

0-61	50-61	40-50	30-40	20-30	10-20	0-10	Depth in feet
19,445	212	930	2,260	4,080	5,440	6,523	Volume of water in acre feet
704	58	76	199	155	114	102	Area of lake bottom in acres
19,445		for salmonids	5 p.p.m.	Below 70° F.	salmonids	Above 70° F.	Zone
			(39%)	7,482 acre ft. 488 acres	(61%)	11,963 acre ft. 216 acres	Water
704		¥	(69%)	488 acres	(31%)	216 acres	Bottom

According to this calculation, the upper 61 per cent of the water volume of the lake is too warm for salmonids during late summer, and this warm water is in contact with 31 per cent of the bottom area of the lake. The deep water which is regarded

as suitable for salmonids includes 39 per cent of the lake volume, and this zone is in contact with 69 per cent of the bottom area of the lake. Thus, purely on the basis of depths, water volumes, temperatures, and oxygen (partially deficient in the deep water of the lake), Haymock Lake is a mediocre body of water for salmonid fishes (especially for Togue), in comparison to the average good trout or togue lake throughout the southern part of the State.

zoa, 1,100; Rotifera, 800; Myxophyceae, 2,000; Volvocales, 3,400; sample) Adult copepods, 664; nauplii, 183; Cladocera, 44; Protoaverage volume at the deeper level. The organisms differ qualift., 0.11 c.c. The second station is irregular in yielding a greater tative results in average volume of plankton organisms per cubic 16,000; Dinophyceae, 274 Desmidiaceae, 0; other Chlorophyceae, 13,000; Bacillarieae feet to the surface are as follows: (Based on the 12:00 M. lation of Cladocera and Desmids. The calculated average numtatively from the Moosehead plankton in a greatly reduced popu-35-15 ft., 0.06 c.c. 5:00 P. M. Aug. 12: 15-0 ft., 0.08 c.c.; 35-15 foot of lake water are: 12:00 M. Aug. 12: 15-0 ft., 0.13 c.c.; Moosehead, itself a relatively unproductive lake. The quantistratum. The lake is poor in plankton even when compared with calculate the plankton volumes for the usual 35 foot-15 foot and from 35 feet to the surface. By difference it is possible to bers of the various types of organisms per cubic foot from 15 was not operating, hauls were taken from 15 feet to the surface the two water analysis stations. Since the net closing device Four plankton samples were taken from Haymock at

Bottom Fauna. The bottom soil and bottom food organisms of Haymock Lake were studied by an analysis of 33 bottom samples collected during the period from August 14 to 18 by a 9" x 9" Ekman dredge. These samples were from stations scattered fairly uniformly over the area of the lake. The depth distribution of the samples was closely representative of the depth distribution of the bottom area of the lake, with 5 samples from depths of 1 to 10 feet, 13 samples from 11 to 30 feet, and 15 samples from 31 to 60 feet. The bottom soils encountered in these samples were mostly gravel and sand at depths of 1 to 10 feet; some gravel, mostly sand, and some mud at depths of 11 to 30 feet. The

types of organisms and the total volume and number of each type in these 33 samples were as follows:

All organisms	Sman clams (mostly Sphaeridae)	Campil along /	Chaile	niosquito larvae (Corethra)	Moonit larvae	Wides Is-	Coddicate In	Bootle laws	The stay of the st	March number, ourrowing type	Marrier nympus (310418)	Aldorfy sweet string	Fresh water shairs	Acrostic continuous	Topolog
2.401	. 0.14			. 0.061	. 0.994	. 0.015		. 0.06	0.043		0.02				Volume in c.c. Number
138	19	22	4	9	88	1	ట	1	6	43	н	11	60	. 22	Number

From a quantitative standpoint, the bottom fauna was mostly burrowing Mayflies and midges. The Mayflies were mostly from depths of less than 30 feet, and the midges were mostly from 30 to 60 feet of water. The average quantity of organisms per sample, for the 33 Haymock samples, was 4.2 organisms of 0.073 c.c. in volume. Calculations based on these figures give 7.5 organisms of 0.13 c.c. in volume per square foot of lake bottom as the average for the bottom fauna over the lake as a whole during late August. This average quantity of bottom fauna is about twice the quantity found in Moosehead Lake, more than was found (during previous summers) in other large lakes in Maine, but much less than has been found in Maine lakes of a size and depth comparable to Haymock (see page 35). The bottom fauna in Haymock was definitely a scanty one at the time of the August sampling.

The shoals of Haymock Lake, in water less than five or six feet deep, have a population of the larger bivalve molluscs numbering approximately two to four individuals per square yard. Twenty-six specimens, picked up at random on the bottom, consisted of 12 Anodonta implicata Say, 13 Elliptic complanatus (Dillwyn), and 1 Alasmidonta undulata (Say).

Fish Fauna. Our knowledge of the fish fauna of Haymock Lake is based on the results of seven over-night sets of a 375-foot

oldentifications made by Dr. Henry vander Schalie, Museum of Zoology, University of Michigan.

experimental type of gill net (same as used on Moosehead Lake, see page 35) and 5 seining collections. The gill net sets were at locations scattered over most-of the lake. The nets were set at representative depth ranges throughout the lake basin, but each net set was confined to a very limited depth range (not over six feet). The seining collections were made at several stations around the shore of the lake; four collections were made during the daytime, and one extensive collection was made after dark (9:00 to 11:00 P. M.). A list of the fish species, and the number of each, obtained from Haymock Lake by gill nets and seines is as follows:

