THE RANGELEY LAKES, MAINE; WITH SPECIAL REFERENCE TO THE HABITS OF THE FISHES, FISH CULTURE, AND ANGLING

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INTRODUCTION.

This report is based primarily upon a biological and physical examination of Umbagog Lake during the summer of 1905 by a party detailed by the Bureau of Fisheries, under the immediate direction of the writer. During the summer of 1904 similar work had been conducted by the same party at the Connecticut Lakes in northern New Hampshire. The proximity of the Connecticut Lakes and their tributaries to some of the headwaters of the Androscoggin system, having a possibly significant bearing upon the local geographical distribution of the fishes, made it desirable to ascertain the faunal relationship. Umbagog Lake was selected as the particular field of operations owing to its geographical position and the fact that since the erection of Errol Dam it is the final reservoir of the entire headwaters of the Androscoggin River. Umbagog is not a representative lake, as its physical conditions, both natural and those brought about by artificial modifications, are far different from any of the other lakes in the system. It is, however, in many respects a peculiar one, and, owing to the peculiarities, offered an attractive subject for faunal study, both by itself and in its relation to the rest of the Rangeley chain of lakes.

A thorough biological survey of the whole upper Androscoggin system, or even of the lakes of the principal chain, would have afforded a more valuable contribution to science and fish culture, but it would have entailed more time and a larger party than were available.

Although the remainder of the chain received no special study by the party, the writer, in previous years, had opportunity for making observations therein, especially upon the fishes, and it has been possible to obtain much information from other sources. The accompanying descriptions of the lakes and their physical conditions are mainly adapted from the first and second reports of the Maine Water Storage Commission for 1910 and 1911, respectively. The appended maps are somewhat modified copies of those made by the water-resource branch of the United States Geological Survey in cooperation with the Maine Water Storage Commission.

This report is mainly concerned with the present condition of the fish fauna of the lakes as affected by the modified physical conditions and the introduction of various nonindigenous species and the possible bearings upon the maintenance of the fishing

in those waters and fish culture and fish-cultural distribution in general. This involves not only an analysis of the data concerning the habits and local distribution of the fishes and their relation to their environment, gathered during the investigation and desultory observations, but a consideration of the history of angling and fish culture in those waters.

LOCAL GEOGRAPHY AND PHYSICAL FEATURES OF THE RANGELEY LAKES SYSTEM.

The Rangeley Lakes lie in the western part of Maine, just below the forty-fifth parallel of latitude; in fact, Cupsuptic Lake, at present a northern arm of Lower Rangeley, or Mooselucmaguntic Lake, just impinges on that parallel. The general trend or flow of the lakes is southwestward, discharging their waters into the Androscoggin River. There are five large lakes in the chain, having an area of 64.59 square miles. The entire drainage area, exclusive of that of the Magalloway River, is 635 square miles, making the area drained by the Androscoggin at Errol Dam, the lowest of the storage dams, situated about 5 miles below Umbagog Lake, 1,095 square miles. The total storage of these five lakes is 21,357,358,000 cubic feet. They have an average elevation above sea level of about 1,420 feet at high-water line.

The Rangeley series comprises four, or, as sometimes denominated, 5, large lakes, which are not upon the same level, as shown by the following statement:

	Feet (high-water line) above sea level.
Oquossoc, or Upper Rangeley Lake	1,517
Mooselucmaguntic, or Lower Rangeley Lake	1,467.41
Molechunkamunk, or Upper Richardson Lake	1,448.9
Wellekennebacook, or Lower Richardson Lake	1,448.9
Umbagog Lake	1,246.3

Cupsuptic Lake is practically a portion of Mooselucmaguntic, and Molechunkamunk and Wellekennebacook really compose one body of water between the outlet of Mooselucmaguntic and Middle Dam. A narrowing in the lake gives rise to the popular designation of the two expansions as separate lakes.

The surrounding country is mainly hilly, and, excepting immediately about Umbagog and Upper Rangeley Lakes, is principally a vast forest, which has been more or less modified by many years of lumbering operations and, to some extent, by forest fires. Lumbering operations are still extensively carried on, with somewhat different objects and certainly by different methods from those of olden times. The lakes and streams have also been modified both for lumbering and milling purposes, and the lakes now form the principal storage reservoir for the great mills all along the Androscoggin, particularly at Berlin, N. H., Rumford Falls, Livermore Falls, Auburn, Lewiston, and Brunswick, Me.

Such modification of the physical conditions could not fail to have had effect in one way or another on the fauna of the lakes. Changes in the level of the lakes necessarily would tend to change the feeding and breeding places of the fishes, and dams interfere with their migration from one lake to another.

Wells stated in 1869 that there were four dams in the Rangeley chain—one at the foot of Rangeley (Oquossoc), 10 feet high with 4-foot head of water; one, Upper Dam, at the foot of Lower Rangeley (Mooselucmaguntic), 20 feet high with 14-foot head; one, Middle Dam, at the foot of Richardson (Wellekennebacook), 16 feet high with 12-foot

head; and one on the Androscoggin below the mouth of the Magalloway, at Errol, 14 feet high with 14-foot head. The present dams are mentioned in connection with the individual lakes controlled by them.

There is much outlying or tributary water composed of lakes and streams, some of which are of considerable size. Some of the ultimate headwaters of these Rangeley Lakes affluents are in close proximity to the headwaters of other river systems, as the Connecticut, St. Lawrence, and Kennebec, but doubtless in most, if not all, instances there are topographical barriers to the interpassage of fishes.

There are no available data as to when the lakes begin to freeze or which freezes first. The time of freezing depends greatly upon the season, and probably the smaller bodies of water will be completely frozen first. The time of the breaking up and clearing of the lakes varies also with the season.

The phenomenon of the clearing of the lakes of ice is usually referred to as "going out." One says, "The ice has gone out of the lakes," as though it had at some particular time left by the way of the outlet. As a matter of fact, its departure is mainly by the reverse process of its coming; the melting process, however, is aided by winds and waves, which drive the ice about and dash it against the shores.

The depth to which the lakes freeze depends upon the weather conditions, but the Rangeleys oftentimes freeze at least 3 feet. On April 7, 1893, it was reported that the ice was 28 inches thick, all solid blue ice; about the middle of March, 1895, it was said to be fully 3 feet thick, one-half of which was solid blue ice and the rest snow ice; and on April 19, of the same year, it was stated that the ice was 22 inches thick.

The following statement shows the dates of the clearing of the lakes from 1875 to 1915, inclusive:

1875.....May 28	1889.....Apr. 29	1903.....Apr. 29
1876.....May 26	1890.....May 9	1904.....May 1
1877.....May 6	1891.....May 14	1905.....May 2
1878.....Apr. 26	1892.....May 9	1906.....May 13
1879..... ———	1893.....May 21	1907.....May 19
1880.....May 8	1894.....May 2	1908.....May 10
1881.....May 15	1895.....May 7	1909.....May 14
1882.....May 21	1896.....May 9	1910.....Apr. 19
1883.....May 14	1897.....May 12	1911.....May 13
1884.....May 11	1898.....May 6	1912.....May 3
1885.....May 16	1899.....May 7	1913.....May 4
1886.....May 5	1900.....May 15	1914.....May 18
1887.....May 20	1901.....May 4	1915.....Apr. 29
1888.....May 23	1902.....Apr. 28	

OQUOSSOC LAKE.

Oquossoc or Rangeley Lake proper, sometimes called Upper Rangeley Lake, is the uppermost of the series. It is generally but irregularly rhomboidal in shape but with long coves at each angle—Rangeley Cove at the northeast, Greenvale Cove at the southeast, Outlet Cove at the northwest, and South Bog Cove at the southwest. The other principal coves, named in order from the eastward, are Hunter and Smith Coves on the north and South and Little South Coves on the south. The islands are few in number, principally Dicksons, northwestward of Greenvale Cove, and South Bog Islands at the entrance of South Bog Cove.

Oquossoc Lake is about 5⅓ miles in a direct line in its long axis from the east to west end. The Greenvale and Outlet Coves are the longest two, each about 1½ miles, making the extreme length of the lake approximately a little over 8 miles. Its greatest width directly north from just east of South Cove is nearly 2 miles, and the narrowest place at right angles to the east and west axis is about four-fifths of a mile, northward from Long Point to just west of Mingo Springs; that is, about 1¾ miles from the west end of the lake. The Maine Water Storage Commission gives its average high-water elevation above the sea as 1,577.2 feet and its area as 9.76 square miles. The greatest depth, 145 feet, is in the upper end, about three-fourths of a mile northward and westward from Greenvale Cove or directly north by compass from Haines Point, the western limit of Greenvale Cove. Greenvale Cove is 60 to 94 feet deep near its entrance, shoaling gradually to the head of the cove. South Bog Cove carries 14 to 30 feet in its deepest water. The mid lake carries from 50 to over 100 feet as far west, at least, as a line northward from South Bog Islands. Thence it shoals irregularly northwestward to the outlet.

The storage is controlled by a crib dam of the open-weir type, over which the water seldom, if ever, flows. The right-hand half of the dam is occupied by the usual log sluicing gates, housed over. The elevation of the sill is 60.65 feet above the sill of the dam at the foot of Mooselucmaguntic Lake, giving the outlet, Rangeley stream, a considerable current in its 2.6 miles course to the lake below. The stored water of this lake, some 2,584,328,000 cubic feet, is usually the last to be drawn upon, and hence high level is usually maintained through the summer tourist season.

The principal tributary waters are as follows: Northeast of Rangeley Village is Gull Pond, having an area of 0.75 square mile and being about 1¼ miles long by five-eighths of a mile wide, which discharges its water into Haleys Pond through a stream about three-fourths of a mile in length. Haleys Pond is approximately three-fourths by one-half of a mile in its greatest diameter and has a depth of 7 to 17 feet, the deepest water being at the upper end. It is separated from Oquossoc Lake by a dam and short stream only, which empty into Rangeley Cove. The northern affluents are: Round Pond, about one-half by less than one-fourth of a mile, connected by a short stream with Dodge Pond, which is 1⅛ miles long by a little over one-fourth of a mile wide and empties into Hunter Cove through Dodge, or Collins Brook, something over 1 mile in length. The deepest water of Dodge Pond is at the outlet end, where it is 40 feet, but it carries a depth of 35 feet to near the upper end. About one-fourth of a mile from Dodge Pond another stream from Quimby Pond joins Dodge Brook. Quimby Pond, with an area of 0.27 square mile, is about three-fourths by one-half of a mile in extreme diameters and its outlet about 1½ miles in length. There are several other brooks from diminutive ponds or none on the north shore, but they are of no consequence so far as this report is concerned. Flowing into the extreme end of Greenvale Cove is Niles Brook from the eastward and Long Pond Brook, conveying the waters of Long Pond and its tributary brooks. Long Pond is about 1⅞ miles long and three-fourths of a mile in its southern diameter. The distance from Long Pond to the lake by the outlet is about 1⅞ miles. There are several brooks tributary to Long Pond, one of which comes from a small pond something over 2½ miles to the southwestward, and Long Pond is not over one-half of a mile in a direct line from the headwaters of a branch of Sandy River, a tributary of the Kennebec. Several minor brooks empty

into the lake on its southern shore between Greenvale Cove and South Bog Cove. At the southern end of South Bog Cove, South Bog Brook, some 5 miles or more in length, discharges the waters of Mountain and Beaver Ponds. Mountain Pond is about one-half of a mile long and somewhat less than one-fourth of a mile wide. Its outlet is over 1½ miles long, with a considerable pondlike expansion in its course, and joins the outlet of Beaver Pond about three-fourths of a mile below the latter pond, to form South Bog Brook. Beaver Pond is about five-eighths of a mile long and one-fourth of a mile wide. Various small brooks enter the lake between South Bog Cove and the outlet. The chief importance of many of them, and it is of considerable importance to the lake, is that they afford shelter or nurseries, as it were, for young trout.

The permanent village of Rangeley is situated on Rangeley Cove, the terminus of the Sandy River and Rangeley Lake Railroad. There are numerous summer hotels, public camps, and private summer residences, especially at the east end, along the north shore and east end of the lake. About three-fourths of a mile from the outlet is the comparatively recent village of Oquossoc, reached by the Rumford Falls and Rangeley Lake branch of the Maine Central Railroad.

MOOSELUCMAGUNTIC LAKE.

This lake, sometimes referred to as Lower Rangeley and the Big Lake, is the largest of the Rangeley chain. The upper part of Mooselucmaguntic now floods what was formerly Cupsuptic Lake and extends from Cupsuptic River down about 4¼ miles to a narrow part of the lake, or just below the combined mouth of Kennebago and Rangeley Streams. From Cupsuptic River to Upper Dam the distance is between 11 and 12 miles; from the same stream to Bemis, about 16 miles; and from Bemis to Upper Dam, about 7 miles. Before the lake was raised to its present level the separation between the two lakes was much more marked than at present. The upper part runs in a direction a little east of south and with irregular shores and deep bays.

Mooselucmaguntic proper begins at the lower end of Cupsuptic Lake, about half a mile above Haines Landing, not far from the village of Oquossoc, previously mentioned, and runs almost due south for a little over 5 miles to Students Island. At the upper portion it is about a mile wide, but gradually broadens to the widest part of the lake about 3⅘ miles from the entrance to Cupsuptic Lake. The direct east and west line from the head of Bugle Cove to the opposite shore is 3⅘ miles, but in a northwesterly direction to a point at the head of a small cove, just east of Wildwood Camps, it is about 4$\frac{1}{10}$ miles. From the first line mentioned it narrows again to a line crossing Students Island in a southeasterly direction from Brandy Point, which is on the west shore of the lake, 5 miles from Haines Landing. Here the lake takes a northwest direction, extending from the end of a cove near Bemis to the head of a cove on the southerly side of Brandy Point. This portion is of fairly uniform width except in the coves mentioned, the widest part being at the Bemis end just southeast of Toothakers Island, where it is 2$\frac{1}{10}$ miles across. From Brandy Point to a point on the southwest shore at the entrance to the outlet cove it is about 1½ miles. From the latter point to Upper Dam, at the foot of Mooselucmaguntic Lake, it is just 1 mile. The narrows at the entrance of Cupsuptic Lake are about one-half of a mile across, and it is about three-fifths of a mile across to a point northwest of Haines Landing. The distance between Students Island and Brandy Point is seven-tenths of a mile, and Students Island,

four-fifths of a mile long and half as wide in its broadest diameter, is one-fifth of a mile at its southeast end from the east shore or broad cape south of Bugle Cove.

The other important island of the lake is Toothakers, previously referred to, the northwest end of which is slightly over 1 mile from Students Island and the southeast end about 1½ miles from Bemis Station. It is irregularly elliptical in shape, about 1⅘ miles long by nearly four-fifths of a mile wide in its greatest diameters.

Pleasant Islands, famous as the location of a sportsmen's camp and unimportant for any other reason, are situated about 3 miles in a direct line up Cupsuptic Lake from Haines Landing. A group of small islands, known as Browns Islands, just above the entrance to Cupsuptic Lake, are nearly 1½ miles from Haines Landing. There are other small islands in Mooselucmaguntic Lake, particularly in Wildwood Camps Cove and the cove just north of it. At a number of places shoals occur, where the depth is only a few feet at high water and which appear as islands at low water.

The altitude of Mooselucmaguntic at high water is 1,472.4 feet, and its area, including Cupsuptic Lake, is 28.27 square miles.

On the east and west portions of the lake the deepest part is found south from the west end of Students Island, where it is 100 feet. The average depth for quite an area is probably about 50 feet. East of Toothakers Island the maximum depth is from 30 to 35 feet, and the deepest part of the lake is in Bugle Cove, where a depth of 124 feet is found about 2$\frac{1}{10}$ miles northeastward of the northwest end of Students Island. Cupsuptic Lake is very shallow above Pleasant Islands, but below this point the deeper waters carry 50 and 60 feet.

Upper Dam at the outlet, the height of which during the last 10 years or so has been increased to the level of the land on the south shore of the lake, controls the storage of the lake, giving it at high water 10,002,039,000 cubic feet. The dam is about 200 feet between abutments. A dike extends from each abutment to the higher land beyond; that in the southeast being nearly a mile in length, mostly of artificial construction. The sill of the dam is 18.03 feet above that of Middle Dam at the foot of Wellekennebacook. The original bar that formed the dam for the natural lake is about one-half mile above the present dam, and if the gates at the dam are opened a sufficient amount the water in the pool between this bar and the dam is drawn down to a point below the water in the lake.

The shores are irregular, with points and bays both large and small. The greater part of the shore is covered with driftwood and "dry khi," in some of the low places for one-fourth of a mile. This is particularly true of the portion about Cupsuptic Lake. The greater part of the shore line is wooded, being covered with second-growth timber, both hard and soft.

There is but little lowland bordering the lake, this being found at the eastern extremity near Bemis Stream and a small area near Upper Dam. There is also lowland on the east around the entrance of Kennebago and Rangeley Streams and at the upper end of Cupsuptic Lake. With the exception of these low places the land gradually rises, the 5-foot contour being from 50 to 100 feet back, on the average, and the 10-foot contour about 150 feet.

The principal tributaries of Mooselucmaguntic Lake are Cupsuptic and Kennebago Rivers and Rangeley Stream in the northern part of the lake and Bemis Brook at the southern end. There are a number of other small brooks flowing into the lake at various places.

Cupsuptic Pond is a small body of 0.30 square mile area at the extreme headwaters of Cupsuptic River near the boundary line between Maine and Quebec. Cupsuptic River, receiving many branches in its course, some of which rise in the Boundary Mountains, flows southward through three townships, or about 17 miles in a direct line, to Cupsuptic Lake. Cupsuptic Pond is not far from the head of the lower east branch of the main inlet of Parmacheenee Lake, but a rather large mountain intervenes. Parmacheenee Lake is only about 4 miles in a direct line from the Cupsuptic River, but the intervening country is mountainous.

Kennebago River has its extreme source in the Seven Ponds, the larger of the group being in township 3, range 5. The principal pond, shown on the maps as Big Island Pond, of 1.20 square miles area, is in the northeast corner of the township. It flows into Long Pond, or the Straits, situated in about the center of the township. Into Long Pond several tributary streams from other ponds converge. The extreme headwaters of some of these streams are in close proximity to the headwaters of Arnold River, which flows into Lake Megantic in the Province of Quebec and is a tributary of the St. Lawrence River. The Boundary Mountains form a separation. Another of the branches heads in a small pond not over three-fourths of a mile in a direct line from a small pond in the extreme headwaters of Dead River, a tributary of the Kennebec system. There is naturally a topographical division between the two waters, but it is not nearly so marked as in the Boundary Mountains. Long Pond, or the Straits, is approximately 18 miles in a straight course to the junction of the Kennebago River and Rangeley Stream. Kennebago River flows very irregularly in a southward direction and in its lower portion is especially sinuous. About 10 miles directly northward of the junction with Rangeley Stream is Kennebago Lake, situated a little to the left of and connected with the Kennebago River by a short outlet. Little Kennebago Lake is not far north of this in the course of the river and has an area of 0.26 square mile.

Kennebago Lake is situated mainly in Township 3, range 3. It is stated that the distance from the dam at the outlet to Indian Rock at the mouth of Kennebago River is 12.3 miles, and the elevation of the lake at average low water is 1,774 feet, or 327.7 feet above the sill of the gate at Upper Dam. The lake is approximately 4½ miles long, with a greatest width of less than 1 mile. Its area is stated by the Maine Water Storage Commission report to be 2.74 square miles at low water, and 4.13 square miles at high-water line. In most of its extent the lake carries 20 to 50 feet close to low-water line, and in the deeper portions 60 to over 100 feet, having a storage capacity at low water of 350,828,000 gallons. The lake lies approximately in a southeasterly and northwesterly direction. In the southeastern half the shores are mainly comparatively high and the water bold; in the other half there is considerable low land that is flooded at high water, and even Little Kennebago Lake is flooded out by the high water of this lake.

Bemis Brook rises from two branches, one of which heads in Four Ponds. The largest and lowermost of the ponds is about 2½ miles in a direct line from Bemis at the southern end of Mooselucmaguntic Lake. Four Ponds, as is also the head of the other branch of Bemis Brook, are very close to headwaters of branches of Swift River, a tributary of the Androscoggin, and a pond at the head of Swift River, is shown on the maps as not over one-half of a mile distant from a pond at the head of a branch of Sandy River, but in a very hilly country.

RICHARDSON LAKES.

These lakes are practically one body of water consisting of two expansions connected by The Narrows.

UPPER RICHARDSON.—The main inlet is the outlet of Mooselucmaguntic Lake, which enters Upper Richardson or Molechunkamunk Lake a little north of midway of its eastern side. Molechunkamunk is about 6⅘ miles in length and not over 1 mile in greatest width. The lake is somewhat crescentic in shape, the convexity being toward the east. The shores are more or less irregular in outline and comparatively low in most places. The principal coves are West Arm, at the west side of the north end of the lake, and Half Moon Cove, on the west side of the lake about 3⅓ miles south of West Arm. There are not many islands. A few small ones are at the upper end opposite and near the entrance of the West Arm. A large one is opposite the east side of the entrance to the Narrows. There are also a few that at high water are mostly submerged and at low water merely dry shoals, but which were probably originally small islands.

The principal tributary streams besides the main inlet are the following: At the extreme northern end the outlet of the Richardson Ponds enter the lake through an extensive swamp. The Richardson Ponds are designated as the East and West Richardson Ponds, of which there are two each. The eastern ponds are small and flow into the lower of the western ponds, which is about the same size as the eastern ponds. The principal pond of the group is one of the western pair and only a short distance from the lower one. It is about 1¾ miles long by three-fourths of a mile wide, irregularly elliptical in shape, with a large island about the middle and a small one near the outlet. In a direct line by the way of the outlet the foot of this pond is only a little over one-third of a mile from the lake, but following the stream it is considerably farther, as the stream is very winding. Also flowing into the north end of the lake is Beaver Brook, which pursues a meandering course in an easterly direction conveying the waters of Beaver Pond, only one-fifth of a mile distant from the lake in a direct line from the mouth of the brook and much less from the head of the West Arm. Beaver Pond is irregular in shape with a strongly projecting shore line and consequent deep coves. Beaver Pond is about 1¼ miles long with an extreme width of about three-fourths of a mile and has an area of about 0.93 square mile. There appear to be no other brooks of consequence on the western side of the lake. The largest is a dead-water outlet of a large swamp situated about 3 miles from the head of the lake.

On the east side Mill Brook flows into the lake nearly opposite the West Arm. On the same side of the lake, about 1$\frac{9}{10}$ miles southward of the inlet, Mosquito Brook enters the lake, and about 2$\frac{3}{10}$ miles from the mouth of Mosquito Brook is the mouth of Metallak Brook. Metallak Brook flows into a broad cove directly behind the previously mentioned island near the east side of the entrance to the Narrows. Metallak Brook is formed by three or more ramifications. About three-fourths of a mile from the lake it is joined by a branch that discharges the waters of Metallak Pond, about 2½ miles southeast of the lake. This pond is about three-fourths of a mile long and a scant one-fourth of a mile wide and is narrowly elliptical in shape.

LOWER RICHARDSON.—The other expansion, known as Lower Richardson or Wellekennebacook Lake, is not quite as long but somewhat wider than the upper lake and is also crescentic in shape, the convexity being to the westward, giving the two lakes

combined a sort of a reversed S shape. The total length in a general northwest and southeast direction is about $5\frac{3}{10}$ miles. The greatest width of about $1\frac{1}{2}$ miles is in the upper portion, whence it narrows to one-third of a mile or less. The immediate shores are, for the most part, considerably higher than those of the upper lake. The shore line is fairly regular and there are few strongly projecting points. Horse Beef Point on the western side is near the foot of the Narrows, and about two-fifths of a mile from this point on the same side of the lake is another prominent cape known as Jackson Point. The southern end of the lake gradually tapers to the extremity of what is known as the South Arm. There is no landmark defining the beginning of the South Arm, unless it is a small abrupt projection from the eastern side, known as Hardscrabble Point, a little over 2 miles from the foot of the Narrows and something over 3 miles to the extreme head of the South Arm. At the inner portion of the South Arm is a chain of islands and connecting bars inclosing a shallow-water area known as the Pocket. At the end of this place the immediate shore is low and there is only 17 feet height of land between high-water line and the headwaters of Black Brook, a tributary of the Androscoggin River. There are but few other islands, and they are very small. The most noted of these is Spirit Island, not far southward of Hardscrabble Point. Its name indicates its legendary origin.

There are no important tributaries. The largest is Black Cat Brook, entering the western side of the lake some distance below Middle Dam Cove.

The dam that controls the flow of these lakes is known as Middle Dam, and is about 170 feet between abutments. It is a house dam, completely controlling the flow through the gates, with no provision for an open overflow or weir. The sill of the dam is 197.08 feet above that of Errol Dam at the head of the Androscoggin, just below Umbagog Lake. The dam, which is about 22 feet from sill to floor, will hold a head of about 21 feet.

The combined area of the two lakes at high-water line is 13.08 square miles, having a total capacity of 5,294,276,000 cubic feet. The general depth of Molechunkamunk Lake is somewhat less than that of Wellekennebacook. At the northern end and between the mouth of Mill Brook and the islands and bar obstructing the entrance to the West Arm the depth ranges from 17 to 32 feet, but within the West Arm a considerable portion carries a depth of 72 to 87 feet. The 87-foot point is the deepest water of the lake. In the main lake the deepest soundings made are at a point about midway of a line across the lake and about four-fifths of a mile above a parallel line drawn across from the inlet, where 82 feet are found. Between this point and a line from the mouth of Mill Brook the depth varies in the deepest portions from about 40 to 50 feet. About midway of a cross line from the inlet 80 feet of water occurs, shoaling both easterly and westerly but carrying a good depth to very near shore. The deep portion of the lake then carries depths ranging gradually from about 80 down to about 20 or 30 feet just before the Narrows are reached. The upper half of the Narrows carries 30 to 40 feet and the lower half 12 to 30 feet of water. In a line from Jackson Point to Lakewood Camps Wharf on the northern side of the outlet cove, a distance of 1 mile, the depth ran from 27 feet at the point to 48 feet about one-half the distance from the point, thence down to 12 feet near the wharf. In a line from Jackson Point directly across to the eastern shore the water deepened from 41 feet not far from the point to 78 feet about halfway across, thence shoaled to 23 feet about one-tenth of a mile from shore. In a line from the ter-

mination of the last line mentioned to the Lakewood Camps Wharf, again starting with a depth of 15 feet not far from shore, within two-tenths of a mile 73 feet occur, which deepen to 91 feet about 1 mile from Lakewood Wharf, toward which it gradually shoals. Again, in a line from Lakewood Wharf to a point about one-third of a mile northward of Hardscrabble Point the water gradually deepens without much variation to 98 feet about 1⅕ miles from the wharf, thence for the remainder of the distance, about four-tenths of a mile, it shoals to 22 feet not far from shore. Another line of soundings from the same wharf approximately in a mid line down the South Arm finds 100 feet, the deepest of the lake, about 1⅓ miles from the wharf. Thus far the deepening was gradual, but from this point on the bottom seemed to be more or less irregular, and there is a depth fluctuating between 48 and 81 feet for about 1½ miles farther, where the water is generally not over about 30 feet. Within the Pocket the deepest water is only 8 and 9 feet.

THE OUTLET OF RICHARDSON LAKES.—The outlet of Richardson Lakes is Rapid River, which is about 6 miles long, connecting these lakes with Umbagog Lake, in this distance falling about 200 feet. Slightly over one-half of a mile below Middle Dam is an expansion of the river known as Pond-in-the-River. This pond has an area of 0.83 of a square mile and a capacity of about 86,981,000 cubic feet at high water. It is irregularly triangular in shape, the apex being at the southeast end and the inlet entering at the eastern and the outlet leaving at the western basal angle. The distance from the mouth of the inlet in a straight line along the eastern shore is nearly 1⅜ miles and something over 1$\frac{3}{16}$ miles to the quick water of the outlet.

The northern side of the pond curves irregularly southward, forming a broad or rounded point somewhere near midway between the inlet and outlet. In a straight line from this point to the apex of the triangle it is nearly 1⅛ miles, carrying a depth of water from 10 feet near this point to 30 feet not far from the southern end of the pond. There is a fairly general depth of 19 to 29 feet. There are a few shoals at times becoming islands, in the pond.

A small brook enters the apex from the southward and another from the northward enters the cove immediately west of the mouth of the outlet.

The fall of Rapid River, previously mentioned, makes the stream a very quick one all the way to the level of Umbagog Lake. The present dam at Errol has flooded the lake to such an extent that it extends a broad dead-water arm up the Rapid River to the so-called falls, some miles from the old mouth of the river. The river is very rocky and contains bowlders of various sizes from pebbles to those of tons in weight, and there are, consequently, many pools and eddies in its course.

Locally, frequent mention is made of the falls of Rapid River. There is no decided pitch or abrupt waterfall in the course of the stream. The term falls merely distinguishes the rapid portion from the lower, or dead water, part of the river.

UMBAGOG LAKE.

This lake, lying partly in Maine and partly in New Hampshire, is the lowermost in the Rangeley chain of lakes. It has an elevation at high water of 1,246.3 feet above the sea and is the immediate source of the Androscoggin River. It seems never to have had any other than its aboriginal name.

The lake is irregular in shape, proportionally long and narrow, with many deep coves and resulting points. Nearly two-thirds of it is in New Hampshire. The general

direction of the lake is north and south. From the extreme southern portion to the most northern end is about 7⅘ miles, and from the same southern point (Lakeside) to the entrance of Sunday Cove at the northeastern end is about 9 miles. Its irregularity of shape prevents exact determination of the greatest width, but approximately it is about 2 miles and the average from one-half to 1 mile. The distance from Errol Dam to Sunday Cove Landing, via boat route, including the crooked channel, is about 8⅘ miles.

At its northern end is a large area that may be designated as a bay, its right to this name being bestowed by a broad cape that projects from the eastern shore in a northeasterly direction into the lake and Moose Point, on the opposite northwest shore about one-half a mile distant. The distance across this cape at its northwestern end is approximately 4,000 feet. The northern corner is called Brandy Point and the southwestern corner Pine Point. Opposite and slightly northward is the entrance to the Androscoggin River. The distance to this river directly across from Pine Point is about three-fourths of a mile; from Brandy Point to the shore directly north is nearly 2 miles.

The area of Umbagog is 15.8 square miles, second in size to Mooselucmaguntic and a little larger than the combined Richardson Lakes. Its total capacity of 3,476,715,000 cubic feet is greater than Oquossoc but considerably less than the Richardsons. This is due to its shallowness, it being the shoalest of all the lakes.

The lake carries a general depth of 10 to 17 feet. The deepest places are two so-called deep holes, one situated off Sunday Cove the other not far distant from the mouth of Rapid River. In the first place, the Maine Water Storage Commission reports 46 feet, in the latter 43 feet. In 1905, during a stage of retained waters, the Bureau of Fisheries' party got about 50 feet in each place. The larger coves quite generally have water from 6 to 8 or 9 feet deep, sometimes close to shore, except in the smaller adjunct indentations.

The contours of the lake in general follow fairly close to the shores, except in the northern half, where considerable flat land occurs. This is especially true along the outlet and in the lower part of the Magalloway, where extensive meadows appear that are flooded at high water. A similar condition exists at the mouth of Cambridge River, to be described later. These places at certain stages of water form large lagoons, locally known as "logans," which harbor a great deal of aquatic life and afford rich feeding places for the various fishes to which the shallow warm water is not uncongenial.

The bottom of the lake is composed mostly of rather soft mud, and the coves, especially the shallow ones, produce a profuse growth of vegetation.

There are but few islands, most of which are in the lower or southern portion of the lake. Southwestward of Tylers Point is Metallak Island, shown on recent maps as Duttons Island, a summer cottage of a Mr. Harry Dutton being located there. His residence occupies about one-half of the island, which has a sea wall surrounding it. It is said that during high water in the spring the island is flooded, the water at times reaching nearly to the foundation of the house. South and west of this island are several small ones, and one large one, known as Big Island, situated off the mouth of Thurstons Cove. Big Island is irregularly quadrangular in shape, its long axis of about four-fifths of a mile lying east and west. Its greatest width, about three-fourths of a mile, is at the western end; it is constricted a little east of the middle to three-eighths

of a mile; and is approximately one-half of a mile wide at the eastern end. The location is such as to make two comparatively narrow passageways from the southern to the northern portions of the lake—one by the western shore toward Thurstons Cove, thence about one-third of a mile across from the lower western angle of the island and carrying from 6 to 8 feet of water; the other about the same distance from Tidswells Point, with 10 to 12 feet of water.

COVES.—The principal coves are Sturtevants, Sunday, Rapid River, B Brook, and Tylers from north southward on the east shore, and Sargents, Thurstons, and Block Island from south northward on the west side. Sturtevants Cove is a broad cove a short distance northward of the entrance to Sunday Cove. Its northwestern shore is rather low and the southeastern comparatively high rising ground. Not far from the high shore the cove carried a depth from 17 to 7 feet toward the mouth of Sturtevant Brook.

Sunday Cove is situated at the northeast side of the previously-mentioned large bay. From the entrance to head it is 1 mile and has a greatest width of about one-third of a mile, but the entrance is only one-tenth of a mile across. It is near the head of this cove that the steamboat landing for the Rapid River carry to Middle Dam is located. Something less than a mile south of the entrance to Sunday Cove is the cove at the mouth of Rapid River. About 1½ miles southward of Pine Point is the entrance to B Brook Cove, which is an indentation nearly 1 mile long and about one-third of a mile wide. The southern side rises more abruptly than the northern side and is formed by the northern shore of a broad cape the southern projection of which is Tylers Point. Immediately south of Tylers Point is a broadly triangular, comparatively deep-water cove called Tylers Cove. It carries 14 feet of water well up into the cove, the shores of which are fairly steep, especially on the north side.

Sargents Cove is a shallow-water indentation at the west end of the east and west southern expansion of the lake. It is triangular in shape and has only 4 or 5 feet of water in the deepest part. From the point bounding the northern side of the cove the shore of the lake runs very regularly northwestward for about 2 miles to the entrance to Thurstons Cove, which is irregularly triangular in shape, nearly a mile long, with water shoaling from 6 feet at its entrance to 1 foot at the head. Block Island Cove is small, shallow, and of not much consequence. It is situated about 1 mile northwestward of Metallak Island.

Situated between a low marshy point at the southern side of the present entrance of the Androscoggin River and the comparatively steep southern shore at Molls Rock, is a small cove that is, in some portions, 10 feet deep. The head of the cove is only a few yards from a bend in the Androscoggin River. A boat or canoe portage here is known at Molls Carry.

On the north side of the river entrance is another long marshy neck of land only a few yards across, by which over a mile of distance is saved by using Richardson Carry in boating or canoeing from the upper end of the lake. This region about the entrance of the river south and westward of Moose Point consists of shallow water, lagoons, and marsh.

TRIBUTARIES.—The largest and most important affluents of Umbagog Lake are Rapid River, the outlet of the Rangeley Lakes above, and Cambridge River.

Rapid River.—From Pond-in-the-River this stream pursues a rocky and more or less turbulent course, as may be inferred from its name, for a distance of about 5 miles, having a fall in that distance of about 200 feet. The rapid portion of this stream, as has been previously stated, is commonly referred to as the falls, but there are no distinct pitches that could be properly designated as waterfalls. Huge bowlders and ledges *in situ*, however, cause very rough water in many places when the stream is high. The low ground at the lower end of the river and the overflow from high stages of water in Umbagog Lake make a wide area of still water for about 1 mile in a direct line to the foot of the falls. At low stages of the lake and river the channel from the falls is more or less winding and the current is far from rapid. The bottom of the stream in the dead-water portion is mainly muddy, and there is much aquatic vegetation here, as well as in the overflowed areas or lagoons left by receding waters.

Cambridge River.—This stream enters Umbagog Lake at the eastern end of the southern east and west expansion, the debouchure being at Upton Mills, where for many years there has been a dam completely obstructing the stream. Below the dam there is a low ledgy drop into the still water of the river channel in the lake. Formerly the river extended through meadowland for a direct distance of over 1 mile. At low water it is a winding channel with dikelike banks beyond which is shallow water or flats. At high water the dike is nearly or quite covered, especially at the lake end, and at lower stages of water there are occasionally passages through into the lagoons.

The Cambridge River is formed by two branches, which unite about 3 miles above Upton Mills to form the main river. The branches are known, respectively, as Swift and Dead Cambridge. The Swift Cambridge has its principal source in Grafton, Me., near Bald Mountain, where two or more small brooks unite. One brook rising in Grafton Notch has its source very near the Bear River, a tributary of the Androscoggin. Another, the principal brook source, rises in York Pond among the hills north of the mountain. This pond is about 4 acres in extent and very shallow, the greatest depth being about 7 feet, in one place only. The inlet at the east end of the northern side of the pond is a short thoroughfare connecting it with a small pond of about 2 acres in extent and of about the same depth as York Pond. The shores of both ponds are bordered more or less with boggy ground with the ordinary bog shrubs. The outlet leaves the pond at its north side and is a small, swift, abruptly graded mountain brook almost all the way to its junction with the other branch.

At Grafton, from the junction of the brooks, the Swift Cambridge rapidly increases in size, but for some distance it is a deep, comparatively slowly flowing stream. The character of the stream between Grafton and the pond above the dam near the Andover Road bridge was not ascertained. Above this dam the pond is several acres in extent but long and narrow. Below the dam the river is quick water, rocky, and full of bowlders, with now and then some deep pools and eddies down to its junction with the Dead Cambridge.

The Dead Cambridge rises in C Pond in C Surplus and flows westward for about 4 miles in a direct line to its junction with the Swift Cambridge. The Maine Water Storage Commission report gives the area of C Pond as 0.52 of a square mile. The Dead Cambridge issues as a small alder-covered brook, which condition obtains for one-half of a mile or more to a meadow and overflowed area produced by an old gate dam known as

the Sluice. The Sluice is estimated to be 8 miles from Upton Mills, following the river. From the alder-tangle portion of the brook to the upper end of the pond produced by the backed-up water above the dam it is a grassy meadow interspersed with clumps of bushes and trees. Through this meadow the brook averages, perhaps, 16 or 18 feet in width, much narrower in some places and considerably wider in others, especially in the pools. The stream is everywhere very sinuous, the pools are very deep, and the bottom mostly of sand. In many instances, especially on the deep side, the pools are overhung with alders, and each pool has its greatest depth at one side or the other, usually on the short bend. The backwater above the Sluice extends as a moderately wide but shallow pond for perhaps one-half of a mile above the dam.

The Sluice is situated between two high and steep ridges or moraines, commonly called horsebacks, which, diverging, extend some distance downstream, leaving a narrow margin of meadow on the right-side part of the distance but wooded steep shores on the other. The stream emerges from this region, the lower end of which bears the local name of the Onion, into an extensive meadow, estimated to be 2 miles in length and fully a mile in width. Through this meadow, which is covered with a prolific growth of meadow grass and "Joe-Pye weed" (*Eupatorium purpureum*), the brook pursues a very winding course to its junction with the Swift Cambridge. Throughout its course there is no quick water, except a little just below the Sluice, and the bottom is sandy or muddy, mostly sandy, all the way. From the Sluice to the meadow the stream is generally deep, with frequent large, deep pools, but through the meadow it is generally shoal with an extensive growth of pond weed (*Potamogeton*).

From the junction of the Swift and Dead Cambridge branches, known as the Forks, the Cambridge River is a slowly flowing stream perhaps 50 or 60 feet in general width but varying considerably. The country is here low and wooded, with many lagoons produced by spring freshets and the changing course of the stream. The banks and bottom are mostly sandy and the stream varies in depth, having here and there wide deep pools and shallow reaches covered with a profuse growth of water plants, consisting of two kinds of yellow pond lilies, pond weed, etc. The water is dark red, almost black in deep places. The foregoing conditions were those observed in July, August, and September, but in the spring the river discharges a large volume of water and the current of even the Dead Cambridge is far from mortal slowness.

Upton Mills dam forms a pond of considerable extent, the bottom of which is mainly muddy from deposits by the river and decaying vegetation. Power for a sawmill is furnished by this pond.

Next in importance as a tributary of Umbagog is B Pond, situated in Upton, formerly Township B, 3 miles in a direct line from Umbagog Lake but only about a mile in a direct line from Rapid River about a mile below Pond-in-the-River. The Maine Water Storage Commission report gives the area of B Pond as 0.90 of a square mile. The pond is irregularly cycloid in shape, and there is a comparatively large island near the southwestern shore. B Brook discharges its waters into Umbagog Lake at B Brook Cove. Its course is very irregular, almost entirely through woodland and bogs.

Sturtevants Brook is a small brook flowing into Sturtevants Cove.

Sunday Brook flows from a small pond about 1 mile in a direct line from Sunday Cove, into which it empties.

Several other rivulets, some of which are entirely dry during the summer, others perennial spring-fed brooks but which have no names, flow into the lake at various places. The importance of these little brooks is mainly that in the spring and early summer young trout and other fishes occur in them. Three of these brooks were to some extent studied and were given names for convenience in note making, and the names have been used in this report and on the maps. Wildcat Brook is a hillside brook of very small size that flows into the lake at the southern end a short distance from Lakeside. It was full of water up to July 10 and entirely dry on July 14. Another small brook, which contained some water throughout the summer, flows from some springs in the open pasture back of the Lakeside House and empties into the lake at the foot of the hill near Lakeside post office. It was named P. O. Brook. Thurstons Brook, flowing into Thurstons Cove, has its source in Bullhead Pond. This pond derived its name, not from the presence of the catfish of that name, but because it was by the obstinate persistence of one of the party in following a certain direction that the pond was found. It is a small, shallow, muddy, plant-grown pond with scarcely any rocks visible about the shore and bushes growing to the water's edge. It is situated about 1½ or 2 miles from Thurstons Cove at a considerable elevation, so the brook is a purling rivulet for most of its course.

The Magalloway River system may be considered as practically tributary to Umbagog Lake, inasmuch as it discharges into the Androscoggin River above Errol Dam, not far below the lake.

Magalloway River is a much ramified and very sinuous stream, having its extreme headwaters in the Boundary Mountains. Mention has already been made regarding the contiguity of these sources and those of some of the branches of the upper waters of the Connecticut River. The Magalloway drainage area is given by the Maine Water Storage Commission report as 460 square miles. The greater part of the river is located in Maine. It leaves the State for a short distance about 6 miles in a direct line from the mouth of the river. It permanently leaves the State about 4½ miles in a direct line from the mouth of the river, or a little over 4 miles in a direct line below Wilson's mills. Its immediate source is in Parmacheenee Lake, the area of which is shown by the Maine Water Storage Commission report to be 4.35 square miles. The most important Maine tributaries are the Little Magalloway, Black Cat Brook, North Branch Brook, Metallak Pond and Brook, Lincoln Pond and Brook, and Sturtevant Pond and Brook—all below Parmacheenee Lake and noted as trout waters. The largest and most noted tributary is the Diamond Stream, wholly in New Hampshire, which joins the Magalloway at its first point of departure from Maine. The upper course of the river below Parmacheenee Lake for a comparatively short distance is quick water, thence to Aziscohos Falls, some 13 miles in a direct line below Parmacheenee Lake, it is overflow, produced by a dam at the falls. The area of the overflow prior to the completion of the new Aziscohos Dam is stated to have been 6.5 square miles. This new concrete dam has increased the flooded area to 10.5 square miles, making a storage reservoir about 14 miles long with a capacity of 8,000,000,000 cubic feet. Most of the course of the river below Aziscohos Falls is smooth water and usually navigable by small steamboats nearly to the mouth of Sturtevant Brook, about 3 miles in a direct line, but much more by river, from the mouth.

Errol Dam, located 5 miles below the outlet, controls the storage of Umbagog Lake and is about 3½ miles below the mouth of the Magalloway River, thus making the latter stream one of the feeders of Umbagog Lake.

The Androscoggin River from the lake to the mouth of the Magalloway is a winding channel between two naturally formed dikelike embankments, with here and there openings into the lagoons beyond. Beyond the Magalloway's mouth the banks are low but wooded, without much swampy ground except at the mouths of brooks and narrow strips of lagoonlike areas by the river and margin, probably formed by slight changes in its course or conditions. The channel has a depth ranging from 12 to 37 feet. The bottom is mainly muddy. The immediate margin bears a profuse growth of water plants, and patches of yellow water lilies are everywhere of frequent occurrence.

The dam is a wooden structure completely housed over and 175 feet long between abutments. The entire flow passes through various gates of different sizes. There is no provision for overflow besides the gates.

Below the dam there is a decided decline, occasionally an almost torrential rapid, when the water is on. Immediately below the dam, especially on the right side of the river, the shore is an almost precipitous rocky cliff, at the foot of which is a deep pool formed by an eddy. The quick water ends in a broad expanse of smooth water at Errol below the bridge. Here, from the right, enters a considerable tributary known as Clear Stream. Thence for about 3 miles to Molnichwock Falls the current is strong but smooth.

The next principal tributary of the Androscoggin below the lake, and the only other one with which this report is concerned, enters the Androscoggin from the left just above Molnichwock Falls. This is Molnichwock Brook, which at the river end is a narrow dead-water area, perhaps one-half mile long, bordered by an extensive shrub-grown bog or marsh. In high stages of water the stream may be navigated by canoe for 4 or 5 miles before it becomes obstructed by overgrowing and ingrowing alders and other bushes. The stream rises in Molnichwock Pond in Maine, about 9 miles in a direct line from its mouth.

Molnichwock Pond is irregularly cycloid in shape and of an estimated area of about 20 acres. It is situated among the wooded hills of Upton. The immediate shores in most places consist of a narrow border of bog with the shrubs characteristic of such places. Around the shore margin is a zone of yellow pond lilies and other aquatic plants. The bottom is mostly of soft mud. The depth at the outer edge of the lily growth was about 6 feet. A line of soundings through the middle, west to east, at approximately equal intervals, gave 7, 7½, 8, 9, 9, 9, and 9 feet, shoaling gradually on the west and northwest sides; 7 feet of water was found nearer shore on the east and southeast sides. The deepest water was 8 and 10 feet on the east and southeast sides about 50 feet from shore and about 40 yards from shore on the west side. There is a large shoal at the outlet at the east side of the pond.

The outlet of the pond is a very small rocky brook, which condition obtains for an unknown distance. In its course, perhaps 6 or 7 miles from the mouth of the stream, are two meadows, the smaller not far above the larger and the two separated by woodland and alder growth. The lower meadow is grass grown, with here and there clumps of alders and other bushes and trees, especially on the margin of the brook. Through this meadow, which is perhaps 1 mile long in a direct line, the brook, with many shoal reaches

and deep pools, winds its way over a sandy bottom. Most of the shoals bear a growth of water plants, mostly of pond weed. Below the meadow for a long distance, probably all of the way to the meadow near the mouth, the brook flows through a narrow bottom land, on each side of which are steep hills. This bottom is a close growth of alders and other small trees entangled with clematis vines and bedstraw. In this locality the brook varies also from shoals to broad deep pools, usually with sandy, but sometimes with clay, bottom.

If it were not for the alders bent down and growing horizontally across the brook with consequent jams of débris, there is usually water enough to afford canoe passage to the mouth of the brook. An occasional fallen tree also obstructs, but such obstruction is more easily surmountable than long areas of low-lying alders. As previously stated, the lower end of the brook flows through a bog such as is commonly designated as a heath, especially at its upper end, but decidedly meadowlike farther down. The brook bottom is entirely sandy until the mouth is reached and with shoals and deep pools, some of which are 30 feet across, deepest on the long curve and often a sand spit on the short one.

FISH FAUNA OF THE RANGELEY LAKES.

The recorded fish fauna of the Rangeley Basin is a limited one, at present consisting of only 19 species, of which 13 are native—if the eel can be called native—the other 6 having been introduced, and there is no certainty that one of these has become established.

In their geographical faunal relations, in a few instances, these waters are peculiar, and this fact was noted many years ago. In 1862, C. H. Jackson [a] said:

> These Androscoggin Lakes generally afford grander scenery than any others in the State. Their waters afford several kinds of fishes not found elsewhere, and wild animals are common in the forests adjacent, so that there are fine places of resort among them for the student of natural history. The *Salmo oquassa* Girard, or blueback trout, an uncommon variety of dace, and a red-sided sucker are peculiar to these waters. The togue and pickerel are not found here.

At a meeting of the Boston Society of Natural History,[b] October 5, 1864, F. W. Putnam remarked that until the present season he had thought that the Great Lakes fauna had extended to the larger lakes of Maine, but from his exploration of the Richardson chain he was now convinced that such was not the case, as there were but 3 or 4 of the 14 species of the Richardson Lakes which were of the same species as those of Lakes Champlain and Superior. The absence of the perch, bream, shiner, pout, pickerel, and the cyprinodonts in the Richardson Lakes was a marked characteristic of that fauna, distinguishing it from that of the Great Lakes. And in speaking of the Sebago Lake fauna he went on to say that there was also a *Lota* and a species of *Salmo* not found in the Richardson Lakes.

In continuation of the discussion, Dr. Pickering stated that he had passed the summer on the Androscoggin River, 25 miles from Lake Umbagog, the lowest of the Richardson Lakes, and that he had found the chub abundant and the pickerel not rare. Perch had been taken there for the first time during that season. Mr. Putnam remarked in response that the fishes of the Androscoggin River were different from those of the lakes at its headwaters, and that but few species passed from the river to the

[a] Second Annual Report upon the Natural History and Geology of the State of Maine, 1862, part II, p. 327, 328.
[b] Proceedings, Boston Society of Natural History, X (1864–1866), 1866, p. 64.

lakes. A species of *Lota* had been taken in the Androscoggin but never in the lakes, so far as he was aware. The eel had been occasionally found in the lakes at Upper Dam but never in the lakes above that dam.

The indigenous species of this region thus far recorded are the following: Long-nose sucker (*Catostomus catostomus*), common sucker (*Catostomus commersonii*), chub (*Semotilus bullaris*), blackspot chub (*Semotilus atromaculatus*), chub minnow (*Couesius plumbeus*), brook shiner (*Rhinichthys atronasus*), bronze minnow (*Phoxinus neogæus*), redfin (*Notropis cornutus*), shiner (*Notemigonus crysoleucas*), eel (*Anguilla rostrata*), trout (*Salvelinus fontinalis*), blueback (*Salvelinus oquassa*), and Miller's thumb (*Cottus gracilis*).

Of the six introduced species, all but one (*Salvelinus aureolus*) [a] have become more or less established and there is some doubt about the correctness of the record of the planting of that one in Rangeley Lakes. The brown trout (*Salmo fario*) has been planted in Loon Lake and Cow Pond, both of whose waters are in the Rangeley region but belong to the Kennebec system. The introduced species that have become established in one or more of the lakes are: Hornpout (*Ameiurus nebulosus*), whitefish (*Coregonus clupeaformis*), salmon (*Salmo sebago*), smelt (*Osmerus mordax*), and pickerel (*Esox reticulatus*).

The following table of geographical distribution of 39 indigenous and introduced fresh-water species includes only those that have been recorded as caught in those waters. The items in the column for Rangeley Lakes are not repeated in the Androscoggin River Basin column except when records are common to the two localities.

TABLE 1.—RECORDED GEOGRAPHICAL DISTRIBUTION OF FRESH-WATER FISHES, INCLUDING INTRODUCED SPECIES BUT NOT ANADROMOUS INDIGENOUS FORMS, IN WESTERN MAINE AND NORTHEASTERN NEW HAMPSHIRE WATERS.

Name of species.	Rangeley Lakes.	Androscoggin River Basin.	Presumpscot River Basin.	Kennebec River Basin.	Upper Connecticut River Basin.
Hornpout (Ameiurus nebulosus)	b ×	×b	×	×	.....
Long-nose sucker (Catostomus catostomus)	×	.....	.....	.....	×
Common sucker (Catostomus commersonii)	×	×	×	×	×
Chub sucker (Erimyzon oblongus)	.....	.....	×	.....	.....
Red-bellied minnow (Chrosomus erythrogaster)	.....	×	.....	×	×
Chub (Semotilus bullaris)	×	×	×	×	×
Blackspot chub (Semotilus atromaculatus)	×	×	.....	×	×
Chub minnow (Couesius plumbeus)	×	×	×	×	×
Brook shiner (Rhinichthys atronasus)	×	×	×	×	×
Long-nosed brook shinner (Rhinichthys cataractæ)	.....	.....	.....	.....	×
Bronze minnow (Phoxinus neogæus)	×	.....	.....	×	×
Bridled minnow (Notropis bifrenatus)	.....	.....	×	.....	.....
Redfin (Notropis cornutus)	×	×	×	×	×
Shiner (Notemigonus crysoleucas)	×	×	×	×	.....
Eel (Anguilla rostrata)	×	×	×	×	×
Whitefish (Coregonus clupeaformis)	b ×	.....	.....	.....	.....
Whitefish (native) (Coregonus labridoricus)	.....	.....	×	×	.....
Round whitefish (Coregonus quardilateralis)	.....	.....	.....	×	×
Chinook salmon (Oncorhynchus tschawytscha)	.....	.....	.....	b ×	.....
Landlocked salmon (Salmo sebago)	b ×	b ×	×	b ×	b ×
Brown trout (Salmo fario)	.....	b ×	.....	b ×	b ×
Lake trout (Salvelinus namaycush)	.....	×	.....	×	×
Blueback (Salvelinus oquassa)	×	.....	.....	.....	.....
Trout (Salvelinus fontinalis)	×	×	×	×	×
Smelt (Osmerus mordax)	b ×	×	×	×	.....
Cobosseecontee smelt (Osmerus abbottii)	.....	.....	.....	×	.....
Wilton Pond smelt (Osmerus spectrum)	.....	.....	.....	×	.....
Pickerel (Esox reticulatus)	b ×	×	×	×	×
Shore fish (Fundulus diaphanus)	.....	×	.....	×	.....

[a] Report on the propagation and distribution of food fishes, by John W. Titcomb. Report Commissioner of Fisheries for the year ending June 30, 1904 (1905), p. 64.

[b] Introduced.

TABLE 1.—RECORDED GEOGRAPHICAL DISTRIBUTION OF FRESH-WATER FISHES, ETC.—Continued.

Names of species.	Rangeley Lakes.	Androscoggin River Basin.	Presumpscot River Basin.	Kennebec River Basin.	Upper Connecticut River Basin.
Brook stickleback (Eucalia inconstans)				×	
Fresh-water stickleback (Gasterosteus atkinsii)		×		×	
Ninespine stickleback (Pungitius pungitius)		×	×	×	
Long-eared sunfish (Lepomis auritus)		×		×	
Pumpkinseed (Lepomis gibbosus)		×	×	×	
Black bass (Micropterus dolomieu)		[a] ×	[a] ×	[a] ×	
Perch (Perca flavescens)		×	×	×	
White perch (Morone americana)		×	[a] ×	×	
Miller's thumb (Cottus gracillis)	×	×	×	×	×
Burbot (Lota maculosa)		×	×	×	×

[a] Introduced.

The following table gives the distribution of the species found in the Rangeley Lakes as shown by the writer's records and observations only. Doubtless waters for which there are no records contain most of the species recorded for any body of water of the system.

TABLE 2.—DISTRIBUTION OF SPECIES FOUND IN RANGELEY LAKE AND TRIBUTARIES BY THE AUTHOR.

Name of fish.	Oquossoc.	Moosehicmaguntic.	Richardson.	Umbagog.
Hornpout (Ameiurus nebulosus)	×			×
Long-nose sucker (Catostomus catostomus)		×		×
Common sucker (Catostomus commersonii)	×			×
Chub (Semotilus bullaris)	×		×	×
Blackspot chub (Semotilus atromaculatus)	×			×
Chub minnow (Couesius plumbeus)	×		×	×
Brook shiner (Rhinichthys atronasus)				×
Bronze minnow (Phoxinus neogæus)				×
Redfin (Notropis cornutus)	×			×
Shiner (Notemigonus crysoleucas)				×
Eel (Anguilla rostrata)			×	
Whitefish (Coregonus clupeaformis)				×
Salmon (Salmo sebago)	×	×	×	×
Blueback (Salvelinus oquassa)	×	×	×	
Trout (Salvelinus fontinalis)	×	×	×	×
Smelt (Osmerus mordax)	×	×		×
Pickerel (Esox reticulatus)				×
Miller's thumb (Cottus gracilis)				

TABLE 3.—DISTRIBUTION OF SPECIES IN UMBAGOG LAKE, INCLUDING TRIBUTARIES AND OUTLET, 1905.

Name of fish.	Umbagog Lake.	Dead Cambridge River.	Swift Cambridge River.	York Pond.	Molnichwock Pond.	Molnichwock Brook.	Androscoggin at mouth of Molnichwock Brook.
Hornpout (Ameiurus nebulosus)	×						×
Long-nose sucker (Catostomus catostomus)	×						
Common sucker (Catostomus commersonii)	×	×				×	
Chub (Semotilus bullaris)	×	×	×				
Blackspot chub (Semotilus atromaculatus)		×	×	×	×		
Chub minnow (Couesius plumbeus)		×	×		×		
Brook shiner (Rhinichthys atronasus)		×					
Bronze minnow (Phoxinus neogæus)		×					
Redfin (Notropis cornutus)		×					×
Shiner (Notemigonus crysoleucas)	×						
Whitefish (Coregonus clupeaformis)	×						×
Salmon (Salmo sebago)	×						×
Trout (Salvelinus fontinalis)	×	×	×	×	×	×	×
Smelt (Osmerus mordax)	×						
Pickerel (Esox reticulatus)	×						×

HORNPOUT (*Ameiurus nebulosus*).

The hornpout is a member of the catfish family (Siluridæ), the membership of which is large and the natural distribution of which is very wide. The general geographical range of the hornpout, according to authorities, is the Great Lakes, the Ohio Valley, and eastward to Maine, southwestward to Texas, and southeastward to Florida; and its distribution has been extended even to the Pacific coast. This species is common in coastwise streams and lakes of Maine, and in certain river basins it is found in some of their most northern sources. It is not native to the Rangeley Lakes, although it occurs naturally in more southern waters of the Androscoggin Basin. Impassable natural barriers prevented its access to those lakes. The writer has been unable to learn the definite history of its introduction there. It was stated by a resident of Rangeley that a number of years ago some one brought a few to the region and planted them in a private pond, from which they escaped into the lake. Another introduction is said to have been purposely made in Umbagog Lake a number of years ago.

The hornpout thrives best in ponds and lakes with muddy bottom and profuse vegetation. It is an omniverous and indiscriminate feeder, but to a great extent sub-

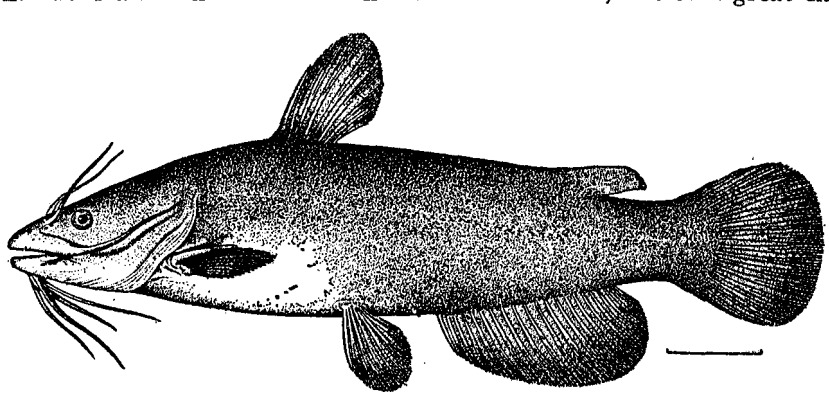

FIG. 1.—Hornpout (*Ameiurus nebulosus*).

sists upon vegetable and animal life that it finds upon the bottom. It is also a scavenger when opportunities present. It is mainly a nocturnal feeder, but will eat by day or night. Moonlight nights are the most favorable for hornpout hook-and-line fishing. It is reputed to eat the spawn and young of other fishes. In Forest and Stream, January 30, 1904, E. A. Samuels wrote that he once caught a hornpout the stomach of which contained a small yellow perch, two or three snails, and a young trout of about 3 inches in length.

It is said that the hornpouts hibernate. If the hibernation begins early enough, it removes one serious objection to its presence in Rangeley waters by minimizing the danger of its devouring trout and salmon spawn. However, it is doubtful if the hornpout reaches the spawning grounds of those species to an alarming extent even if it does not hibernate early, as they spawn in quick water, as a rule, and the hornpout affects quiet water. In this connection it may be mentioned that on October 21, 1904, the writer caught a large number of small hornpouts in a wire minnow trap set off the landing at the Mountain View House, Rangeley Lake. A peculiarity of these little hornpouts was their color, which was a beautiful purplish, iridescent bronze.

The breeding time of the hornpout in this region was not learned, but elsewhere it is usually in the spring. It deposits its eggs in a hole under rocks, old sunken logs, submerged stumps, etc. When hatched, one of the parent fish remains with the brood of young until they are at least an inch in length.

The hornpout is notoriously tenacious of life when removed from the water. Many stories in illustration of the fact have been related, but one that came under the personal observation of the writer is worthy of mention. On August 2, 1905, many hornpouts were caught in the seine at B Point. They were taken to the laboratory about 12.30 p. m. and thrown upon a piece of paper on the floor. The next morning at 9 o'clock (about 20½ hours after capture) four showed indications of life and they revived when placed in water.

This fish was found almost everywhere in Umbagog Lake throughout the season, especially in shallow coves at the mouths of brooks, where they were usually rather small. The largest observed were taken at the mouth of Sturtevant Brook and in the deep hole off Sunday Cove. They averaged about 1 pound each in weight. Hornpouts were also found in the Androscoggin River below Errol Dam and at the mouth of Molnichwock Brook. Most of those caught in Umbagog ranged from 3 to 8 inches in length.

The hornpout is an excellent food fish.

LONGNOSE SUCKER (*Catostomus catostomus*).

This sucker is sometimes called red sucker and red-sided sucker, owing to the red or reddish stripe that is frequently present along the side in the breeding season. It is also known as small-scale sucker. It is found from New Brunswick and New England

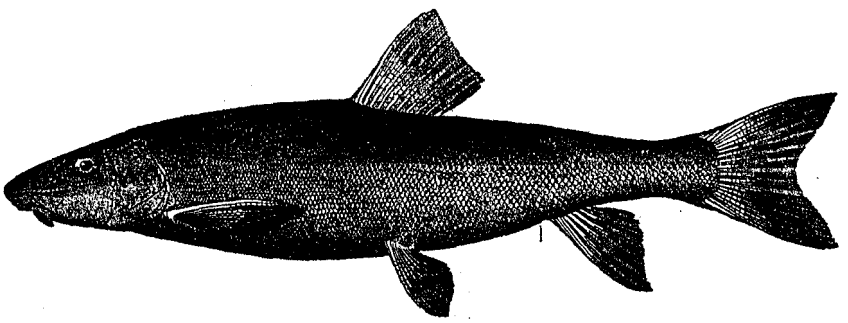

FIG. 2.—Longnose sucker (*Catostomus catostomus*).

westward to the Great Lakes and northward to Alaska, and in an isolated instance has been collected in the mountain waters of West Virginia. The earliest reference to its possible occurrence in the Rangeley Lakes was in the second annual report upon the Natural History and Geology of the State of Maine, 1862, part II, page 327, where the red-sided sucker is mentioned as peculiar to the Androscoggin Lakes. This reference was for a long time a doubtful one owing to the fact that the common sucker often has red sides. It was not positively recorded from Maine waters until a few years ago, when it was found in Craigs Brook. Subsequently, however, it was found to be quite commonly distributed, especially in the northern part of the State.

Many years ago Prof. F. W. Putnam made a small collection of fishes in the Rangeley Lakes, which had remained unidentified in the museums of the Essex Institute and

Boston Society of Natural History until they were examined by the writer a few years ago. In the collection was found one specimen from Cupsuptic Lake. In 1905 the Bureau of Fisheries' party collected a number of specimens in Umbagog Lake.

There appear to be two distinct sizes of adult longnose suckers which have been generally regarded as this one species, the smaller size reaching only about 8 or 9 inches and the larger 18 inches or more in length. In some waters the smaller size only occurs—the Connecticut lakes, for example, where breeding fish 3¾ to 5⅔ inches long were found—and in others only the larger form is found, as in the Rangeley Lakes. But there are other waters where both distinct sizes occur, as in the Eagle Lakes of Fish River in Aroostook County, where the small form ranged from 5⅛ to 7⅔ inches in length. The two forms having somewhat different breeding seasons even in the same waters suggest the possibility of their being distinct species. In fact, in 1886, Mather[a] described the smaller one as distinct under the name of *Catostomus nanomyzon*.

This species is regarded as a comparatively deep-water fish, seldom entering shallow water except to breed or feed upon the eggs of other fishes.

Its breeding season in Rangeley waters has not been ascertained, but in some other waters of Maine it spawns in June. Its food, like that of the other suckers, consists mostly of minute animal and some vegetable life obtained from the bottom, and it is known to feed extensively upon the eggs of other fishes as well as its own.

On July 27, 1905, one was taken in a gill net off B Point, on July 28 another was caught, on August 3 several were taken, and on August 17 about 50 were taken by the same means and in the same place. On August 17 one was caught in a gill net in the deep hole off Sunday Cove. (See Table I, p. 590.)

The longnose sucker may be readily distinguished from the common sucker by its longer snout and more tapering head and finer and more numerous scales.

It sometimes takes a baited hook very readily and is a fairly good fish to eat.

COMMON SUCKER (*Catostomus commersonii*).

This is one of the widest distributed and well-known suckers, abundant in almost every stream, pond, and lake from Quebec and the Great Lakes to Montana and Colorado and southward to Missouri and Georgia. It reaches a weight of 4 or 5 pounds in

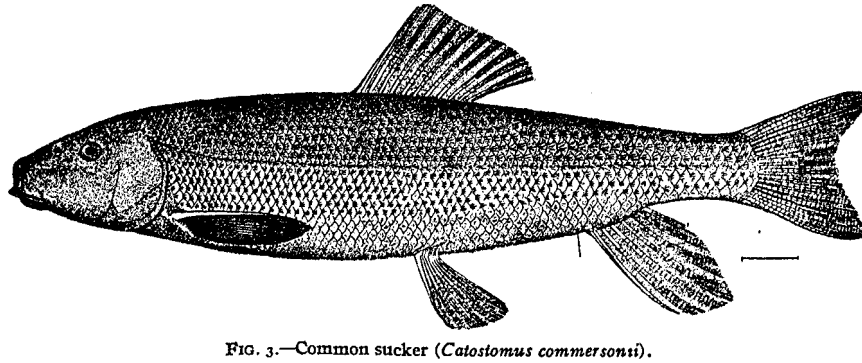

FIG. 3.—Common sucker (*Catostomus commersonii*).

some waters, and in others its largest adult size is only a few ounces. The largest taken by the Bureau of Fisheries' party in Umbagog Lake had a total length of 16 inches.

[a] Mather, Fred. Memoranda relating to Adirondack fishes, with descriptions of new species, from researches made in 1882. Twelfth Report, Adirondack Survey, appendix, zoology, 1886, p. 36.

This sucker feeds upon small animal and vegetable objects that it sucks up from the bottom, although occasionally it takes a baited hook, even rushing at it with the vigor of a trout, and it has been seen taking insects at the surface and has been caught on an artificial fly. It is a spawn eater, too, and is almost always present in large numbers upon the spawning beds of trout and salmon.

This fish is very prolific. It ascends streams, even rivulets when possible, to spawn. Its breeding season depends upon the latitude to some extent, but in Maine it spawns usually in May and June. The exact breeding time of this fish in Umbagog Lake was not ascertained.

Suckers, young or adult, were found almost everywhere throughout the season. The following localities were noted: Umbagog Lake, at various places; Wildcat Brook; Dead Cambridge; and Molnichwock Brook. It ranges in size from 1½ to 16 inches.

A few specimens, from about 5⅘ to 6⅔ inches long, taken in a minnow trap at Rangeley, October 17, 1900, were of a beautiful bronze coloration with a series of indistinct large blue-black spots along their sides. (See Table II, p. 591.)

CHUB (*Semotilus bullaris*).

Other names by which this widely distributed fish is known are fallfish, windfish, dace, silver dace, and chevin. It occurs commonly in eastern Canada and the United States east of the Alleghenies as far south as Virginia. Its size varies greatly in different

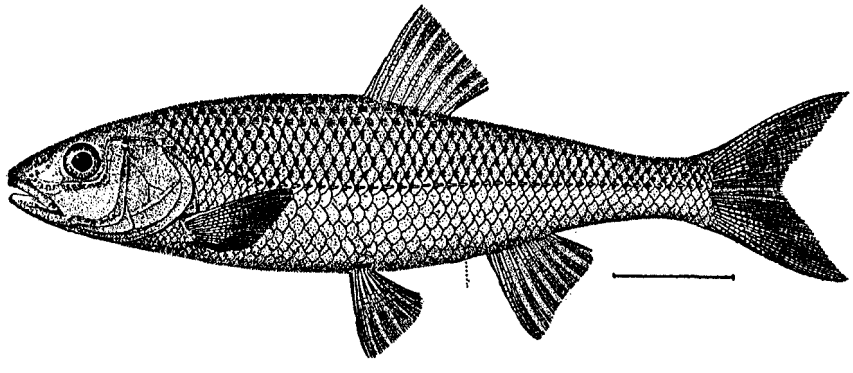

FIG. 4.—Chub (*Semotilus bullaris*).

waters and becomes larger in the North than in the South. In small streams and ponds it is correspondingly smaller, and in small brooks it reaches maturity when only a few inches long.

The variation in appearance of the chub at all seasons is almost as great as the variation in size, and in breeding season the sexes differ much in color and somewhat in other respects. Small adult fish resemble young of the larger fish, being silvery and having a dark stripe along the sides. Larger fish are silvery, with the stripe showing but faintly or not at all, and still larger ones show no stripe and have dusky posterior exposed margins to the scales. The largest individuals have sexual and age variations, but in general it may be said that in these the colors are more evident and pronounced, the head being black, purple and blue, and yellow, with golden and bronze reflections; back, olive green; sides, purplish or bronze; belly, yellowish silvery, or white; posterior margin on lateral scales, black. The metallic luster and iridescence is beyond graphic description, and the artist's brush can but inadequately represent the varying hues and reflections.

The chub is almost omnivorous, eating everything that a trout will eat and much that the trout will not. Although toothless, it is a rather voracious fish eater. On August 12, 1905, in a "logan" at the entrance of the Androscoggin River, some fish that were at first supposed to be pickerel were observed pursuing some smaller fish, perhaps young chubs or other minnows. The smaller fish when pursued went skipping over the surface like skipjacks. Several of the larger fish were caught and found to be chubs of about one-half to 1 pound or more in weight, and were found to be feeding upon young pickerel 2 to 2½ or 3 inches long. Thus, while the chub affords food to other fishes, it takes a turn about.

As a game or food fish the chub is not highly esteemed. When hooked, it fights well for some time, but yields somewhat more quickly than the trout. It will take bait, troll, or fly. It will bite more readily than the trout, but is, however, sometimes wary and capricious. Sunshiny days are unfavorable for catching chubs. Small ones usually take the hook more readily than large ones.

That the chub is not esteemed as food is due rather to lack of flavor than to any disagreeable taste and also because other more delectable fish usually occur where the chub is caught.

The breeding habits of the chub are very interesting. Along the quiet reaches of streams or in shallow waters of ponds or lakes peculiar heaps of fine gravel or pebbles have been noticed, probably, by everyone traversing such places. These are the nests of chubs. In the Proceedings of the Boston Society of Natural History, vol. 1, 1844, p. 196, it is stated that at the meeting of September 4 "Dr. Wyman mentioned that on a late visit to the Magalloway River he had noticed in the river bed mounds of pebbles 2 or 3 feet in diameter, which he was told were heaped up by a fish called chub at its breeding season and that its eggs were deposited among the stones. He referred to the statement of a similar fact with regard to the lamprey eel, in Dr. Storer's report, and remarked that he was not aware of any other instance of the kind." Again, at the meeting of September 18, "Some conversation arose on the subject of the mounds in the Magalloway River, mentioned at the last meeting, supposed to have been built by the fishes for the purpose of depositing their eggs within the pile. Dr. Bigelow stated, on the authority of an experienced angler, that the stones are removed by the fish for the purpose of depositing the spawn in the cavity thereby left in the sand."

In the "Fishes of the Connecticut Lakes"[a] a detailed account is given of observations made by Supt. Charles G. Atkins, United States Bureau of Fisheries station, Craigs Brook, Me., May, 1878, from which the following is extracted:

On May 8 a small chub was seen standing over a hollow at the lower end of a heap of gravel 3 feet long and 1 foot wide, and he repeatedly drove off other chubs, but by and by there came another larger male and drove away the little one and henceforth took charge of the nest. He was very vigilant, dashing immediately and furiously at every approaching fish just as landlocked salmon do. After a while, several times he was seen to take a pebble in his mouth and carry it to the heap and drop it. By and by a female came swiftly along and was seen struggling in an erect position over the lower end of the heap, with the male close to her, then she disappeared and the male remained alone over the nest. On May 9 the same large male was seen on the nest, but near him another smaller one, apparently a male, which the larger one did not this time drive away. The small one was later seen driving off others, and when the large one was absent would pick up stones and place them on the heap. But of all those that appeared to be females none lifted a stone. The large male was also at times seen to

[a] Bureau of Fisheries, document No. 633.

convey pebbles to the heap. He was seen to make 15 or 20 trips to a gravel place on the opposite side of the brook and later, with pebbles from it, return to the nest, a distance of 6 or 8 feet. Sometimes he would have one stone and sometimes several small ones and rarely a mouthful of very fine gravel, and once a stick 3 or 4 inches long was brought and laid on the heap. There was then observed several times a sudden gathering of a number of supposed females from the immediate neighborhood, comprising all of the chubs within 5 or 6 feet or more, and a simultaneous rush for the nest, where only a confused mass of struggling fish could be distinguished, some of which turned over so that the gleam of the belly could be seen. The old male was always there.

The following communication, entitled "Stone luggers," appeared in Forest and Stream, June 23, 1881, page 410:

During a recent visit to the Thousand Islands of the St. Lawrence I observed what I had never seen before, and something unfamiliar to most anglers. On the south shore of beautiful Round Island two mounds were discovered by a friend of mine situated, say, 10 feet from the water line and in about 3 feet depth of water. They were built of pebbles in the form of a pyramid. One must have comprised a bushel or more of small stones; the other was not so large. By patient watching the fact was discovered that these mounds were made by chubs, which could be seen carrying the pebbles in their mouths from near the water line to the hillocks. They worked incessantly and perseveringly, seeming unconscious of the presence of spectators. If driven away by dropping a stone upon them, they would quickly return and resume operations, always in nearly the same place, going over the same line to the same place to find the small stones.

The writer then asks for information regarding the purposes of the mound, etc. After commenting upon the uncertainty of the identity of the fish, the Forest and Stream expressed a wish that it had a specimen. In the issue of the same paper of December 22, 1881, p. 412, a note entitled "Mound-Building Fishes" stated that a specimen had been sent to Prof. G. Brown Goode for identification and he had decided that it was *S. bullaris*.

In the Geographical Journal, July, 1897, Dr. Robert Bell, in a paper on exploration to the south of Hudson Bay, said that:

Chubs are called "awadose" (stone carriers) by the Indians from their habit of collecting gravel and stones, weighing from less than 1 ounce to about a pound, and depositing them in a heap in the bottom of a river as a suitable spot for hatching their eggs, which are placed in their singular nest. This is done in the spring. A larger or smaller number of fishes, whose bodies would weigh from a pound to 3 or 4 pounds, work together to build the nest, the size of which will depend upon the number of workers. They pick up the stones with their mouths and bring them to the heap, one at a time, from far and near. These nests are made in tolerably shallow water where there is a moderate current, which favors the hatching of the ova. Their form is generally conical, and they contain on an average a cartload of gravel and stones, but they vary from a wheelbarrow load up to 4 or 5 tons. The fact that the stones weigh fully one-third less under water than in the air helps to account for their ability to carry the larger ones, which may be seen in hundreds of these heaps.

In the American Naturalist for May, 1907, Dr. Alfred W. G. Wilson writes about these chub nests with several photographic illustrations, but stated that while the Indians and others maintain that the chub does the work he had been able to find no one who has seen the fish at work. But one would infer that Dr. Bell or some of his informants had seen the fish at work, as he stated definitely that they work several together and carried the stones in their mouths.

In Maine Woods, June 26, 1908, in an article on the chub, the writer stated that on several occasions he had seen chubs at work on such nests, but to the best advantage in June, 1907, at Whites Bridge, Sebago Lake. When standing on the bridge at some height above the water, everything on the bottom could be seen plainly. He watched

one chub off and on for several days, and during that time the chub was never idle, always carrying stones to the heap or driving off other fishes. The other fishes in the vicinity of the nest were black bass, suckers, perch, shiners, and other chubs. The chub avoided or else did not mind the black bass very much. The bass, however, would seldom approach the heap, excepting when a school of shiners would swim over it, when one or more bass would dart at them. That which promised to be a valuable natural history observation was destroyed by some one catching the chub.

In the previously mentioned Putnam collection were specimens of chubs from Richardson Lake. On October 17, 1900, and October 28, 1904, the writer collected small ones in a minnow trap in Oquossoc Lake. During July, August, and September many were caught, from young only 2 or 3 inches long up to 13 inches long, in Umbagog Lake, Swift and Dead Cambridge Rivers, and Androscoggin and Magalloway Rivers. (See Table III, p. 591.)

BLACKSPOT CHUB (*Semotilus atromaculatus*).

Although a very commonly distributed fish in Maine, there was no record of its occurrence there until it was found at Freeport, Me., in 1892 and 1893.[a] It was subsequently found in many other localities. Only in one or two instances were any dis-

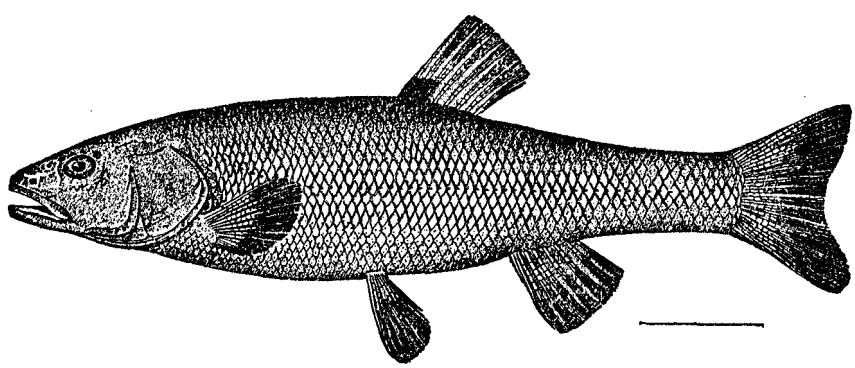

FIG. 5.—Blackspot chub (*Semotilus atromaculatus*).

tinctive common names applied to it. At Green Lake it was called mummy-chub and at the Connecticut Lakes in New Hampshire it was designated as mud-chub. The name blackspot is applied to this fish in allusion to the black spot at the base of the anterior end of the dorsal fin. Its geographical distribution is given in "Fishes of North and Middle America" as Maine and western Massachusetts to southern Missouri, Wyoming, and Canada, chiefly in small brooks, where it is often the largest and most voracious inhabitant.

It does not attain so large a size as the common chub; in New England it reaches a length of not over 10 inches, so far as is known, but averages considerably less.

This chub spawns in early summer, at which time the body of the male becomes of a darker hue and the pectoral and ventral fins are often a bright orange color, and there are horny excrescences on the snout and top of head. The nesting and breeding habits are described by Prof. Jacob Reighard in great detail[b] and illustrated by reproductions

[a] Kendall, W. C., and Smith, Hugh M.: Extension of the recorded range of certain marine and fresh-water fishes of the Atlantic coast of the United States. Bulletin, U. S. Fish Commission, 1894 (1896), p. 17.