							1										1
It is probable that the amount of will notting on Tr	Cush of Burbot (Lota tota maculosa)	Cuel or Bushet (I - Corrus cognatus)	Frank-water Carles (C.)	eunieri)	The mind Still (rimephates p. prometas)	Fat handed Winner (Onrosomus eos)	Red-hollied Dec (Ct.	Common china (Notropus A. heterolepis)	Plack road Chi. (Vi puemocus)	Lake Chub (Comercia di Linia atratulus)	Block-nood Dog (BL)	trichi) bace (Margariscus margarita nach-	North (Leacosomus corporate)	Fallfish (I controlled to the commersonnii)	Common molecular (Catalog J. Jontmales)	Brook Trant (Saladian Cristivomer a. namayoush)	Species
1	:	1	:		:	:		:	:	•	:		8	13	11	55	Number in 7 gill net collections
,	14	4	95		125	6	195	92	49	4	జ		15	80			Number in Number in 7 gill net 5 seining collections collections

their known habitat preferences, with the salmonids mostly from ferent species caught during the seven net sets conformed to per 24 hours in Haymock. The depth distribution of the difthe same, but the nets caught about three times as many Togue net catches from Moosehead Lake, the catch per 24 hours of Common Suckers and Brook Trout from Haymock was about 9.3 Common Suckers, and 2.0 Brook Trout. As compared to the ting, and the catch of fish per net per 24 hours was 9.6 Togue, gill net sets represented a total of 182 hours or 5.5 days of netcertainly the dominant predator of the lake, and is much more the most abundant of the larger non-game species. The seven abundant than the Brook Trout. The Common Sucker is by far Brook Trout, and 3 Fallfish are representative. The Togue is fauna, and that the totals of 53 Togue, 51 Common Suckers, 11 Lake was adequate to reveal the composition of the larger fish propage that the amount of gill netting on Haymock

the deeper water, the suckers from all depth ranges, and the fallfish from shallow water, as seen in the following tabulation of fish caught in each net set:

8 to 9 21-25 26-36 38-34 40-41 39-45 55-56	Depth range of individual net sets, in feet
0 0 4 12 12 16	Togue
0100010	Brook Trout
8 8 8 8 8 8 8	Common
0 0 0 0 0	Palled

The one Cottus cognatus caught in the gill net (an unusual occurrence) was in the net at a depth of 40 to 41 feet.

One obvious peculiarity of the fishes taken by the gill nets in Haymock was their large average size. There were no exceptionally large fish, but there was a definite scarcity of small fish, 7 to 12 inches long. Almost all of the Togue were from 2 to 31/2 pounds in weight, the three Fallfish were large, and a large proportion of the suckers and trout were fairly large. (See Plates XI and XII for Haymock fish, as compared to Plates VI to X for a relatively larger proportion of smaller fish from Moosehead Lake.)

The fauna of smaller fishes on the shoals of Haymock Lake, as revealed by our seining collections, is noteworthy mostly in view of the variety of minnow species, and the complete absence of any warm-water game or pan fishes. The Common Shiner, Black-nosed Shiner, Fat-headed Minnow, Common Sucker, and Three-spined Stickleback were the most common of these smaller fishes. But none of these was very abundant, and the entire shoal fauna of smaller fishes was regarded by the experienced collectors as scanty from the standpoint of quantity.

A seining collection on Smith Brook, the outlet of Haymock Lake, on August 13 yielded Fallfish, Common Shiners, Blacknosed Dace, Common Suckers, and Creek Chubs (Semotilus a. atromaculatus). Seining along ¼ mile of the stream just below the lake yielded no trout. At 10:00 A. M. on August 13, the water temperature was 75° F., the air 77° F. The brook is not a good trout feeder-stream for the lake. It gets too warm; and, being the lake outlet, it would remain warm, day and night, during most of the summer.

of fish younger than seven years and the scarcity of fish in

The VII- and VIII-fish from Haymock are of

age-length curve for the species because of the complete absence

The data (Table XXII) do not furnish a satisfactory

or Lake Trout collected from Haymock Lake represented age groups VII to XIII, with the majority of these fish confined to the three age groups VII to IX. The oldest and largest fish was 25.1 inches long, weighed 6 lbs., 5 ozs., and was in its thirteenth sum-

groups X to XIII.

mer of life.

Food of Haymock Fish. Analyses were made of the stomach contents of the 53 Togue, 11 Brook Trout, and 3 Fallfish from Haymock Lake. The results of these analyses are summarized in the following tabulation of the volume in c.c. and number (in parentheses) of each type of food organism found in the stomachs:

DT.TS

(8)

Growth of Trout and Togue in Haymock Lake. The 53 Togue absence of any smelts in the stomachs of these togue and trout self, but most of these Togue and Brook Trout were probably too consistent with the scarcity of the bottom fauna in the lake itis either very rare, or more probably not present, in the lake. is regarded by the writers as unquestionable proof that the Smelt suckers which occurred throughout the lake with the Togue, large to feed extensively on bottom organisms. The scarcity of bottom organisms in the diet of these fish is were not large enough to feed on the abundant, but fairly large, on a relatively small-sized food fish. Apparently the Togue an occasional minnow, cusk, or sucker was 3 to 5 inches long. stomachs were mostly sticklebacks and sculpins and a few in-Thus these 2- to 3½-pound Togue and Brook Trout were feeding mostly from 1 to 2 inches long (they were all measured). and to some extent on plankton waterfleas. The fish in their These Togue and Brook Trout had fed mostly on small fishes dividuals of other types. These sticklebacks and sculpins were The complete Only

TABLE XXII. Lengths, weight, sex, and maturity for different age groups of Togue and Brook Trout collected by neis from Haymork Laboratory

Species, and Date of collection (1944)	Age in growing seasons, including 1944 as a completed year	Number of fish	Average and range in lengths and weight			Ratio	
			Body or standard length in inches	Total length in inches	Weight in ounces	of males to females	Maturity*
Togue or Lake Trout Aug. 8-11	VII	11	15.6 (12.1-17.4)	18.2 (14.4-19.9)	34.3 (15.2-45.8)	7 to 4	Ten fish mature, the smallest on was an immature male.
	VIII	26	(15.3-19.0)	20.0 (18.1-22.0)	41.0 (83.4-54.2)	15 to 11 ,	Four females in poor condition and not maturing, all others
	IX	14	17.7 (16.3-18.7)	20.6 (18.8-22.0)	48.5 (36,1-49.2)	5 to 9	All fish mature,
	x	0	*****	******			
	XI	1	17.8	20.8	47.1	1	******
	XII	0			70.00	1 to 0	Fish mature,
	XIII	1	21.5	25.1	101.2	*****	*****
Brook Trout Aug. 8-10	ш	8	8.2 (7.9-8.6)	9.4 (9.1-9.8)	4.4 (4.1-4.9)	1 to 0	Fish mature, All immature,
	IV	8	10.3 (8.9-11.9)	11.7 (10.1-13.6)	9.1 (5.8-14.9)	3 to 0	All immature.
	, v	2	15.9 (14.4-17.4)	18.0 (16.3-19.7)	35.0 (23.3-46.7)	2 to 0	Both mature.
	VI .	3	14.6 (13.6-16.8)	16.9 (15.5-18.9)	28.6 (24.7-35.9)	8 to 0	All mature,