[b] Bulletin, Bureau of Fisheries, Vol. XXVIII, 1908, pt. 2 (1910), p. 1111–1136.

of photographs taken under water. These habits are very similar in many respects to those of the common chub. The upright position assumed by the female in spawning indicates that the common chub in the position described by Atkins was during the act of spawning, although nothing was noted regarding the position of the male as described by Reighard.

The blackspot chub, while comparatively numerous in the smaller ponds and some of the streams, seems to be rather scarce in the lakes so far as collections indicate. On October 21, 1904, one was caught in a minnow trap at Mountain View Wharf in Oquossoc Lake. This is the only record for the lakes, but during July, August, and September numerous specimens were taken at Sluice Dam in Dead Cambridge River and at the dam in Swift Cambridge River. It was particularly abundant in York and Molnichwock Ponds and in the Swift Cambridge River at Grafton. The two largest specimens secured were 6½ and 7 inches long, respectively, taken in Molnichwock Brook.

CHUB MINNOW (*Couesius plumbeus*).

There seems to be no distinctive common name for this fish other than the above, which was coined to supply the deficiency. The name seems properly applicable, since the fish is a minnow closely related to the common chub.

This species, a few years ago recorded only from Lake Superior, is now known to be common throughout northern New England and occurs in almost every lake, pond,

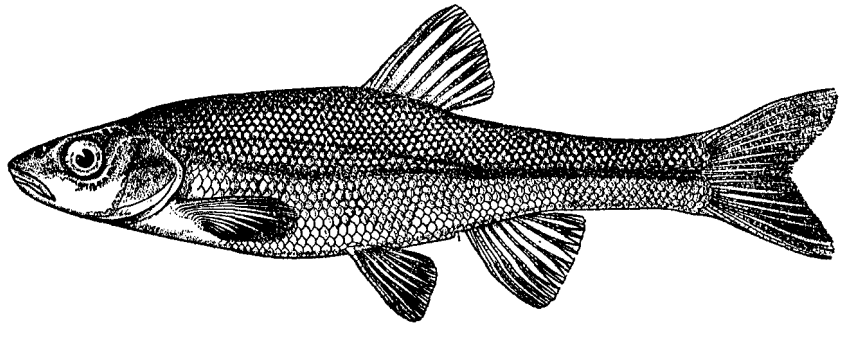

FIG. 6.—Chub minnow (*Couesius plumbeus*).

river, and brook in Maine. Putnam collected it in Metallak Brook and Richardson Lake, and the author got some in Oquossoc Lake in 1904. It was found in both Swift and Dead Cambridge Rivers and in Molnichwock Pond in 1905.

The chub minnow feeds chiefly upon animal food, as insects, etc. It also eats small fishes.

Its breeding season in the Rangeley Lakes region was not ascertained, but in some lakes in Maine where it ascends brooks to spawn it does so in May. It was found breeding in the Connecticut Lakes brooks in early July. In breeding season, in some waters at least, the scales of the entire body are margined with a series of fine tubercles or so-called pearly bodies.

This fish may be readily caught with baited hook and frequently with small fly. It is an excellent live bait.

BROOK SHINER (*Rhinichthys atronasus*).

This species of dace does not lack for local names. Its book name is blacknose dace, and it is variously called rock minnow, brook minnow, rock shiner, pot belly, pottle belly, etc. The last two names are derived from the frequent distended appearance of the abdomen due to tapworms, with which the fish seems to be extensively affected.

Its geographical range is extensive, and the fish is found in almost every brook and in some lakes and ponds from New Brunswick and Quebec south to northern Alabama

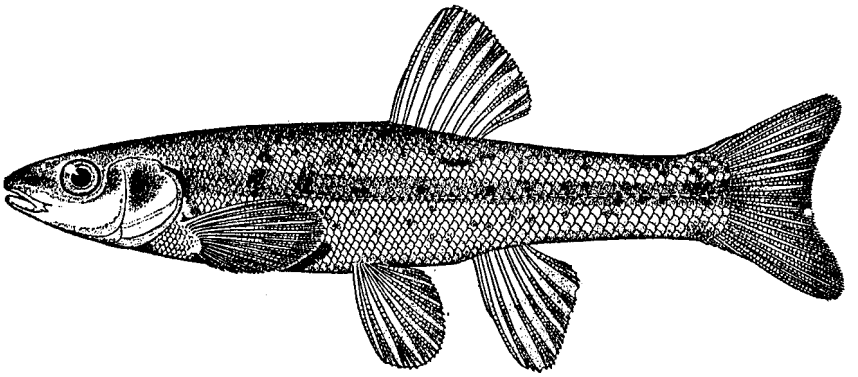

FIG. 7.—Brook shiner (*Rhinichthys atronasus*).

and west to Minnesota. It feeds mainly upon insects, especially their aquatic larvæ, and entomostracans. It breeds in late spring and early summer.

The only specimens collected in 1905 in this region were a few young and medium-size ones in the Dead Cambridge at and above the sluice on July 22 and August 21. In the Boston Society of Natural History's Museum are some specimens collected in Parmacheenee Lake many years ago.

BRONZE MINNOW (*Phoxinus neogæus*).

Prior to its discovery in New Brunswick in 1888 and again in 1895 by Philip Cox,[a] this species had not been recorded east of Wisconsin and Michigan. It was found by the

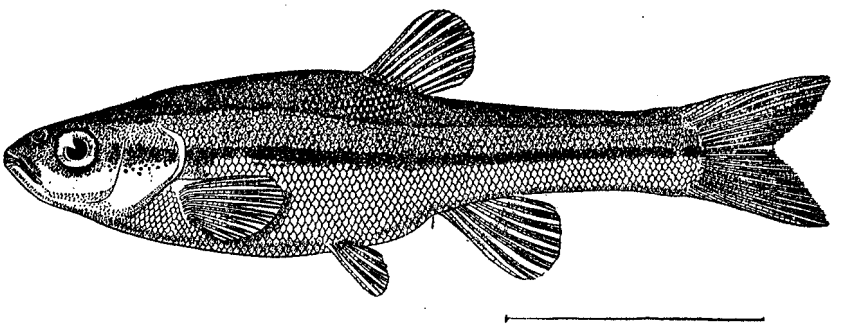

FIG. 8.—Bronze minnow (*Phoxinus neogæus*).

writer in the East Branch of the Penobscot waters, Allagash Lake and Eagle Lake[b] in 1901 and in Indian Stream,[c] a tributary of the Connecticut River in northern New

[a] History and present state of the ichthyology of New Brunswick, with catalogue of its fresh water and marine fishes, Bulletin No. XIII, Natural History Society of New Brunswick, 1895, p. 44.

[b] Notes on some fresh-water fishes from Maine, with descriptions of three new species, Bulletin, U. S. Fish Commission, Vol. XXII, 1902 (1904), p. 356.

[c] The fishes of the Connecticut Lakes and neighboring waters, with notes on the plankton environment. Bureau of Fisheries, doc. no. 633, 1909, p. 29.

Hampshire, in 1904. On July 22 a few specimens were taken at the sluice, on the Dead Cambridge River.

It is a handsome little fish, attaining about 4 inches in length. It feeds upon small insects, eggs, larvæ, worms, and vegetable matter. It makes a good bait and will readily take a small hook baited with worm. Nothing regarding its breeding habits was observed, but it probably spawns in the spring or early summer.

REDFIN (*Notropis cornutus*).

The redfin or redfin shiner derives its name from the red fins of the breeding male. The name is, therefore, not always individually applicable and is not distinctive, as other cyprinids, as well as other fishes, have red fins at times, and this species does not always have them.

The distribution of the redfin is very extensive, according to Jordan and Evermann, inhabiting the entire region east of the Rocky Mountains except the South Atlantic States and Texas. In 1900 and 1904 it was collected in Oquossoc Lake and in Umbagog

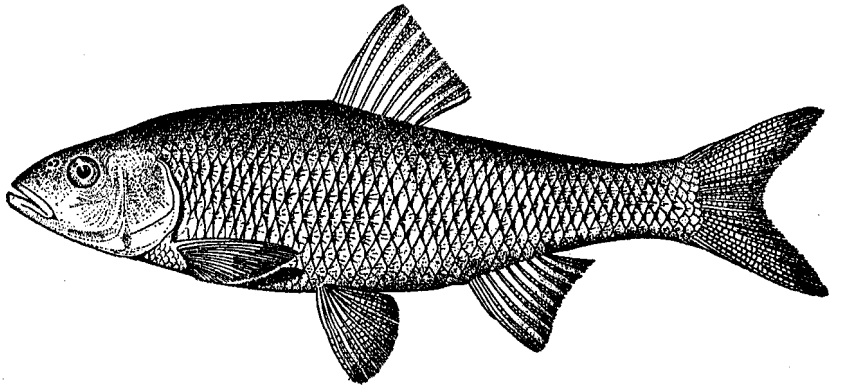

FIG. 9.—Redfin (*Notropis cornutus*).

Lake in 1905, also in the Dead Cambridge River and the Androscoggin River near the mouth of Molnichwock Brook.

The redfin attains a length of 8 inches. Those secured in Oquossoc Lake, October 17, 1900, ranged from $3\frac{7}{10}$ to a little over 5 inches in length, and those from the other waters in 1905 from 3 to 4 inches. (See Table IV p. 591.) The fish is carnivorous, feeding largely upon insects and their larvæ and to some extent, especially in its youthful stages, upon entomostracans. In lakes and ponds the redfin lurks around water plants, where its food is most abundant, but on calm evenings it moves about in schools at the surface over deep water, far from shore, feeding upon insects that have fallen upon the water.

Its breeding time is in the spring or early summer, according to the temperature of the water. At this time the male assumes a beautiful coloration, the fins broadly margined with bright red, the back an iridescent blue, and the sides reflecting all the hues of the rainbow. The head of the male at this time bears conical horny tubercles or excrescences, whence the names horny-head and buckfish.

The redfin will readily take a hook, especially if baited with earthworm, and is also caught on small artificial flies, especially when feeding upon insects at the surface. The fish is one of the best of live baits.

The proportional measurements of Rangeley Lakes specimens differ somewhat from Connecticut Lakes specimens. The Rangeley Lakes specimens average somewhat smaller than those of the Connecticut Lakes and are, therefore, somewhat more slender. The head is proportionally somewhat shorter. Whereas the eye in the smaller fish should be proportionally larger, in the Rangeley fish it is somewhat smaller than in the larger Connecticut Lakes specimen. The snout is considerably shorter. The longest ray of dorsal, which should be proportionally higher than in the larger fish, is considerably lower. The dorsal and anal fin ray counts are the same, but the scales average one more than in the Connecticut Lakes specimen, although the latter comprise some 42 scales.

SHINER (*Notemigonus crysoleucas*).

Other Maine names of more or less restricted use for this fish are pond shiner, bog shiner, and herring.

The recorded range of the species is from Nova Scotia and Maryland to Dakota and Texas—everywhere abundant in bayous and weedy ponds. It was not found at

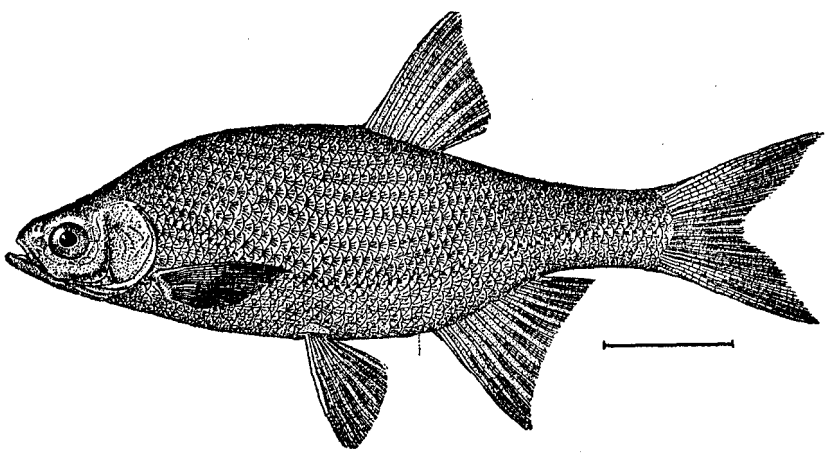

FIG. 10.—Shiner (*Notemigonus crysoleucas*).

all in the Connecticut Lakes and only in the lower part of the Rangeley chain, although it probably occurs to some extent in the upper waters. A great many were taken in Umbagog Lake, the largest being not over 5 or 6 inches long. They were most frequently found at the mouth of brooks in water about 3 feet deep where aquatic vegetation was abundant. As usually observed, it seldom is over 5 or 6 inches long, but in some waters it attains a length of 1 foot or more.

This fish subsists mainly upon insects and entomostracans. It is a most excellent bait fish. Being so abundant in Umbagog Lake, it must contribute largely to the food supply of pickerel.

EEL (*Anguilla rostrata*).

There is no other common name for this fish except some which apply to different sexes, ages, or appearances, such as silver eel, broad-nose eel, sharp-nose eel, etc.

The distribution of the eel on the Atlantic coast and in the inland waters of eastern North America is very extensive, ranging from as far north at least as the St. Lawrence

and south to the Gulf of Mexico and West Indies. It ascends, as young fish, all rivers within its range, often to the very sources, from whence, to breed, it descends to the sea.

It does not seem to be very common in the Rangeley region, which is fortunate, as it is rather destructive to other fishes. It was not observed by the United States Bureau of Fisheries' party in 1905. The only records appear to be those of the State Fish Commission Report for 1878, which is here quoted: "Three eels which had forced themselves through a leak in the gate of the Upper Dam were killed by the weight of water driving them between the logs of which the aprons of the dam are built. These eels were weighed by Thomas McLeod, a strictly reliable man. Their weights were, respectively, 8½, 11½, and 13¾ pounds." In American Angler, April 14, 1883, J. G. Rich wrote: "Large eels have been picked up on this dam measuring 4 or 5 feet, yet we never have caught one in the lake above." In Forest and Stream, November 24, 1900, J. Parker Whitney said that large, lusty, white and yellow bellied eels were found in the lakes, but not very plentifully, and that he had never known them to be caught with bait. He said that he had seen a few weighing from 10 to 12 pounds that were caught fast in the narrow space between the logs of the apron below Upper Dam during the

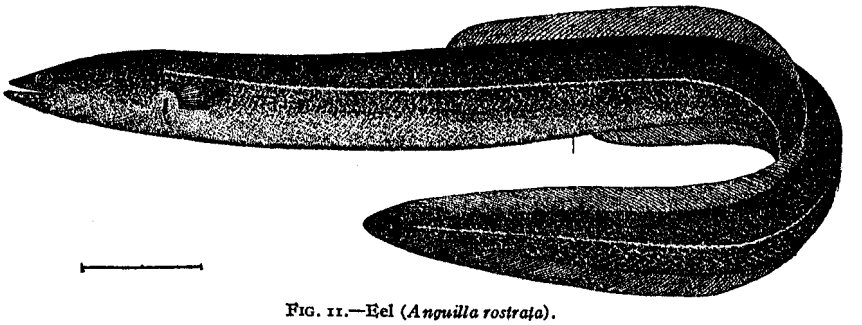

FIG. 11.—Eel (*Anguilla rostrata*).

night passage from the lake above. Both of these statements doubtless refer to the same record mentioned in the State Fish Commission Report.

WHITEFISH (*Coregonus clupeaformis*).

This whitefish is one of the numerous species constituting a subfamily of the Salmonidæ, widely distributed in the northern waters of both hemispheres.

In appearance the whitefishes are distinguished from the rest of the salmon family by having a comparatively small mouth, feeble dentition, and comparatively large scales. They are inhabitants of many of the larger and deeper lakes throughout their geographical range. Some species attain to a weight of over 10 pounds while others to only a few ounces. The different species have somewhat different feeding habits, but, as a rule, nearly all subsist upon the smaller lacustrine animal life, including fishes and in some instances insects that fall upon the water.

Some forms breed on the shoals of lakes, to which place they sometimes migrate considerable distances in the fall of the year; others ascend streams for the purpose of spawning.

All are excellent food fishes, and the present form is highly esteemed.

While there are three species common in many Maine lakes, especially north and east, not one of these is indigenous to the Rangeley Lakes. The native Maine form

closest to this species is usually very abundant wherever it occurs. In some waters its average size is about 1 pound, for which reason, many years ago, it was denominated "poundfish." In some northern Maine waters individuals weighing as much as 6 pounds have been observed. In some localities it is called whiting and in some other New England waters it is erroneously called shad. Among the Canadian French of northern Maine it is known as pointeur and poisson pointu and in other places as poisson blanc.

It subsists largely upon small crustaceans, aquatic larvæ of insects, and small fishes, such as occur in the depths inhabited by whitefish, but it very frequently approaches the surface and feeds upon insects that have fallen upon the water.

It is an excellent food fish, but is not usually regarded as a game fish. The usual methods of capture have been by seining during the spawning runs and with bait through the ice. Yet it has been taken on an artificial fly and by trolling. Upon a light rod and small fly it affords excellent sport, especially in streams, where it may sometimes be caught even in the summer.

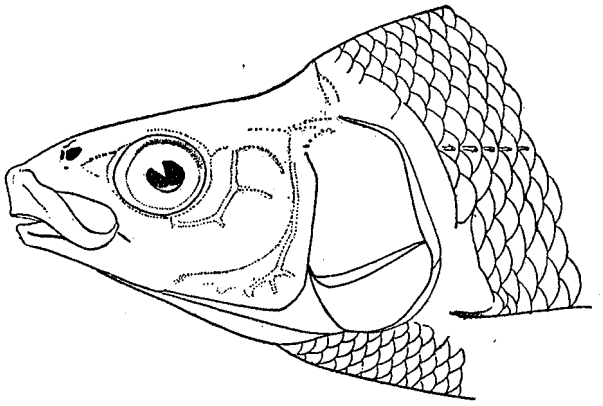

FIG. 12.—Head of Umbagog Lake whitefish (*Coregonus clupeaformis*).

The whitefish of Umbagog is the result of a plant made by the Maine fish commissioners in Oquossoc and Mooselucmaguntic Lakes in 1881, regarding which the Maine Fish Commission Report for that year has the following:

> We were presented by Prof. Baird, from the establishment of Frank N. Clark, Northville, Mich., 1,000,000 whitefish eggs. Owing to the extreme cold weather, long distance of transportation, and tenderness of the eggs, the percentage of loss was large. Should judge about 25 per cent of the eggs hatched. They were received in February; were hatched and turned loose March 20. About 15,000 of these were put in Rangeley, the balance were turned loose in Mooselucmaguntic Lake.

The only possible indication of its subsequent appearance in the upper lakes is the statement of a resident of Rangeley, who told the writer in 1904 that he knew of one, and only one, having been taken in Oquossoc Lake, about three or four years before. In the winter of 1903 it was first detected in Umbagog Lake by Capt. Dana Brooks, of Upton, when fishing for pickerel near Metallak Island. Capt. Brooks subsequently informed the writer that the fish were taken on small fish bait, and some were caught in that way every winter.

H. O. Stanley, then a member of the Maine Inland Fish and Game Commission, had several of these fish sent to the Bureau of Fisheries, with the statement that they were the first evidences of the results of his plant in 1881.

There is some uncertainty regarding whether or not the present form is specifically identical with the common Maine whitefish, formerly known as *Coregonus labradoricus*. A comparison of the specimens from Umbagog Lake with native Maine whitefish of like and diverse sizes reveals some slight but, so far as these specimens are concerned, constant structural differences. The same differences obtain between specimens from Lake Michigan and the Maine fish. While these differences are slight, the characteristics presented by the Maine fish persist in a large number that have been examined.

Whether or not those of the Michigan fish are constant can be told only by an examination of a larger number of specimens. In certain proportional measurements the Umbagog fish approaches the Maine fish, intergrading or interlinking the Michigan with the Maine form, suggesting that the change to the conditions of environment found in Maine is correspondingly modifying the fish and thus indicating that the differences between the Michigan and Maine fish may be merely ontogenetic. In the dim light of our present knowledge, however, it seems best to continue to regard the native Maine form as a distinct species, although the geographical limits of either form are unknown.

The most conspicuous and about the only distinct differences shown by the specimens examined are in the shape of the head and form of some of the head bones. In the Umbagog fish, as well as those of the Michigan waters that have been examined, the supraoccipital and parietal bones slope from the nape to the frontals, forming a somewhat concave profile, figure 12. In the Maine fish the profile is always straight and continuous with the line of the nape, figure 13. In the Umbagog fish the opercular bones are proportionally deeper and the supplementary maxillary proportionally longer and narrower than in the Maine fish, and the lower jaw of the Umbagog fish is slightly shorter than in the Maine fish.

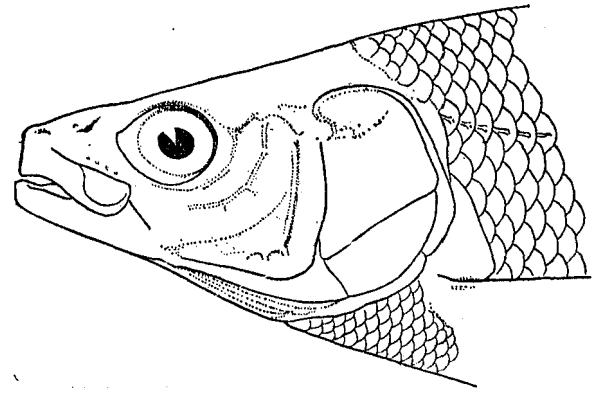

FIG. 13.—Head of Maine whitefish (*Coregonus labradoricus*).

The following comparison of averages of proportional measurements of the Umbagog, Maine, and Michigan fish, respectively, in many instances shows the previously mentioned intergradation:

Head of Umbagog fish longer than that of the Maine fish and slightly longer than that of the Michigan form.

Maxillary, longer than Maine and Michigan, the latter two essentially alike.

Mandible, shorter than Maine, about the same as Michigan.

Snout, shorter than Maine, intergrading with Michigan.

Interorbital, essentially the same in all.

Eye, about the same as Maine, but somewhat larger than Michigan.

Depth, about the same as Maine; less than Michigan.

Longest dorsal ray, about the same in all.

Longest anal ray, longer than Maine, shorter than Michigan.

Pectoral, longer than Maine, shorter than Michigan.

Ventral, longer than Maine, shorter than Michigan.

Longest gill raker compared with eye, longer than Maine, shorter than Michigan. (See Table V, p. 592.)

The number of gill rakers is somewhat greater than in the Maine fish and somewhat greater than in the Michigan form, overlapping both, but the latter more than the former. The increase in the average number of gill rakers does not indicate that the fish is adapting itself to coarser food, as the fact that it takes a small fish bait suggests, but rather that its principal subsistence consists of more minute forms. This, if a fact, perhaps will account for it disappearing from the upper lakes and more or less permanently abiding in Umbagog, where the plankton is more abundant.

Why it should descend the Androscoggin as far as Berlin with the apparent intention of going farther is an unanswerable question.

Elmer Bean, of Berlin, N. H., informed the writer that some years ago two specimens of whitefish were found in the grate of the flume of a pulp mill at Berlin and that he had frequently caught them on bait at the mouth of Molnichwock Brook. In 1905 one, 12⅜ inches long, was taken by the Bureau of Fisheries' party in a gill net in the deep hole off Sunday Cove August 17, and one, 16 inches long, was caught on a hook and line at the mouth of Molnichwock Brook July 17.

SEA SALMON (*Salmo salar*).

The Atlantic salmon, sometimes designated as sea salmon to distinguish it from the fresh-water or so-called landlocked salmon, is a resident of the north Atlantic along the coasts of Europe and America, ascending all suitable streams. In Maine the Androscoggin was one of a number of rivers formerly ascended by the salmon, but owing to impassable falls it never reached the Rangeley Lakes. The only interest attached to this species so far as those lakes are concerned is in the fact that a number has been introduced there from time to time and the possibility of their having con-

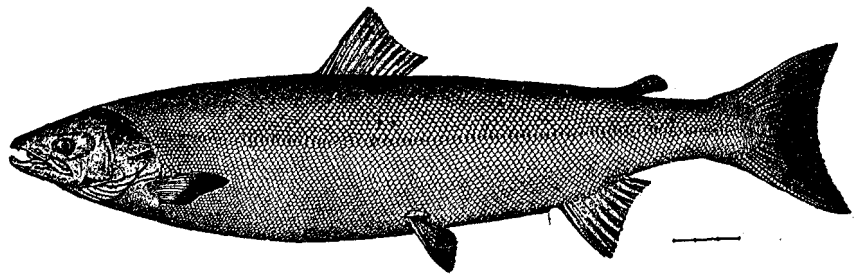

FIG. 14.—Sea salmon (*Salmo salar*).

tributed to the salmon stock of the lakes. The following plants were made: Ten thousand fry in 1873; 99,000 fry in 1881; 194,600 fry in 1882; 1,000 yearlings in 1900–1901.

The differences by which this species can be distinguished from the landlocked salmon are slight and by the ordinary observer would probably not be noticed. The most conspicuous external characteristics are the smaller, more pointed head, more slender caudal peduncle, more numerous scales,[a] and radical difference in color in the adult sea salmon. So far as relates to the desired or undesired result of its introduction into these waters, its distinguishing characteristics are of little moment now. The desired result was to furnish fish for the angler. To him its structure is of no concern so long as its size and gameness are satisfactory, its table qualities being equal to those of the other species. The undesired results are its effects upon other fishes. Its feeding habits in these waters probably would not differ from the landlocked salmon, and its effects upon the game fishes would likely be the same as in the case of the landlocked salmon.

The first salmon caught of which there is any record was taken in 1875 and weighed one-half pound. This might possibly have been from the plant of Schoodic salmon of 1874, but that is a pretty good growth from fry in one year. Another weighing 2

[a] There is some doubt about this character.

pounds was taken in 1876. Both of these were possibly sea salmon.[a] No more were taken until 1880, when one of 4 pounds was recorded; but it can not be positively ascribed to the sea-salmon plant, for the Schoodic salmon planted in 1875 and 1876 had five and four years, respectively, in which to reach that size.

The two salmons weighing 6 and 12 pounds, respectively, taken in Mooselucmaguntic Lake in 1882 might have been from the plants of either sea or Schoodic salmon, but the 79 caught at Middle Dam in the same year, weighing up to $4\frac{3}{16}$ pounds, averaging $1\frac{2}{8}$, were some of the landlock stock.

No more salmon, so far as records show, were caught in any of the lakes until 1887. The records for that year were one of $7\frac{1}{2}$ pounds in Rangeley Lake and one of 5 pounds from Richardson Lake. Thus it seems that the survivors of the original stock of sea salmon had then all disappeared.

SALMON (*Salmo sebago*).

In fish culture this fresh-water salmon is otherwise known as landlocked salmon, Schoodic salmon, and Sebago salmon, and in local parlance in some places is designated as salmon trout and blackspot to distinguish it from the common trout (*Salvelinus fontinalis*). Landlocked salmon is a misnomer. It is, moreover, not euphonic, and long custom alone partly justifies its use. Fresh-water salmon would be more appropriate.

In Maine its natural waters were restricted localities in the St. Croix, Union, Penobscot, and Presumpscot River Basins. It, or a kindred form, occurs naturally also in a few lakes of New Brunswick and Nova Scotia, and an apparently distinct but closely related species is found in the Saguenay River Basin in Quebec. The claim that it occurs in Labrador is somewhat uncertain and perhaps based upon mistaken identification. Yet there is no apparent reason why it might not be found there.

This salmon subsists upon insects and fishes, particularly upon smelts. In fact, in its native waters its existence seemed to depend in some way upon the presence of smelts, and in other waters it thrives only where the smelt has been introduced.

The spawning, as a rule, takes place in November, and the eggs hatch the following spring. In most instances, if possible, salmon ascend or descend streams to spawn upon gravelly bottoms in quick-running water. When such streams are not available, the operation takes place on gravelly shoals of the lake, but it is doubtful if in such places the process amounts to much. In the breeding season there are more or less structural and chromatic changes in the fish. The jaws of the male are prolonged, the under jaw becomes hooked, owing to a knoblike cartilaginous proliferation that fits into a socket in the snout, but in some cases passes up, over, or through the end of the snout. The colors of both sexes become brighter, brown, orange, yellow, and blue appearing on the bodies, especially the male, and occasionally faint orange spots on the tail, which at other times is spotless. The salmon practically cease feeding at this time. They probably do not breed oftener than every other year. The age of maturity is probably about 4 years, although some individuals are more precocious and some are retarded more or less.

[a] In the Transactions of the American Fish-Cultural Association for 1883, p. 49, without giving the year, Atkins stated that about 50 domesticated Schoodic salmon about 2 years of age were introduced. This might have been prior to the 1873 plant of sea salmon.

The young salmon, after it is able to swim and feed, whenever possible, like the young of the sea salmon and the common trout, enters small brooks tributary to the spawning stream in the vicinity of the breeding place, and always little salmon a few inches in length occur on the rips and in shallow eddies and pools of the breeding stream, which suggests that, other conditions being favorable, such places should be selected in which to plant young fish, whether fry or fingerlings, rather than to place them directly in the lake.

The records of plants are very incomplete and otherwise unsatisfactory. There are no available records of the number planted by private clubs and angling associations. The State reports often lack some element of a complete record. Very often the number is not given. It is very difficult to assign the plants of some of the reports to the proper years. The later State reports, published every two years, usually give the records for one year only—that of the report. Sometimes it is difficult to know which pond is meant, in that the records for ponds are very incomplete, a number of ponds in the State bearing the same name.

From the viewpoint of recent years it seems somewhat astonishing that, though the larger lakes were stocked with the salmon, some of the smaller ponds were not left to the trout. Instead, however, almost every little pond in the region has received some landlocked salmon. The earlier introductions were usually fry, and in later years the majority were fingerlings, with some yearlings.

PLANTS OF SALMO SEBAGO IN THE RANGELEY LAKES.

1875	5,000	1898	4,000	1907	136,000
1876	3,000	1899	2,000	1908	176,000
1877	18,000	1900	65,000	1909	184,937
1881	18,750	1901	3,014	1910	60,137
1883	198,000	1902	14,500	1911	124,500
1884	153,000	1903	12,000	1912	(a)
1895	(a)	1904	234,015	1913	82,000
1896	(a)	1905	900	1914	37,500
1897	4,800	1906	24,000		

INCREASE IN NUMBERS AND RATE OF GROWTH.—It has always been assumed that, other things being equal, the rate of growth, as well as the size attained, by any fish depended upon its food supply. Atkins said (loc. cit.) that when introduced into new haunts the salmon has often grown to an unwonted size and sometimes at an accelerated rate. The records show that at the Rangeley Lakes salmon of considerable size were not taken in large numbers until after the introduction of smelts, although large individuals were occasionally caught. The food supply must have been mainly the fishes already occurring there and to a great extent, no doubt, the little blueback, which rapidly disappeared as the salmon increased in numbers. The smelt was introduced too late to save them. From the year following the introduction of smelts there was a progressive, though fluctuating, increase in numbers of salmon but no great variation in the average weight. The average weight, as shown by the records, however, decreases to some extent as the number caught increases.

Forest and Stream, July 22, 1875, contained the following notice:

A lady caught at the mouth of the Rangeley River a landlocked salmon weighing a half a pound, the first ever captured in this vicinity, and probably the first returns of the salmon fry put in at Kennebago Rapids by the Maine Fish Commission in the spring of. 1873.[b]

[a] No records.

[b] Referred to under sea salmon.

Again, in the same paper, June 8, 1876, it was reported that a 2-pound landlocked salmon was caught about the same time from Rangeley Stream, "the first stranger of any size that has been caught from the recent importations into these waters." This paper reported in its issue of June 7, 1877, that several salmon, weighing from 1 to 4 pounds, had been taken, and on August 19, 1880, five were reported, the largest of which weighed 4 pounds.

The American Angler, July, 1882, contained a statement to the effect that at noon on July 2 a landlocked salmon weighing nearly 4 pounds was taken in swift water below the dam (Middle Dam). This was the largest one ever taken there.

Commissioner H. O. Stanley reported to Forest and Stream, October 26, 1882, as follows:

> I am very happy to say that the salmon put in an appearance in the Rangeley Stream for the first time. Some of them were very large. I saw five of them in a pool, which I estimated would run from 4 to 10 pounds each. They have also been taken in the lakes below. For the short time that has elapsed since they were introduced and the small number of eggs this increase has been remarkable.

In American Angler, April 14, 1883, J. G. Rich, writing of record trout, said that at the same time there were also taken many landlocked salmon, the plant of which was made about five years previously, the fish weighing from 5 to 10 pounds. The same paper, July 24, 1884, stated that a 5-pound salmon had been taken from Umbagog Lake, and that a large one had been hooked and lost in Mooselucmaguntic Lake. This paper, November 25, 1886, contained the statement that in the previous September, while fishing in Rapid River opposite the old Oxford Club House, a landlocked salmon that had two rows of red spots on each side and two others that had only black spots were caught. On May 22 of that year four salmon weighing, respectively, 3, 8, 9, and 11 pounds were reported. In Forest and Stream, June 3, 1886, a correspondent wrote that the showing up of landlocked salmon in the Androscoggin Lakes that spring had established a happy fact for anglers and a triumph in fish propagation very gratifying to everybody, and more especially to the worthy fish commissioners of the State, who had labored so arduously in that direction.

Writing of Rapid River in American Angler, February 6, 1886, J. G. Rich stated that fishermen reported the taking of a great number of trout and salmon 8 or 10 inches long, about the same number of each kind.

Forest and Stream, May 26, 1887, stated that it was worthy of note that trout scores of the early arrivals at Rangeley Lake were sprinkled with landlocked salmon, and the American Angler, June 11, of the same year, stated that in addition to trout they then had a fair quantity of landlocked salmon. Hardly a day passed without one or two being brought into camp, weighing 2 pounds on an average, while much larger ones were often seen and taken, and it was thought that the day was not far distant when there would be a plentiful supply of this variety. The same paper, June 30, of that year, said that there were numerous reports of the capture of landlocked salmon in the Upper Androscoggin Lakes, particularly Rangeley Lake. The catches of trout were said to be sprinkled now and then with a salmon or two. But there was no report of any in the lower lakes of that chain for that season.

A Philadelphia correspondent of Forest and Stream, October 13, 1887, established a record of salmon taken on a fly as follows:

It may interest the readers of Forest and Stream to learn that on Monday, September 26, I took a landlocked salmon in the Rangeley Lake (near the end of the lake at Greenvale) which weighed 7½ pounds. I used an ordinary 7-ounce fly rod, small linen line, 6-foot leader, dark Montreal, and a light-colored fly, the latter being the drop, which he took in a manner that showed that he meant business. * * * This is said to be as large a salmon as was ever taken from the Rangeley Lakes with a fly.

Forest and Stream, May 31, 1888, stated that considerable success was noted that spring in taking landlocked salmon in Rangeley Lake. One of 5 pounds and one of 6½ pounds were reported as well as a large number of smaller sizes. The report continued:

It is worthy of note, however, that although these landlocked salmon have been planted in the other lakes of the Androscoggin chain, and that these lakes are all connected by quite respectable rivers in point of size, yet but very few salmon have been taken other than in Rangeley Lake.

In the same paper, a communication dated Mav 25 stated that parties were catching more landlocked salmon than ever before.

The report of each succeeding year indicated an increase in number and size of salmon, also their gradual appearance successively down the chain of lakes. Forest and Stream, July 30, 1891, stated that it was quite evident that the introduction of landlocked salmon into the Maine lakes was going to be a success. But, as shown elsewhere, there appeared no positive and definite salmon records for 1892, 1893, and 1894. Reference to fish were, in all probability in part at least, to salmon, but owing to the element of uncertainty such indefinite accounts are not here included.

Forest and Stream, July 24, 1897, contained a communication, dated July 12, in which it was recorded that Prof. S. R. Morse, of Atlantic City, N. J., took a 13½-pound salmon "the largest landlocked salmon ever taken with hook and line from Rangeley waters." Another angler, about the same time, took one of 12 pounds. Both were caught in Upper Rangeley, or Oquossoc Lake. Up to this time the majority of the salmon had been caught in the upper lakes, particularly Oquossoc. Forest and Stream, May 28, contained the following notice:

In the pool below the dam (Upper Dam) a number of salmon have been taken. This is all the more remarkable when it is remembered that only a few have ever been taken there before, though a good many have been taken in the lakes above.

Yet a continuous increase is evident and became pronounced in 1896. From then on the references are not, as hitherto, from the interest in a few salmon taken but to the large catches and large size of the fish. In Forest and Stream, July 11, 1896, a correspondent wrote:

The landlocked-salmon record at Rangeley, already referred to, is a remarkable one. The first 21 salmon taken by guests of the Rangeley Lake House, and almost within sight of the house, actually weighed 135 pounds 2 ounces, an average of 6 pounds 7 ounces to the fish. Fifteen of the same fish weighed 112 pounds 14 ounces, an average of 7 pounds 8 ounces. The catch of the above fish began May 7 and ended June 4. A great many large salmon have also been taken since.

The predicted success of the introduction of landlocked salmon into the Rangeley Lakes seems to have been consummated. In 1900 Forest and Stream, July 7, noted: "Never before has Rangeley Lake seen such excellent fishing." The fish caught were all salmon. In 1901, under date of May 26, a note from Upper Dam read: "A remarkable feature is that almost as many salmon are being taken as trout. * * * While

the supply of trout has scarcely lost anything, a supply of salmon has been added." A record of the catch by guests of the Rangeley Lake House on June 5 consisted of 17 salmon but not a single trout.

In 1906, the year of the largest catch of salmon in the Rangeley Lakes, during the week up to May 30, the records of the Rangeley Lake House showed 34 salmon and 3 trout. In Maine Woods a comparison of two weeks fishing during the last of May and June, 1905 and 1906, was made as follows: 1905, 53 trout and salmon weighing from 3 to 8¼ pounds; 1906, 74, of which 5 were trout, the largest 5½ pounds, the largest salmon 9 pounds. The paper stated that this was the best record ever made by guests of the Rangeley Lake House. Another score was reported covering the time from May 15 to July 3, inclusive, consisting of 278 fish aggregating 1,147¾ pounds and averaging 4 pounds 2¼ ounces, with no fish under 3 pounds entered. Another report in the same paper stated that during July the guests of the same hotel had recorded 127 salmon and only 1 trout, which weighed 5½ pounds.

Size attained in Rangeley Lakes.—The largest salmon on record for Rangeley Lakes are one of 18½ and one of 17½ pounds, taken by State fish culturists in 1905. The largest taken by an angler was one of 16½ pounds, caught by George T. McNeil,[a] a Boston Pullman-car conductor, in 1903. There are two records of 13½-pound fish, one in 1897 and the other in 1911. One of $12\frac{9}{16}$ pounds was taken in 1902; three of 12½ pounds in 1898, 1903, and 1910, respectively; one of $12\frac{1}{10}$ pounds in 1907; two of 12 pounds in 1882 and 1900, respectively; one of 11½ pounds in 1905; one of 11 pounds in 1886; one of 10¾ pounds in 1896; one of 10½ pounds in 1901; one of 10¼ pounds in 1908; and one of 10 pounds in 1899. The average weight for the last 10 years, up to and including 1912, was a little over 4¼ (4.26) pounds.

In 1915 the average weight as ascertained from 549 records ranging from 1 to 8½ pounds, was a little over 3½ (3.55) pounds.

CATCHES OF SALMON AND TROUT COMPARED.—It has been maintained by some that the trout decreased in numbers as the salmon increased, which opinion is to some extent supported by deduction from the following data:

In Upper Rangeley Lake, or Oquossoc Lake, the first salmon was caught in 1887, two more were taken in 1888, none is recorded for 1889 and 1890, and one is mentioned next for 1891. No more records appear until 1896, when 23 salmon are recorded but no trout. In 1897, 35 salmon, ranging from 3 to 13½ pounds, are recorded and 6 trout from 2 to 6½ pounds. In 1898, 45 salmon weighing from 3⅛ to 12½ pounds and 32 trout weighing from 2½ to 8½ pounds are recorded. The records for 1899 show 65 salmon, ranging in weight up to 10 pounds and averaging 4⅘ and 5 trout weighing from 3½ to 6¼ pounds, averaging 5 pounds. Of this catch, 92.86 per cent were salmon and 7.14 per cent trout. In 1900, 6 salmon ranging from 4½ to 12 pounds are on record but no trout. In 1901, 11 salmon weighing from 2 to 7½ pounds but no trout are recorded. In 1902, 11 salmon weighing from 3¼ to 10 pounds and 3 trout weighing from 3½ to 6¾ pounds are reported. In 1903 salmon appeared in considerable numbers but were followed by a big decrease in 1904. The records show also a decrease in trout, but from then on the numbers increased fluctuatingly.