^{*}Where fish are indicated as mature, it was judged from the stage of development of their reproductive organs that they would have spawned during the fall of 1944

physical and chemical environment, the lake is very mediocre ing the summer. In other words, from the standpoint of the considerable oxygen depletion occurring in the deep water durcontained in the hypolimnion (deep and cold layer), and with a small lake, not very deep, with a small percentage of its water classes), or it might be that the species in Haymock would not lake is small, or factors of temperatures, depth, or oxygen might trout and togue water. Thus, either a space factor, because the environmental conditions. Haymock Lake is comparatively a attain so large a size as frequently as in Moosehead because of fewer number of old fish (an effect of cyclic abundance of year very large togue in Haymock may be attributed either to the observational proof. In comparing the Haymock togue with survival of the smaller ones. This is merely a theory with no to 10-pound togue in Moosehead is obvious. The fact of fewer those from Moosehead, the relatively greater abundance of 5do so until a depletion of the larger ones would allow a greater togue consume most of the smaller ones, and would continue to tion for such a cycle of abundance is that the many large-sized togue in our Haymock collections is regarded as evidence that ing half a pound to one pound. The absence of these smaller and in Moosehead they caught many III- to V-year togue weighmock togue grow at a normal rate (as compared to Moosehead a fish of that age in Moosehead. Our data indicate that the Haythese smaller togue were rare in the lake. A suggested explana-The same gill nets were used in both Moosehead and Haymock, abundance of age groups, with most fish VII to IX years of age. fish) up to an age of VII to VIII years and to a weight of 2 to 3 and XI-fish from Haymock are smaller. The single XIII-fish tion of Togue in Haymock was obviously in a stage of cyclic pounds, after which their growth is slower. The 1944 populafrom Haymock was definitely smaller than would be expected of about the same average size as the corresponding fish from Moosehead Lake, but there is a definite indication that the IX-

Psubsequent to writing this report, the writers received a letter dated December 15, 1946 from Mr. George S, Fuller of Boston who owns the one set of camps on Haymock Lake. According to his letter, Mr. Fuller and a companion have fished Haymock Lake for many years formerly had excellent trout this year [1944] it seemed to have pretty nearly reached the depths of poor have special significance in connection with our observations. If our conclutions are correct that togue are in a definite cycle of abundance and are now appearance of abundant year classes of togue, because of competition, would to be expected that the disappearance of the trout population. But it is equally may be followed by an increase in abundance of the present abundant cycle of togue may be followed by an increase in abundance of trout.

operate in limiting the size of togue in Haymock more than in Moosehead.

The 11 Brook Trout from Haymock included age groups III to VI (Table XXII) and the growth curve represented by these few fish is quite similar to that for trout from Moosehead. The larger Haymock trout were 2 to 3 pounds in weight and were V and VI years old.

Summarizing our scale records, the growth of togue and trout in Haymock compares favorably with that in Moosehead, except that in Moosehead there are more very old fish of a very large size.

were not being eaten extensively by the togue and trout. on extensively by the togue. Apparently, the Smelt is not sculpins also inhabit the deeper waters of the lake and are fed varied fauna of smaller shore fishes, of which sticklebacks and to the preponderance of older age groups. The lake also has a average size. In the case of togue, this large average size is due some trout, and these salmonids and suckers are of a fairly large not an excellent togue or trout lake, but a mediocre one. basis of depth, temperatures, and dissolved oxygen, the lake is lake has an abundant population of togue and of suckers and has 704 acres in area, and has a maximum depth of 61 feet. On the summarized briefly as follows: The lake is about two miles long, Summary. Bottom food organisms are not very abundant, The results of the study of Haymock Lake may be The

It has been our assumption that the Togue is pre-eminently a deep-water fish, requiring a lake with a considerable area that was at least 60 to 80 feet deep. However, the situation in Haymock Lake has indicated that the Togue will thrive in a lake that is not especially deep and even though the deep water is not especially favorable from the standpoint of dissolved oxygen.

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PLATE I

Making tests on the chemistry of the water.

Upper: A bottle of water for oxygen determination is being obtained from the Kemmerer water sampler (the brass cylinder). This sampler is adapted for collecting a water sample from any desired depth.

Lower: A colorimetric pH test is being made on a sample of water.

MATERIA PRESENTATION

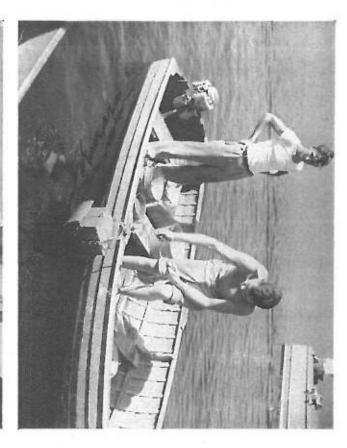




PLATE II

Upper: An Ekman dredge, $9" \times 9"$ square, with the jaws open, being lowered for collection of a bottom sample.

Lower: A pail of mud brought up from the bottom of Moosehead Lake by one haul of the Ekman dredge. The entire sample is screened through the #20 mesh sieves for collection of the bottom organisms.

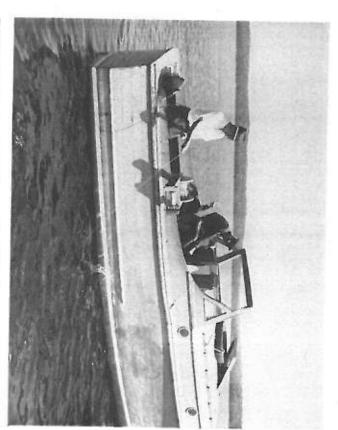




PLATE III

Upper: Sounding of Moosehead Lake was done with brass chains and tiller ropes marked at 2- and 5-foot intervals. The boat was brought to a standstill at each sounding. For depths of the lake, see the folded map on inside of the back cover of this report.