The first salmon taken in Mooselucmaguntic, weighing one-half pound, and 9 trout were recorded in 1875. The following year 1 salmon of 2 pounds and 35 trout were

[a] Forest and Stream, June 6, 1903, p. 468.

recorded. No more salmon appear in the records until 1880, when a 4-pound one is mentioned with 18 trout. There are no records for 1881 for either trout or salmon. Two salmon of 6 and 12 pounds, respectively, and 203 trout are reported in 1882. No further salmon records appeared until 1891, when 2 are recorded and 11 trout. Then follow three years of no salmon records. In 1895 salmon reappear and increase gradually, with some fluctuation till 1912.

The number of trout decreased on an average but fluctuated greatly until 1910, when there was a large increase that was maintained and increased to 1912, but a larger number was taken in 1911 than in 1912.

The percentage of trout naturally decreased with the increase in number of salmon, but the later increase of trout suggests that the decrease was not alone due to the disproportionate increase of salmon but to actual decrease in number of trout, which the records of catches also, to some extent, indicate. A later increase in percentage of trout indicates some reestablishment, perhaps, but still shows a preponderance of salmon.

In Richardson Lakes, Molechunkamunk and Wellekennebacook Lakes, the first salmon were recorded in 1882, when 79, averaging 1⅞ pounds, were mentioned. No more records appear until 1887, when one 5-pounder was reported. The next year 2 of 3½ and 5 pounds, and in 1889 4 weighing from 3½ to 8 pounds were recorded. No records appear in 1890, but in 1891 one 6-pounder was reported. No more are given until 1898, from which year some were reported each year to 1912. The larges. number was caught in 1903, when 56 salmon and 137 trout were on record for the seasont The next largest number was in 1906, when 44 salmon and 25 trout were caught. In 1909, 38 salmon and 31 trout constituted the number appearing in the records. The records for three succeeding years were: 1910, 8 salmon and 19 trout; 1911, 6 salmon and 6 tout; and 1912, 10 salmon and 10 trout.

For the entire chain of Rangeley Lakes continuous salmon records do not appear until 1895. One was caught in 1875; 1 in 1876; 1 in 1880; 81 in 1882, against 236 trout; 7 in 1886; 2 in 1887; 4 in 1888; 4 in 1889; and 5 in 1891.

TABLE 4.—RESPECTIVE NUMBERS OF SALMON AND TROUT RECORDED FROM OQUOSSOC, MOOSELUCMAGUNTIC, AND THE ENTIRE CHAIN OF LAKES IN THE 21 YEARS FROM 1895 TO 1915, INCLUSIVE.

Year.	Oquossoc.		Mooseluc-maguntic.		Entire chain.[a]		Year.	Oquossoc.		Mooseluc-maguntic.		Entire chain.[a]	
	Salmon.	Trout.	Salmon.	Trout.	Salmon.	Trout.		Salmon.	Trout.	Salmon.	Trout.	Salmon.	Trout.
1895	.....	.....	2	162	3	168	1906	374	18	172	52	590	95
1896	.....	.....	4	10	37	10	1907	242	44	136	72	396	150
1897	35	6	10	66	25	75	1908	301	9	100	56	415	80
1898	45	20	23	180	71	242	1909	124	6	105	55	267	92
1899	65	5	32	40	97	45	1910	214	42	243	108	465	163
1900	52	.....	56	27	63	29	1911	161	21	252	214	419	237
1901	11	.....	13	14	26	16	1912	245	34	292	126	547	170
1902	11	3	89	47	108	56	1913	214	31	187	38	423	99
1903	200	29	171	69	418	207	1914	149	18	248	94	405	124
1904	28	5	69	7	100	13	1915	92	19	405	64	549	96
1905	10	22	153	61	363	83							

[a] Including Pond-in-the-River but not Umbagog. Apparent discrepancies in the total for each year of the entire chain when compared with the total for the individual lakes are due to the admission of general references to Rangeley Lakes, no particular lake being designated.

TABLE 5.—PERCENTILE PROPORTIONS OF SALMON AND TROUT, IN ROUND NUMBERS, FROM OQUOSSOC, MOOSELUCMAGUNTIC, AND THE ENTIRE CHAIN OF LAKES IN THE 21 YEARS FROM 1895 TO 1915, INCLUSIVE.

Year.	Oquossoc.		Mooseluc-maguntic.		Entire chain.[a]		Year.	Oquossoc.		Mooseluc-maguntic.		Entire chain.[a]	
	Salmon.	Trout.	Salmon.	Trout.	Salmon.	Trout.		Salmon.	Trout.	Salmon.	Trout.	Salmon.	Trout.
1895.....	.....	.....	2	98	2	98	1906.....	95	5	76	24	86	14
1896.....	.....	.....	29	71	80	20	1907.....	84	16	67	33	72	28
1897.....	85	15	13	87	25	75	1908.....	97	3	64	36	84	16
1898.....	69	31	11	89	22	78	1909.....	95	5	66	34	75	25
1899.....	93	7	44	56	68	32	1910.....	83	17	69	31	74	26
1900.....	100	.....	67	33	68	32	1911.....	88	12	54	46	64	36
1901.....	100	.....	48	52	61	39	1912.....	88	12	70	30	76	24
1902.....	78	22	65	35	66	34	1913.....	87	13	83	17	81	19
1903.....	87	13	71	29	67	33	1914.....	89	11	72	28	76	24
1904.....	85	15	90	10	89	11	1915.....	83	17	86	14	85	15
1905.....	90	10	71	29	81	19							

[a] Including Pond-in-the-River but not Umbagog.

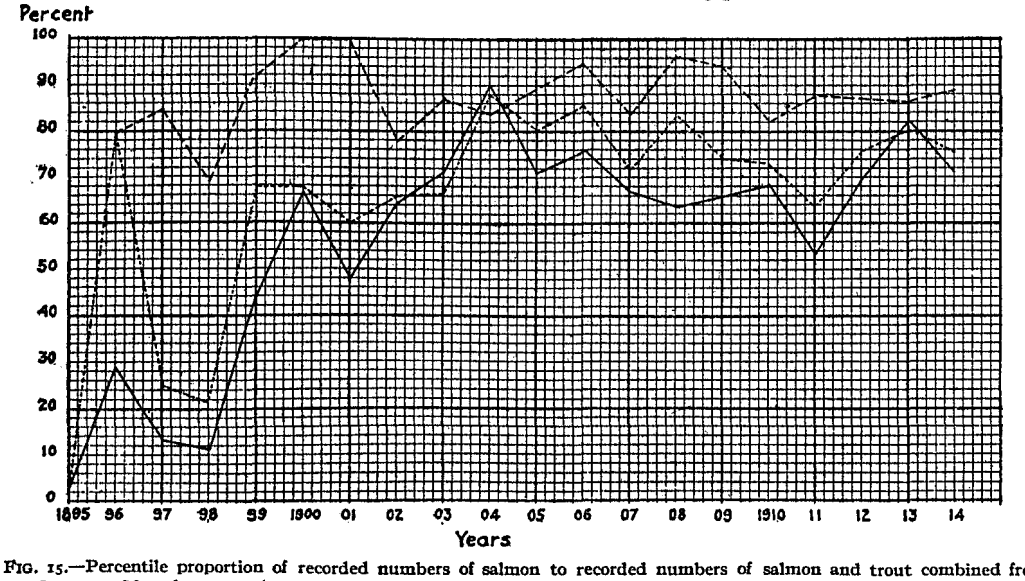

FIG. 15.—Percentile proportion of recorded numbers of salmon to recorded numbers of salmon and trout combined from Oquossoc, Mooselucmaguntic Lakes, and the entire chain of lakes, in the 20 years from 1895 to 1914, inclusive. Broken, line, Oquossoc Lake; solid line, Mooselucmaguntic Lake; dotted line, the entire chain.

TABLE 6.—RATIOS OF SUCCEEDING YEARS TO THE FIRST YEAR OF THE PERIOD OF 21 YEARS OF SALMON AND TROUT RECORDED FROM OQUOSSOC, MOOSELUCMAGUNTIC, AND THE ENTIRE CHAIN OF LAKES IN 21 YEARS FROM 1895 TO 1915, INCLUSIVE.

Year.	Oquossoc.		Mooseluc-maguntic.		Entire chain.[a]		Year.	Oquossoc.		Mooseluc-maguntic.		Entire chain.[a]	
	Salmon.	Trout.	Salmon.	Trout.	Salmon.	Trout.		Salmon.	Trout.	Salmon.	Trout.	Salmon.	Trout.
1895.....	(b)	(b)	100	100	100	100	1906.....	1,068	300	8,600	32	1,966	56
1896.....	(b)	(b)	200	6	1,233	6	1907.....	691	733	6,800	44	13,200	95
1897.....	100	100	500	41	833	39	1908.....	860	150	5,000	34	13,833	48
1898.....	128	333	1,150	111	2,366	149	1909.....	354	100	5,250	34	8,900	55
1899.....	186	25	1,600	25	3,223	27	1910.....	611	700	12,150	67	15,500	97
1900.....	148	.....	2,800	17	2,100	18	1911.....	460	350	12,600	132	13,966	142
1901.....	31	.....	650	9	866	9	1912.....	700	567	14,600	78	18,233	100
1902.....	31	50	4,100	22	3,600	33	1913.....	611	517	93,500	23	14,100	59
1903.....	571	483	8,550	42	1,393	123	1914.....	426	300	12,400	58	13,500	73
1904.....	80	83	3,450	4	3,333	8	1915.....	263	317	20,250	40	18,300	57
1905.....	600	367	7,650	38	12,100	49							

[a] Including Pond-in-the-River but not Umbagog.

[b] There were no comparable records in 1895 and 1896. In 1896 there were 23 salmon and no trout recorded.

TABLE 7.—NUMBER OF SALMON AND TROUT OF RANGELEY LAKES AND RATIOS OF SAME TO THE FIRST OF SIX PERIODS OF FIVE YEARS EACH, OVERLAPPING TWO YEARS.

Period.	Salmon.		Trout.		Period.	Salmon.		Trout.	
	Number.	Ratio to 1895.	Number.	Ratio to 1895.		Number.	Ratio to 1895.	Number.	Ratio to 1895.
1895–1899.....	233	100	540	100	1904–1908.....	1,864	800	421	78
1898–1902.....	367	157	388	72	1907–1911.....	1,962	842	722	134
1901–1905.....	1,015	436	375	69	1910–1914.....	2,259	969	793	147

TABLE 8.—PERCENTILE PROPORTION OF SALMON AND TROUT OF RANGELEY LAKES AND RATIOS OF SAME TO THE FIRST OF SIX PERIODS OF FIVE YEARS EACH, OVERLAPPING TWO YEARS.

Period.	Salmon.		Trout.		Period.	Salmon.		Trout.	
	Percentile proportion.	Ratio.	Percentile proportion.	Ratio.		Percentile proportion.	Ratio.	Percentile proportion.	Ratio.
1895–1899.....	30	100	70	100	1904–1908.....	82	273	18	26
1898–1902.....	49	163	51	73	1907–1911.....	73	243	27	38
1901–1905.....	73	243	27	38	1910–1914.....	74	246	26	37

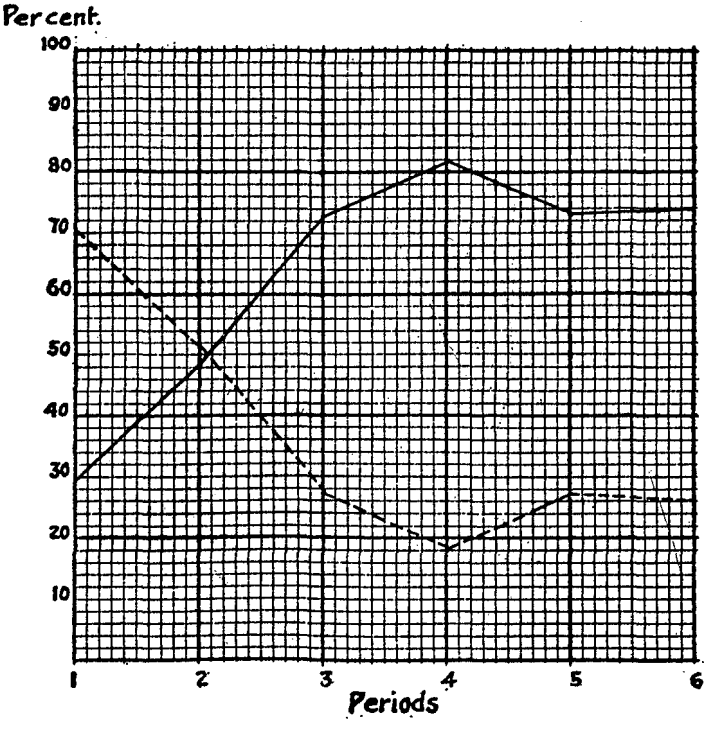

FIG. 16.—Percentile proportions of salmon and trout recorded from Rangeley Lakes in 5-year periods overlapping 2 years. Solid line, salmon; broken line, trout.

In these records the decline in the number of trout is markedly great in the first three periods, and this notwithstanding the increased number of fishermen. But in the last four periods there is a great increase in the number of salmon and an increase of trout in the last two periods. As is shown elsewhere, the increase in the catch of

trout is due to an increased number of anglers and consequent records, with the admission of a greater number of the small fish to the records.

In 1903, according to Maine Woods, February 13 of that year, Capt. F. C. Barker, testifying before a legislative committee regarding the need of a fish hatchery at Rangeley, stated: "The salmon are increasing, while there is a falling off in the number of trout. Of course there are more people who fish for them than did a comparatively few years ago, yet the spawning beds show the decrease to a perceptible extent." Regarding the same matter, John A. Decker testified as follows: "The salmon fishing is good, while the trout are diminishing. While the salmon are a gamer fish, there is something attractive about the trout, and if the present conditions continue it will be only a short time before it will be a rarity to catch a trout in those waters."

The salmon preponderated over trout constantly in the records of catches in the Rangeley Lakes from 1899. Regarding the fishing in 1904 to August 13, Forest and Stream had the following communication:

> The fishing in Maine this season has been about up to the average. The trout, I think, have fallen off, but the salmon have more than made up the decrease in trout. They have thrived wonderfully, making their appearance in many new lakes year by year. If it were not for the landlocked salmon the fishing would have deteriorated very perceptibly. They are the coming fish in Maine.

Undoubtedly the increased output of the hatchery has had an appreciable effect upon the maintenance of the trout supply, as it has in the increase of the salmon. Yet the conclusion is unavoidable that the salmon have had a marked effect upon the trout supply of the lakes.

GAMENESS.—This salmon is undoubtedly one of the gamest of game fishes, but times and circumstances modify these qualities in one way or another. Trolling or plug fishing will not afford the sport that fly fishing does. As a rule, the smaller fish are far more active than the very large ones.

It is impossible to adequately describe all of the factors that enter into the composite characteristic termed "gameness," and it is unnecessary, as every angler who has caught the fish knows it well and those who have not caught them can form but little idea from graphic descriptions. Regarding gameness in proportion to the size of the fish, it may be said that as a rule the larger fish are less likely to do much leaping from the water, while small fish are very active leapers at almost any time of the year. About the middle of June the writer caught a 13-pound salmon, trolling a fly and using a 4½-ounce fly rod. The fish did not leave the water until netted and restricted his activities to short runs, sounding, and sulking. It took 40 minutes to get the fish. About the same date a 1½-pound salmon, caught on the same rig by casting in the outlet of the lake, although it required much less time to net it, leaped from the water 17 times by actual count, occasionally three or four times in rapid succession. It was stated in a sportsmen's paper that the 12½-pound salmon caught by Mr. Rogers in Rangeley Lake, September 25, 1898, was landed in 15 minutes, while one of 10½ pounds taken by Judge Whitehouse, June 9, came out of the water four times and was landed in 1 hour and 55 minutes.

It is the general impression that this salmon will not take a fly except in certain bodies of water, but there is probably no lake or stream inhabited by the fish where it will not take a fly in fly time, although the very large fish are less likely to do so than smaller ones. Such an impression probably got abroad through the fact that those

who have tried the fly in doubtful waters have not long persisted in that method, their impatience causing them to soon resort to the customary method. However, it has long been demonstrated that the Rangeley Lake salmon is a fish that takes the fly, although formerly it was supposed not to. At Upper Dam in June, 1891, C. J. Bateman took a salmon on a fly, regarding which, Forest and Stream, June 11, of that year contained a notice to the effect that the fish weighed 7 pounds 14 ounces and was taken in the pool below Upper Dam on an 8½-ounce rod and Montreal fly. It was hooked at 7.45 a. m. and landed at 8.20 a. m. An elaborate account of the same event appeared in the same paper June 25, by which time the fish had apparently increased 10 ounces.

FISHING SEASON.—The fish usually can be caught by some means throughout the open season. This applies to any body of water inhabited by the salmon. The most productive time, however, is usually when the lake is free from ice up to the first of July or the beginning of the heated season. Occasionally one is caught by any of the usual methods during the summer, although stillfishing with live bait during July and August is the most likely method to yield fish. The largest salmon ever taken on a hook in Sebago Lake (22½ pounds) was caught in this way on a redfin bait, on the first day of August, 1907, but on the same day the writer caught a 16-pound fish by surface trolling, using a small smelt as bait. In some waters the fish has been caught by trolling and on a fly late in September, and the writer has caught the fish up to 3 pounds weight in early October in the Presumpscot River, the outlet of Sebago Lake.

FISHING PLACES FOR SALMON IN RANGELEY LAKES.—As in the case of the trout, in the early part of the season salmon may be taken almost anywhere in the lakes, but particularly about points and shoals and at mouths of streams, especially when smelt are running. Later in the season they resort to deeper water. Small salmon, and sometimes even large ones, linger in the quick water and pools below dams much longer than about the shores of lakes.

As has been stated previously, salmon seem to preponderate over trout in Oquossoc Lake, and it may be considered now a salmon lake. The salmon have made their way down the chain of lakes even into Umbagog Lake and the Androscoggin River, and occasionally some have been planted in the lower waters, as in Richardson Lake, Rapid River, and Umbagog Lake. It is quite noticeable, however, that the increase in numbers of salmon was gradually and successively progressive from the upper to the lower lakes. The first salmon in Umbagog Lake was mentioned in Forest and Stream July 24, 1884, which contained a statement to the effect that a 5-pound salmon had lately been taken there. In 1905 the salmon was reported to be common in that lake. A gill net set in the deep hole off Sturtevants Cove in 53 feet of water, August 17, took 6 small salmon measuring 14⅞, 15, 15½, 15½, 15⅞, and 16¾ inches, respectively. (See Table VII, p. 593.) A small one of perhaps 1-pound weight was caught July 17 in the Androscoggin River at the mouth of Molnichwock Brook. On August 23 a young one 7 inches long was caught on a baited hook at Molnichwock Falls.

In the spring and early summer excellent salmon fishing is said to be found at the foot of the rapids below Errol Dam and to some extent in pools on the rapids when the water is not too high or too low.

BLUEBACK TROUT (*Salvelinus oquassa*).

A group of chars comprised in the genus *Salvelinus* and composed of a number of nominal species completely encircles the Northern Hemisphere in its geographical range and is restricted at the north only by perpetual ice. Its southward extension varies as indicated by the recorded distribution of the nominal species but is essentially boreal or alpine, occurring in the eastern United States in only a few isolated instances. At the time the blueback was first scientifically described [a] no other species of char, excepting the common brook trout, was scientifically recognized in the eastern United States, and since then only comparatively few specimens have found their way into collections, and very little has been written about this species. Therefore, there is a dearth of information regarding its relationships and habits, and most of that which is known is scattered through sportsmen's journals. Forty years after Girard called the attention of the Boston Society of Natural History to this fish Dr. David S. Jordan [b] stated that no specimens were on record from any waters in the United States other than the Rangeley Lakes. Dr. Jordan seemed to consider it specifically identical with an Arctic char described under the name of *Salmo naresi* by Dr. Günther [c] and also with specimens collected by Kumlien at Cumberland Gulf and identified by Dr. Bean as *S. naresi.*

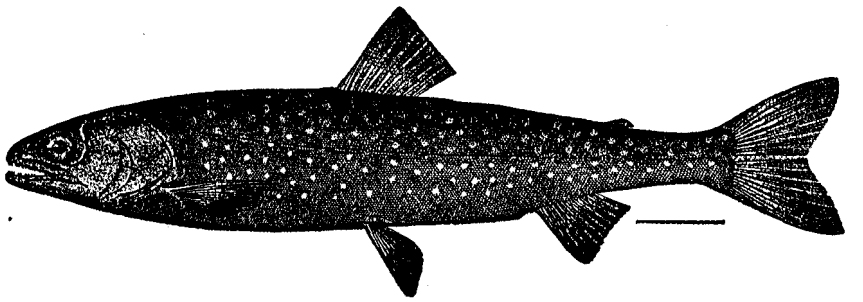

FIG. 17.—Blueback trout (*Salvelinus oquassa*).

Dr. Jordan expressed the opinion that it was probably an Arctic fish that for some reason kept its hold in the Rangeley chain but had become extinct in other lakes of northern Maine, if it ever lived there.

Later, however, Dr. Bean [d] wrote that the blueback was certainly known only from lakes and streams of western Maine, but thought that the justice of its identification with Nares trout was open to question. In American Fishes (1888) G. Brown Goode said that the blueback was probably a landlocked form of *S. stagnalis.*

The blueback is undoubtedly not only closely related to the previously mentioned fish but to other nominal species of Arctic chars, as well as to the European saibling and the later described Canadian red trout and golden trout of Sunapee Lake and other New England waters. In fact, it has been suggested that all are specifically identical but subject to ontogenetic variations.

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[a] Charles Girard, at the meeting of the Boston Society of Natural History of Oct. 20, 1852. Proceedings, Boston Society of Natural History, vol. 4, 1853, p. 262.

[b] Forest and Stream, Dec. 14, 1882, p. 389.

[c] Proceedings, Zoological Society of London, 1877, p. 476.

[d] Forest and Stream, supplement, Apr. 4, 1889.

Unless the blueback is identical with those other forms, its known range was, until 1905, restricted to the Rangeley Lakes. In that year, however, the writer [a] provisionally recorded as this species specimens from Rainbow Lake, the headwaters of a tributary of the West Branch of Penobscot River, Piscataquis County, and later additional specimens were received from the same place. Very possibly careful search might reveal them in other Maine waters.

SIZE.—Girard stated (loc. cit.) that the fish attained from 8 to 10 inches in length. The Report of the Maine Fish Commission for 1874 stated that it was reported to reach a length of 8 inches, and the report for 1878 said that the fish were quite small, usually averaging four or five to the pound. H. O. Stanley, one of the Maine fish commissioners, wrote in a letter to Fred Mather [b] that he did not believe that out of a thousand two could be selected that would vary 1 ounce in weight, or that five could be picked out that would vary an ounce from a pound, aggregate weight.

In 1883 Mr. Rich stated (loc. cit.) that he had never seen one that weighed over 6 ounces, and in another place he said that they ran from 5 to 8 inches in length and weighed from 4 to 6 ounces. In American Fishes, previously cited, Dr. Bean was quoted to the effect that it was not known to exceed 10 inches in length from existing collections, but that specimens of much larger size might be expected. In the revised edition of the same work in 1903, edited by Dr. Theodore Gill, it was stated that anglers now and then catch what seemed to be bluebacks weighing as high as 2 and 2½ pounds.

HABITS.—While the first published information respecting the blueback was that by Girard (loc. cit.), it was locally known, particularly to the inhabitants of the region and to a few visitors, many years prior to Girard's notice. In an article entitled "Blueback trout," [c] J. G. Rich, a resident of Bethel, Me., wrote that in 1844 he visited the Rangeley Lakes and then first heard of this fish, which the settlers called blueback, not apparently regarding it as a trout. At that time, he stated all that was known regarding the fish was that about the 10th or 20th of October of each year they ran up what was called Toothaker Cove from Rangeley Lake into a small brook, the outlet of Quimby Pond.

Girard stated that the abode of the blueback was "Moosemegantic" Lake, in which, he said, it remained concealed during the greater part of the year, and indicated that about the 10th of October it came near shore and ascended in shoals the Rangeley outlet to "Lake Oquassa." After the middle of November, he mentioned, the fish returned to Mooselucmaguntic Lake and was seen no more until October of the following year. However, Mr. Rich wrote (loc. cit.) that until the building of Upper Dam about 1858, when the fish was discovered in Kennebago and Rangeley Streams and below Upper Dam, he had never seen it in any other stream than the outlet of Quimby Pond, which in a later article he designated as Dodge Pond outlet. This stream, however, is the joint outlet of both ponds. He stated that although he had fished all of the Rangeley Lakes, the Magalloway, Parmacheenee, Cupsuptic, "Beama", Kennebago, and Rapid River waters for more than 35 years he had never seen the fish elsewhere than in the places first mentioned and at no other season of the year than the late fall months. But later he was informed that they had appeared below Middle Dam.

[a] Maine Sportsman, Feb., 1905, p. 117. [b] Forest and Stream, May 5, 1887. [c] Forest and Stream, Jan. 4, 1883.

Another correspondent[a] of the same paper wrote that the bluebacks had not that year appeared in wonted numbers at the Upper Dam, but that they had been observed in large numbers at the mouth and well up in Sawmill Brook, a narrow rocky stream.

Regarding the run of bluebacks in Sawmill Brook in the fall of 1887, Oscar Cutting, a guide of the region, was referred to in Forest and Stream, December, 1887, as reporting that the stream was lined with them for some distance up the brook and that so intent were they upon reaching their breeding grounds that the fish were piled up in the shallow water in the little pools and eddies.

Capt. F. C. Barker (loc. cit.), writing regarding their disappearance from below Upper Dam and appearance in Sawmill Brook, said that the disappearance was plainly due to the fact that the water in the lake below was so high that it backed up over the rips where they usually spawned, "rendering the whole line of rips as quiet as a mill-pond." Capt. Barker expressed the view, also, that the large numbers occurring that year in Sawmill Brook were attributable to this cause, but he thought more or less of them had always spawned there.

The previously mentioned characteristics were also referred to in the reports for 1875 and 1878. In American Angler, April 14, 1873, Mr. Rich wrote that they ran up the brook at night and back in the morning. Forest and Stream, November 26, 1874, said that on the 10th of October, or within three days of that date, the outlets of Gull and Dodge Ponds, both emptying into Rangeley Lake at points 6 miles apart, and the outlet of Rangeley Lake, 6 miles from Dodge Pond, were thronged by myriads of these exquisite little fish. The waters of the streams were said to be actually filled with a crowding, springing multitude, gathering like smelts and alewives to deposit their spawn. It was stated that they did not make spawning bed as did salmon and trout, but deposited their eggs in all parts of the stream, remaining about 10 days, when they returned to the lake, to be seen no more until the 10th of October the following year.

In the same paper for December, 1874, Elmer Merrill wrote that five or six years previously he had spent the month of October in this region and for the first time saw the blueback trout of which he had heard. He said that the fish came up Rangeley Stream from Cupsuptic and Mooselucmaguntic Lakes to the pool below the dam, where they were observed in myriads, the water being literally black with them, and from under every stone, slab, or log in the stream scores would shoot out when disturbed. He said also that the same conditions obtained in the streams emptying into Rangeley Lake.

In a letter to Fred Mather, published in Forest and Stream, May 5, 1887, Commissioner Stanley wrote that the bluebacks were very hardy fish and nearly as tenacious of life as the eel or bullhead. He stated that he had frequently seen them alive in the morning after they had lain on the shore all night.

Regarding the same matter, J. Parker Whitney[b] wrote that they were much more tenacious of life than the brook trout and that he had had them out of water an hour, apparently lifeless, and resuscitated them by putting them in water again. He said that a number would live in a barrel of water without change for weeks, which treatment would be fatal to the ordinary trout.

FOOD.—The only mention of the food of the blueback is the statement of J. Parker Whitney (loc. cit.), who said that their teeth were very fine and numerous and that they

[a] Forest and Stream, Dec. 15, 1887, p. 408.

[b] Forest and Stream, Oct., 1896, and Report of Inland Fish and Game Commission of Maine for the year 1896.

evidently lived upon "ground feed and the variety of infusoria which are so plentiful in the lakes." Mr. Whitney, in a letter to the same paper in 1900, explained that "ground feed" of the lakes was "an important element with all fish, composed of insectivorous varieties and largely of viscous matter which settles profusely."

The stomach contents of some small bluebacks of Rainbow Lake consisted of a large quantity of insect larvæ and entomostracans. These fish were taken in the latter part of the winter by bait fishing through the ice.

CAPTURE.—George Shepard Page, in 1874 (loc. cit.), wrote that notwithstanding the great numbers of anglers who have frequented the Rangeleys during recent years, fishing all portions of the lakes with all manner of bait on the surface and down in the deep, no one had ever caught a blueback and none had ever been seen at the surface.

E. S. Merrill (loc. cit.), stated that his party did take a few with bait in Rangeley Stream.

The Maine commissioners' report for 1874 said that now and then in deep fishing with bait in the lakes one was caught and that exceptionally in the breeding season one would take a bait, but it was not considered a "biting or game fish," although he had caught a bushel and a half in a day with baited hook. They were caught mostly with dip nets.

However, the report for 1878 stated that the fish haunted the deep water in ponds, where they could be freely taken in summer with baited hook in about 40 feet of water.

Capt. Barker (loc. cit.) said that sometimes a blueback would take a bait in deep water, but never knew of one taking the fly.

The usual method of capture was, as stated by Mr. Stanley, by means of dip nets while the fish were ascending the brooks in October.

Mr. Rich[a] said that in 1844 they were taken in large quantities by the Rangeley people, though they never fished for them with a baited hook, but either netted or speared them. Mr. Rich said that he had been informed that the fish could sometimes be taken with a baited hook, but that he never succeeded in catching one or even attracting their attention. He described the method of fishing[b] in words to the effect that improvised nets consisting of bags with ash bows and handles were set in sluices or fishways constructed of rocks in such a way that the fish were guided into the nets. In this way, he said, several bushels would be secured by each man in a night, which was the only time they could be caught, as they ran up at night and back before morning.

The various communications are somewhat contradictory regarding the presence of fish in the brooks during the day. It is probable, however, that while some may have returned to the lake during the same night many did remain for a longer time, but being for the most part concealed, as one person stated, the impression was given that the brook was vacated. Those who caught the fish with baited hook in the brooks at this season undoubtedly took them in the daytime.

Regarding the capture of some by hook in the spawning season, it may be said that this is not improbable. However, those caught by this means were probably fish that had finished spawning and had lingered in the stream, as is the habit of a number of salmonoid fishes, especially the males, and which have been known at such times to take a baited hook which they would not notice prior to spawning.

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[a] Forest and Stream, Jan. 4, 1883.

[b] Forest and Stream, Jan. 4 and Apr. 4, 1883.

Forest and Stream, August 6, 1898, contained a communication from a Rangeley Lakes correspondent, in which it was stated that a blueback was reported to have been taken by trolling.

FOOD VALUE.—Referring to a special exemption of the blueback from protection by the law applying to other trout, a correspondent of Forest and Stream, November 26, 1874, expressed the opinion that it was proper and wise, as it enabled the settlers in that section to supply themselves with quantities of superior fish food that, smoked and salted, added very materially to their limited bill of fare.

Forest and Stream, November 15, 1877, indicated in the following statement that this fish was to some extent marketed: "The first of the Rangeley bluebacks have come to the market from Maine and will be as usual at E. G. Blackford's stall in Fulton Market."

According to Mr. Rich, the settlers prepared those caught on the spawning beds in the fall for their use as food in the following winter and summer. Some were cured by salting, others by drying, and still others by smoking. Some dressed them, others cured them whole. Mr. Rich wrote: "It is proverbial of certain families that they lived on bluebacks and crossbills," and that the crossbill, a small bird, was cured whole.

Regarding its gustable qualities, opinions seem to have differed, as indicated by those expressed by the various individuals previously referred to in this paper. However, the pro and con opinions may each have been based upon different conditions. The first run of fish prior to spawning would be in much better shape than some time after spawning and before they had recuperated. This may be said respecting any fish.

Girard pronounced the blueback highly flavored and more delicate than the brook trouts in Europe and America and said it resembled *S. umbla* of the Swiss lakes in peculiarity, habits, and delicacy.

Mr. Merrill found them a nice pan fish, "juicy, tender, and delicate," but he preferred the brook trout.

The Maine fish commissioners, in their report for 1874, stated that they had eaten only fish taken on the spawning beds and to them it was not palatable but was as much so as the brook trout under the same circumtances. On the other hand, in the report for 1875, the statement is made that it was an excellent table fish, "most persons deeming it equal in flavor to the brook trout," and, again, the report for 1878 said that it was much esteemed as a fine pan fish.

A correspondent of Forest and Stream, December 15, 1887, wrote that although males were selected the flavor was not generally pleasing. Mr. Whitney (Forest and Stream, Nov. 24, 1900) said that for food purposes it was inferior to the brook trout and to his taste it was soft and muddy.

EARLY DESCRIPTIONS.—Girard (loc. cit.) described the blueback as follows:

It is from 8 to 10 inches in total length. The body is subfusiform, slender, and the most graceful of the trout family. The head is proportionately small, conical, coregonoid in shape. The mouth is smaller than in *S. fontinalis*. Differences are likewise observed in the structure of the opercular apparatus. The fins have the same relative positions as in the brook trout but are proportionately more developed, with the exception of the adipose, which is considerably smaller; their shape is alike, except that of the caudal, the crescentic margin of which is undulated instead of being rectilinear. The scales are somewhat larger, although they present the same general appearance as those of the brook trout. The lateral line is similar in both of these species. A bluish tint extends all along the back from the head to the tail, so that when seen from above the fish appears entirely blue; hence, the name "blueback" given to

it by the settlers of that neighborhood. The sides and abdomen are silvery white in the female and of a deep reddish orange in the male, spotted in both sexes with orange of the same hue as the abdomen. The dorsal and caudal fins are brownish blue bordered with pale orange in the male; the pectorals, ventrals, and anal of a fiery orange, blackish blue at the base, with their margin of purest white. When first taken out of the water, it is impossible to imagine anything more beautiful and more delicate in the way of coloration in fishes of the temperate zone.

Mr. Page said of them (loc. cit.) that they had no bright vermilion spots; the ventral, anal, and pectoral fins bright scarlet, but without the black and white lines so conspicuous on the brook trout; and the tail more forked.

In Forest and Stream, December 10, 1874, page 277, C. A. Kingsbury, of Philadelphia, stated that he had received some bluebacks, a careful, critical examination of which led him to believe them to be an undescribed species, and at the meeting of the Philadelphia Academy of Sciences, November 17, 1874, he had presented the specimens and given a minute description of the species under the name of *Salmo cœruleidorsus*. This communication was referred to the standing committee on ichthyology, and at the suggestion of Dr. Leidy a specimen was sent to Prof. Baird, who advised him that it was the *Salmo oquassa* of Girard. In the same paper, on the same page, was published a description of the fish by James W. Milner, under date of November 29, 1874, to whom it appears Mr. Blackford had sent specimens. He stated that the form of *oquassa* was much more slender and with a tendency to prolongation not seen in the brook trout. Thus, in the depth of body and of head compared with their lengths, the pectoral fin prolonged to a slender point, the two lobes of the caudal extended in the same way, showing a decided furcation, and the opercular bones prolonged into a more acute angle. On the contrary, the maxillary bone did not extend as far back of the eye, in *S. oquassa* trout. The interopercular bone is much larger in *S. oquassa* and the suboperculum is wider. The tail in *Salmo fontinalis* is more truncated than in any species it is likely to be confounded with. The following is taken from the Maine commissioners' report for 1874, pages 17 to 18:

This beautiful little fish takes its name from a bluish tint on the back, not unlike the bloom of a plum. They are spotted like a trout, and to a casual observer the difference in a basket of fishes would not be noted. But like the togue they have only the yellow and black spots but not the red. Their tints and colorings are very beautiful, particularly in the male, the pectoral fins rivaling in color the autumn-tinted maple leaves. Like the dying dolphin, their brilliancy of color is lost or fades away with their lives. They are more delicate and symmetrical in shape than the brook trout and have the tail forked.

In his letter to Fred Mather in 1887 (loc. cit.) Mr. Stanley wrote:

The adult fish does not have any white on the fins at all like the brook trout. The fins of the male are bright red or the color of bright autumn leaves. When taken from the water they are of a dark color, but after death turn to a light yellowish cast. The spots are very minute, very thick, very bright yellow and red; both thicker and brighter than on the brook trout.

PROTECTION.—It has already been mentioned that under the general trout law the blueback was afforded no protection. The first protective law for trout seems to have been enacted in 1869, chapter 20, section 18, in which the blueback trout in Franklin and Oxford Counties was specifically exempted.

The great abundance of this fish having been maintained for so many years in the face of the great slaughter on the spawning beds and the importance of the fish in the winter food supply of the settlers indicated that protection was not needed or desirable. However, as early as 1874 the Maine fish commissioners' report for that year stated that

it was the opinion of the commissioners that it was a great mistake to allow these beautiful fishes to be taken at all, as it was to the blueback that they attributed the great size of the Rangeley trout. They further stated that it was their opinion as the blueback diminished in numbers so would the far-famed Mooselucmaguntic trout, and went on to say that the blueback was to the Rangeley Lakes what the myriads of smelt were to Sebago Lake and Reeds Pond.

Capt. Barker [a] wrote that the fish was very valuable as food for the brook trout and stated that it was a very common occurrence to catch trout in deep water with a blueback in its stomach, especially in the winter.

Finally, some time in the nineties a comparatively rapid decrease in the number of bluebacks appearing in their accustomed spawning places became so marked that protective legislation was urged, but it was not until 1899 that a law was passed providing that "it be unlawful to fish for, take, catch, or kill any blueback in any waters of the State at any time" (chap. 42, sec. 5, P. L. 1899). Protection, however, had been too long delayed.

In the fall of 1900 the writer visited Oquossoc Lake with a letter from Commissioner Stanley to George Esty, a reliable fish and game warden of that region. Mr. Esty's aid in every way possible was requested in the letter. A man in whom Mr. Esty had confidence agreed to watch a certain stream where the fish used to fairly swarm and, as Mr. Esty said, were dipped and hauled away by the barrel and cartload. This man watched the stream throughout the spawning season without seeing a single blueback. This was the famous outlet of Dodge and Quimby Ponds. In Kennebago Stream, the Oquossoc Angling Association caught one pair of bluebacks. The male had been liberated but the writer secured the female, which weighed about 1 pound. In 1902 a few large bluebacks were taken by spawn takers, and in 1903 five more, all that were taken, were secured by the writer. In 1904 another visit was made by the writer to Oquossoc Lake. The State fish hatchery located on Rangeley Stream was then in operation, and the fish culturists were taking trout and salmon in that stream by means of a weir and in Kennebago Stream by seine. Only three bluebacks, these ranging as high as 2 or 2½ pounds, were secured or observed, although they were looked for at all of their former breeding places. The writer has been unable to learn that even a single specimen has been taken since. It would seem, therefore, that the blueback is probably extinct in the Rangeley Lakes. In the Maine Sportsman, February, 1905, referring to the probable cause of the decrease in numbers of bluebacks, the author wrote:

> There is evidently a recent decrease in the numbers of this fish, almost to a complete disappearance from their usual spawning grounds. On the other hand, occasionally fish larger than used to be caught, even up to 2 or 2½ pounds, I am told, are caught by anglers, when fishing for other trout and the salmon, both in Mooselucmaguntic and Oquossoc Lakes. That these fish are verging on extinction in these waters can not, I think, be wholly ascribed to excessive fishing. For much more than 50 years such fishing has been carried on with but little appreciable diminution of their numbers. Of course, injurious effects are sooner or later inevitable from such drafts upon them. But in their case it seems as if there must be additional factors at work. Here again our conditions of growth and existence may be brought into consideration. If trout depended largely upon bluebacks for subsistence, salmon rapidly increasing in numbers in these waters would doubtless come in for their share. Recognizing this possibility, the State commission planted smelts in the lakes in 1891.[b] They have also flourished and waxed great in numbers.