Lower: Hauling one of the 375-foot experimental gill nets on Moose-head Lake. Two suckers in the net are in view in this photo.

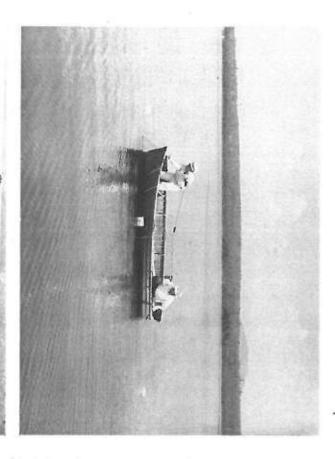




PLATE IV

Upper: Examining one of the experimental gill nets set in a suspended position at a specified depth below the surface. Numerous small floats (three shown in the photograph) were used to suspend the net above the bottom.

Lower: Two Land-locked Salmon caught by the experimental gill net at a depth of 30 feet. The net had been suspended at a depth level of 30 feet in water 80 feet deep. Lily Bay, August 3, 1944.

MAINE DEVELOPMENT COMMISSION PHOTOS,





PLATE V

Upper: All fish collected by the gill nets were taken to the field laboratory, where they were weighed and measured, scale samples were saved for studies of age and growth, and the stomachs were saved for food analyses.

Lower: Part of the survey personnel examining fish collections taken by gill net and seine.

MAINE DEVELOPMENT COMMISSION PHOTOS

PLATE VI

Gill net collections from Moosehead Lake.

Upper: From North Bay, near Center Island, August 22, 1944, from a water depth of 45 to 63 feet. Five Brook Trout, 2 Togue, 1 Land-locked Salmon, 2 Menominee Whitefish, 1 Cusk, and 3 Fine-scaled Suckers. The salmon (upper right) was 21.8 inches long and weighed 3 pounds, 61/2 ounces.

Middle: From off Hardscrabble Point, August 18, 1944, from a water depth of 47 to 56 feet. Two Togue, 1 Common Whitefish, 3 Common Suckers, and 25 Fine-scaled Suckers.

Lower: From North Bay, near Center Island, August 22, 1944, from a water depth of 44 to 45 feet. One Brook Trout, 5 Togue, 2 Common Whitefish, 1 Menominee Whitefish, 2 Cusk, and 3 Fine-scaled Suckers. The Brook Trout (the largest fish) was 20.9 inches long, and weighed 3 pounds, 13 ounces.

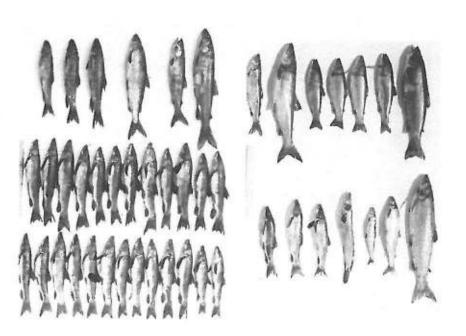


PLATE VI

PLATE VII

Gill net collections from Moosehead Lake.

Upper: From west of Farm Island, August 16, 1944, from a water depth of 83 to 102 feet. One Cusk, 5 Fine-scaled Suckers, I Common White-fish, and 5 Togue. The Cusk was 25.8 inches long and weighed 4 pounds, 12 ounces.

Middle: From Lily Bay, August 1, 1944, from a water depth of 38 to 48 feet. One Fine-scaled Sucker, 1 Menominee Whitefish, 2 Brook Trout, 9 Cusk, and 8 Common Suckers.

Lower: From west of Farm Island, August 17, 1944, from a water depth of 70 to 100 feet. Six Togue, 14 Fine-scaled Suckers, 1 Cusk, and 1 Common Sucker. The largest Togue was 21.7 inches long, and weighed 3 pounds, 3½ ounces.





PLATE VII

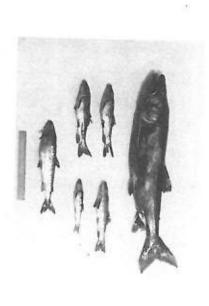
ATE VII

Gill net collections from Moosehead Lake,

Upper: From Big Duck Cove, July 11, 1944, from a water depth of 26 to 27 feet. Eleven Brook Trout, 1 Cusk, 1 Land-locked Salmon, 5 Togue, 6 Common Suckers, 1 Common Whitefish, and 3 Menominee Whitefish. The three largest Brook Trout were 23.5, 21.4, and 20.6 inches long, 5 pounds 5 ounces, 3 pounds 15 ounces, and 3 pounds 8 ounces in weight, and had lived through 6, 6, and 5 winters, respectively.

Middle: From Big Duck Cove, July 11, 1944, from a water depth of 55 to 75 feet. One Togue (the large fish), 4 Fine-scaled Suckers, and I Menominee Whitefish. The Togue was 34.9 inches long, and weighed II pounds, 111/2 ounces.

Lower: From Spencer Bay, July 18, 1944, from a water depth of 23 to 24 feet. Seventeen Brook Trout, 69 Common Suckers, 3 Togue, and 1 Land-locked Salmon.



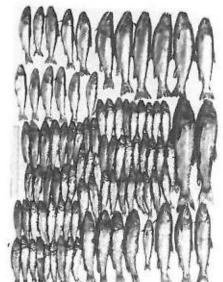


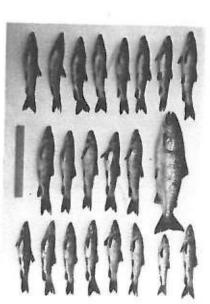
PLATE VIII

PLATE IX

Gill net collections from Moosehead Lake.

Upper: From east of Farm Island, July 25, 1944, from a water depth of 63 to 65 feet. Two Togue. The larger one was 31.2 inches long, and weighed 14 pounds, 8 ounces.

Middle: From off Hardscrabble Point, August 18, 1944, from a water depth of 56 to 67 feet. One Land-locked Salmon and 21 Fine-scaled Suckers. The salmon was 20.2 inches long, and weighed 4 pounds, 8 ounces. Lower: Off the south end of Farm Island, August 18, 1944, from a water depth of 18 to 21 feet. Ten Common Suckers.



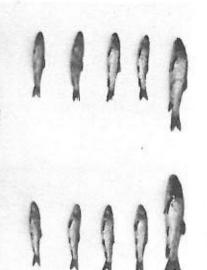


PLATE IX

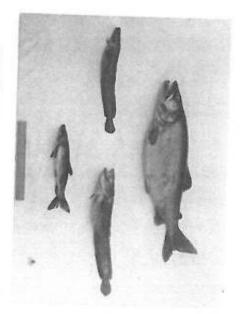
Gill net collections from Moosehead Lake,

Upper: From west of Farm Island, August 17, 1944, from a water depth of 100 to 108 feet. One Togue, 2 Cusk, and 1 Fine-scaled Sucker. The Togue was 27.2 inches long, and weighed 9 pounds, 13 ounces.

Lower: West of the south end of Farm Island, June 22, 1944, from a water depth of 76 to 100 feet. Thirteen Togue, 5 Fine-scaled Suckers, and 1 Common Sucker. The three largest Togue were 29.8, 28.1, and 26.7 inches long, 13 pounds 0 ounces, 9 pounds 15½ ounces, and 8 pounds 10 ounces in weight, and had lived through 11, 8, and 10 winters of life, re-Middle: Along the west shore of Kineo, June 29, 1944, from a water depth of 52 to 55 feet. Twelve Fine-scaled Suckers, 12 Togue, 5 Common Suckers, and 3 Cusk. The largest Togue weighed 3 pounds, 12½ ounces.

spectively.

As a summary, Plates VI to X, incl., show a total of 57 Togue, 36 Brook frout, 4 Land-locked Salmon, 8 Menominee Whitefish, 5 Common Whitefish, 103 Common Suckers, 94 Fine-scaled Suckers, and 20 Cusk. These totals are roughly representative of the totals for these species caught in on these plates are fairly representative of the size range of fishes caught by the nets. Therefore, Plates VI to X are believed to represent the general composition of the fauna of larger fishes (over 8 to 9 inches long) in Moosehead Lake, with the exception that salmon are more abundant than is indicated by these collections (see text). Each of these photos shows the fishes caught by one net in one over-night set.





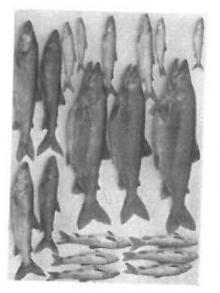


PLATE X

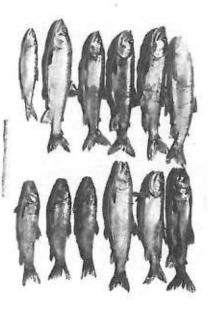
PLATE XI

Gill net collections from Haymock Lake.

Upper: From a water depth of 21 to 25 feet, August 9, 1944. One Brook Trout, 14 Common Suckers, and 1 Crayfish.

Middle: From a water depth of 55 to 56 feet, August 9, 1944. Nine Togue and 3 Common Suckers. The largest Togue was 20.9 inches long, and weighed 3 pounds.

Lower: From a water depth of 3 to 9 feet, August 10, 1944. Five Common Suckers and 3 Fallfish. The largest Fallfish was 18.5 inches long, and weighed 2 pounds, 9 ounces.



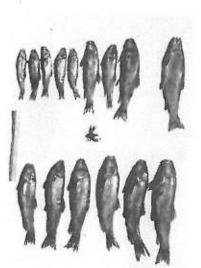


PLATE XI

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PLATE XII

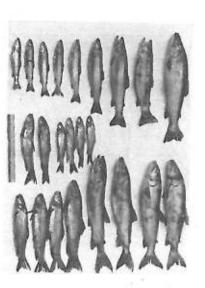
Gill net collections from Haymock Lake.

Upper: From a water depth of 26 to 36 feet, August 10, 1944. Nine Brook Trout, 4 Togue, and 10 Common Suckers. The largest Brook Trout (upper left) was 19.7 inches, and weighed 2 pounds, 14% ounces.

Middle: From a water depth of 40 to 41 feet, August 11, 1944. Twelve Togue and 3 Common Suckers. These Togue ranged from 2 pounds, 2½ ounces to 2 pounds, 15½ ounces in weight.

Lower: From a water depth of 33 to 34 feet, August 11, 1944. Twelve Togue and 13 Common Suckers. The largest Togue weighed 3 pounds, 6 ounces, and most of them weighed over 2 pounds.





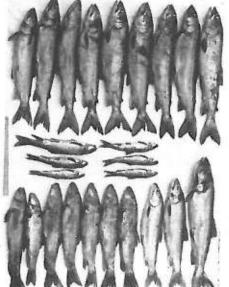
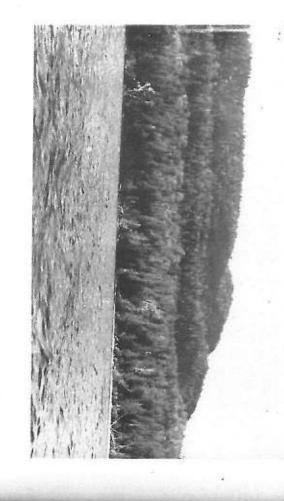


PLATE XII



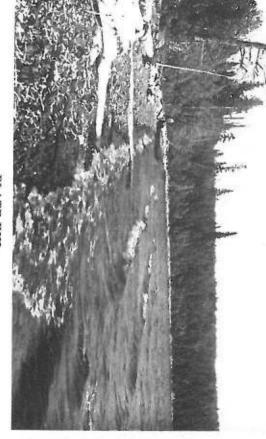


PLATE XIII

Haymock Lake, in T. 7 and T. 8, R. 11, Piscataquis County, Maine. Two views of the east end of the lake. August 13, 1944. Upper photo is looking northeast. Lower photo is looking south.