[a] Forest and Stream, Jan. 12, 1888.

[b] In 1900 a spawn taker of the Rangeley and Oquossoc Angling Association told the writer that 1891 was the date of the first plant of smelt in these lakes.

The decrease in numbers of bluebacks was synchronous with the increase in number of salmon, and coincidently the last blueback was taken in the year following the largest catch of salmon up to that date. There can be no doubt that the blueback entered largely into the food of the salmon, especially prior to the introduction of the smelt, living as it did in the deep waters to which salmon resorted during the summer months, and the introduction of smelt and later legislative action were both too late to save it. On the other hand, the large size of the few surviving bluebacks was very probably due to the smelt. Although the food of the blueback was formerly the smaller animal life of the lake, probably largely consisting of entomostracans, insect larvæ, and worms, the smelt afforded it an abundant additional supply of food, owing to the fact that while almost in a larval stage young smelts frequent deep water after leaving their birthplaces in the brooks. (See Tables VII, VIII, p. 593.)

WHITE TROUT (*Salvelinus aureolus*).

To the fish culturists this char is known as the golden trout or aureolus and sometimes as Sunapee trout or Sunapee Lake trout, these latter names due to its having been first discovered in Sunapee Lake, N. H. The name golden trout is derived from its

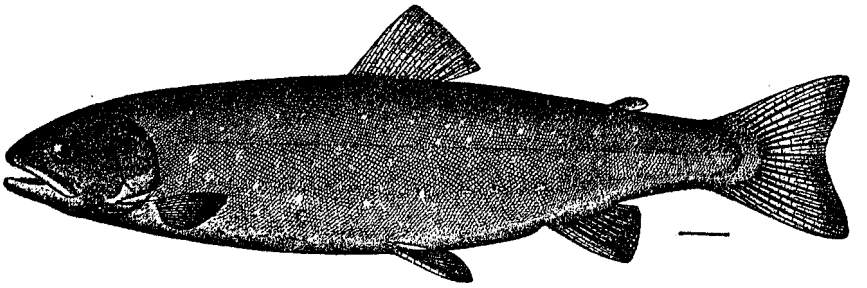

FIG. 18.—White trout (*Salvelinus aureolus*).

technical name, *aureolus*, which was given to it in reference to the golden sheen of the living fish in the water. The local name, white trout, is more appropriate to its summer coloration, when the brilliant orange of the males is absent. It is known as white trout at Sunapee Lake and is thus distinguished from the common trout (*Salvelinus fontinalis*) which at Sunapee Lake is called native trout, due to the popular impression, doubtless, that the white trout was introduced.

About the time the fish was discovered at Sunapee Lake there was an animated discussion regarding its identity, some claiming that it was the result of introduction of the saibling (*Salvelinus alpinus*) from Europe. But it was pretty conclusively shown that none of the lot brought from Europe was placed in Sunapee Lake or into any waters from which it could gain access to that lake. Others claimed, with more basis for their claim, that it was a blueback which there is no doubt was introduced about five years before the so-called discovery of this fish, which had attained a large size owing to favorable conditions in the lake. Some individuals were not wanting who averred that they had known the fish for many years prior to the introduction of bluebacks. The blueback advocates would have rejoiced had they foreseen that this fish in its native waters would reach the size of an average Sunapee white trout, as the main argument against the blueback theory was the small size attained by the blueback. As a matter of

fact, the small size was the chief difference. Dr. Bean mentioned one additional character; that is, the difference in the gill rakers, which in the blueback were always straight and in the Sunapee fish usually more or less curled and distorted. But this character does not obtain in the small Sunapee fish, and in the large blueback they are frequently as distorted as in the Sunapee fish. Indeed, it is a difficult matter to distinguish a large blueback from a white trout after it has been preserved in alcohol for some time, or even when fresh. The writer, some years ago, suggested that the differences were ontogenetic. Such differences as exist as shown by the specimens examined are shown in the description of the blueback.

The white trout has been found also in Dan Hole Pond, N. H., Floods Pond, Me., and Averill Pond, Vt. Its discovery in these ponds precludes the necessity of going to Europe to account for its presence in Sunapee Lake. It seems unaccountable to many that the fish could have existed always in Sunapee, fished so much as it was, and not be detected before. As a matter of fact, this is not an unknown phenomenon. While the ponds subsequently found to contain white trout were perhaps not fished quite as generally as Sunapee, yet they were probably fished as much by the inhabitants about its shores, who, doubtless, did not distinguish the fish from the common trout, at least only to the extent of considering it a peculiar form of the latter.

The white trout is a rich and savory fish for the table, being fat in season, to which its flavor is apparently due. It is caught mainly by plug fishing with live bait and cut bait and very occasionally with worms. Not infrequently it is taken by trolling, but with a deep line as a rule. The best bait seems to be the smelt, which was introduced into Sunapee Lake and has always existed in Floods Pond. It is sought by still or plug fishing in about 80 or 90 feet of water in Sunapee Lake and about 30 to 40 feet in Floods Pond (in June). The fact that it is a deep-water species would in part account for its being seldom observed by the old inhabitants.

It is said to attain a weight of 10 pounds in Sunapee Lake, but a fish of 5 or 6 pounds in recent years is a monster.

In 1903[a] or 1904 white trout were planted in Mooselucmaguntic Lake, according to the report of the United States Bureau of Fisheries for that year. It is not known with what results; and probably should one or more be caught it would be considered another big blueback, to go on record as that species caught on a hook, which is a rare occurrence. It is unfortunate that the fish was planted in these waters, for it will confuse the history of the blueback, which, if not quite extinct, might increase in numbers again, and new reports of bluebacks will not be positive.

BROOK TROUT (*Salvelinus fontinalis*).

This char is everywhere in Maine the trout or brook trout par excellence. It is naturally peculiar to eastern North America. In Canada it occurs in many streams and tributary waters of the Great Lakes and St. Lawrence River and the Gulf of St. Lawrence as far north at least as Hamilton Inlet on the Labrador coast. Its northern limit is not definitely known, but it is restricted on the east by the Atlantic Ocean and it extends southward in the Alleghenies to headwaters of streams in the mountains of Georgia and Alabama.

[a] There is an element of doubt attached to this record. The late State Commissioner Brackett wrote in reply to an inquiry regarding it, made about the time the record was first published, that he had no knowledge of any such plant. It is possible that it was an error in copying localities when the report was prepared.

This trout is, or was once, everywhere common in Maine, and the Rangeley Lakes were not the least renowned for this superb fish. It is closely related to the blueback and other chars of which mention has been made but having quite distinct coloration, and it is generally less slender in form than the others. Among themselves, however, the trout differ greatly in shape and color, not only those from different waters but often those of the same body of water or different localities in the same lake or stream. Modifications of both form and color appear in the breeding season. In the Rangeley Lakes region differences of form as well as of color have been noted, giving rise to the suspicion that they might be distinct species, if not actually regarded as such.

J. G. Rich, of Bethel, Me., to whom reference has already been made, a man of many years' acquaintance with the trout of Rangley Lake, contributed an article entitled "The trout of Maine waters" to the American Angler, April 14, 1883. Mr. Rich was inclined to believe that more than one species of trout, besides the blueback, existed in the Rangeley Lakes. In the way of illustration he described several contrastive forms. One locally called the cedar tree trout, receiving its name from Cedar Tree Point, near which it spawned, was thought to differ more pronouncedly from the other trout than the landlocked salmon did from the Penobscot salmon. However, he stated that he sent one to Prof. Agassiz, who pronounced it "nothing else than simon pure *Salmo fontinalis*."

The cedar tree trout was stated to be thin, flat, and short, with very highly colored sides. Contrasted with it was a long, round, light-colored, almost silvery trout, with white flesh, occurring in deep waters. Another of similar appearance, weighing about three-fourths of a pound and having yellow flesh, was said to congregate at the mouths of certain brooks during the last of August and first of September. Still another, but very plump and with red flesh, occurred at some other places. In the spawning season, October and November, even as far up as the small headwaters of "Beama" Stream, Metallak Brook, and the inlet of Richardson Ponds, there was said to be still another highly colored variety, which ran in weight from about 3 ounces to a pound and in appearance was the most beautiful of all, but no better, if as good, for the table. Among these, he said, were found both red and white meated fish. He went on to say that in many years of winter fishing very few of this kind of trout were caught in the lakes and ponds and were seldom taken except on the spawning grounds. He concluded, therefore, that they did not mix with the other kinds but probably resorted to some special location.

Continued residence of trout in one locality modifies the appearance of the fish according to the conditions obtaining in the locality. The appearance of trout as affected by various environments and conditions may be stated in general somewhat as follows:

Slender, light-colored, silvery trout in clear, sandy lakes and ponds, or localities in bodies of water where such conditions obtain, and clear, sandy, quick-water streams.

Stout, dark-colored trout in lakes or ponds or localities of lakes or ponds having muddy bottom and considerable vegetable growth, and particularly water discolored by vegetable stain. The same may be said of streams, and it may be added that the swifter the flow of water where the trout occurs the slenderer it is likely to be. Various degrees and mixtures of conditions correspondingly modify the fish subjected to them. The shape and color also vary with the size and age of the fish and, as previously stated, are often greatly changed in the breeding season.

Most of the distinctive colors and form characters of Mr. Rich's cedar tree trout and of the upper-water brook trout were obviously the color modifications which take place in the breeding season, which is accounted for by their seldom being caught at any other time. Occasionally, after the breeding season recuperation is delayed and the trout retains the appearance of the breeding fish for an unusual period.

Mr. Rich referred to the color of the flesh of the trout as though it were a variety characteristic. The cause of this red color has long been a mooted question. A theory that has been entertained for many years is that it was attributable to red-pigmented food, such as some crustaceans. This theory seems to be defective, for other fish feeding extensively upon exactly the same kind of food always have white flesh. Young or rapidly growing trout never have red flesh, but under uniform favorable conditions a change from white through various shades of yellow, pink, and red may be traced, the intensity increasing as the fish approaches maturity. Breeding fish often rapidly lose the red or yellow tint, becoming white meated. Apparently, trout of some waters are always white meated and others, while attaining a yellow shade, never reach the red stage. These last two phases are particularly noticeable in fish which pass much of their life in quick water.

After taking everything into consideration, it would seem that the character or quantity of food influences the color of the flesh only in its fattening effects, and it is only the intrinsic fat or oil in the fish which produces the red flesh and delicious flavor of the red-meated trout. The oil or fat is naturally red as that of some other animals is naturally white or some other color, and it is the amount permeating the fish that gives the color its intensity. A well-fed, comparatively inactive adult trout will present a more intensive shade of the flesh than a fish of the same age living in running water, where its livelihood depends upon its activity, although it may be a well-conditioned, shapely fish. In the latter instance the food has been assimilated and utilized in the development of energy. The fact that, according to Mr. Rich, both red and white meated fish are found in the same school on the spawning beds does not detract from the theory, for probably all individuals are not equally fat or equally advanced in the spawning process, and the meat of such fish inversely and progressively, or sometimes irregularly, becomes white. Besides, as Mr. Rich in another place stated in effect and as has been observed, there are almost always immature males on the ground for other than breeding purposes, which seems to be to augment their diet at the expense of the breeding fish; that is, by eating the eggs as deposited.

Food.—The trout seems to avail itself of whatever animal life is available, and vegetable food is not always eschewed. A detailed list of what trout have been known to eat would be more astonishing than valuable. However, the general and principal food supply upon which the adult fish depends may be divided into two classes—fishes and insects.

The trout of brooks subsist largely upon insects, particularly the aquatic larvæ of numerous species, such as caddis flies, May flies, *Chironomus*, and dragon flies, and also upon insects that fall upon the water or hover over the water while depositing their eggs. The food of trout of larger streams, ponds, and lakes, of course, consists of the particular kinds that the waters afford and these often differ materially from each other and seasonably in the same water. In all waters there is a seasonal supply of insects that varies with the season and locality, but where food in the form of fishes is

available the insect food appears to be more or less neglected, particularly by the larger fish.

The diet of the trout, however, varies not only with the season but with the age of the fish. The seasonal variation, however, may be one of convenience, but that of different stages of growth is influenced by suitability.

The first food of trout fry consists largely of minute crustaceans and small insect larvæ, such as *Chironomus*, black fly, etc.; and that of the fingerling, of larger insect larvæ, worms, and small insects, which diet, however, is not exclusive and is controlled more or less by the habitat and environment.

The regular food supply of the adult trout of Rangeley Lakes, aside from the insects and more or less accidental or incidental animals, was formerly, without much doubt, the small fishes occurring there, including its own young and eggs to some extent. The blueback trout was believed by the late Commissioner Stanley to have been the main dependence of the large trout and that it was due to the blueback that the trout attained its large size.

J. Parker Whitney,[a] to whom reference has previously been made, said that in December and January there was a notable scarcity of live bait, meaning small fishes, and that in February and March it was very difficult to find. "Yet," he said, "the trout are seldom empty of small fry or chubs, and it is quite likely that the trout root them out of the mud. This is indicated by earth and often lumps of clay found in their stomachs." He stated that he had caught large trout often with a small handful of clay balls in their stomachs. "In winter," he continued, "the contents of their stomachs are quite miscellaneous—glutinous ground feed, chubs, varieties of small fry, rarely bluebacks, suckers, and in a few instances I have found whole clams in shells up to 3 inches in length."

If the disappearance of the blueback deprived the Rangeley trout of an important food supply, it has been more than compensated for in the smelt which was introduced. In the Rangeley Lakes the smelt does not attain a large size, has multiplied tremendously, and is locally available as food for trout from one end of the year to the other.

Regarding the smelt, Mr. Whitney wrote (loc. cit.) that it was apparently an admirable food for the salmon and trout and in the spring seemed to be their principal food, as their stomachs seemed to be crowded with them, and that he had repeatedly observed from 50 to 70 in the stomach of a single large trout.

FEEDING TIME.—The feeding habits of trout are influenced by both internal physiological and external physical conditions, so that it does not feed at all times of the year or the day. While it takes food readily up to the breeding time, breeding fish are not much inclined to feed. The postnuptial wasted condition of the fish would naturally impel it to recuperate by feeding, but at that time food is scarce. This, however, is compensated for by the cold water making the fish more or less sluggish or dormant, when there is little metabolism and little or no food required. But these two forces are contending, as it were, and the fish, therefore, will eat when there is anything to eat, but they can get along without it. The warming of the water and other physical changes stimulate them to activity and need of food. The foregoing statement, however, should not be construed to mean that trout do not feed in the winter time when food is available, for it is well known that they are readily taken by fishing through the ice,

[a] Forest and Stream, Nov. 24, 1900.

but in this case the best fishing is in the latter part of the winter. Therefore, it would seem that to some extent its abstinence, if any, is enforced partly by scarcity of food.

There seem to be instances, judging by the behavior of the fish toward anglers, when the fish do not feed much during the summer months, especially at the surface in warm bodies of water, and such feeding as there is occurs during the night or on overcast or rainy days. Moreover, during the recognized fishing season there are often days when the fish will not take bait or fly, and during the day when feeding the time is usually early in the morning or in the cool of the evening.

It is a matter of common remark that on some days trout will bite ravenously and on the following day or for days it will not bite at all; also, at times the fish will rise to a fly freely for some time and then suddenly cease to rise, although there are many fish still there. Pertinent to this subject at the Rangeley Lakes, an angler wrote regarding September fishing that for 10 successive days he cast steadily, "whipping every nook and corner" of the pool at Upper Dam, without a single rise, yet he could see the big fellows breaking water every little while. He said that on September 15 he fished Cedar Tree, Minters Favorite, and Metallak Brook without getting a rise. Then he tried Brandy Point, Sandy Cove, and Trout Cove with the same result. "The fish were there—I saw dozens break water—but they would not bite."

In contrast to the foregoing experience was that of another angler, who, speaking of the pool below the old stone dam at Upper Dam, said that it was a cold, blustering gusty day, with occasional sleet, late in September, so cold that he frequently had to go ashore to a fire to warm his benumbed hands. He stated that he caught on a fly in rapid succession 10 fish, ranging from 3 to 8¾ pounds and aggregating 57 pounds.

Referring to the celebrated Marble-Morse fish mentioned in another place in this report, an angler present at the time of its capture wrote that he remembered how for several years in the autumn the great trout came alone to the same place in a moderate swirl of water above the dam. He said that the fish became the target of many ambitious efforts of both fly casters and bait dabblers. On occasions he would signify his presence by rising to the surface, and with a quiet surface and the sun's rays in a favorable quarter he could be observed lying quietly or slowly moving about. Flies were cast and sunk, also worms, grasshoppers were lowered and trolled in vain, until one day an old guide "who would have scorned to have taken him any other way than fairly, allowed his worm-baited hook to rest upon the bottom for a while, from which it was seized by the fish, which soon lay gasping on the grass."

It is evident that the apparent caprices or idiosyncracies of trout are too much individualized to permit of much generalization. There are several things that may be assigned as at least partial causes of some of the phenomena exhibited by the fish. It has been noticed that when feeding it will fill itself to repletion and then periods of varying length ensue when the fish will not take food at all. Apparently having become surfeited, it puts in the rest of the time in utilizing what it has acquired. Changes of temperature and barometric pressure and other meteorological conditions may also be assignable explanations, and there may be more truth than poetry in the old rhyme relating to the direction of the winds.

HABITATS.—In the spring of the year the trout begins to scatter and often may be found at almost any point in the lake, its location being controlled by its food supply to a great extent. But as the hot weather approaches it becomes more and more restricted

in its movements, until finally it resorts to cool waters of deep holes or cold inflowing brooks. Again in the fall it congregates on shoals or at the mouths of streams which it ascends to spawn. After spawning it gradually works back into the lake and is found about the mouths of streams or wherever food may be found. It is this run-down fish that has been mentioned previously by a correspondent as constituting one of his supposed distinct races.

In an article published in Forest and Stream, November 24, 1900, J. P. Whitney wrote that in December and early January the trout are comparatively plentiful in a few feet of water below the ice, but that afterwards they are mostly in from 15 to 40 feet.

Brooks possessing suitable conditions are occupied throughout the year and sometimes year after year, at least in some portions. While streams tributary to lakes afford nurseries from which the lake receives an annual supply, many trout, continuing small, reach maturity and pass their whole existence in the brooks.

MIGRATORY MOVEMENTS.—Trout are not generally subject to extended migrations, and in the far inland waters, excepting their movements for breeding or seasonal accommodation, they are rather localized in their habits. Near the coast, however, when possible, they often enter the sea, and in certain localities there seems to be a race of almost permanent marine trout, entering fresh water at more or less regular periods. In New England such fish are locally known as salters.

One Rangeley Lake observer, in a communication to a sportsmen's journal, wrote that the trout were not migratory in their habits, although in exceptional instances they would roam about more or less and sometimes go long distances. Otherwise they would frequent the same feeding grounds, although making their usual spring and autumnal movements. He further stated that if a trout was carried away from its accustomed haunt and placed in the water it would return forthwith, thus displaying a remarkable homing instinct. He cited one instance of a trout, known by a hook left in its mouth, which was caught again the next day in its original place, having traveled a distance of 3 miles during a dark night beneath 30 inches of ice and snow.

Mr. Rich wrote [a] that he once saw a school of trout several acres in extent making their way from the headwaters of the lake toward the inlet. They were said to be swimming near the surface and the water appeared to be alive with them. They could plainly be seen from the boat and were of all sizes, some very large ones being among them. He said occasionally one would break water.

The population of tributary waters is mainly brought about by wanderings of young fish which tend to move upstream and into smaller streams after they begin to feed, although adult trout, while in pursuit of food, sometimes gradually make their way into neighboring waters.

BREEDING.—The trout spawns in autumn during the falling of the water temperature, the season varying somewhat with the latitude and also with the local temperature of the water. In general, including all localities and conditions, it may be said to extend from September into December. The duration is about two months for the trout of any body of water. In the Rangeley Lakes the height of the season is from about the middle of October to November, depending somewhat on the conditions and weather. The season may be delayed or interrupted by weather conditions.

[a] J. G. Rich, American Angler, Apr. 14, 1883.

The sexes differ much in appearance at the breeding time. The head of the male is longer, the lower jaw somewhat hooked, the mouth and teeth larger, and the coloration more brilliant, the belly and some of the fins being a brilliant red, and the white margin of the pectorals and ventrals more distinct. The body also becomes flat or slab-sided and has a thick coat of mucus, almost or quite obscuring the scales. (See Pl. XLIII, Table IX, p. 594.)

The age of maturity varies somewhat. The male is usually more precocious in that respect than the female. Artificially reared trout have been found mature at 1 year of age. A colored picture of a 14-months-old female only 7⅝ inches long, still bearing parr marks and in a spawning condition, is shown in the Manual of Fish Culture issued by the United States Fish Commission in 1900. The usual age of maturity under natural conditions is doubtless somewhat more advanced. As shown in another place, the size of the fish does not indicate its age; therefore, breeding brook residents only 2 or 3 inches long are not necessarily young fish, although possessing parr marks.

According to Livingston Stone, all 2-year-old trout spawn; some yearlings do and some do not; and the main dependence of the trout breeder for eggs is on trout upward of 2 years old. The duration of fertility, which has not been ascertained, is also variable. But very large fish, although found on the spawning grounds, are often old and practically sterile.

Usually there are established breeding places to which the fish resort year after year unless changes of physical conditions occur. The Rangeley Lakes are extremely liable to such changes, which affect both streams and shoals as spawning resorts. Ofttimes lowering of the water exposes the bars that most streams form in the still water at their mouths, thus preventing the entrance of trout, and, of course, shoals in the lake will be laid bare by the same means. In Forest and Stream, October 15, 1891, it was stated by a correspondent that in the Rangeley region the trout had begun to seek their spawning grounds as usual, "But," using his words, "the spawning grounds are not found where they should be. On the contrary, the water has far receded from them and they are only flats of dry gravel, in some instances many rods from water sufficient for trout to spawn in."

In the same paper, January 12, 1888, Capt. F. C. Barker, a lifelong resident and observer of the Rangeley region, wrote to the effect that for years before the Union Water Power Co. modified Mooselucmaguntic Lake one of the largest spawning beds to be found anywhere in the Rangeley region was off the Bemis Bar and in not less than 8 feet of water 40 rods from shore. Year after year they came there and did their spawning, but when the water was raised only 2 feet higher over their bed they abandoned it altogether.

The trout begin to assemble on the shoals or in the streams, as a rule, during September, usually in the latter part of the month, in the Rangeley region, but they are not at this time quite ripe. The run then continues well into October, sometimes later. The fish appear to go in schools, and there seems to be a consensus of statements that the early runs are composed entirely of males. In his article regarding his observations in Kennebago Stream, Mr. Rich stated that the males came first, "cleaning off the stones until they fairly shone in the sunlight." Then they seemed to leave all at once for a day or two, afterwards returning with the females; but a curious fact was observed that while before the arrival of the females the beds were covered with males, afterwards there were but few of them. In his former article he stated that there are always more males than females, sometimes three to one.

In the Rangeley Lakes region, doubtless, the trout spawn on every suitable shoal and ascend every suitable stream when possible. The most famous spawning places are Rangeley, Kennebago, and Cupsuptic Streams and the outlet of Mooselucmaguntic Lake below Upper Dam. Mosquito, Sawmill, and Metallak Brooks are also of importance, and "Beama," or Bemis Stream, has been mentioned in this connection. Kennebago Stream is stated to be ascended sometimes as far as Kennebago Falls, which present insurmountable obstruction, but Capt. Barker stated that the 7 miles between its mouth and the Ash Tree is the usual resort and probably furnishes Mooselucmaguntic and Cupsuptic Lakes 75 per cent of their trout, but another writer in Forest and Stream, November 3, 1894, was of the opinion that nine-tenths of the Rangeley trout spawn in still waters where the water was affected by springs.

With the trout frequenting different shoals or streams, there are frequently differences of size of the fish composing the runs. One locality may comprise small fish, another large ones, the individuals being of more or less uniform size. Regarding this fact, having spoken of the anglers catching out big fish from those coming on to the spawning grounds, Mr. Rich wrote:

> I am now referring to the largest brook trout, which run together in masses, all nearly the same size, or at least of 2 pounds weight and upward. One-pound trout, as a rule, spawn in entirely different localities and by themselves and commonly earlier in the season by some weeks. This is not, however, exclusively so, for many 1-pound trout are often mixed with larger ones on the spawning grounds.

In American Angler, vol. VI, November 8, 1884, p. 297, Mr. Rich graphically described the first run of trout in the Kennebago River in 1884, where, he said, from the last of September to the freezing of the river in November, the trout resorted to spawn. He wrote that on September 22, having been attracted by the splashing of the water, sounding "like a drove of moose wading in the river," he saw a large school of trout, many of which were of large size, jumping out of the water and going through various maneuvers as they made their way up the river. They continued to run in large schools until all the spawning beds up along the river were fully occupied. He said that the number of trout running up the river could not be estimated, but that in the small space of about 5 rods the spawn takers secured 500 trout from October 1 to 12.

By flapping away the sand and dirt the trout form shallow hollows in the gravel, which serve as nests in which the eggs are deposited and covered with gravel or pebbles.

Mr. Rich (loc. cit.) stated that the beds were made of small round pebbles piled up in heaps, 3 or 4 feet across, and that these pebbles were carried in the fishes' mouths, sometimes quite a distance. The beds accumulated sediment and river muss during the year, and when the time for spawning drew near the male trout congregated near the spawning grounds in great numbers and cleaned the beds and made them as bright as if they had been polished. The fish then retired and in some ten days or two weeks returned with the female trout in large schools, which lay around in the vicinity of the beds until their time of deposit arrived.

While most of this statement is doubtless correct, Mr. Rich apparently mistook old chub nests for those of the trout, due perhaps from having observed the trout utilizing them. He may have guessed that the trout carried the pebbles to the heaps in their mouths. In another article regarding nests in Kennebago Stream he stated that his observations there afforded no reason for changing his views of the manner of trout spawning except that the beds there appeared to be flat and formed of small cobbles.

The spawning process is thus described by Mr. Rich:

The female drops some spawn, then with a dexterous movement of her under fin turns a pebble over it, whirls back and forth around the bed a minute, and then goes through the same operation again, the male occasionally sidling up to the female and both touching bellies together for an instant; then the male leaves her and looks after the spawn, and if he finds it he gobbles it up. The above operation is continued for many days, until the female has deposited all her ova.

The eggs are not all emitted at one time, but a female trout, usually attended by one and the same male, occupies the nest for several days. Mr. Rich says (loc. cit.) that if the female is taken from the bed the male will leave, but if the male is removed the female will remain and ere long another male will take the place of the one removed.

Trout are not infrequently observed with ripe spawn out of season, during almost any month of the year. A writer in a sportsmen's journal in 1894 stated that in the Rangeley region well into January he had observed through the ice trout spawning, and that in August not long before he had caught a pregnant 7-pound fish from which spawn was dripping. The fish was said to have been caught by slow trolling with worm bait in about 30 feet of water. The writer once caught, in early June, a 2-pound trout that contained ripe spawn.

The eggs vary in size, but are usually one-sixth of an inch in diameter. The number yielded by one fish depends on its size and age, yearlings usually producing from 150 to 250; 2-year-olds, 350 to 500; and older fish, 500 to 2,500.[a]

Regarding the number and size of the eggs, Livingston Stone stated:[b]

The number of eggs to a fish is given as 1,000 to the pound, but it is often more than this and varies much with the size of the eggs, those having small eggs yielding the most in number. I have taken 1,800 eggs from a pound trout, and once took over 60 eggs from a trout that weighed just half an ounce immediately after being stripped.

The eggs of the trout are large compared with those of most fish, except the salmon. They average about three-sixteenths of an inch in diameter, varying very considerable in size, the very largest containing probably twice the bulk of the very smallest.

They are sometimes colorless, sometimes orange hued, and sometimes have a rich-red tint. The cause of the variation in the color of the egg is not positively known. It has been thought to be hereditary.[c] It has also been attributed to the color of the flesh of its parent, and to the nature of the parent's food.[d] A correspondent of Mr. Buckland says that the tints can not depend on the color of the parent's flesh, because all graylings' eggs have similar tints and all graylings are white-fleshed.

The eggs are hatched in the spring, the time being determined by the temperature of the water. Warm water hastens and cold water retards the hatching.[e] After it is hatched the young trout lies concealed amongst the gravel until the yolk sac is absorbed, when it is capable of feeding. Then it gets into shoal water along the stream's margin or on the ripples, and whenever possible into rivulets and other small waterways. It ascends such places for considerable distances.

GROWTH AND AGE.—A correspondent of Forest and Stream, June 23, 1887, asked the questions "What causes the *Salmo fontinalis* to grow to such a size in the Androscoggin

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[a] Manual of Fish Culture.

[b] Domesticated trout, how to breed and grow them. Sixth edition, 1901.

[c] Massachusetts, Fisheries report, 1868, p. 31.

[d] Fish Hatching, Buckland, p. 19, 20.

[e] Under artificial conditions the time necessary for the development of the eggs has been found to vary from about 125 days in water at 37° F. to 50 days in water at 50° F.

waters? Why are not the trout as large in Moosehead and other Maine lakes?" Then he proceeds to answer the questions himself: "Cut open the maw of one of the great trout and the question is answered. There you will find minnows in several stages of digestion, from the one just gulped down to only the backbone of the first one eaten. It is the feed. Millions of the chubs, Cyprinidæ, are there for trout to eat. It is probable that these numerous Cyprinidæ are increasing faster than the trout."

The foregoing explanation to the effect that the food is the main cause of the size attained is doubtless true, but the inference that an unusual abundance of food in the Rangeley Lakes resulted in fish larger than elsewhere in Maine was not well founded. In some other Maine waters—Moosehead, for instance—such food as he mentioned is fully as abundant, with some additional species. Still other lakes are even better supplied. The probabilities are, too, that trout fully as large as those of Rangeley are taken or at least occur in other Maine waters, although the Rangeleys still hold the cup for the record fish. In Square Lake not many years ago a trout of 10 pounds was caught, and the writer has personal knowledge of one of over 11 pounds taken not long ago in Belgrade Lake.

The fact is that the Rangeleys have been before the public for a longer time and the records of big fish have been made public. Less famous waters have doubtless afforded local fishermen at least as large fish as ever were authentically recorded from the Rangeleys, but public attention has not been called to them.

However, it is, as the correspondent said, due in great part to the food. But combined with plenty of available food must be room in which to grow. For some reason or other there seems to be a necessity for range. A trout will not attain a very large size in restricted quarters, no matter how much food it has.

The large size attained by the Rangeley trout naturally aroused interest regarding the age of the large fish, and there is a tradition that when Prof. Agassiz was asked how old the big Rangeley trout probably were he replied that no man living could tell; they might be 10 or 200 years old.

Forest and Stream, November 1, 1877, describes an experiment undertaken by George Shepard Page, president of the Oquossoc Club, directed toward learning something of the rate of growth of trout in Rangeley Lakes. Platinum wire was cut into 1½-inch lengths, flattened at one end, and various numbers stamped thereon from ½ to 4, also the numbers 70, 71, 72, etc., to denote the year. As trout were captured they were weighed, one of these tags passed through the skin just under the adipose fin, securely twisted, then the fish liberated. In the course of two or three of the years named a large number of these trout were labeled. In June, 1873, one of them was reported; a trout weighing 2¼ pounds was caught and found to bear a tag marked "½–71," showing that this particular fish had gained 1¾ pounds in two years. No further notice of the results of this tagging appears to have been published.

As previously stated, trout grow faster and larger in the larger bodies of water when food is plentiful than in smaller or more circumscribed places. Given plenty of room and plenty of food, it is a question to what size a trout might not attain. There are at least two natural conditions aside from those of environment just mentioned that probably affect trout. There is, doubtless, a natural size limit beyond which the trout could not go if it lived to be 200 years old. But even if there were no size limit, the species doubtless has a more or less definite life tenure that would in any case limit its growth.

The comparatively recent development of the study of scales has shown that rarely, if ever, is a greater age than 10 years attained by European trout (*S. fario*), and probably not that; the lake trout of Scandinavia probably not over 12 years.

Allowing, then, an average growth of 1 pound a year, as suggested by Mr. Page's experiment, the record fish would be only 12½ years old. It is quite probable that trout seldom live longer than 12 or 15 years.

Seth Green stated[a] that trout differ in size and growth in nearly every locality and then again the speckled trout which inhabit lakes are known to attain a larger growth than the speckled trout of the streams. He said that from careful measurements of brook trout from Caledonia Spring Creek he had found that a brook, or speckled trout, when first hatched is nine-sixtenths of an inch long; at six months old, 2 inches long; at one year old, 4½ inches long; at two years old, 6½ inches long; at three years old, 8 inches long; at four years old, 9 inches long; at five years old, 10 inches long; and at six years, 12 inches long. After they have reached the age of six years their increase in length is usually very slow, but, like old men, they increase in breadth and thickness. These measurements are a fair average, but fish are like people and animals—some grow faster than others under the same conditions, and frequently a 2-year-old trout will be as large as a 3-year old.

In Forest and Stream, June 30, 1887, page 495, some one writing under the pseudonym of "Percival" gave the following formula for ascertaining the approximate weight of normally shaped trout:

$$W = \frac{L\ G^3}{1{,}000,}$$

in which W equals weight, L equals length from eye to root of tail (not total length), and G equals girth, which, as the formula shows, should be cubed. The result is the weight in ounces. In fish up to, say, 5 pounds, this is extremely close, in larger fish it of course, is liable to slight differences, increasing as the fish departs from normal form. As an illustration, he said: "Applying this, now, to some of the fish whose measurements and weights are given by Mr. Page, say, for example, his own trout, which was 30 by 18 inches, and subtract a reasonable amount for nose to eye and tail (for the length was, of course, total), we find the weight 10½ pounds, which is close to Mr. Page's figures. Applying it to Mr. Grote's trout, we find it about 8½ pounds, which is what the fish must have weighed." (See p. 553.)

LARGE TROUT.—The size which the trout might attain was for a long time a subject of disputatious and argumentative discussion. Hallock mentioned one from the Nepigon River that was said to have weighed 17 pounds. In newspapers and sportsmen's journals even greater weights have been reported from other localities, some of which were in Maine. The largest trout reported from the Rangeley Lakes was one of 24 pounds, said to have been taken in 1872 by a boy, who had left his hook baited with a minnow in the water over night. In connection with the account of this fish, others of 17, 15, and 12 pounds were alleged to have been subsequently caught. Such records undoubtedly were based upon mistaken identification or misinformation.

In American Fishes G. Brown Goode stated that the brook trout seldom exceeded 2 or 3 pounds and a 5-pounder was thought a monster. He referred to the Rangeley

[a] American Angler, vol. III, May 16, 1885, p. 312.

Lakes as a famous locality for large fish and mentioned one obtained by Prof. Agassiz in 1860 that weighed 11 pounds.

In 1905, in answer to an inquiry by Maine Woods, State Fish Commissioner H. O. Stanley stated that the largest trout he had ever seen taken in Rangeley waters and weighed, was caught by Luman Sargent, an Upton guide, which tipped the scales at 11½ pounds. The next largest was one that he, himself, had caught which weighed 10½ pounds. Mr. Stanley said that this was the famous fish that George Shepard Page took to New Jersey. Mr. Stanley continued that in his "boyhood days more than 60 years ago" he had seen larger fish that his father used to bring home from those famous waters in the fall. The fish were not weighed, having been dressed and salted when they were brought home, but as he recalled them they looked more like codfish than trout. He said that he had no doubt but that larger fish than the first two mentioned had been caught, but he had never known one to be weighed.

The records and data referred to in the following pages were compiled from Forest and Stream, the American Angler, and Maine Woods. Back numbers of the latter previous to 1903 were not available, but it supplements the other two, which about that time ceased to publish regular accounts. The information is probably far from complete, excepting, perhaps, that relating to the very large fish. Probably all fish above 9 pounds of weight that have been caught since the first issues of Forest and Stream have been recorded and probably most of those of 9 and 8 pounds taken by anglers; in other words, those that were large enough to attract attention in a region noted for large trout.

Aside from the fabulous monsters previously mentioned, no authentic record of a Rangeley trout above 12½ pounds appears. There are four records of Rangeley Lakes trout weighing from 12 to 12½ pounds, of which only two are authentic, the others being more or less uncertain estimates. All but one of these were taken on the spawning beds, and the exception is a 9½-pound fish reported as weighing 13 pounds.

The first was the one caught by Mr. Stanley, with which George Shepard Page's name has been associated. Concerning this fish, Mr. Page wrote in Forest and Stream, June, 1883, that in 1867 he carried alive to his private pond in New Jersey a female trout weighing 8⅜ pounds and a male that weighed exactly 10 pounds. They were weighed after they had been three weeks in captivity, during which time they had eaten nothing. In Mr. Page's words, "They had endured the discomforts of 9 miles across Rangeley Lake in a fish car which contained 43 brook trout averaging 5 pounds each, 35 miles by wagon road, 400 miles by railroad, across Boston and New York by express wagon, and 2 miles by wagon in New Jersey. Describing this experience on one occasion to the late Prof. Agassiz, I inquired what they probably lost in weight. He replied, 'The male trout at least 2½ pounds and the female 1½ pounds.' " This would make them 12½ and 9⅞ pounds, respectively. The male trout was 30 inches in length, 18 inches in circumference, and 11 inches in diameter. In Forest and Stream Mr. Page later stated that the male fish weighed after death 10 pounds and 1 ounce and that according to Stanley and Atkins it would weigh approximately 12 pounds.

This weight was not equaled until 11 years later, when two men dipping blueback trout, in October, 1878, caught two trout, one of which, a female, according to Commissioner Stanley, weighed 12 pounds and a male that weighed 10½ pounds. Both were returned to the water. This is possibly the record referred to by Capt. Barker

in a letter to Forest and Stream under date of March 28, 1886, in which he said: "As far as I know, the large trout taken near Rangeley Dam a few years ago by the men fishing for breeding purposes still stands at the head of the list of our large trout. I did not see the fish weighed, but a man who did told me this afternoon that the weight was an honest 12 pounds 2 ounces."

In September, 1879, another large trout was heralded in the papers as weighing 12 pounds, caught by a Mr. Marble and his guide, Steve Morse, of Upton, at Upper Dam, September 30. A correspondent of Forest and Stream who saw the fish weighed stated that its actual weight, taken some time after the fish was caught, was 11¾ pounds.

Forest and Stream, July 8, 1886, published the following:

The biggest brook trout.—We have to record the capture of brook trout weighing 12½ pounds by Mr. J. Frederic Grote, of 114 East Fourteenth Street, New York City, in Mooselucmaguntic Lake, Me., on June 11. The fish was a female, and Mr. Grote kept it in a car for one week, when it died. It was weighed several times at the Mooselucmaguntic House in the presence of John Schultz, of Philadelphia, and the proprietors, Messrs. Crosby and Twombley. It was 26½ inches long, 17¾ inches girth, 7¾ inches deep, and 4 inches thick through the back. The guide was Jerry Ellis. * * * We believe this to be the largest brook trout yet recorded.

In Forest and Stream, June 23, 1887, George Shepard Page wrote in comment that C. T. Richardson informed him that the trout was one that Jerry Ellis, Mr. Grote's guide, called an 8-pound trout, but did not weigh it. After the entrails were removed, having been in the car four days, it weighed 8½ pounds. Commissioner H. O. Stanley estimated the weight as 8½ or 9½ pounds, basing his estimate on the known weight of one of the same dimensions.

Of trout weighing 11 pounds and over but below 12, the one previously referred to, 11¾ pounds, caught by Steve Morse, guide to Mr. Marble, was taken September 29, 1879, and reported as a 12-pound fish. Doubtless 11¾ pounds is authentic.

June 7, 1887, Dr. S. J. Mixter, of Boston, caught, by deep trolling with minnow bait, three trout of the respective weights of 11¾, 9½, and 6 pounds. In answer to an inquiry by William C. Harris, publisher of the American Angler, regarding the largest fish, C. T. Richardson stated that he saw the trout weighed after nearly 1 pint of spawn had run out of her and the stated weight was absolutely correct. This record is almost entitled to enter the 12-pound class. As it is, however, it is the largest fish caught on a hook and line by an angler during the fishing season in the Rangeley Lakes. Its length was 27½ inches; depth, 8½ inches; thickness, 4 inches; girth, 20½ inches.

Of trout weighing from 10 pounds, inclusive, up to 11, there were 15, of which two of 10 and 10½ pounds, respectively, were taken on the spawning grounds in 1867; one of 10, also a spawner, taken in 1873; two of 10 each, also spawners, in 1878; one of 10¼ and one of $10\frac{9}{16}$, taken in September, 1885, the latter having been caught by John Prentice near Brandy Point. Regarding it the editor of Forest and Stream stated that it was the third largest. One that weighed 10⅝ pounds nine hours after it was caught was taken in June, 1886, by Dr. Charles Haddock, of Beverly, Mass. It was said to be a "clean-cut, perfectly symmetrical fish 28½ inches long and 16½ inches girth." This fish was again reported in Forest and Stream of July 27, 1895, with exactly the same data, as having been caught that year. In 1888 one of 10½ pounds was taken in August, and another of 10½ in May, 1890. One of 10½ was taken in

June, 1897; one of 10 in May, 1898; one of 10 in May, 1903; one of $10\frac{8}{16}$ July 30, 1907, by Capt. S. Z. H. Slocum, U. S. Army; and one of 10 in May, 1908.

Of fish ranging from 9 pounds upward, but not including 10 pounds, there are records of about 30, of which the largest was $9\frac{3}{4}$, caught in May, 1901. Two others almost as large, $9\frac{11}{16}$ each, were caught in September, 1897, and June, 1906, respectively. Nine of $9\frac{1}{2}$ pounds each are mentioned as having been caught October, 1877 (for fish culture); October, 1878 (for the same purpose); August, 1883; June, 1884; September, 1885; June, 1887; September, 1897; July, 1910; and May, 1911. Five of $9\frac{1}{4}$ pounds each were taken, respectively, in October, 1873 (for fish culture); September, 1884; September, 1885; April, 1896; and September, 1897. One stated to weigh over 9 pounds was recorded for May, 1890, taken on a fly at Upper Dam. One of $9\frac{1}{8}$ pounds was taken for fish culture in October, 1878, and one of the same weight was caught in September, 1892. Eleven or more of 9 pounds, taken at spawning time, have been recorded.

Over 60 weighing 8 pounds and over and less than 9 pounds are authentically recorded, of which not more than a dozen were fish-cultural records.

The foregoing reveals that of trout ranging from 8 pounds to $11\frac{3}{4}$ or possibly 12 pounds not over 75 were recorded as caught by angling in open season in a period of over 40 years.

TROUT AS A GAME FISH.—By many anglers the trout has always been regarded as the paragon of game fishes. It is, however, due to an ensemble of attributes rather than to any particular quality. In certain points it is far surpassed by other fishes. The black bass in some ways requires more concentrated attention to effect its capture. In point of activity there are several northern fishes that are equal to or excel the trout. The fresh-water salmon will arouse more excitement by its evolutions and tactics, and the whitefish, pound for pound, surpasses them all in every way. The bass, the salmon, and the whitefish all are leapers. They leap when first hooked, and they usually continue to leap until free or wearied by excess of energy. The trout seldom leaps from the water except when rising to a fly, and never more than once when hooked and not often that once. Sometimes when first hooked in trolling the fish will go into the air, then its action is one of dogged pulling and shaking. The writer has heard of but a few instances of trout leaping after being hooked. Once the writer caught a 2-pound trout on a small combination of spoon and fly, and when the trout struck and was hooked it went out of the water. In one of the sportsmen's journals some one described the catching of a 7-pound trout in the Rangeley Lakes. It was stated that the fish jumped full length in the air. At the time there was 100 feet of line out, and it took almost an hour to land the fish. It was stated of the $9\frac{1}{4}$-pound trout caught September 1 by Thomas Barbour that it was taken on a white-tipped Montreal No. 2 fly with a $4\frac{1}{2}$-ounce rod and that "Mr. Barbour worked one and one-half hours from strike to finish before he had the big fellow reduced to possession."

There is, then, an inexpressible something in the trout besides activity or those qualities which are usually regarded as gameness that makes it such a general favorite.

FISHING PLACES.—The fishing places are not the same for all times of the year. They are also different for the different methods of angling and are affected by the height of water. In the main, the enumeration by J. G. Rich holds good to the present day, notwithstanding the many changes in physical conditions. However, some of the places named by him are now closed to fishing.

Generally, from the 15th to the 20th of May trout are abundant at the mouths of brooks and rivers, as well as in eddies at the foot of all rapid waters where there is a deep hole, and later in the white water. By the latter part of May, according to Mr. Rich, trout are distributed all over the lakes, and any novice could easily secure a good string. Particular mention was made of the narrows and the rapids of Kennebago and Rangeley Streams for large trout. He named Indian Rock and above on Rangeley and Kennebago Streams as good pools with plenty of trout. These places were stated to be particularly good in September.

It was said that in August and about the 1st of September large trout are found off the long sand beach near Bemis, where all fishing was done from boats. Excellent fishing in June and the last of September, of about 1-pound trout with occasionally larger ones, among the islands 5 miles down the lake was mentioned. Eight miles down the lake and about 2 miles above Upper Dam, at Brandy Point, the largest trout were found. Bugle Cove and Trout Cove in Mooselucmaguntic Lake afford many records of large trout.

The pool at Upper Dam is famous for the large trout, numbers of them, and fly fishing. This pool is estimated to be 300 feet long and 200 feet or more in width, with a strong current through the middle, making two strong whirlpools, one on the right and one on the left. The fishing is done mostly from boats either at the mouth of the pool or on the back waters. It is probably this pool that was referred to by Mr. Rich as the inlet of Richardson Lake, where, he says, good fishing may be had almost any time, but especially in June and September.

Mosquito Brook is stated to have been a famous place.

Off Metallak Brook, where the water deepens, was favorably mentioned as a good place. In the vicinity of this brook is a continuous sand beach, and some distance out from shore the shallow water makes suddenly off into deep water, forming a steep bank. Near this bank, in an area of perhaps one-half a square mile, was a good fishing ground, where trout congregated and stayed winter and summer. This location, being at the upper end of the narrows connecting upper and lower Richardson Lakes, where there is supposed to be more or less current, forms a natural fishing point, which was not generally known to the people or the guides but was known to the Indians in old times.

Down the narrows, 1 mile from Metallak Brook grounds just mentioned, was the famous Cedar Tree Point, mentioned as an October, November, and winter fishing ground. These months are now out of season. But still farther down the narrows, where the lower lake begins, was a famous place for large trout in the spring. Some days they would rise to a fly, but usually, as in most deep water in June, the method was baiting and sinking.

Next in order mentioned by Mr. Rich was Middle Dam, at the head of the outlet into Rapid River, where the largest trout were taken.

As already stated, in the general fishing season trout are caught in some way almost anywhere—from wharves, off points at mouths of streams, and about shoals. Certain special places mentioned are resorted to when the fishing is not so widespread and the fish are more or less congregated for one reason or another. Sometimes such grounds, perhaps through some of the previously mentioned changes of conditions, are unproductive. Then it is that the complaints of poor fishing arise. Even then, according to the experienced, good fishing is possible to those recognizing the cause by searching for

similar places elsewhere. In August, 1899, one angler of many years' residence at the lakes stated that he had most remarkable luck taking fish from grounds that he had never thought of before, and later in the same year said that there were more trout than ever and that they were to be had by those who know where to go and how to take them.

METHODS AND TIME OF FISHING.—The methods of fishing in the Rangeley Lakes may be classed under three general heads—trolling, fly fishing, and bait or still fishing, locally known as "plug fishing." It is unnecessary to describe these methods. Under bait fishing, however, it should be said that the ordinary fishing from shores or wharves with bait is not classed as plug fishing, which is bait fishing in deep water. It is necessary to note this distinction in the discussion of plug fishing.

The fishing at these lakes begins with the disappearance of the ice in the spring. Then it is mainly by trolling until well into June and sometimes later. Fly fishing is variable in the time of its opening, but usually begins with the first real warm weather and the presence of insects on and over the water. Fly fishing ceases with the warming of the shore and surface water to such a degree that it is uncongenial to the trout. Then the fish resort to cool waters, either at some depth or at the mouths of cold streams. At this time some resort to plug fishing, which is the usual method during the warm summer months. When the weather begins to cool, fly fishing is resumed and used to be at its best during the month of September when the fish were congregating on shoals and at mouths of streams preparatory to spawning. However, any one of these methods may be successful, according to conditions and circumstances, at any time of year.

There are those who visit the lakes for trolling only. When the fishing by that method declines they leave. Others first fish by trolling and stay for fly fishing. Still others would scorn any other method than by the fly at any time, but they are few. It has been stated that the trolling season begins about the time the ice leaves and that its duration is variable. It has elsewhere in this paper been noted that on several occasions it lasted well into July. Regarding the size of the fish caught by this method, there seems to be no limit either way, excepting in the size attained by the fish and in ability to take the bait into its mouth. One six days' trolling record in June was 32 trout weighing 85 pounds, from 1 to 7 pounds each. Another one-day record, April 25, 1896, was thus stated: "Caught by trolling a bunch of worms at the end of 50-foot line, one trout of 9 pounds flat and another 9¼. This spring hundreds were caught in this way ranging from 1 to 5 pounds."

A sportsmen's journal correspondent writing under date of June 9, 1882, in regard to fine catches of large trout, stated that most of the trout had been taken with worms and minnows. The previously mentioned alleged 12½-pound trout, afterwards decided to have weighed not over 9½ pounds, was stated to have been caught with a minnow bait in deep water.

Regarding the method of trolling, while it is effective, it subtracts much from the gameness of the fish, especially when sinker and gang hook are used, and the fisherman loses much from the sport by the stiff trolling rod usually employed. The method par excellence, the praises of which have been sounded in song and story, is fly fishing, and while from the time of the jig and spear there have been fly fishers they seem to be increasing in number, and some who in the old days would not have hesitated to jig a trout that could not be secured by other means now have abandoned all other methods and catch

the trout by fly alone or not at all. Mr. Rich, writing under date of October 1, 1880, stated that trout of the largest size could, and now can be, seen lying upon their spawning grounds, but they charily rise to the fly. The most of those taken are baited with spawn, although many parties will not deviate from the more sportsmanlike way of fly hook and delicate rigging.

As long ago as 1887 a correspondent of the American Angler wrote:

> The character and modes of both fishermen and fishing have greatly changed during the past 10 or 15 years; formerly most who visited the region fished either by trolling or "plug fishing" (from an anchored boat over a place baited to attract the fish). As an illustration, permit me to mention the fact that the first time I saw one of Maine's most distinguished Senators of a score of years ago he was "plug fishing" for the greater part of the day, but now, no doubt (for he still lives), he would scorn the idea of using anything but a fly. Scarcely a fisherman now goes out to troll without taking his fly rod with him, while many never think of using anything else, and we trust the day is not far distant when all other modes of trout fishing will be abandoned.

The season for fly fishing also varies, but, as previously stated, it begins in general at about the decline of the spring trolling. Regarding it, an experienced angler, under date of June 10, 1893, wrote to a sportsmen's paper:

> The height of the trout season in Maine waters is over so far as the spring season is concerned, and many of the parties have returned and are returning. Still, there are others who will go fly fishing purely, and they will follow up all of the month of June and well into July. There will then be a lull till late in August, or during the heated term, after which the fall fly fishing will begin.

The earliest date of the opening of the fly-fishing season was mentioned in a letter dated May 23, 1898, to a sportsmen's paper, in which it was stated that at Mill Brook one person took 30 trout on a fly in one day, early as it was, and that it seemed that the trout began to rise as soon as the smelts were done running. The next earliest was mentioned under date of May 30, 1891, when it was said that trout had just begun to come up to the fly at Upper Dam, and the same was true of the upper lakes, but up to that time the weather had been unusually cold. On June 1, 1877, at Upper Dam it was reported that the trout had commenced rising finely to the fly, and about 50 fish had been taken in that manner in the previous 24 hours. On the other hand, on June 10, 1882, it was stated that there was no fly fishing owing to the retarded season. On June 7, 1889, trout and salmon were reported to be rising to the fly.

The fishing is mentioned in July as follows: July 9, 1874, many under 3 pounds were taken on flies. This, however, probably refers to the last of June fishing, at least in part. July 10, 1899, it was stated that the fishing continued better than usual after the hot weather came in, although there was the same complaint that trout did not rise to the fly as readily as in former seasons. Still, there had been some fair fly fishing at the Upper Dam and at other places. On July 17 of the same year it was reported that a good many small trout had been taken on the fly at Haines Landing and at Bemis; and again on July 22 it was said that fly fishing was holding out well. On July 26, 1899, a report was to the effect that at Mountain View trout were just beginning to rise to the fly and at sundown when flies hovered over the lake the trout fairly jumped out of the lake to catch them. On July 28, 1892, there were reports of remarkably good fly fishing on the large lakes after the water began to fall. At Upper Dam, for the week previous, fly fishing had been the best of the season.

A report dated August 14, 1905, stated that during the previous 10 days over 20 trout and salmon had been taken on the fly, most of them weighing over 2 pounds but all

under 3 pounds; and on August 30, 1876, it was reported that trout were rising to the fly very handsomely.

September 21, 1901, fly fishing was reported good, and on September 26, 1905, it was stated that there was excellent fly fishing from the wharf in front of the Mountain View Hotel, and more than 100 fish had been taken there, but it was not stated whether they were trout or salmon. The first of the large trout taken by Commissioner Stanley at Upper Dam in 1878 was on September 22. Trout were caught throughout September and until October 10, inclusive.

It is stated that the largest trout taken on the fly were caught in September, but large trout have been taken on the fly at other times, and doubtless many of the records not definitely stated as taken on the fly were so caught. The largest so taken by any angler is one caught by the late Senator Frye, that weighed slightly over 10 pounds. So far as the available published records show, the next in size, one of 9½ pounds, was taken at Upper Dam by Thomas Barbour in 1897. Other records are of September, 1874, one of 7 pounds; August, 1876, two of 5 pounds and some of 1½ to 3 pounds. In September, 1885, one angler caught one of 4, one of 7½, and one of 8½, and three others got one each of 5½, 7½, and 9½ pounds. J. A. French furnished and vouched for the correctness of a list caught at Upper Dam on a fly in August and September, 1890: August 29–31, 6½, 6¼, 4½, and 6¾; September 1–30, inclusive, $8\frac{3}{16}$, $6\frac{3}{16}$, 4, $6\frac{3}{16}$, 9⅛, 6½, 7¾, 7¾, $7\frac{7}{16}$, $6\frac{1}{16}$, $5\frac{5}{16}$, $6\frac{3}{16}$, 6¾, 5, $5\frac{5}{16}$, $7\frac{5}{16}$, 6¼, $7\frac{3}{16}$, 6½, 6⅞, $6\frac{5}{16}$, 4⅞, and 8⅞.

Plug fishing.—As elsewhere stated, the so-called plug fishing is from anchored boat over some deep hole where the fish congregate in the summer months. Oftentimes these places are or have been baited to attract the fish. For many years plug fishing was an approved and favorite method of even those who disapprove of it now. The alleged and apparent, or perhaps it should be said evident, decrease in number of large trout gradually and justly became to be, in part at least, laid to this method. From time to time efforts were made to secure legislation to prohibit plug fishing, but the influential antagonism to such measures defeated them. Therefore, plug fishing has continued, but not wholly unabated. There are sportsmen who will not resort to that mode even if there are those who will not desist. The plug fishing method is due to the fact that, as a rule, trout, especially large ones, could be caught in no other way during the midsummer season, and there were places where trout could be caught throughout the season. Mr. Rich stated that if one wished to catch a big trout in midsummer he must bait and sink in deep water, the usual depth being 40 to 50 feet. Letters to the writer from Daniel Haywood and Daniel Haley, both experienced guides of Rangeley and lifelong residents of the region, stated that still, or plug fishing, was all done in 35 to 40 feet of water with clay bottom.

It was reported that on August 6, 1874, a party of two at Stony Battie, Mooselucmaguntic Lake, took with bait 26 trout that weighed about 30 pounds, and good success was had at Bugle Cove. In 1880 it was authentically reported that on August 20 one man and his guide, fishing from 1 p. m. to 5 p. m., in 30 to 40 feet of water, in Mooselucmaguntic Lake, took 16 trout weighing 52 pounds, as follows: One, 8½; one, 5½; one, 5; one, 4½; two, 4; one, 3½; three, 3; one, 2; and six, 1 pound each. In 1884 an angler, writing on August 9, contributed the following statement to a sportsmen's paper:

The trout fishing here is something remarkable. Yesterday, August 8, a gentleman took five trout weighing together 28 pounds. A few days before he captured 8 weighing 38 pounds. The only mode

to get these large fish, veritable leviathans in size and nature's jewels in glistening beauty, is by deep-water bait fishing. The angleworm is very catching, and a long line of, say, 60 yards is needed.

In 1896 the following remark by Senator Frye appeared in Forest and Stream:

From time to time my attention has been called to the fact that in the heat of the summer, when the trout had sought the spring holes for cool water, they were captured by deep fishing with worms and minnows in enormous quantities, all of them killed, many wasted. That this murderous slaughter, in which, I am happy to say, no sportsman participates, has had a serious effect I have no hesitation in affirming, and my knowledge of those waters is certainly equal to that of any other person. If summer plug fishing in Mooselucmaguntic Lake is not prohibited by law, in time serious results will follow.

In the May 7 number of a sportsmen's journal of 1899 a special notice was published, as follows:

The fish commission is to give a hearing at the Rangeley Lake House, May 17, as to the proposition to close the whole Rangeley system to all bait fishing after July 1 of each year. The summer guests at the hotels will oppose the action, but the sportsmen, who usually fish by trolling in the spring and with the fly in the fall, are strongly in favor of some action that shall stop the taking of trout by what is termed "baiting up" in the summer time. Deep water is selected, and minnows, chopped up, are thrown in for several days in succession. When the big trout have been tolled to these feeding grounds, the hooks are brought into requisition, attached to 50 or 100 feet of line, as the case may require. In this way many beautiful trout are taken that have sought the deep water to escape the heat. The petition to the commissioners is directed more especially to the stopping of this sort of fishing.

FACTORS AFFECTING TROUT FISHING AND THE ABUNDANCE AND HABITS OF TROUT.—Adverse natural and artificial conditions affecting the trout supply and permanent or temporary quality of the fishing have been referred to. Among these may be mentioned the modifications produced by dams, meteorological conditions, number of anglers, natural and introduced enemies, undue and unseasonable fishing, and the introduction and artificial propagation of other species.

Effects of modification of lakes by dams upon trout.—The modifications produced by dams that permit of raising or lowering the water in the lakes are most potent factors in modifying the habits of the fish, as well as at times in fish destruction, directly and indirectly.

Competent observers have, from time to time, called attention to these effects. The general concensus seems to have been that in their permanent and ultimate effects the dams were advantageous rather than otherwise, in that the high water afforded more extensive and protected feeding grounds for trout. But there were some who expressed the view that disaster to multitudes of fish invariably followed the sudden opening or closing of the gates. In 1896 the late Senator Frye wrote, among other things:

The constant changes in the height of water, making to-day a bar on which to drop a fly, and in a month water over it deep enough to float a gunboat, are disturbing elements. These things only illustrate the necessity of creative and preservative agencies if this fishing in the lake is to continue to be attractive to sportsmen.

Height of water.—As has been stated on another page, in every body of water the fishing varies by the season, by the month, by the day, sometimes by the hour, and even shorter periods. A period of success or failure the angler usually tries to account for, commonly ascribing it to the weather or the height of water. Frequently, too, prophesies regarding the fishing prospects are based upon the height of water in the lakes. Usually such predictions have been favorable, although contradictory at times; the

fishing promises to be good because the water is high or because it is low. Again, if it happens to be poor fishing when the water is low, it is predicted that it will improve upon the rise, and vice versa.

As a matter of fact, the character of the fishing depends not upon one condition alone but upon a combination, sometimes of several conditions. Such opinions regarding these points as have been mentioned in some sportsmen's journals have been noted by the writer. The period in which notes referring to height of water and fishing were found extended, nonconsecutively, from 1873 to 1902, representing 15 years.

From these notes it was observed that there were seven stages of high water and poor fishing, nine stages of high water and good fishing, seven stages of low water and poor fishing, and five stages of low water and good fishing. From this it would seem that high water was the most favorable, although both high and low water exhibited the same number of stages of poor fishing and low water somewhat more than one-half as many stages of good fishing, which leads to the repetition of the suggestion that the fishing is influenced by many other conditions besides the stage of the water.

Weather.—From time immemorial the weather has been believed to be the most powerful controlling influence affecting fishing. As it affords an ever-ready topic of conversation when there is nothing else to talk about, so it serves as an excuse for poor luck in fishing or good catches, as the case may be. Probably this is based to a great extent on solid ground, but oftentimes the adverse effect is on the angler rather than the fish. However, there are, without doubt, early, late, and unfavorable seasons that may be correctly ascribed to meteorological conditions. Also, sudden changes affect the fishing one way or the other.

As shown by the ice records, the opening of spring is variable. Some seasons the cold weather may continue well into the summer, with only now and then a warm day. Again, it may be hot early, and dry and hot weather last all summer and fall. Again, there is often a wide range of conditions within a very short space of time, as, for instance, a weather record in 1903 was to the effect that on April 29 the thermometer at Bemis registered 70° F.; April 30, 69° F.; May 1, 31° F. at noon, and spray from the waves would freeze in icicles on the bushes near the lake shore; while May 2, at 4.30 p. m., the mercury stood at 20° F.

Of 34 reports to various sportsmen's papers regarding the quality of the fishing which was referred to the weather conditions, there were 14 of cold weather and good fishing, 4 of cold weather and poor fishing, 2 of hot weather and good fishing, 4 of hot weather and poor fishing, 2 of hot weather and poor fishing changing to good fishing with cold weather, 1 of cold weather and poor fly fishing, but good bait fishing, 1 of the first warm day of the season affording the first good fishing, 1 of cold but warmer with the best fishing for years, 1 of fair and warmer and good fishing, 1 of fine weather and fine fishing, 1 of good weather and good fishing, 1 of best of weather and best of fishing, and there was one report of a backward, cold season with poor fishing followed by a continued hot spell and poor fishing, with a complaint that the fishing was playing out.

The foregoing reports signify very little, for some of them come from those who fish by trolling, others from fly fishermen, and perhaps others from bait fishermen, and some of them state the conditions, perhaps, affecting all kinds of fishing. As a rule, during cold or very cool weather fly fishing is rarely good, while trolling is at its best.

When warmer weather and fly fishing begins, which is perhaps as much due to the presence of flying insects as the weather, the trolling, as a rule, ceases. And there is a period during midsummer when usually the only successful method is by deep-water bait fishing, locally called plug fishing. However, throughout the season—any season, in fact—if the angler fishes in the right place at the proper time of day he may catch some fish by any one of the methods mentioned. But the disagreeable conditions known as hot and cold, windy and rainy, disincline many anglers to prolonged attempts to find fish, and the attractions of hotel or camp outweigh the inclination to catch fish when to do so necessitates early rising for morning trolling or a long boat ride in the hot sun to a fly-fishing ground where the fish rise to the fly only in the first evening dusk. Therefore, as previously stated, much depends upon the angler as well as upon the weather, and good or bad weather fishing reports result accordingly.

Number of anglers.—Various conditions affecting the fishing, or that may affect it from time to time, have been mentioned. No one of these necessitates a constant progressive diminution. One factor not previously mentioned that would tend in that direction unless it were safeguarded by enforced restrictive and limiting laws is that of numbers of fishermen.

Prior to 1891 no railroad extended nearer to any of the Rangeley Lakes than Bethel, Rumford Falls, and Farmington. From those stations the angler was obliged to travel by stage and buckboard, and in some instances on foot a part of the distance, for 20 or 30 miles or more. Even then a great many anglers annually visited the lakes. The region became famous for its numerous large trout, and an increased number of anglers were attracted by the fishing. As the number of visitors increased, accommodations increased accordingly, and the lakes became more accessible by improved roads and extension of railroads. As early as 1883 it was stated on good authority that the number of visitors annually frequenting the Rangeley Lakes then reached the large number of 3,000, to accommodate whom capacious hotels, camps, and cottages had been erected. Since then facilities for reaching the lakes have been increased and improved and accommodations of every character, from unpretentious camps to large, fashionable hotels, as well as almost innumerable private summer residences, have been established, and it is an unusual season when they are not all filled.

In a letter to a sportsmen's journal, dated June 8, 1889, which was before a railroad reached any point on the lakes, a correspondent estimated that there were 1,000 people on the lakes the week before.

Before a legislative committee in 1903, regarding the establishment of a hatchery at Rangeley, an owner of very commodious camps said that for the past four years he was obliged to turn away people who wanted accommodations. Another camp owner stated that there were then 10 sportsmen to 1 nine years previous, when he first went to the region.

It is not necessary to call attention to the possibilities of depletion from unrestricted fishing by an unlimited number of anglers. Artificial propagation and due regard to conservation greatly reduces the danger. Yet, as mentioned elsewhere, there is a limit to the efficacy of artificial stocking of the lakes, imposed by the limitations of biological capacity, the significance of which is that it is possible to conceive of so many anglers that the lakes could not support enough fish to afford good fishing to all; also, that there is danger of deterioration from overstocking, sooner or later resulting in general depletion.

Enemies.—From ova to senility the trout is subject to destruction by enemies. These enemies are many and various, almost every zoological class, as well as some botanical classes, being more or less represented. Bacterial, fungus, plasmodial, and parasitic diseases destroy them individually and epidemically. Nonparasitic, as well as parasitic, worms and crustaceans and some insects are not infrequently fatal. Among the vertebrates certain fishes, batrachians, reptiles, birds, and mammals can be mentioned. Of these, disregarding man, the fishes, not excepting the trout itself, are the most serious. Under normal conditions these are some of nature's regulatory provisions for maintaining those conditions. It is only when normal conditions are disturbed that the enemies become generally harmful.

The normal enemies of trout in the Rangeley waters have probably existed there as long as the trout, and trout existed in normal numbers until civilization interfered with the natural conditions. This interference augmented the numbers of some enemies and diminished the number of others. The increase has been chiefly amongst the fishes, the decrease among the birds and mammals. These natural enemies were not exclusively enemies of the trout, but included other fishes, some of which were also trout enemies. The additional enemies of the trout were not only direct but competitive enemies, thus doubling their injurious effect. Thus, it may be seen that the decrease in birds and mammals can not have compensated for the increase amongst the fish enemies.

As has been seen in the faunal list, the Rangeley Lakes were peculiarly free from voracious fishes such as occur in most other trout waters, even in the neighboring river basins, and some of which were found in the Androscoggin itself but which had no natural access to the lakes. The principal resident enemies were suckers, chubs, eels, and miller's thumbs, and while most of these were, in a way, naturally inimical, they were to some extent directly and indirectly essential to the trout's existence. Eels seem never to have been abundant, at least within the memory of man. The others were not too abundant and were rendered so only by man's interference; that is, by the introduction of other more abundant and more easily obtainable food, thus making the original food, the fishes named, unnecessary, as they were less apt to be eaten, and permitting and promoting a greater multiplication of them.

The directly inimical fishes that have been introduced into these waters are the hornpout, pickerel, and salmon. The effects of their accession are discussed in other places in this paper.

Of the natural enemies, the suckers are particularly harmful on the spawning beds of trout, at least in some places, where they devour the eggs.

The chub is to some extent harmful in that direction but more so in eating the fry, and in this they are not restricted to naturally produced fry, as the following note indicates, and which suggests the advisability of careful selection of the place of deposit for artificially hatched trout. Regarding trout fry planted in Gull Pond, a letter from J. F. Teach, to Maine Woods, dated September 25, 1903, contained the following:

A few days ago a number of trout fry from the Rangeley hatchery were put in here at my camp. The next morning, observing these fish schooled in dense masses amongst the rocks on the water's edge, Anthony Tibbetts, a guide, suggested catching a few chubs, of which there are multitudes in the pond, in order to find certainly whether that fish devoured trout fry. Twenty-six chubs were taken out accordingly, and every one, large and small, was packed to the lips with these trout.

According to some observers, however, the trout is his own worst natural enemy, and this is, to some extent, true. Mr. Rich said that as soon as the female trout begins to deposit her eggs several chubs, suckers, and small trout appear on each side of her ready to devour her eggs. While those on one side are dispersed by the male, others rush in from the opposite side, and thus it continues throughout the spawning season. Mr. Rich thought it was doubtful if on some spawning beds a single egg escaped, and, he continued, the destruction of eggs by trout themselves is a very serious matter. He said that male trout when caught from the spawning beds are often found with their stomaches full of spawn, but he was inclined to doubt if the male in immediate attendance upon the female participated in the spawn eating, as when caught he is found to be thin and slab-sided and his stomach usually empty. But Mr. Rich stated that on some beds the spawners seem to be without any particular mates, having a half dozen or more males in attendance, the appetites of which do not seem interfered with and which indiscriminately make a mad rush for the eggs as soon as deposited, apparently securing every one. He wrote that he had seen a hundred trout congregated in an area not over 10 feet square and in such close proximity that there was hardly any intervening space; that it was not uncommon in the late autumn, before the ice had made near the shore, to find half a dozen trout digging over the spawning beds for some eggs that may have previously escaped observation; and that in this operation they frequently assumed a perpendicular position, often with their tails flapping above the water surface.

Probably the most destructive bird enemies to trout were formerly the loon, sheldrake or merganser, heron, fish hawk, and kingfisher. All of these, excepting possibly the kingfisher, are now comparatively scarce.

Of mammals, mink and otter were the most destructive, the coon and bear perhaps aiding to some extent. All of these, too, are comparatively rare.

J. Parker Whitney, in the report of the Maine Fish Commissioners for 1896, wrote that next to man he thought the great blue heron was the greatest destroyer of trout at these lakes. He said that this bird was an incessant nocturnal as well as a daily feeder, of inordinate appetite, and although its principal food was chubs and frogs it destroyed a great many trout and would get away with quarter pounders, if not larger. They had no hesitancy in striking and fatally wounding trout of over 1 pound in weight. Yearly he had seen trout swimming about that had been pierced by this bird's bill, and in 1896 he had caught two which were unfit for food, each over 1 pound in weight, having holes as large as pipe stems nearly bored through them from the back. It was a question in his mind if this bird, of which hundreds frequented the shores of the lakes from early spring till the ice, did not, in the aggregate, kill more trout, principally small ones up to one-half pound, than all the fishermen. He went on to say that, aided by the loons, kingfishers, and mink, they undoubtedly did, and added that the mink was a voracious feeder and would destroy large numbers with the greatest ease from congregating pools and breeding streams which feed the lakes.

Destruction by man.—Some of the natural agencies tending toward the depletion of trout waters have already been mentioned. But of all destructive agents man has been, and to some extent still is, directly and indirectly, willfully and unwittingly, the most energetic, most persistent, and most effective. The aborigines resorted to all the means known to them at all seasons to secure fish, and the trout was one of the principal contributors to their support. But the Indian, it is said, never took more than he

required, even if possible. But in many instances the paleface proved himself selfish and wanton to a superlative degree. This does not apply to the original white settlers or to the immediate or following generations, but to later incomers, to whom some one has referred as representatives and minions of incorporated desire for gain.

The water-power and lumbering interests apparently cared not whether the spawning grounds of the trout were destroyed by flood or drainage or by the log drive. It was no concern of theirs whether trout were destroyed by suddenly depriving them of water, and they had no interest in whether angleworms or dynamite were used to supply the workman with fish food, or whether it was during spawning time or any other time, as long as "grub expense" was reduced by a supply of free fish. In fact, it was never given a thought, and it was not brought to their attention until almost, or quite, too late to avert the extermination of this fish.

The early inhabitants of the region in the neighborhood of the Rangeley Lakes—and a distance of a great many miles was not remote in those days—were accustomed not only to get their families' winter supply but also a market supply of trout during the fall and winter. It was a common practice to spear them at night by torchlight. Mr. Rich recalled that one night at Trout Cove an old hunter and himself took by this means 100 "beauties," which weighed 600 pounds the next morning.

In 1879, in a letter to Mr. Rich, the former fish commissioner of Maine, the late H. O. Stanley, said he could well remember the time, some 20 years prior, when it was very common to take 100 pounds of red-spotted trout in one-half day's fishing, but since that time the practice of taking them with grapnel, spears, and nets had become common, and the fish were greatly diminished. He recalled seeing at a fisherman's camp, one October morning in 1854, 100 trout, weighing 600 pounds, that had been speared the night before. Mr. Stanley probably saw the catch referred to by Mr. Rich, in which he participated.

It is stated that about 1860 laws were not known and that trout had for years been netted at the head of the river and taken out by the wagonload for the market; also, that jigging them off their spawning beds in the fall was customary.

Along in the eighties it was generally admitted that trout, especially large ones, were decreasing in numbers, and the fact was ascribed by the anglers to various causes, but to no one of them did it seem to occur that he himself might be particeps criminis. One reason for the alleged decrease in big trout given by Mr. Rich was that anglers had found most of the places where trout congregated preparatory to going onto their spawning beds and diligently and persistently fished for them day after day, rain or shine, and took every fish that would rise, and so reduced the schools of big fish.

It appears that spearing, jigging, and dynamiting were not confined to the early depredations, if the allegations of some Rangeley Lakes anglers were true. In 1887 native residents, and even some anglers, were accused of long-standing jigging. Having discussed these alleged practices, a writer to Forest and Stream, in 1888, stated:

> One would imagine that the facts written here would sufficiently account for the poor success fishermen now meet at the lake, but there is one more, far worse than any mentioned, and for which the Water Power Co. is responsible. The workingmen at the dams took the trout in great numbers during autumn from the spawning beds, and every fish so taken means the destruction of hundreds of thousands of their species. They were speared by daylight and by torchlight, dynamite cartridges were exploded in the water, and the fish were destroyed by the wholesale.

It is not only the adult fish that suffer from destructive agencies, but the young are subjected to them almost on every hand. They enter the shallow water of shore and brook to escape their enemies of deep water and are beset by enemies of land and air. There, also, they are liable to perish through change of physical conditions that act rapidly and effectively. The shoals of small brooks, laid bare by hot weather, restrict the young trout to little pools, which later evaporate, and the fish die, being unable to get to permanent pools or into the lake; or, while in the shallow shore waters of stream or lake, the sudden opening of the gates of a dam previously closed for some time leaves the fish confined in the pools, which, if they do not evaporate, often become so warm that the fish perish, or else they become the prey of birds and mammals or even of frogs and snakes.

In small brooks the danger is not alone from evaporation. Freshets are sometimes disastrous. The writer has seen a spring-fed rivulet suddenly swollen by rain until it overflowed onto a wood road, carrying many small trout out into the ruts and wheel tracks, where the fish were left by the comparatively sudden subsidence of the water, and doubtless many that he was unable to rescue ultimately perished.

In Forest and Stream, June 25, 1904, the late E. A. Samuels, of ornithological and piscatorial fame, cited an instance of waste of trout fry in the following words:

> The most remarkable waste of trout fry that ever came to my observation occurred a number of years ago at the Middle Dam, on the Rangeley Lakes, Me. The gates of the dam had been wide open and the water had been running over the lower flashboards the whole length of the dam for several weeks, and in consequence of this abundance of water the river below the dam was more than bank full, the water spreading into the bushes along the shores sometimes several rods beyond the stream itself. In the middle of the river the water was a roaring, rushing, foaming mass, which pitched and tumbled over huge bowlders and ledges in the wildest manner imaginable; but along both shores it was murky and foam covered and there was little motion in it except that which was caused by eddies and small waves from the rushing midstream.
>
> As I was standing on the bank one day, busily engaged in casting the fly in the still water above, I was joined by two men whom I afterwards learned were employees of the Lewiston Water Power Co. They had come to close the gates, for a big raft of logs was coming down the lake above and a full head of water was needed. They went about their work at once, and they did it thoroughly, for the gates were not only tightly closed, but new flashboards were put on the dam, and almost every drop of water was held back. As a result of this action the river bed below the dam was emptied of water almost as quickly as would be a basin held in one's hand. The rapidity with which the water dropped was astonishing, and it seemed as if I could in a very few minutes walk about everywhere in the bed of the stream where the water had been, before the gates were closed, from 4 to 6 feet deep. There I found almost countless numbers of small trout, which had been left by the receding waters among the bushes, crevices in rocks, and shoal places, they being unable to escape with the quickly vanishing water. They were little fellows from about an inch and a half in length, and there must have been thousands of them. I never saw such a havoc in my life. How it happened that so many of these small trout had congregated at that point I never knew. They were all nearly of one size and may have been of the season's hatch which had ascended the 5 miles of Rapid River, in which there are a number of famous spawning beds, and had been stopped by the dam; but whatever the cause might have been that brought them there, they reached the dam only to find destruction.

Trout culture at Rangeley lakes.—The Oquossoc Angling Association was organized in 1867, but it was not until 1873 that the first hatchery was erected. This was on "Beama" Stream. In 1877 another was built near the old dam on Rangeley Stream. Regarding this hatchery Forest and Stream in 1883 reported: "This hatchery has been

regularly employed and fully 250,000,000 young trout turned into the lake. Many thousand landlocked salmon eggs have also been hatched and the young fry liberated."

While trout were hatched and planted by the Oquossoc Angling Association and other clubs for a number of years, and probably also by the State, no records of the distribution of the trout in the Rangeley Lakes appear until 1895. The following statement shows the number of young fish planted each year in Rangeley Lakes and tributaries, as indicated by available records:

1895	100,000	1905–6	6,000	1910	243,250
1896–1901, inclusive	(a)	1906	157,000	1911	473,000
1902	1,500	1906–7	29,600	1912	323,000
1901–2	15,000	1907	369,000	1913	585,000
1902–3	7,500	1907–8	75,000	1914	407,750
1903–4	10,300	1908	82,400		
1904	[b] 169,336	1908–9	98,800		

The foregoing figures total 2,653,136 young fish, representing a period of 20 years. When all the adverse conditions with which they have to contend before reaching maturity and the low expectancy of life tenure for the majority of them are taken into consideration, this number, if all were planted in Rangeley Lakes, would seem hardly sufficient to supply a large number of anglers with satisfactory fishing or even to maintain the stock. A concrete but impossible example of this inadequacy may be given by hypothetically assuming that all of the fish attained maturity and that the 1883 estimate of 3,000 annual visiting anglers was maintained. Then the 60,000 anglers in the 20 years would average about 44 fish each by catching all the fish.

THE ALLEGED DEPLETION OF TROUT.—Some factors which might have caused any apparent or real diminution of the trout supply of the lakes that have been mentioned:

1. The effects of dams, etc., it has been seen, may have been only temporary or they may have produced permanent effects, either of which would be more or less manifested in the quality of the fishing and give rise to dissatisfaction or apprehension. The high or low stage of water, one of the effects of dams, in either stage, simply high or low, would have little or no direct effect upon the perpetuity of the trout supply and only a temporary effect upon the quality of the fishing.

2. The effects of seasonal or weather conditions would have no direct significance but might have considerable influence upon the character of the fishing.

3. The number of anglers undoubtedly, according to circumstances, signifies potential depletion.

4. Enemies unduly increased in number or effectiveness, without compensating factors, are also of serious significance.

5. Destruction by man, which involves some of the foregoing, as well as many additional elements, is significant of tremendous possibilities in the way of depletion.

6. Fish culture or artificial propagation is effective in preventing depletion in proportion to the adequacy of the effort. The resistance presented by some of the previously mentioned factors, however, might render adequacy of effort impossible and thus serve only to retard depletion. In other words, artificial propagation must be sufficient to offset the losses through adverse conditions and operations. If fish culture continues

[a] No records.

[b] Statement of number planted with no definite localities given, probably many of them not in Rangeley waters.

to maintain or increase the resistance through fresh supplies of enemies, in the form of salmon, for instance, an expenditure of so much more trout-cultural energy is necessitated, to which there must be a limit.