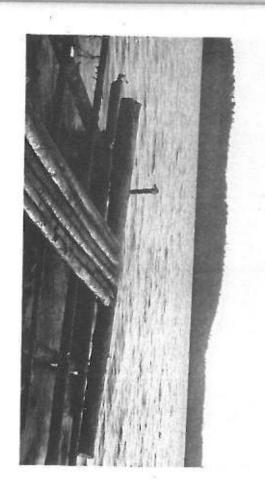




PLATE XIV

Upper: Haymock Lake. Looking south across the lake from a temporary dock at the lake survey campsite. August 14, 1944.

Lower: Smith Brook, the outlet of Haymock Lake, about 200 yards below the lake. Lake survey party making a seine collection.

PLATE XV

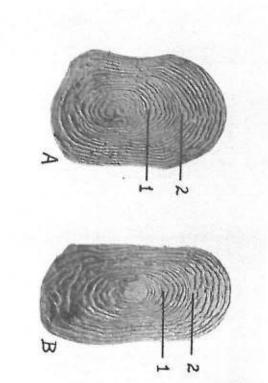
Scales of Brook Trout.

A.—Haymock Lake. August 10, 1944. Immature male, total length 9.1 inches, weight 4.1 ounces. Fish in its third summer of life. The scale shows two year marks, plus seven circuli in the anterior field (upper in the photograph) representing growth during 1944.

B.—North Bay of Moosehead Lake. July 12, 1944. Immature female, length 8.7 inches, weight 4.0 ounces. Fish in its third summer of life. Winter marks numbered 1 and 2.

C.—Spencer Bay of Moosehead Lake. July 18, 1944. Immature male, length 9.4 inches, weight 4.4 ounces. Fish in its third summer. Winter marks numbered 1 and 2.

D.—Lily Bay of Moosehead Lake. August 1, 1944. Immature male, length 13.5 inches, weight 16.9 ounces. Fish in its fifth summer of life. Winter marks numbered 1 to 4.



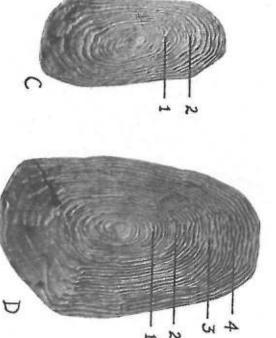


PLATE XV

PLATE XVI

Scales of Brook Trout.

A.—From just north of Sugar Island on Moosehead Lake. August 3, 1944. An adult female, length 19.6 inches, weight 2 pounds, 14 ounces. The scale shows five winter marks, and a relatively large sixth-summer scale growth which would indicate that this fish had nearly completed its 1944 growth by August 3.

B.—From Lily Bay of Moosehead Lake. August 1, 1944. An adult female, length 15.1 inches, weight 1 pound, 10 ounces. Fish in its fifth summer of life. Four winter marks are numbered 1 to 4.

C.—A 19% inch Brook Trout, weighing 3 pounds, 12 ounces, caught in Moosehead Lake, September 28, 1892, and recorded in the fish-record book at Wilson's Camp. The scale shows 4 winter marks; the fish had lived through 5 growing seasons (including 1892).

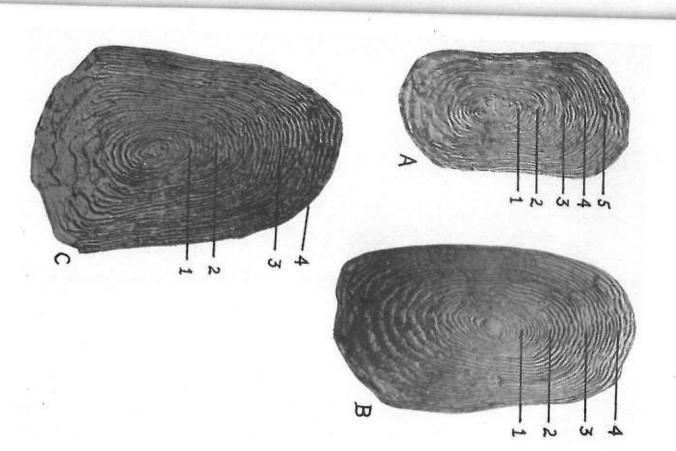


PLATE XVI

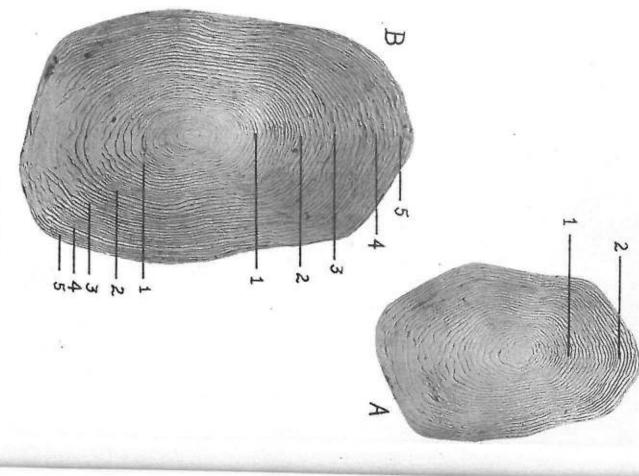


PLATE XVII

A.—Scale of a Togue or Lake Trout. North Bay of Moosehead Lake. August 25, 1944. Immature male, length 9.8 inches, weight 4.6 ounces. Fish in its third summer of life. The scale shows two winter marks numbered 1 and 2.

B.—Togue from Moosehead Lake, north of Farm Island. July 14, 1944. Immature male, length 15.9 inches, weight I pound, 4 ounces. Fish in sixth summer.