Most of the foregoing points have been for years mooted questions, but the efficacy of artificial propagation has not often been questioned. In passing, there is one point more relating to artificial propagation that should be mentioned, which is that every body of water has a safety line beyond which artificial stocking becomes retroactive, thus introducing subtle, intimate, and intricate additional factors of depletion involving not only the artificial but the original stock.

That originally the Rangeley Lakes abounded in trout there is no doubt. J. G. Rich, in his article so often quoted in this paper, writing of the old days, stated:

> We had never then heard of pot fishers or poachers, and there had been no law enacted against the taking of trout any way one choose, and we went at it by the quickest possible method. But by and by parties began to come from the cities, and after years of abundance trout not only grew scarcer but became more wary, and finally we got a fish law; but it was years before the free natives of the forest could see the justice of being curtailed in their liberty of when, where, and how they should take them.
>
> Every brook, every stream, and every pond and lake was literally full of them. Of course there were proper times to fish at certain places; for instance, at places where ample quantities could be taken at one time none could be had at another time. I have seen the Cambridge River at the foot of Umbagog so crowded with trout rushing up stream that you could almost walk across it on the backs of the fish (if this is a fish story, it is an actual fact). And again in the fall of the year great schools would rush into the mouths of rivers and coves near their spawning grounds, so as to fairly blacken the water, and they were hungry. This was the "border ruffians" pork barrel, and they availed themselves of it. * * *
>
> At the first freezing over of the lakes and rivers, at the mouths of small brooks and around certain stony banks in the lakes and near late spawning grounds, hundreds of pounds could be taken in a day, and the hunters were pretty sure to improve these opportunities. Sometimes these trout lay in very shallow water. Many times have I cut through the ice, and the water rushed up thick with mud, and after a few moments the trout began to bite, and a regular rush began, generally of about 1-pound weight, interspersed with individuals that weighed 3, 4, 5, or 6 pounds, and which must have touched the ice with their backs while their bellies rubbed the sand below.

In the foregoing instance some allowance must be made for the enthusiasm that usually is associated with piscatorial retrospection. Doubtless, however, it is a fair illustration of the early abundance of trout in the Rangeley Lakes region, in support of which there are many other authentic accounts. In those days it was the privilege of but a few to avail themselves of such abundance, but, as has been previously stated, with the passing of years the fame of the Rangeley Lakes for their plenteous supply of mammoth trout attracted an ever-increasing number of anglers to the region. At first it appeared that few, if any, failed to secure satisfactory numbers, even if they all did not capture a monster. Large quantities were annually, perhaps it may be said weekly, shipped home by anglers. These, particularly the large ones, were often exhibited in sportsmen's store windows and elsewhere, thus increasing the numbers to try their luck at the lakes. After a while, with increase in number, it was quite natural that some should be disappointed, since, as a rule, the fish are not generally distributed in a lake but congregated in more or less restricted localities, and the places occupied change at different seasons of the year or under certain conditions. These places constitute the favorite fishing grounds. All new comers, as well as the old resorters, went to the same places. The natural results are obvious. Fewer fish would be caught by the individual, not only on account of a division of the spoils, as it were, but even if the fish were no

scarcer many fishermen on the same grounds at one time would make the fish wary or actually drive them away. That such conditions obtained, even in the early eighties, is evinced by the numerous complaints of poor fishing and the explanations of it current in sportsmen's journals of that period.

For years there was a general steady complaint pervading the more or less fluctuating adverse and favorable reports regarding the fishing in Rangeley Lakes. Such complaint came not from occasional visitors but from permanent residents on the shores and from persons of many continuous years of experience. On the other hand, there were counter arguments and statements from individuals of the same classes. In evidence of their contention that the fishing was as good as ever, better, or improving, they published the catches of individuals that made an excellent demonstration of the good when no mention was made of the many more who caught no fish.[a] Many of those who claimed that the fishing was not declining were those whose business interests were at stake, depending upon the annual visitors for success. Some of the same individuals testified before the legislature regarding the necessity of a hatchery and fish propagation at the akes, but this may have been of prophylactic rather than therapeutic intent.

There are always some, who, disappointed on a fishing trip, decry the lake or stream as depleted. Such failures are usually due to some more or less temporary cause. Even in well-stocked waters the quality of the fishing varies. There are annual, seasonal, monthly, weekly, daily, and even hourly variations, and sometimes within shorter periods of time. These variations are caused by one or more of innumerable natural conditions or circumstances. To these may be added those produced by artificia causes, which are also too many to be here enumerated. Undoubtedly, in their palmiest days the Rangeley Lakes were not always uniform in respect to the quality of the fishing. At any rate, the earliest available records reveal seasons of poor as well as good fishing. However, the question with which the present-day angler is concerned does not relate to the well-known good and off seasons but to whether or not the fishing has generally and greatly declined, and, if so, what, if any, is the remedy.

In an effort to ascertain, as nearly as possible, the true situation during the time in which the disputes relating to the alleged decrease of trout took place, the writer undertook to compile all of the quantities and sizes of trout and all the expressed opinions afforded by Forest and Stream, American Angler, and Maine Woods, and to compare the published individual views with the synchronous conditions indicated by the figures. In this way it was found that out of 42 years for which definite records were available there were 18 years yielding 100 or more fish each. The highest numerical record was in 1874, followed by 1883 and 1898, in the order named. In the latter year, however, the number did not amount to one-half of the number of 1883. The lowest three years, in the order named, were 1906, 1877, and 1914, and a fluctuating decline was noticeable, particularly marked from 1883, or about the time at which the complaints regarding the deterioration of the fishing began to appear.

Beginning comparisons with 1881, 18 years of the period of 34 years to 1914, inclusive, contained synchronous records and favorable or unfavorable statements. From

[a] In 1882 there were 236 trout recorded, 107, or about 45 per cent of which, were caught by two anglers. Again, in 1883, there were 513 trout recorded and eight anglers caught 350, or about 68 per cent of them. If such proportions were anywhere nearly uniform throughout the period covered by this report, it would indicate that the great majority of the fish of standard size were not recorded or else that the fishing was satisfactory to only a few more skillful or more fortunate anglers.

these data the following table was formed, which aims to give a comparison between the years of synchronous numerical records and the statements of opinion regarding the quality of fishing.

TABLE 9.—COMPARISON OF YEARS OF HIGH AND LOW RECORDS WITH PUBLISHED STATEMENT REGARDING THE QUALITY OF FISHING IN EACH YEAR.

Year.	Record.	Statement.	Year.	Record.	Statement.	Year.	Record.	Statement.
1881	Low	Favorable.	1888	High	Unfavorable.	1899	Low	Favorable.
1882	High	Do.	1889	do	Do.	1900	do	Do.
1883	do	Do.	1894	Low	Do.	1901	do	Do.
1884	do	Do.	1896	do	Favorable.	1905	do	Do.
1885	Low	Do	1897	do	Do.	1907	High	Do.
1887	do	Unfavorable.	1898	High	Do.	1914	do	Unfavorable.

In only 3 out of 18 years did the allegations regarding decline conform to the records, and on one of these there was a statement to the contrary. In four years, also, there were complaints respecting decline when the records were high, and in one of these, while a decline was admitted, the fishing was said to be still good, in another that there were individual good catches, and in another there was a contrastatement to the effect that the fishing had not declined.

In seven years of low records there were statements to the effect that fishing was good and no contrary allegation seems to have been made. In four years, besides those of contradictory statements, there were reports of improved fishing conforming to the records in the respective years.

From the foregoing it would seem that the allegations regarding decline were based largely upon variable individual experiences and seasonal variation. However, since at times competent anglers had grounds for complaint, a relative decline, at least, is indicated. As the term "quality of fishing" is but an expression referring to public angling opinion, a relative decline practically amounts to an actual decline so far as the public opinion is concerned. That there was such a decline is indicated to some extent by the records.

Number and size of trout.—The question of the alleged decrease in the number of trout in the Rangeley Lakes can not be positively settled by figures. The records of the catches of early and recent years afford unsatisfactory comparison for the reason that in former years they were more or less unauthentic and mainly of the large fish. Later, as camps and hotels with increased patronage appeared along the whole chain, more complete records were kept and many of them published in sportsmen's journals. However, these records by no means showed the actual numbers caught, and the fluctuations in the annual records were doubtless, partly at least, due to irregularity of publication, yet the number of fish caught probably affected publication, so that in some degree there is thus afforded an index to the conditions.

Again, in respect to the average size of the fish, it is difficult, from the records, to arrive at a definite conclusion due to the fact that in many of the years only small numbers of large fish were recorded and in others, while the standard of lowest limit was 2 pounds, often those of smaller size were admitted. Some indication is afforded, however, by using the figures pertaining to standard fish only. But as respects both the number and average weights of the fish, there enters the indeterminate factor of

increase in number of anglers, for the number of fish might thereby appear to be maintained or increased, and while there might be an actual decrease in average weight of the fish caught, it would not appear if the standard of size were strictly regarded in the records.

Inasmuch as all extraordinarily large fish were probably recorded and more than likely published, the records as concerns numbers of such fish may be fairly depended upon, although the exact weights as recorded, for proverbial reasons, may not always be regarded as authentic. However, the stated records, if not an obvious distortion or consistently reducible to approximate fact, must be accepted.

In 1894, regarding the average weight of Rangeley Lakes trout, Mr. Rich wrote that probably they averaged larger than from any other waters. He stated that he would estimate the average weight caught in the lakes, not including outlying ponds, at a pound, and he further stated that of late years he had kept no record, but did until some 15 years previous, when he had a record of over 6,000 trout, which averaged nearly a pound and a quarter.

In the records of weight, as in those of numbers, the greatest fluctuations occurred prior to 1890, and it is quite evident that the fluctuations were due to irregularity of the weights and numbers of fish recorded and the frequent absence or disregard of standard size. There is a decrease in the number of fish composing the high records, and from about 1900 there is a gradual increase in the numbers composing the low records, due to a tendency to greater regularity. These tendencies are manifested in all three of the classes of fish discussed; that is, all sizes, 2 pounds and over, and 8 pounds and over.

The previously mentioned tendency to fluctuation and the general trend of the whole period from 1873 to 1914, comprising 42 years, may be indicated by arranging the figures for the individual years in 13 groups of six years each, overlapping three years each. In the following table and diagrams this has been done for the three classes of trout discussed. This arrangement shows considerable fluctuation in the number of fish but to some extent levels the average weights in respect to all fish. The largest numbers were recorded in the first, fourth, third, and last periods, in the order named. Therefore, while there was some falling off from the first to the last period, there was a large increase from the fifth period. There was a large increase in average weight from the first period, the largest average being in the second period. In the last some decrease is shown. However, from the fifth period the fluctuations are all in the fractions of a pound over 3 pounds, and the average of the fifth and last is essentially the same, representing the extremes of 30 years.

In the case of fish of 2 pounds and over, the fluctuation is much greater than in the other instance both in number and average weight. A tremendous gain is shown in the last period over the first, the number being the largest of all the periods. The average weight in the last period is the lowest of all the periods, the highest being in the second. The average weight is constantly higher in the first seven periods than in any of the subsequent six periods, representing 24 and 18 years, respectively.

The numbers of fish of 8 pounds and over show a very heavy falling off from the first to the last period, but the fluctuations are great, the twelfth period yielding more fish than the first, and the largest number being in the first period while the smallest

is in the tenth. There is not a very wide fluctuation in the average weights, but some decrease is shown from the first to the last period. The heaviest average was in the second period, and the indications are of a decrease in number and average weight of large fish.

The following table and diagrams more clearly show the general trend for the 13 periods designated:

TABLE 10.—CATCHES OF TROUT IN 13 PERIODS OF 6 YEARS EACH, OVERLAPPING 3 YEARS.

Period.	All trout.		2 pounds and over.		8 pounds and over.		Period.	All trout.		2 pounds and over.		8 pounds and over.	
	Number.	Average weight.	Number.	Average weight.	Number.	Average weight.		Number.	Average weight.	Number.	Average weight.	Number.	Average weight.
		Pounds.		*Pounds.*		*Pounds.*			*Pounds.*		*Pounds.*		*Pounds.*
1873–1878...	1,092	1.91	136	5.05	22	9	1894–1899...	589	3.50	292	4.68	19	8.79
1876–1881...	356	4.36	96	5.56	18	9.40	1897–1902...	464	3.64	309	4.53	11	9.11
1879–1884...	945	2.46	261	4.78	27	8.60	1900–1905...	415	3.35	347	3.90	6	8.85
1882–1887...	1,017	2.61	302	5.12	44	9.27	1903–1908...	654	3.48	570	4.09	25	8.73
1885–1890...	521	3.57	280	5.41	47	8.89	1906–1911...	832	3.78	737	4.03	27	8.77
1888–1893...	451	3.26	247	5.09	31	8.58	1909–1914...	885	3.59	781	3.82	10	8.64
1891–1896...	257	3.83	114	5	13	8.55							

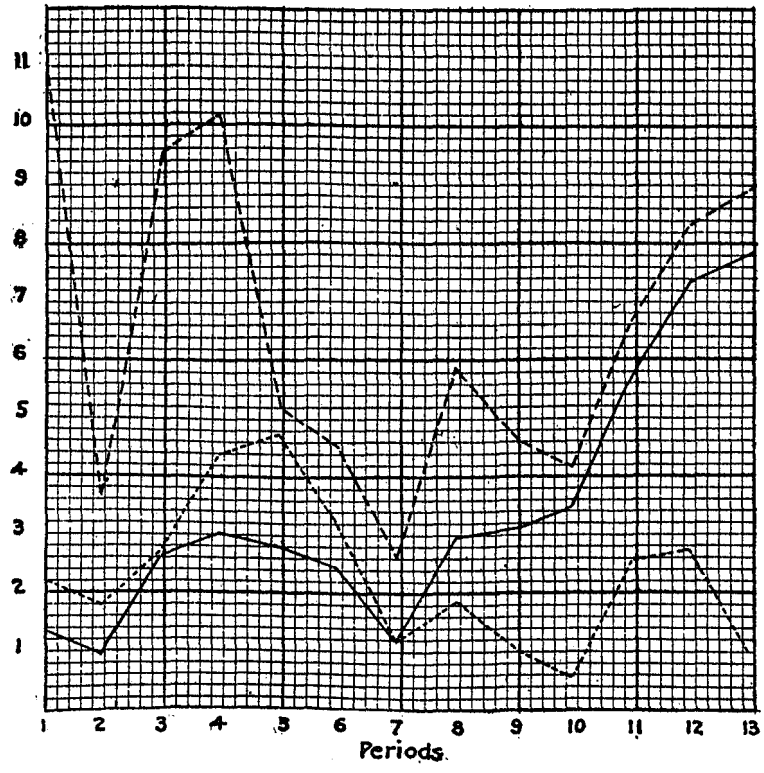


FIG. 19.—Numbers of trout recorded from Rangeley Lakes in 13-year-periods of 6 years each, overlapping 3 years. Broken line, all trout, numbers in hundreds; solid line, 2 pounds and over, numbers in hundreds; dotted line, 8 pounds and over, numbers in units.

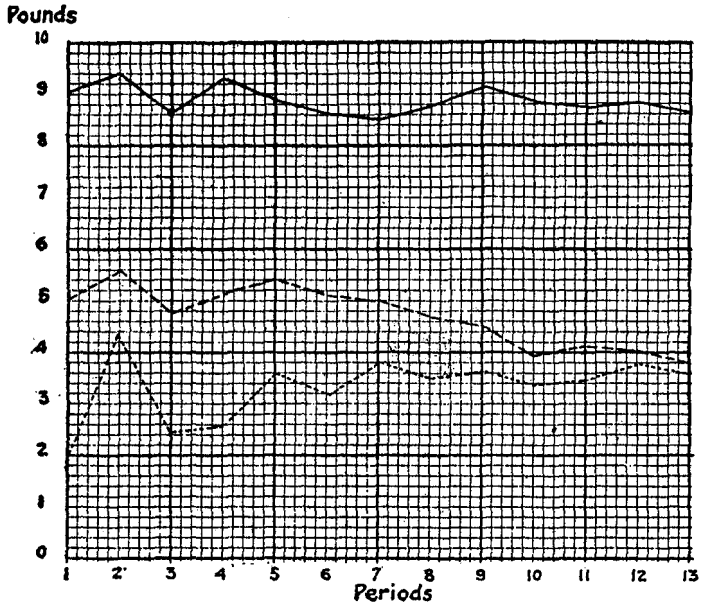


FIG. 20.—Average weight of trout in 13-year-periods of 6 years each, overlapping 3 years. Dotted line, all trout; broken line, 2 pounds and over; solid line, 8 pounds and over.

Records, by lakes.—The assignment of records to the lake in which the fish were caught is impossible in many cases. Many published accounts refer to general regions, and when the report is from some specific locality it is not always possible to ascertain beyond doubt from which lake the fish came. For instance, Mountain View may have reported fish from Mooselucmaguntic Lake or Rangeley Stream without specifying the water. Doubtless the great majority of Upper Dam catches were from below the dam in Mollechunkamunk waters. However, in the present compilation all Mountain View fish have been attributed to Oquossoc and all Upper Dam fish to Mooselucmaguntic. Consequently, Mooselucmaguntic Lake has far larger records than do the Richardson Lakes.

Number and size of trout, by lakes.—In 1887 a correspondent of a sportsmen's paper wrote: "It is a feature of these big trout worth mentioning that the largest have all come from Lake Mooselucmaguntic, the largest of the chain, though there is merely a dam between that lake and Richardson Lake below. The largest fish ever taken in the latter lake would not go over 10 pounds, while the record of the Rangeley Lake, above Mooselucmaguntic, is not much better." Another correspondent in 1896, on the other hand, wrote: "We discovered that Mooselucmaguntic furnished big fish, Rangeley Lake numbers, and Richardson the biggest and finest." However, all the largest fish, from 11 pounds up, were definitely referred to Mooselucmaguntic. The other lakes furnished more or less of the fish from 8 pounds up, but the records compiled for the present report do not throw much light upon the comparative rank of the three lakes, owing to the fact that Mooselucmaguntic doubtless includes many properly belonging to Richardson, because of the uncertainty or impossibility of always ascertaining whether Upper Dam records pertain to the lake above or to the pool below the dam, as previously noted.

From the foregoing figures the inference is that the number of trout greatly decreased until the nineties, when they increased again, but the highest later numerical record, 1914, did not attain to the quantity recorded in the seventies and early eighties. However, there appears to be but little change in the general average weight,[a] and really large fish were taken every year, but not quite so many in any one of the later years as in the earlier years represented by the records. And there is no reason why a trout, if permitted to live, should not attain as large a size as formerly; in fact, in later years, owing to the increased amount of food, its chances are better than in the seventies and eighties.

The foregoing leads to the conclusion that, notwithstanding artificial propagation, the trout of the Rangeley Lakes has decreased to such an extent that there is not an adequate supply, and it may be added that the game-fish supply falls short of the demands, as indicated by the following quotation from the Maine Woods, September 17, 1914, page 1:

> Mountain View House, Rangeley Lake, September 13: Last Monday Hon. Harry B. Austin, chairman of the Maine Fish and Game Commission, met several of the gentlemen at this hotel who are greatly interested in having the best laws to help keep the fishing in this lake. All seem to realize there are not as many fish or as good fishing now as a few years ago and that something more should be done, and that soon, if the June and September fishermen are to continue to come to these lakes. July and August the summer tourists now crowd this region, but they come not to fish but to live out in the open, to tramp through the woods, drive over hills, play tennis and golf, spend their time on the hotel piazza, but are not often fishermen.

Since the foregoing was written, such data for 1915 as was afforded by the Maine Woods became available. For the entire open season the principal hotels and camps reported 345 anglers whose catches were definitely recorded. The total catch of salmon and trout, the individual weight, or the number and aggregate weight of which were given, amounted to 645 in number, of which 549 were salmon and 96 were trout. The average catch of both salmon and trout to each angler for the season was close to two fish (1.86). Each secured an average of only about one and one-half salmon (1.59) and something over one-fourth of a trout (0.28).

As previously indicated, the salmon ranged from 1 to 8½ pounds and averaged about 3½ pounds in weight. The trout had the same range in weight but averaged a little over 4 pounds each (4.09).

These figures need no further comment than is suggested by the statement appearing in the September 20 issue of the Maine Woods to the effect that anglers who fished every day found far fewer fish than when they first came to the lake (Oquossoc) 20 years ago.

TROUT IN THE AFFLUENTS AND CONTIGUOUS WATERS OF RANGELEY LAKES.—All of the streams and ponds, large and small, discharging their waters into the Rangeley Lakes are, or once were, inhabited by trout. In most of them the trout were permanent inhabitants; in a few they appeared only periodically. In some the trout have been depleted by overfishing or by other means, in some the introduction of salmon has had a deleterious effect, and in others the trout fishing still remains satisfactory. The trout of these waters vary in size and appearance according to the character of their habitat.

[a] The decline in the average weight of fish of 2 pounds and over seems mainly ascribable to the diminution in number of trout of 8 pounds and over.

Some are noted for the beauty or delectability of the fish, and some are distinguished for the sport afforded the fly fisher. The following notes do not include all affluents and are very incomplete in other respects but supply more or less information regarding the places mentioned.

Quimby pond.—This pond has been said to be the only one in Maine in which trout would rise to the fly as soon as the ice was out. The protective restrictions applying to this pond in late years seem to have maintained good fishing, the trout appearing about as plentiful, at least up to a few years ago, as in early times, but the fish average somewhat smaller. Early records included fish of 3 pounds, but later they seldom exceeded 1¼ pounds.

Cupsuptic River.—In the early seventies trout from three-fourths to 1½ pounds were plentiful in this river, but in late years they appear to have diminished in number.

Rangeley Stream.—There are many records for this stream, but most of those of large size are for the fall fishing when the trout are entering the stream for spawning purposes. Early records indicate that in July the fish averaged about 1 pound in weight, but in September many were taken ranging from 2 to 5½ pounds. This stream is now closed to all fishing, excepting in a restricted locality. (See fish and game laws of Maine, 1915–16.)

Kennebago Stream.—The large trout taken from this stream were of the fall run, but there are always more or less trout of fair size therein. They were much larger and more numerous in the old days than in later years. The trout ran about the same as in Rangeley Stream.

Kennebago Lakes.—The water in the lakes is cold spring water, a large number of mountain brooks emptying into them. The lakes are noted for the fly fishing throughout the season. The trout never averaged over one-quarter to one-third of a pound, although some fish weighing a pound are caught and an occasional large fish has been recorded, even up to 5 pounds.

C Pond.—The trout of C Pond are still numerous and always of comparatively small size, averaging less than a pound in weight. An inquiry regarding the color markings of the trout of this pond appeared in Forest and Stream, November 25, 1886: "In addition to their red spots they have about as many black spots as a landlocked salmon. In other respects they are no different from other trout in adjacent waters. What is the reason these trout have black spots?" The black spots referred to were not the natural pigmentation of the fish but parasitic cysts. Many fish occurring in warm waters are affected with this parasite. Just why the C Pond fish are so affected is not evident.

B Pond.—In 1883 J. G. Rich, writing of the trout of this pond, said that they were dark colored, plump shaped, and red spotted, generally red meated, and the sweetest table fish he had ever tasted. He wrote that they were locked in the pond, which was about a mile long with an outlet that ran partly under ground, and that no other fish inhabited the pond. Numerous reports in Forest and Stream from 1889 to 1903, inclusive, contained records of large catches of trout from this pond ranging from 1 to 5¾ pounds in weight and averaging about 1⅔ pounds.

Magalloway River.—Below Aziscohos Falls the principal fishing places in the main river are at the mouths of cold brooks at certain seasons. They have been caught at the falls even in summer, and above the falls the trout are usually at the mouths of streams, excepting when suitable quick water is found above the dead water. The

principal fishing is in the tributaries. Fish up to 6 pounds in weight are not infrequently taken now.

Sunday Pond.—In May and June trout have been recorded weighing from 1 to 3½ pounds from this pond.

Diamond Stream.—This stream was once noted for beautiful brook trout up to 1 pound or more in weight.

Diamond Ponds.—These ponds contain fine trout, differing in size in the two ponds according to a report to the effect that in the lower pond trout would not weigh more than three-fourths of a pound while in the upper pond the fish ranged from 2 to 3 pounds.

Parmacheenee Lake.—This lake has long been the most famous of the trout waters of the Magalloway system. No recent records or accounts of this lake are at present available. In 1873 it was stated of Parmacheenee trout that they were not as large as in the other Androscoggin lakes, ranging from 1 to 5 pounds, with rarely one of 7 pounds, which was then the largest known to have been taken.

Cambridge River.—The traditional early abundance of trout in this stream has been referred to in another place. In spring and early summer occasional good catches are now made at certain places, but particularly in a pool a short distance below the forks or the junction of the Dead and Swift Cambridge Streams. Here the water forms a deep pool on the right side of the stream as it makes a bend to the left, and the current is fairly strong even in midsummer. No trout were taken here during the summer of 1906, but there was an abundance of chubs (*S. bullaris*).

Dead Cambridge.—As has already been noted, this stream is the outlet of C Pond In spring and early summer trout can be caught throughout its course at certain places, but especially at the mouth of a small brook called Hastings Brook at the Onion, and the pools up to the sluice. The large pool below the sluice affords excellent trout in early summer and in the fall. During the months of July and August only very small trout are caught there. But above the sluice dam to C Pond the fishing at times is excellent for small trout. In 1905, on July 23, the writer made the following observations on the upper waters of the Dead Cambridge up to 1 or 1½ miles, perhaps, of C Pond. On the way up stream some trout were seen jumping. The sun was occasionally obscured by clouds, giving varying periods of sunshine and shade. Fishing with a fly while the sun was obscured many trout were caught. Having three flies on the leader, they were often taken in twos and threes. When the sun shone the fish would not bite. The largest trout was perhaps one-half pound, and they averaged about one-third of a pound. Blackspot chubs 6 or 7 inches long and common chubs of smaller size were common in the same waters. The temperature of the water about noon at the points where the trout were caught was 60° F. At the sluice it was 72° F. Below the sluice a few very small trout were taken. On August 19 no trout could be found above the sluice, but a few small, slender, dark-colored ones about 6 or 7 inches long were caught on bait and flies below it. On the twentieth, while no trout were found where they were caught in July, about 70 from 6 or 7 to 10 inches long were taken in the pond above the sluice. However, as the gates of the dam were open, the water was very low above the pond. The trout in the pond rose readily notwithstanding the sun was shining brightly. The temperature at the places where the trout were taken in July was 60° F., at the sluice 62° F., and below the dam 62° F.

On September 21 a party of two, in the pool below the sluice, caught a lot of trout, some of which weighed as high as 3 pounds. It was said that they were sluggish, taking

bait slowly and a fly not at all. On September 23 the writer, in the pool below the sluice, caught about a dozen trout 7 to 12 inches long. They were nearly or quite in breeding condition and rather dark colored and slab-sided. On the 24th six trout from 6 to 10 inches long were taken on the fly. The smallest was an immature female, the others well-advanced males. Just above the dam one plump but white-meated trout was secured. Notwithstanding the much higher water, no trout could be caught up the stream where they were caught in July.

Swift Cambridge.—This stream is said to have once afforded excellent trout fishing and to be still a good trout stream in the spring and early summer at certain places in its course. On July 11, 1905, the writer caught six trout from 5 to 8½ inches long in the rocky pools below the Andover road bridge.

Sturtevants Brook.—During the summer of 1905 scarcely any water entered the lake from this brook. It was but a trickling rivulet, although the water was cold. On August 9 three trout were caught in shallow water at the mouth. One taken on a fly weighed 2½ pounds. Two others of one-half and 1 pound, respectively, were taken on worm bait. Again, on August 12, one of one-half pound was caught here on worm bait. It was reported, however, that Mr. Dutton had made some good catches on a fly at this place.

Not far from this brook is the famous deep hole of Umbagog Lake, off the mouth of Sunday Cove. In about 53 feet of water, on August 12, one trout weighing 1 pound was caught on worm bait, and on August 17 six trout from about 10 to 12 inches in length were taken in a gill net set in the same place. With the trout, six salmon and one whitefish were caught. One of the salmon's stomach contained three smelts.

Molnichwock Pond.—This pond once afforded comparatively large trout. Fishing through the ice in the latter part of the winter of 1883, the writer caught two trout of about 2 pounds each, and on August 18, 1905, he caught here six trout, three of which were 8, 8¼, and 8¼ (one being a well-advanced female), and three were 12½, 13, and 13 inches long, respectively. All of the latter were well-advanced females. The 12½-inch fish contained in its stomach a chub minnow (*Couesius plumbeus*) 4¼ inches long. The temperature of the outlet of the pond was 56° F., at mouth of inlet 62° F., surface out in the pond 70° F., and the bottom in 10 feet of water at the east end of the pond 62° F.

Molnichwock Brook.—At the meadows this brook has for years furnished most excellent brook-trout fishing. If it were not almost impossible to fish the brook in the wooded or alder portion, it would undoubtedly have been exhausted long ago. The writer, on several occasions in 1905, fished this portion of the brook with the following results: July 16, 51 trout, averaging about 8 inches in length, one of three-fourths of a pound; July 27, 55 trout, 7 to 10 inches in length; August 6, 57 trout, 6 to 11 inches long. Most of these were secured in the alder tangle below the meadow. On August 23 only 3 trout were caught, and they were small, dark-colored individuals, 5 to 6 inches in length.

SMELT (*Osmerus mordax*).

The smelt is most widely known as a marine fish which ascends fresh water to spawn, but there are many coastwise and some rather remote fresh waters that contain smelts as permanent residents. They are the so-called landlocked forms. In some of these fresh waters the smelt attains maturity and breeds when only 1½ or 2 inches

in length and never reaches a greater length than 3 inches. In other fresh waters the fish grows to a length of 15 inches or more and a weight of at least a pound. There are also many lakes or ponds where intermediate sizes as adult fish occur, and some where there seem to be two distinct adult sizes. Whether these are distinct species or not has not been determined. Many years ago Cope described two Maine fresh-water smelts as distinct species—one, *Osmerus abbottii*, found in Cobosseecontee Lake, the other in Wilton Pond. The latter, from its translucence, was named *Osmerus spectrum*. No other fresh-water smelts have received specific names, and owing to the uncertainty regarding which of these two names, if either, should be used for the Rangeley smelt, the name of the marine form is employed.

According to the statement of a resident of Rangeley, the first plant of smelt was in 1891, but the first and only record for the introduction of smelts into Rangeley Lakes appears in the State fish commissioners report for 1895. In answer to an inquiry by the writer, L. T. Carleton, then chairman of the commissioners of inland fisheries and game, wrote:

Replying to yours of recent date regarding the origin of smelts in Rangeley Lakes, I beg to say that my former associate, Mr. Stanley, writes me as follows: "The first smelts were put in Rangeley Lake from Weld Pond. They were all small not more than 3 inches long when fully grown. Later they were introduced into Mooselucmaguntic from Swan Lake near Belfast. They were of a variety

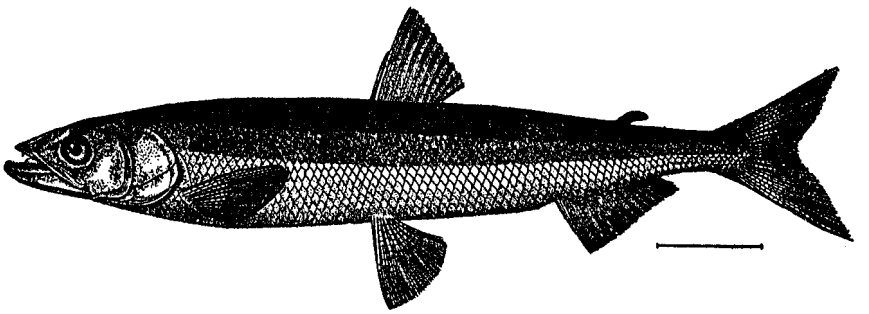


FIG. 21.—Smelt (*Osmerus mordax*).

that grew from 3 to 10 inches in length. None of the large variety were put in Rangeley, the upper lake. The eggs were gathered promiscuously from streams where smelts spawned. They appeared in considerable numbers within four years. They are now plenty in all the lakes from Rangeley down." (March 13, 1907.)

The smelt's food varies somewhat in character according to the size of the fish. Large smelts have been found to feed to a great extent upon smaller fishes, particularly their own young. Small smelts subsist largely upon entomostracans.

The breeding time in some places begins early in March, even before the ice is out of the lake. At other places it occurs in April and in May. At the spawning time the smelt usually ascends brooks, although in some lakes shoal water along shore is the spawning resort. In the Rangeley Lakes the smelts ascend brooks, usually soon after the lakes are free from ice. In 1904 the Maine Woods of May 4 stated that on Saturday the smelts were reported running up Dodge Stream "in bushels," and in the same paper, May 17, 1907, the following appeared:

Smelts are reported to be very much in evidence in Rangeley Stream between Rangeley Lake and Mooselucmaguntic Lake. They have been seen in great numbers near the Oquossoc Angling Association Clubhouse at Indian Rock. Hundreds of them have been caught this spring.

The issue of that paper of May 31 of the same year stated that "One man dipped 4 bushels of smelts, and they were fine eating." The same paper of April 28, 1910, noted: "Smelts have begun to run early this year. A large quantity was taken from Kennebago Stream last week and more this. The smelts are of good size and fine quality, and the quantity is said to be unlimited."

The duration of the spawning run varies in different localities, sometimes continuing a month or more or lasting only a week or two. The Maine Woods, May 12, 1905, stated that the run of Rangeley smelts began as soon as the ice was out and lasted a week or 10 days. The males first appeared on the spawning beds, later both sexes. The eggs are small, numerous, and viscid, becoming attached to stones, stocks, plants, etc. It is recorded that a smelt weighing 2 ounces yielded from 46,000 to 50,000, but the eggs of a smelt 4⅝ inches long, counted by the writer, numbered only 5,893.

The smelts of Rangeley Lakes appear to attain only a small size. Thirty-six specimens collected in Oquossoc Lake about the 10th of May, 1904, ranged in total length from $2\frac{14}{16}$ to $3\frac{8}{16}$ inches, of which 24 varied only $\frac{2}{16}$ of an inch ($3\frac{2}{16}$ to $3\frac{4}{16}$).

Throughout the season, especially after a "blow", smelts are often found washed up on the beaches, but particularly during or immediately after the spawning time they are found in large numbers, dead and dying, at the surface or washed up on the shore. The cause of this mortality has not been ascertained. Only a few years after the introduction of the smelts into Rangeley Lakes it was reported that about the spawning time they were washed up in windrows and by their decay produced an almost intolerable stench. In the year following the recorded introduction Forest and Stream, June 13 (1896) stated that in the vicinity of Rangeley Lake there was a good deal of concern manifested among guides and others at finding a great many dead smelts along the shore of that lake. The suggestion was that some disease had broken out among them. The same paper, May 27, 1899, stated that the dead and dying smelts had been unusually numerous. The Maine Woods, May 12, 1905, reported "lots of dead floating on the surface."

There are those who aver that the presence of smelts in any lake destroys fly fishing and is generally very injurious to bait fishing. Forest and Stream, June 12, 1897, contained the following from the pen of a Rangeley Lakes correspondent:

> Perhaps the poor fishing in Mooselucmaguntic and Richardson Lakes is due to the smelts, which have appeared in great numbers for the first time this spring. Perfectly reliable guides say that the water has been alive with these smelts. Later they have died by the thousands and have been seen floating on the surface dead or dying. Every trout caught has been simply gorged with these smelts. This I saw myself in the case of trout being dressed. The question of these smelts ever having been introduced into the Rangeley waters is a very grave one. Guides and sportsmen who have watched and fished these waters for years are in doubt, to say the very least, and some of them are mad all through. I heard it freely expressed that the most wonderful brook-trout fishing of the world—at the Rangeleys—has been ruined by putting in smelts for landlocked-salmon food—landlocked salmon that can, at the vey best, never equal what the brook trout have been to these waters. As for myself, I have no opinion at present. The smelts in the maw of the trout I have seen and have seen the dead smelts on the water. I have also seen the remarkably fattened condition of the trout as compared with the fish of the past 20 years, with which I have been familiar, catching and examining them each year in greater or less numbers. Would it not have been much better for the State of Maine, through its fish commissioners, to have hatched a great many brook trout each year and put them into Rangeley waters, thus keeping up the supply of a fish altogether satisfactory, rather than to have been dabbling with fish not formerly found there? Who does not remember the introduction of the English sparrow? Who will claim that natural conditions as to fish and game are not the best?

The same paper of May 20, 1899, reported:

The fishing has not been up to former seasons, since the water is the highest ever known, and in both Richardson and Mooselucmaguntic Lakes are millions of smelts, many of them dead from spawning. The trout are "just gorging" on these smelts and will not take artificial flies or other bait till the smelts are gone. Still a few trout are taken.

In the issue of May 27 of the same year the same paper stated that the last reports showed that the smelts were fast disappearing, and there was little doubt but what fishing would be better very soon. The smelts had been remarkably numerous in all the trout and salmon waters of Maine and New Hampshire, with more than the usual number of dead and dying on the surface. Later these little fish disappeared, no one knows whither, and the trout and salmon that had been feasting on them were forced to seek other food.

The same paper of August 30, 1902, contained an article by "Special," entitled "Rangeley trout and the smelts," as follows:

Boston, August 23: Mr. Henry W. Clarke, of Boston, a veteran angler in the Rangeley waters, has just returned from a stay of seven weeks at the Mountain View, foot of Rangeley Lake. This was Mr. Clarke's twenty-eighth successive annual trip to those waters, and his opinions naturally carry a good deal of weight on angling subjects. He says that of all the seasons he has ever spent there the past has shown the poorest fishing. His idea is that the poor fishing is largely due to the putting of smelts into the Rangeleys. He says that the smelts are in deep water the most of the season, only going up into the streams to spawn in the spring. The trout have found them better eating than the old-time minnows, for which the Rangeleys have always been noted, and, like the salmon, they follow the smelts into deep water. Mr. Clarke says that he caught one trout, hardly 3 pounds' weight, which had in its throat and maw 53 smelts. He adds: "It must have taken my hook out of idle curiosity. There could have been no other reason for its biting." Mr. Clarke regards the stocking of the Rangeleys with smelts as a dangerous experiment at the best. He believes that the trout fishing has been greatly injured thereby. Mr. C. P. Stevens, another veteran angler at the Rangeleys, has the same idea. He says never has the trout fishing been so poor in the vicinity of his cottage, in the narrows, Richardson Lake. It is the opinion of other "old timers" at the Rangeleys that the big trout of that region are done for, and it is certain that not half the usual number have been caught the past season, while the catch of salmon has been greater.

The smelt was introduced into these lakes, primarily, as food for salmon, for which purpose these small smelts are particularly suitable, but undoubtedly the trout was also greatly benefited in that way, as indicated by the following notes: Forest and Stream of May 14, 1898, stated that a trout of 1¾ pounds' weight, upon being unhooked, disgorged 13 smelts, and a communication to the Maine Woods of May 31, 1907, stated that a 3-pound trout caught in Mooselucmaguntic Lake had eaten 37 whole smelts, and it was not known how many more. This was said to be a true smelt story, "for," the correspondent said, "I put them on the wharf and the boys counted them."

That the large size attained by trout is due to plentiful food can not be denied, and it is a well-known fact that where trout are practically restricted to insect diet they do not attain a large size. As has been previously stated, the large size of Rangeley trout was ascribed to the abundance of smaller fishes. The change brought about by the introduction of smelts was only one of greater amount of fish food and could in no way affect the manner of feeding. The trout is just as prone to vary its diet by resorting to insect food while smelts are abundant as it is when any other fish, cyprinids, or bluebacks furnish the major part of its food supply. Furthermore, experience on

other waters where smelts abound have shown that the trout as readily takes the fly there as where there are no smelts. When the smelts are running, it is not the usual fly time. When through with their spawning, the smelts go into deeper water. The trout do not seek those waters until the approach of warm weather, when fly fishing ceases, except on some cool pond or at the mouths of cool streams or in the streams themselves.

It may be affirmed that the only fish that has been wisely introduced into Rangeley Lakes is the smelt. It has directly and indirectly been the savior of the trout by affording the trout requisite food and detracting to some extent the attention of the salmon from trout by furnishing sufficient natural food.