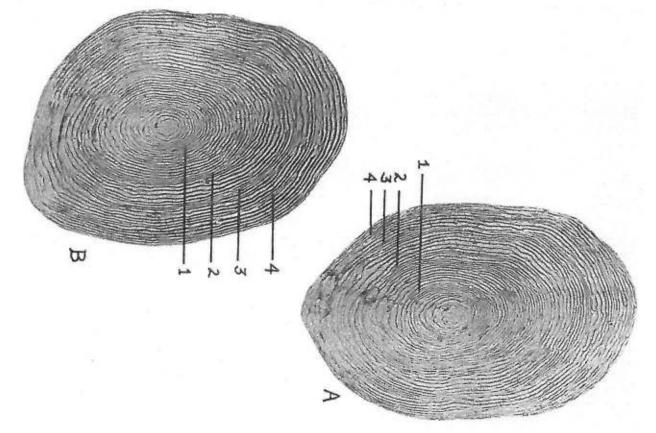


PLATE XVIII

Scales of two four-year-old (fifth summer) Togue from Moosehead Lake.
Winter marks are numbered 1 to 4.

A.—From North Bay. July 12, 1944. Immature female, length 13.9 inches, weight 13.8 ounces.

B.—From west of Farm Island. August 17, 1944. Immature male, length 15.7 inches, weight 1 pound, 1 2/3 ounces.

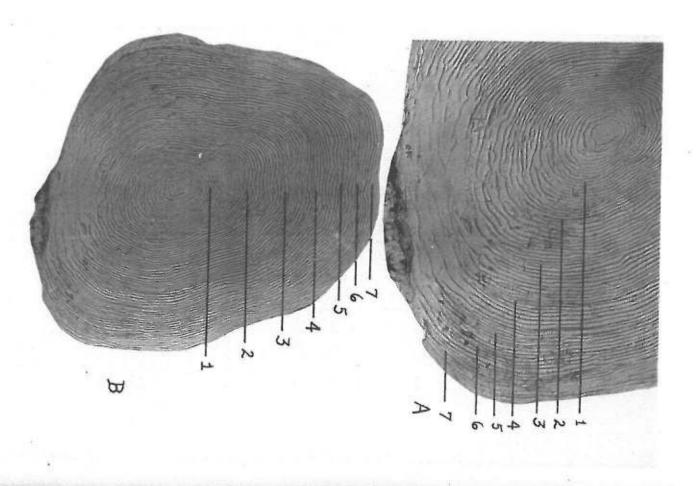


PLATE XIX

Two photos of a scale from a Togue from Moosehead Lake, east of Deer Island. September 1, 1944. Adult female, length 21.3 inches, weight 2 pounds, 14½ ounces. Fish in its eighth summer. Winter marks are numbered 1 to 7. The lower photo (B) is the entire scale. The upper photo (A) is a further enlargement of the lower, right-hand portion of B. Most Togue scales are most-easily read in the posterio-lateral angle, as indicated in A.

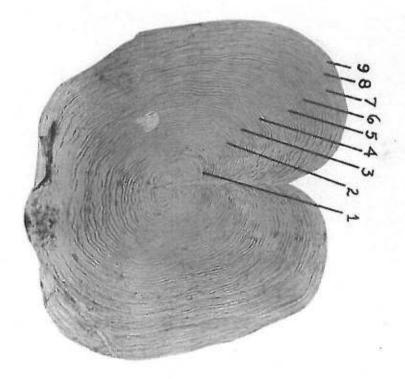


PLATE XX

Scale of a Togue, from Moosehead Lake, north of Deer Island. July 6, 1944. Adult female, length 28.3 inches, weight 4 pounds, 8 ounces. This is an abnormal, double scale, resulting from two scales being incompletely separated in their "skin pockets." Due to the abnormal shape of the left side of this scale, the characteristics of the winter marks are accentuated. According to our interpretation, this fish was in its tenth summer. Winter marks are numbered 1 to 9.

A.—Scale of a Togue from Haymock Lake. August 8, 1944. Adult female, length 19.6 inches, weight 2 pounds, 4½ ounces. Fish in its eighth summer.

B.—Scale of a Land-locked Salmon. Moosehead Lake, east of Deer Island. August 31, 1944. Immature female, length 11.7 inches, weight 8.4 ounces. Fish in its third summer of life. Winter marks numbered 1 and 2. By assuming a direct proportion relationship between scale measurements and length of the fish, it is calculated that this fish was 3.7 inches long at the end of its second summer. Presumably the first two years were spent in a stream; and most, if not all, of the third summer, up to the time of capture, had been spent in the lake.

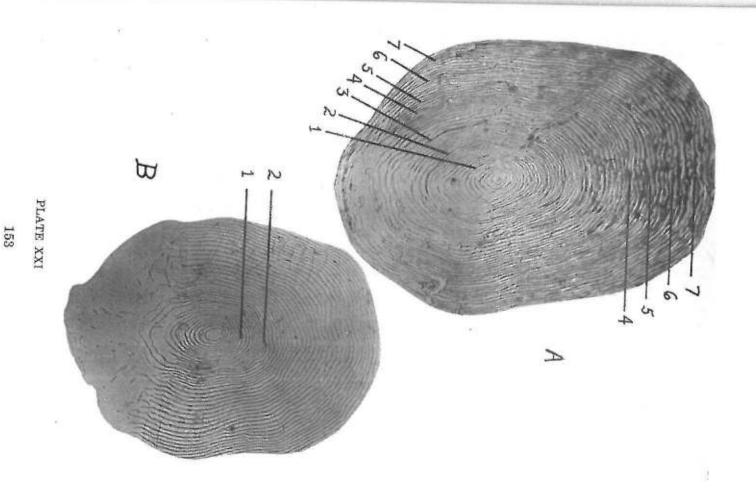


PLATE XXII

Scale of a Land-locked Salmon caught on Moosehead Lake on June 9, 1908. This scale and a record of the fish were obtained at Wilson's Camp. The fish was 25½ inches long, and weighed 6 pounds, 8 ounces. This photo shows most of the anterior (embedded) field of the scale. The fish was beginning its seventh growing season. Winter marks are numbered 1 to 6. A break in the growth rhythm (at x) is not considered to be a winter mark, but, rather, to have occurred during the fourth summer. The first winter mark (at 1) was more obvious in other scales from this fish. For a discussion of the spawning mark (at 5 Sp.), see caption to Plate XXIII.

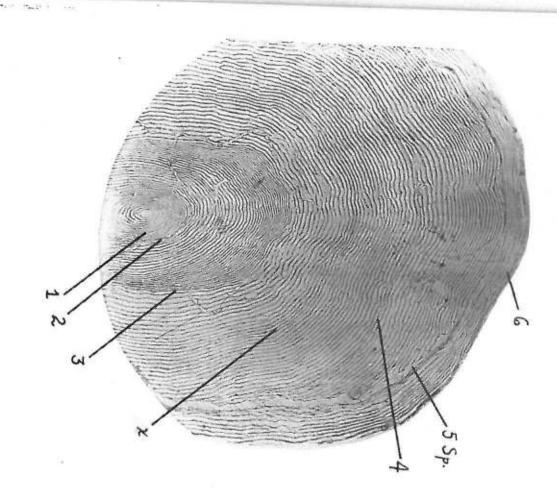


PLATE XXII

PLATE XXIII

Enlargement of a portion of the same scale shown on Plate XXII. Land-locked Salmon caught in Moosehead Lake, June 9, 1908, and recorded in the fish-record book at Wilson's Camp. The salmon was 25½ inches long, weighed 6 pounds, 8 ounces. This portion of the scale shows the great contrast between stream growth (from the focus of the scale out to the second winter mark) and lake growth (outside of the second winter mark). In the lower right is also shown the character of a typical spawning mark on a salmon scale. This fish had spawned at the end of its fifth year. As a result of maturing and spawning, there was an absorption or erosion of the margin of the scale, leaving the margin irregular and resulting in a scar area. When growth was resumed in the sixth summer, the new circuli (at 5 Sp.) were laid down against the scar line forming a spawning mark. An apparent interruption in the growth rhythm during the fourth year is indicated by the line at x; it is not considered to be a winter mark (see also Plate XXII). On this section of the scale, the fourth winter mark was completely eliminated by the erosion of the spawning mark after the fifth

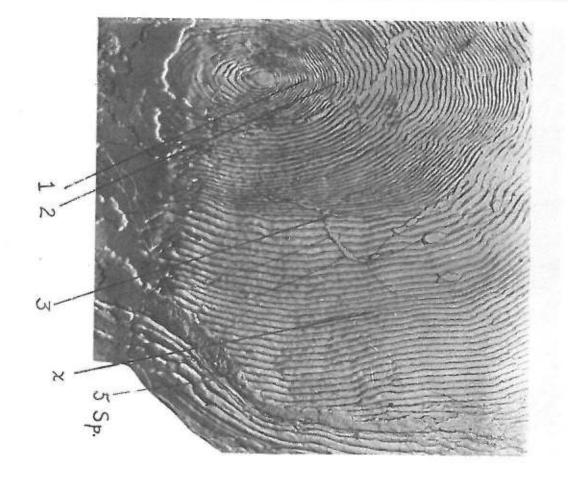


PLATE XXIII

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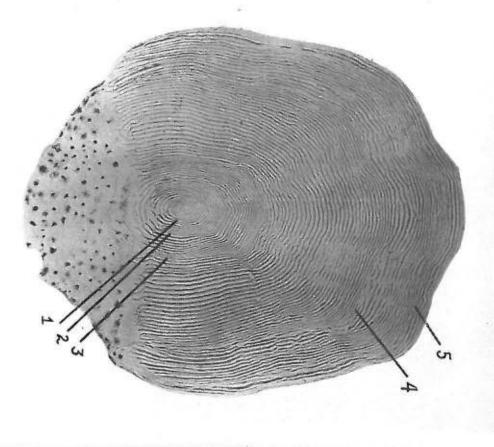
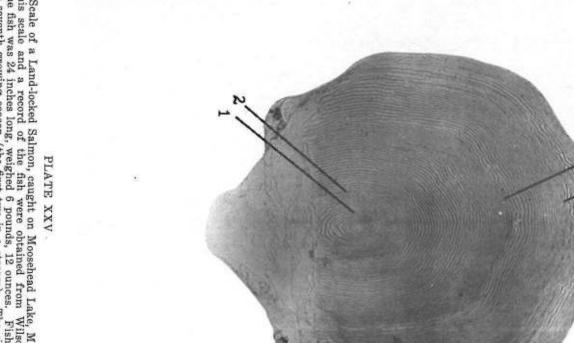


PLATE XXIV

Scale of a Land-locked Salmon, from Lily Bay of Moosehead Lake, August 3, 1944. Adult female, length 19.6 inches, weight 3 pounds, 11% ounces. Fish in its sixth summer. The scale shows three years of stream growth followed by two years and part of a third year in the lake.



Scale of a Land-locked Salmon, caught on Moosehead Lake, May 5, 1918. This scale and a record of the fish were obtained from Wilson's Camp. The fish was 24 inches long, weighed 6 pounds, 12 ounces. Fish beginning its seventh growing season (the first two in a stream). The sixth winter mark did not reproduce well in this photo.

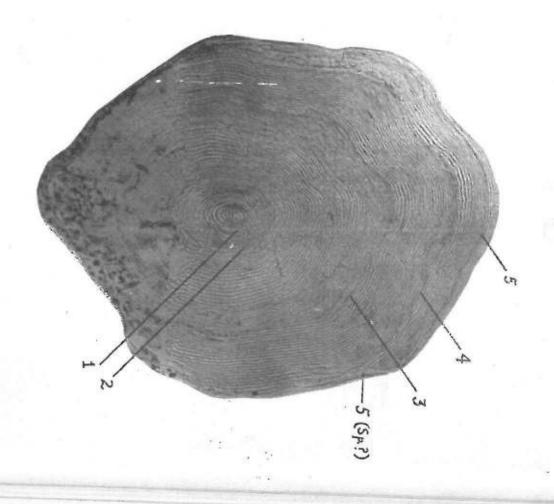


PLATE XXVI

Scale of a Land-locked Salmon. North Bay of Moosehead Lake. August 22, 1944. Adult female, length 21.8 inches, weight 3 pounds, 6½ ounces. Fish in its sixth summer. The fish possibly spawned at the end of its fifth growing season—see 5 (Sp.?).