PICKEREL (*Esox reticulatus*).

This species is the only representative of the pike family in New England waters except in the St. Lawrence drainage or where it has been introduced. It is the only species in Maine. Its geographical range is stated to be from Maine to Florida and Louisiana; common everywhere east and south of the Allegheny Mountains. Originally, or perhaps it should be said aboriginally, the pickerel had a very restricted

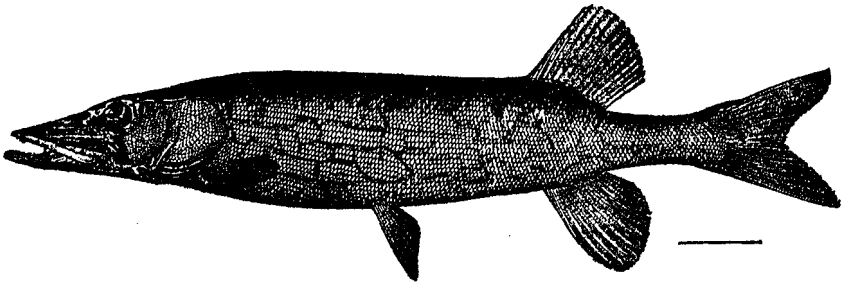


FIG. 22.—Pickerel (*Esox reticulatus*).

natural geographical distribution in the State. Since early days it has from time to time been transplanted to other waters, and from such sources it has made its way into still other waters, so that at the present time there is scarcely a congenial pickerel abode in the State that is not inhabited by it.

Of the Rangeley chain of lakes, Umbagog is the only one inhabited by the fish, and there it was not indigenous. The precise date, manner, and reason of its introduction into Umbagog Lake are uncertain. But there is a sort of tradition among the older inhabitants of the vicinity of the lake that early in the sixties or some time before some inhabitants of the lake shore, having been prosecuted for violating the trout law, out of revenge placed pickerel in Umbagog Lake, where they rapidly waxed great in numbers and size. It is now apparently restricted to Umbagog Lake, being unable to get beyond Middle Dam. It has made its way up the Magalloway River, it is said, as far as Aziscohos Falls, beyond which it can not go of its own accord.

The pickerel sometimes attains a weight of 7 or 8 pounds, but as usually met with 3 or 4 pound fish are considered large ones. There seem to be no records of the sizes attained in Umbagog, but the writer remembers from personal experience that 3-pound fish were very common there in 1883, and the complaint then was that pickerel were not as large as they once were. The largest obtained in 1905 weighed about 4 pounds, measur-

ing 23 inches in length. Other adult fish caught measured 12, 17, 18, 20½, and 20¾ inches, the majority being not much over a foot in length. (See Table X, p. 594.) Young pickerel ranged from 2 to 10 inches in length. The smallest observed were collected on July 15, measuring 2, 2½, and 2¾ inches in total length. Young were fairly common throughout the season, but there was a complaint that it was a poor season owing to the high water and hot weather. It was a fact that no large fish could be caught on a hook until toward the last of August and first of September. Even then the scarcity and small size of the fish were quite noticeable and in strong contrast to some 20 years previous.

The pickerel spawns in spring in shallow water among water plants, brush, or rocks. Its eggs are in long gelatinous masses or strings, and the newly hatched fish are so tiny as to be almost or quite invisible in the water. But they grow comparatively rapidly, yet owing to the small size of the fry they do not appear to reach a length of much over 2 or 3 inches and some of them not even that much in the first season. The pickerel deposits a good many eggs. If it did not it would soon succumb to its numerous enemies to which the young are exposed in shallow water. About its only protection is its quickness of movement and its color when among the water plants.

When feeding, the adult pickerel will eat almost any living thing that it can secure, and will secure anything that moves in its immediate vicinity. It, as a rule, lies under the edges of patches of lily pads or other aquatic vegetation, alongside of a submerged tree or log or a bowlder, whence it darts forth and grabs its prey. Its food consists largely of other fishes, frogs, and such other aquatic animals as it may be able to obtain. Very small young subsist upon small insects, entomostracans, and insect larvæ. As they increase they take larger objects, often those that are greatly disproportionate to their own size. Observations upon the food of pickerel in 1905 revealed that young up to about 4 inches long were feeding upon entomostracans and insect larvæ. Of eight young from 4¼ to 6⅜ inches long caught at the same time and in the same place, six contained fish and four of these were young pickerel. Of another lot, a 4¼-inch fish had another ickerel 3 inches long in its intestinal tract; one, 5⅜ inches long contained a pickerel 3 inches long; another, 5⅞ inches in length had, besides other things, one pickerel $2\frac{1}{16}$ inches long; still another, 7⅝ inches in length contained two small minnows; and one 6⅜ inches long had in its stomach one pickerel 3 inches long and one shiner (*Notemigonus*) 2½ inches long. On another occasion each of two, 7½ and 12 inches long, contained a 1½-inch hornpout and one of them the head of a small chub besides. Each of five fish taken off B Point in a gill net contained partly digested suckers. Other instances were: One, 7½-inch pickerel had the head of a small chub; a 9½-inch fish contained a $2\frac{5}{16}$ inch pickerel; one, about 20½ inches long, contained the bones of a small fish.

The pickerel is reputed to be one of the most voracious of fishes, but it is no more so than the majority of so-called predacious fishes. Like other fishes, it abstains from food for considerable periods, and it does not always feed at any time of day. Indeed, it is rarely that it feeds during the interval between morning and evening. It is a recognized fact that during the summer months, excepting on cloudy or rainy days, the early morning and evening are the best times for pickerel fishing. The pickerel thrives best in shallow, comparatively warm waters, where there are plenty of water plants and the plenteous food incident to such places. In winter it often seeks somewhat deeper waters, and the large fish frequently affect bold rocky shores. The adult pickerel is not much of a wan-

derer and, as a rule, lies in wait rather than searches for its prey. Usually it is the younger fish that make their way upstreams into other waters. It does not thrive in deep, cold lakes.

Many regard the pickerel as a worthy game fish, and as a food fish it is held in esteem by many and disliked by a few.

Some of the inhabitants of Umbagog's shores relate that their fathers remembered when trout abounded in Umbagog Lake, and that if vengeance on the trout as revenge for legal wrongs was the motive that placed the pickerel in the lake the object of its introduction was woefully successful, for the trout practically disappeared and the pickerel became abundant. J. G. Rich, in American Angler, April 14, 1883, wrote:

> For the last 12 years the trout have been fast diminishing, until now only occasionally a large one is to be got, and no small ones seem to be in the lake. I think in 1850 Umbagog was as well filled with trout as any other lake. It certainly yielded great sport to all who came from cities and elsewhere to fish. The last trout I caught from this lake was at Sturtevants Brook, two years ago, and it weighed 3 pounds. At the same time and place I took a large string of pickerel.

Thus, it is with Umbagog Lake as with most other lakes and ponds that once contained trout and now are pickerel waters, it is claimed that the pickerel have destroyed the trout.

The same writer in the same paper of February 6, 1886, said: "Two men went from Bethel last week to Umbagog Lake—the lower or most southern lake of the Rangeleys—25 miles distant, and caught 100 pounds of pickerel in two days."

Umbagog Lake, as has already been stated, is not ideally suited to trout. It is very generally shoal and consequently much warmer during the summer months than waters in which trout thrive best. There are only two restricted localities, or deep holes, to which trout can resort in the warm season in this lake. These deep holes have been known for many years to some of the inhabitants of the region, who availed themselves of the advantage afforded by this knowledge. There has been no time since pickerel were introduced that some trout could not be obtained from these holes, but owing to their restricted limits it has always been comparatively easy to fish them out, and this has been done repeatedly.

The usual habitat of pickerel is widely different from that of trout, although there are individual exceptions. Other fishes, especially suckers and cyprinids, find proper conditions in the same localities that are the favorite abode of pickerel. Notwithstanding this fact and that these fishes are comparatively easy prey, their numbers do not seem to have been diminished. As previously mentioned, there are still some trout in Umbagog Lake. Salmon and whitefish have increased in numbers. Pickerel are fully as destructive to these fishes as to trout. The natural inference, then, is that pickerel have not been the cause of the scarcity of trout in the lake.

In 1882 C. T. Richardson, under date of July 27, in Forest and Stream of August 5, stated that two men caught in Umbagog Lake, in less than 6 hours, 51 trout weighing 103 pounds.

On the other hand, there is a general complaint that pickerel have, in late years, become comparatively scarce and do not attain the general large size that they once did. Constant increase of maintenance of numbers is possible only when adverse conditions are less or exactly equal to the favorable conditions. Maximum size is attained by any fish only when it is provided with sufficient food, room in which to grow, and meets

no check in its career. In other words, when favorable conditions preponderate over the unfavorable. Numbers are reduced by subtraction. The process may be through starvation, disease, natural enemies, etc. There is no evidence of there ever having been a scarcity of food. There are only two records of any undue mortality from unknown causes which might have been disease. One is a communication from J. G. Rich to the American Angler, January 25, 1884, in which, under the heading of "Dead Pickerel in Lake Umbagog," he wrote:

> In the spring of 1880, soon after the ice went out, there were floating on the surface of the water and on the shores dead pickerel in immense numbers and of various sizes, from less than a pound weight to 5 or 6 pounds, more, perhaps, of the large ones. This occurred more in the southern part of the lake, where the water is shallow and the shores grassy, than in the northern and deeper parts, although dead fish were over the whole surface more or less. Other fish exist in the lake besides pickerel, such as chubs and suckers and some trout, yet no other fish were observed to be floating. If I mistake not, the same year dead fish of an unknown kind were seen floating on the Atlantic Ocean in large schools, to explain which various theories were put forth by learned naturalists, but no certain reason given. Some persons here think the mortality among the pickerel was caused by their getting into shallow water and the freezing of the ice to the bottom or a sudden fall of the lake dropping the ice on to them. But if this were the case why did other fish escape? Certainly the pickerel are as active, if not more so, than any other and could fall as rapidly back into deep water and safety. Who knows the cause of this wholesale destruction?

The other record was a statement by C. J. Craig, to the effect that during the last of May and first of June, 1912, the water of Umbagog Lake was higher than ever before known. Dead pickerel were around the shores in large numbers all about the lake. Most of them were good-sized fish. Nothing but smelt was found in their stomachs. Bait was secured by opening pickerel.

As has already been stated, the writer, in 1883, found pickerel abundant and many of fairly large size in Umbagog Lake; therefore, the mortality mentioned by Mr. Rich did not exterminate the pickerel or more than temporarily greatly reduce their numbers.

Many natural enemies can be enumerated, such as birds, frogs, other fishes, and even the pickerel itself. Among the birds, the merganser, grebe, loon, kingfisher, and heron are the most destructive. But the birds have not been numerous enough in many years to seriously reduce the numbers of pickerel.

Bullfrogs are consumers of young pickerel, but their numbers are not sufficient to make any very appreciable decrease in numbers of the fish. That other fish do eat pickerel is well known, as the following incident indicates: On August 12, 1905, in the large "logan" at the entrance to the Androscoggin River, some fish were seen pursuing other smaller fish, which went skipping over the surface of the water. The larger fish, which were at first supposed to be pickerel chasing cyprinids, proved to be chubs after young pickerel. Several from one-third to one-half of a pound in weight were caught on a small casting spoon and found to contain young pickerel from 2½ to 3 inches in length. That the pickerel is somewhat of a cannibal has been previously shown.

But all of the enemies were far more numerous at the time the pickerel were increasing in numbers than they have been in recent years; therefore, there must be some more potent cause of decrease. The reduced size of those now caught and observed can not be due to the above-mentioned enemies, as they prey upon the smaller individuals and the larger ones would be left to grow still bigger. The cause, then, must be something that affects the larger fish.

There is one assignable cause that applies to both the disappearance of trout and reduction in numbers and size of the pickerel, and that is man. He seeks the larger fish, he seeks numbers, and often at a time when the largest numbers of large fish can be obtained, that is, during the winter by fishing through the ice, when pickerel are hungry and its natural food has concealed itself in the mud or amongst the water plants and moves but little or not at all. Ice fishing is one of the most potent causes of the depletion of northern lakes, especially small lakes like Umbagog, of their food fishes, and there can be little doubt that by this means, augmented by annual plug fishing in their limited summer resorts, the trout of Umbagog Lake have been diminished so greatly in numbers.

MILLER'S THUMB (*Cottus gracilis*).

The miller's thumb is a fresh-water sculpin. The only vernacular names that seem to be applied to it in Maine are brook cusk and rock cusk. It is sometimes mistaken for young cusk, *Lota maculosa*, which does not occur in the Rangeley Lakes. This species is apparently the only one in New England fresh waters, disregarding, possibly, the Lake Champlain and St. Lawrence drainage, but it is very common almost everywhere, especially in northern waters. In some places, however, it has become greatly reduced in numbers by other fishes feeding upon it. On the other hand, it is very

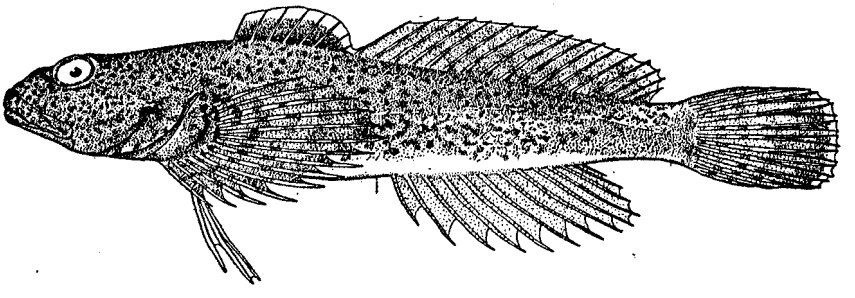


FIG. 23.—Miller's thumb (*Cottus gracilis*).

destructive to the eggs of such species as spawn where it occurs. The only record of its occurrence in the Rangeley Lakes is that of specimens in the museum of the Boston Society of Natural History, collected by Prof. F. W. Putnam many years ago, and the statement of Mr. Haines, of Rangeley, that it is often found in trout stomachs.

It attains at least 4½ inches in length. Large individuals, up to 4 inches long, however, occur in the Androscoggin River, and the writer has examined specimens from Bear River in North Newry. (See Table XI, p. 594.)

The coloration of the different individuals varied somewhat, but in general the body was gray with reddish tinge above, speckled with darker gray, and with traces of five dusky crossbars, of which only the one under the posterior part of dorsal extends fully across the body; spinous dorsal margined with reddish and broad dusky strip through the middle; soft dorsal, pectoral, and caudal finely barred with black.

SUMMARY.

Immediately before the advent of white men the conditions of the lakes were much different from those of the present time. They had a smaller area, lower level, and much less volume. Their intercommunications were unrestricted except by

natural obstructions, which were not barriers to the passage of the larger fishes. Each lake differed somewhat from the others in physical characteristics and consequently in some respects in biological conditions. Each had its natural limit to the amount of life it could sustain and its approximate balance of life, in which area and capacity were controlling factors. But all of these were subsequently altered.

The earliest and most decided modifications of area and capacity were produced by dams, which were not only restrictive in effect upon both the limit and approximate equilibrium of life but, by more or less sudden interference with the habits of fishes, otherwise injurious. These modifications were not constant in their action in any one direction but interrupted and periodic, and their effects were consequently variant. Some of the effects, too, were slow and gradual in development, others sudden and more or less cataclysmic. By the erection of the most recent dams constant higher stages of water than formerly have been produced, accompanied by some advantageous conditions, such as that of enlarged physical and biological capacity. But these were reduced in value by the unsettled conditions resulting from the operations of the dams.

High stages of water are stated to afford new feeding grounds, but this signifies only a change of locality. Fish were enabled to ascend farther up some brooks and even onto low overflowed meadows, but as these stored waters were bound to be drawn upon sooner or later the possible effect of that operation is obvious. The high water facilitates the ascent of streams in the breeding season, but it also covers the former shoals with an excess of water, and other places of suitable depth must be sought.

The inevitable lowering of the water has a much greater reverse effect along the same lines. During the periods of varying length that the dams were closed fish that served as food for trout were prevented from going down stream, but their predilection for such places, causing them to congregate in the still water just above the dam, resulted in a wholesale outflow when the gates were opened. As an illustration, it may be appropriate to mention that several species that otherwise would not have been collected or recorded from the Rangeley region were secured by first opening and then closing the sluice gates in the Dead Cambridge River. Hundreds of minnows of several species and some trout were found in pockets amongst the rocks and even scattered through the bushes of the low-lying banks close to the edge of the stream.

This sudden drawing off of the water also affects seriously the fishes that have entered the overflowed meadows and small brooks, often leaving them stranded to slowly perish as the pools left by receding water become heated or evaporated.

All of these things and more have been and still are operative at the Rangeley Lakes. If by chance the fish have time to become accustomed to temporary prevailing conditions, the sudden changes can be only to their general disadvantage and must necessarily cause a constant unsettled and unstable condition, which can but react unfavorably upon a perpetuity of the fish supply.

Oquossoc Lake is the uppermost and smallest of the chain and is a faunal recipient of only a limited amount of tributary water, while it may contribute to the whole chain below. It may, therefore, be expected that it would be the first to show any disturbance of the general faunal balance. Mooselucmaguntic, including Cupsuptic Lake, is the largest and most diversified of the chain. It not only receives from Oquossoc and from the Kennebago and Cupsuptic systems but from other smaller contributories. Its principal faunal donations are to the lower waters. It should be the slowest to

react to disturbing influences. Molechunkamunk and Wellekennebacook, although smaller than Mooselucmaguntic, probably compensate for their loss through the outlet by the benefit they receive from the upper waters. Therefore, if exact data were available it would, perhaps, show little difference from Mooselucmaguntic save in quantity and would be no more appreciably affected by a general disturbance of the whole chain.

Umbagog has a greater area than Oquossoc or the last two lakes mentioned, but it is generally much shallower and is otherwise of a very different character. Its faunal contributive resources are much more extensive than all of the other lakes together. But owing to the widely different prevailing conditions, some forms of life continue to exist only through tolerance, and are, therefore, in unstable equilibrium and subject to serious disturbances from slight causes. Some of the forms could not at all times tolerate the general conditions were there not ameliorating factors. The ameliorating conditions being restricted, these tolerant forms are necessarily limited in number and are, therefore, more easily exterminated. The stock of such forms depends largely upon renewals from contributive waters.

The deficient general data respecting the distribution of the fishes in the Rangeley Lakes prevent reaching very definite conclusions regarding their source and manner of origin, as well as their ecological importance, past and present, but the few known facts are suggestive. A knowledge of the source and manner of the origin of the fish fauna is not particularly pertinent to a discussion of present-day conditions, but it may be briefly stated that probably the majority of the species gained access during a period of a lower level of the land and relatively higher stages of water and are mostly of northern derivation, perhaps by way of what is now the Kennebec Basin. The fish fauna of the Rangeley Lakes shows a contributory but not much if any recipient relationship to the Androscoggin River, from the fact that most of the Rangeley Lakes species are those of common distribution and are found in the river, while others of common distribution occurring in the river are not found in the lakes.

Of 39 species of fresh-water fishes recorded from Maine, New Hampshire, and Vermont, 35 of which are known from Maine, only 13, or just one-third, were apparently indigenous to the Rangeley Lakes Basin above the Androscoggin River. One of these was for a long time considered as peculiar to the Rangeley Lakes and restricted to two of them. Twenty-one of the Maine fishes are very common in certain regions of the State, and 13 are of general distribution throughout the State. The fauna was thus to some extent unique but of concentrated quality, as it were. There were only two species of food fishes and only one of these a game fish. All but one of the remainder of the fishes that were at all common served as food for this one game fish, some of them as a continuous supply, the rest at least as a seasonal or temporary resource. Thus, one game fish levied more or less upon 11 different species. Some of these reciprocated or retaliated to some extent by attacking the game fish at some stage of its existence, but their principal food consisted of smaller animal life, for which all species competed.

The biological oscillations produced by modifications of the physical conditions have been amplified by the introduction of competitive and destructive factors, resulting in changes in the fauna. Among the fishes, instead of the 12 or 13 original species, there are now 16 or 17, at least one, or perhaps two, of the original forms having been replaced by new ones. There is, perhaps, an approach to a readjusted balance, but

it apparently is unsteady and dependent upon a continuous readjustment by fish culture. The salmon has become the dominant species and, therefore, the most extensive and intensive influence. It has spread throughout the chain of lakes, even into the Androscoggin River. In Umbagog Lake, however, it probably exists to a limited extent only through the favor of the two deep holes. The salmon is the most powerful competitor in the food supply of the trout, as their all-of-the-year habitats are identical and they subsist upon the same kind of food, and the salmon, possibly, to some extent upon the trout. The trout supply evidently requires the aid and advantage of artificial propagation.

The pickerel has been restricted in its effects to Umbagog Lake, where it has never suffered from the lack of sufficient food and where it has not been to any extent dependent upon the trout. On the whole, it has found a congenial habitat in the lake, but has been subject to occasional mysterious mortal epidemics. A possible, if not to say probable, explanation may be found in the existing conditions partly produced by artificial modifications of the biological conditions. The lake being long and narrow, with its longest axis lying north and south and out of the direction of the prevailing winds at the time, receives a comparatively small amount of oxygenation from wind and wave action. The death of a great quantity of plant and plankton organisms, both resident and inflowing, might result in a greater amount of decomposition accompanied by an excessive amount of carbon dioxide. Furthermore a large amount of plankton is usually associated with high carbon-dioxide and low oxygen contents. An obstructed outlet would produce an increased amount of plankton, and an obstructed inlet would, perhaps, produce a temporary partial stagnation. Carbon dioxide is very toxic to fishes, but some fishes are less affected by it than others. The carbon dioxide content is usually highest in April and June. The early epidemic previously mentioned apparently occurred soon after the lake was free from ice, probably some time in May. The epidemic of 1912 occurred in the last of May and first of June, when, it is stated, the dams of the outlet and inlet had been for some time closed for storage purposes. While the cold of winter and early spring would retard decomposition, the surface ice would, on the other hand, prevent oxygenation from winds and wave action. An inspection of the map of Umbagog Lake will perhaps show that its general shape and the location of the main inlet and the outlet would support this idea.

Smelts have increased in number and have spread throughout the chain, even occurring in Umbagog Lake. They are of undoubted value as food for the salmon and trout, in which they have supplanted the blueback trout, and in that direction are of no little importance to the inhabitants of the region, as indicated by the following quotation from Maine Woods, May 1, 1913:

> The smelts began running in Kennebago Stream last Thursday night (Apr. 24), and much sport among the residents is being enjoyed. "Going smelting to-night?" is the form of greeting heard from young and old, and if you don't reply "You bet I am," you are no sport, for when the smelts start up Kennebago Stream the whole town turns out to meet them, for they are the first fish of the season, and when salt cod and herring have been the fish course all winter they certainly do taste good. From Indian Rock to a goodly distance upstream one can see the glint of lantern and small fires, where groups of men and boys are gathered, dipping smelts from the stream to pails, boxes, and grain sacks.

CONCLUSIONS AND SUGGESTIONS.

The artificial modifications of the Rangeley Lakes waters have in some ways been beneficial, in others directly and indirectly detrimental to the fishes of these lakes. Early excessive and unseasonable fishing caused the necessity for legislative and fish-cultural action. The necessity was augmented by the annually increasing number of anglers. The trout supply was not greatly increased by fish culture, owing to the fact that the Rangeley trout were for many years the source of supply for other waters.

Partly to meet the demands of the greater influx of anglers each year, the landlocked salmon was introduced. In furnishing the anglers with more game fish the introduction of the salmon was a success, but its introduction resulted in the extinction of the blueback. The blueback, however, was of no direct importance to the angler; but the fact of its disappearance from this evident cause suggests that the cause of the continued decrease of trout, for some years at least, may have been due to the same fish. The salmon now greatly preponderate over the trout, notwithstanding the extensive planting of trout.

Any maintenance or increase in numbers of trout as shown by the records of catches is only apparent and due to the greater number of anglers fishing there. It is undoubtedly true that the trout are decreasing in numbers and fewer large ones are caught than formerly. To keep up the trout supply, even approximately, many more trout need be planted annually. It is doubtful, however, even with the salmon eliminated, if a sufficient number of trout could be supplied to adequately meet the present requirements of the large number of anglers. The salmon is more responsive to fish culture and conservation, and to the majority of anglers, if not preferable to the trout, furnishes a very satisfactory substitute. It is, however, a matter of regret to many familiar with the one-time glory of the Rangeley Lakes as trout waters that the salmon was ever introduced. But the evil, if it were an evil, has been done and can not be undone. It can, however, serve as a warning to "let well enough alone," and where the indigenous fish is all that can be desired in game and food qualities to attempt to conserve or increase the supply, as needs be, rather than to introduce others, the possible disastrous effects of which can not always be foreseen. Only a few years ago there were those who stoutly advocated the introduction of white perch into Rangeley Lakes. Fortunately, this was not done, and the suggestion now offered is that no other fish than the trout and salmon be planted in the lakes.

Of the other introduced fishes that have become established, it is doubtful if any are of much harm under present conditions. The hornpout is to some extent addicted to eating young fish and to a great extent to devouring fish eggs when available; but probably it does not frequent the spawning beds of salmon and trout. The pickerel in its many years of existence in Umbagog Lake has shown that it is no menace to the upper lakes and of little or no harm to Umbagog. It has been previously stated in this paper that it is the opinion of the writer that fishing through the ice and plug fishing in the deep holes at other times, in conjunction with the general unsuitableness of the lake, is responsible for the scarcity of trout there and that the pickerel had no appreciable effect on the trout. In fact, the lake is better suited to the pickerel than to almost any other game fish.

Even if numerous in all the lakes the whitefish could be harmful only in a more or less remotely indirect way—that is to say, by its effect upon the ultimate or immediate food supply of some species.

Protective laws are now about as restrictive as present conditions require, the only exception being one relating to plug fishing.[a] The opponents of such a law have advanced as an argument that it would deprive women and children of the privilege of fishing from the shore and piers. A law could be framed, which could be more easily enforced than a general law against bait fishing, that would prohibit fishing in deep water only; that is, those places already known or subsequently discovered where trout and salmon can be caught in that way. Summer plug fishing and winter ice fishing are most potent factors in the depletion of any lake.

The writer believes that young trout and salmon should be planted in those places affected by young fish under natural conditions, as has been previously discussed in this paper. Too often young fish are planted directly in a lake and, as it were, into the waiting maws of predacious fishes. Also, they should be planted at a season when food is abundant, as they have been plentifully fed up to the time of planting, and to liberate them in late fall or early winter is but to subject them to very deficient food conditions. Late spring or early summer affords the most abundant food, especially in those waters where the fish should be planted.

[a] At the present time there is a general State law (sec. 31, Chap. 33, Rev. Stat.; amended by Chap. 219, Public Laws of 1917) to prohibit advance baiting, a practice which consisted of depositing meat, bones, fish, etc., for the purpose of luring fish to certain localities, also a special law (sec. 19) limiting the number of salmon and trout that can be taken by plug fishing in one day by any person, party or occupants of any one boat or other conveyance, in Richardson, Mooselucmaguntic and Cupsuptic Lakes, and making it unlawful for any person to fish for, take, catch or kill any kind of fish at any time in Rangeley Lake (Oquossoc) by still or "plug" fishing.

APPENDIX.

TABLES OF MEASUREMENTS AND COUNTS ON SPECIMENS OF FISHES FROM RANGELEY LAKES WATERS AND VICINITY.

Tables I to IV and X and XI comprise certain proportional measurements and counts of fin rays, scales, and other structures. Only the extremes of measurements and the averages are given. The proportions are obtained by dividing the length of one part by another. For example: Head in length without caudal, means length of head from tip of snout to posterior margin of opercle into length of fish to base of of the caudal fin. Eye in head refers to the quotient obtained by dividing the length of the head by length of eye, etc. Scales, as 20–107–15, means that there are 20 scales, counting the oblique series from the front of the dorsal to and including the lateral line; 107 from the upper angle of the opercle to the last fully developed scale at base of caudal; and 15 scales from oblique series from lateral line to base of ventral. Pharyngeal teeth 2, 4–4, 2, signifies 2 rows of the designated number of teeth on each side, 4 in the major and 2 in the minor row. Spines in fins are indicated by roman and rays by common numerals, the small letter "i" indicating simple, undivided, or rudimentary rays.

Tables V to IX, inclusive, comprise the actual measurements in millimeters. The distance from tip of snout to base of caudal is also given, so that any system of working out the proportions may be employed. The terms employed are practically the same as in the other tables. The figures indicating the gill rakers give the numbers on each arm of the gill arch and the total.

TABLE I.—PROPORTIONAL MEASUREMENTS AND COUNTS ON FIVE SPECIMENS OF LONG-NOSE SUCKERS (CATOSTOMUS CATOSTOMUS) FROM UMBAGOG LAKE, 1905.

Parts measured.	Range of measurements.	Average.	Parts measured.	Range of measurements.	Average.
Total length in millimeters	267–330	289	Longest anal ray in head	1. 28– 1. 61	1. 42
Depth in length without caudal	4. 85–5. 11	4. 97	Length of pectoral fin in head	1. 16– 1. 36	1. 27
Head in length without caudal	4. 21–4. 47	4. 34	Length of two ventral fins in head	1. 64– 1. 83	1. 71
Eye in head	6. 37–7. 11	6. 81	Number of dorsal rays	i, 10 –i, 11	i, 10. 20
Eye in interorbital width	2. 75–3. 05	2. 93	Number of anal rays [a]	i, 6 –i, 7	i, 6. 60
Tip of snout to eye in head	2. 11–2. 31	2. 21	Scales	20–103 to 110–14 to 16	20–107–15
Longest dorsal ray in head	1. 33–1. 88	1. 51			

[a] The males had the shorter anal fins.

TABLE II.—PROPORTIONAL MEASUREMENTS AND COUNTS ON THREE SPECIMENS OF COMMON SUCKER (CATOSTOMUS COMMERSONII), FROM OQUOSSOC LAKE, OCTOBER 17, 1900.

Parts measured.	Range of measurements.	Average.	Parts measured.	Range of measurements.	Average.
Total length in millimeters	147–162	(?)	Length of pectoral fin in head	1.44–1.48	1.46
Depth in length without caudal	4.48–4.76	4.67	Length of ventral fin in head	2.05–2.16	2.13
Head in length without caudal	3.59–3.71	3.64	Number of dorsal rays	12	12
Eye in head	5.29–6.52	5.34	Number of anal rays	7	7
Tip of snout to eye in head	2.05–2.17	2.09	Number of scales in longitudinal series	66	66
Interorbital in head	2.46–2.60	2.52	Number of scales in cross series, dorsal to ventral	18	18
Longest dorsal ray in head	1.50–1.76	1.66			
Longest anal ray in head	1.40–1.68?	1.51?			

TABLE III.—PROPORTIONAL MEASUREMENTS AND COUNTS ON EIGHT SPECIMENS[a] OF CHUB (SEMOTILUS BULLARIS), FROM OQUOSSOC LAKE, OCTOBER 17, 1900.

Parts measured.	Range of measurements.	Average.	Parts measured.	Range of measurements.	Average.
Total length in millimeters	127–187	152	Longest anal ray in head	1.65–1.94	1.79
Head in length without caudal	3.78–4.12	3.93	Length of pectoral in head	1.54–1.73	1.61
Tip of snout to eye without caudal	2.64–3.00	2.75	Length of ventral in head	1.88–2.06	1.94
Eye in head	4.50–5.50	5.11	Number of dorsal rays	8–9	8.12
Interorbital in head	1.81–2.00	1.93	Number of anal rays	7–8	7.12
Maxillary in head	2.66–3.10	2.95	Scales	8 to 9–47 to 50–4 to 5	8.50–49–4.62
Mandible in head	2.42–2.75	2.57	Number of lower pharyngeal teeth	2,4–5,2	2,4–5,2
Longest dorsal ray in head	1.20–1.50	1.40			

[a] Three of the specimens were males.

TABLE IV.—PROPORTIONAL MEASUREMENTS AND COUNTS ON TEN SPECIMENS[a] OF REDFIN (NOTROPIS CORNUTUS), FROM OQUOSSOC LAKE, OCTOBER 17, 1900.

Parts measured.	Range of measurements.	Average.	Parts measured.	Range of measurements.	Average.
Total length in millimeters	76–127	112	Number of dorsal rays	8	8
Depth in length without caudal	3.54–4.55	4.17	Number of anal rays	9	9
Head in length without caudal	4.10–4.55	4.32	Scales in longitudinal series	42	42
Eye in head	3.55–5.00	4.16	Number of lower pharyngeal teeth	2,4–4,2[b]	.....
Tip of snout to eye in head	2.50–3.07	2.77			
Longest dorsal ray in head	1.00–1.25	1.13			

[a] Five specimens were males, the others doubtfully females.

[b] Nine specimens uniform; one had teeth 2, 5–4, 2.

TABLE V.—MEASUREMENTS[a] AND COUNTS TAKEN FROM SPECIMENS OF WHITEFISH (COREGONUS CLUPEAFORMIS), FROM UMBAGOG LAKE.

Length to base of caudal.	Length of head.	Greatest depth.	Length of eye.	Length of snout.	Length of maxillary.	Length of mandible.	Width of interorbital.	Depth of head.	Distance from eye to gill opening.	Length of longest dorsal ray.	Length of longest anal ray.	Length of pectoral.	Length of ventral.	Length of longest gill raker.	Number of gill rakers.	Number of scales.	Dorsal-fin formula.	Anal-fin formula.	Sex.
mm.	*mm*	*mm*	*mm.*	*mm.*	*mm*	*mm*	*mm.*	*mm.*	*mm.*	*mm*	*mm.*	*mm*	*mm.*	*mm.*					
312	71	77	15	16	18	26	19.5	34	37.5	48	.....	57	.....	7	10+17:27 10+18:28	10–78–8	iii, 10	iii, 11	♀
400	87	92	16+	20	22	30	24	42	37.5	60	38	69	66	8.5	10+18:28 11+17:28	10–83–8	iii, 12	iii, 13	♀
310	73	88	15+	19	19	28	20	26.5	38+	53	40	61+	55.5	8.5	10+18:28 10+17:27	10–80–8	iii, 11	iii, 11	♂
330	69	73	15.5	16.5	19	26	19	33	36.5	55	40	55	54	7.5+	10+17:27 10+18:28	10–78–8	iii, 12	iii, 13	♀
370	74	81	15	19.5	19	28	21	36	38.5	57	41.5	61	58.5	7.5	10+19:29 11+19:30	10–86–8	iii, 12	iii, 11	♀
330	73	78	14	18	19	27	19.5	34.5	37	54	.....	.....	.....	7.5	10+18:28 10+19:29	10–83–8	iii, 11	iii, 12	♀
352	74	76	15.5	17	20	29	22.5	.....	.....	62	42	60	59	9	10+19:29 11+19:30	11–87–9	iii, 11	iii, 11	♂
270	76	62	13	14.5	16	22	16	.....	.....	45	34	44	44	6	11+18:29 11+18:29	10–84–9	iii, 12	iii, 12	♂

[a] The actual measurements are given in order that anyone desiring to make comparisons may use his own system.

TABLE VI.—MEASUREMENTS AND COUNTS TAKEN FROM SPECIMENS[a] OF BLUEBACK TROUT (SALVELINUS OQUASSA), IN THE UNITED STATES NATIONAL MUSEUM.

Total length.	Lenth to base of caudal.	Head.	Depth.	Eye.	Snout.	Maxillary.	Mandible.	Longest dorsal ray.	Longest anal ray.	Pectoral.	Ventral.	Longest gill raker.	Number of gill rakers.	Number of branchiostegals.	Number of dorsal rays.	Number of anal rays.
mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*				
241	205	41	40	10—	10+	19	25.5	24	.....	29	.....	3—	9+12:21	9	11	11
													9+12:21	9		
222	205	40	42	8	10	17.5	23+	25	.....	29.5	.....	3	8+12:20	9	11	11
													6+13:19	9		
195	170	37	34	7.5	9	16.5	22	23	.....	26	.....	.....	8+11:19	9	11	11
													6+11:17	9		
[b] 288	350	78	68	13	22	40	47	50	.....	48	.....	.....	8+13:21	.....	11	10
													8+12:20			

[a] Sex unknown.
[b] Measurements and counts from a breeding female from Kennebago Stream, 1900.

TABLE VII.—MEASUREMENTS AND COUNTS OF LANDLOCKED SALMON (SALMO SEBAGO) FROM UMBAGOG LAKE, 1905.

Total length.	Length without caudal.	Length of head.	Greatest depth.	Distance snout to dorsal.	Base of dorsal.	Dorsal to adipose.	Base of adipose.	Adipose to caudal.	Pectoral to ventral.	Ventral to anal.	Base of anal.	Anal to caudal.	Least depth caudal pedtuncle.	Longest dorsal ray.	Longest anal ray.	Length of pectoral.	Length of ventral.	Eye.	Snout.	Maxillary.	Mandible.	Interorbital.	Longest gill raker.	Number of gill rakers.	Number of branchiostegals.	Number of scales.	Number of dorsal rays.	Number of anal rays.	Sex.
mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*						
425	375	89	.....	171	49	95	16.5	36	117	80	33	43	33	48	39	56	41	13.5	27	42	52	31	6	7+13:20	12	21–115–21	11	9	....
																								8+13:21	11				
403	350	80	.....	155	42	86	11	30	104	83	26.5	41	30	41	37	50	42	13	23	43	47	27	5	8+12:20	11	21–115–21	12	9	....
																								8+13:21	10				
381	340	76	.....	153	39	80	10	31	107	81	27	39	28	42	30	47	38	13.5	20	36	44	27	5	7+11:18	11	23–115–21	11	9	....
																								7+12:19	12				
377	323	73	77	140	40	77	12.5	34	104	75	26	38	27.5	42	32	50	36	12+	20	35	41	26	5	8+13:21	11	23–115–21	12	9	♂
																								8+13:21	12				
390	337	77	72	150	37	84	12	35	107	76	27	40	27	47	35	55	42	12.5	22	36	41	26	6	7+12:19	10	23–115–21	11	9	♂
																								7+12:19	11				

TABLE VIII—MEASUREMENTS AND COUNTS OF LARGE BLUEBACK TROUT (SALVELINUS OQUASSA) TAKEN FROM RANGELEY STREAM, BREEDING FISH IN 1903.

Total length.	Length without caudal.	Length of head.	Greatest depth.	Tip of snout to dorsal fin.	Base of dorsal.	Dorsal to adipose.	Base of adipose.	Adipose to caudal.	Pectoral to ventral.	Ventral to anal.	Base of anal.	Anal to caudal.	Least depth of caudal pedtuncle.	Longest dorsal ray.	Longest anal ray.	Length of pectoral.	Length of ventral.	Number of branchiostegals.	Longest gill raker.	Number of gill rakers.	Number of dorsal rays.	Number of anal rays.	Number of pores.	Length of eye.	Length of snout.	Length of maxillary.	Length of mandible.	Width of interorbital.	Sex.
mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*		*mm.*					*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	
360	313	76	77	144	38	80	4	30	91	70	38	38	27	46	36	50	80	10	.....	7+12:19	11	11	136	12	21	39	48	25	♂
																		9		.....									
368	326	82	75	146	38	86	4.5	30	93	73	36	33	29	52	41	52	44	10	5	8+15:23	10	9	.....	12	26	47	54	27	♂
																		9		7+14:21									♂
346	308	75	73	134	39	73	5	30	89	69	33	37	25	43	36	48	41	9	5	7+12:19	10	10	.....	12	24	46	52	26	♂
381	336	84	75	145	44	81	5	36	94	67	38	37	29	47.5	42	55	48	9	3	7+13:20	11	11	136	12	26	49	54	28	♂
																		10		7+12:19									
																				9+12:21									

TABLE IX.—MEASUREMENTS OF TROUT (SALVELINUS FONTINALIS) TAKEN FROM RANGELEY STREAM, 1904.

Total length.	Length without caudal.	Head.	Depth.	Eye.	Snout.	Maxillary.	Mandible.	Interorbital.	Longest dorsal ray.	Longest anal ray.	Pectoral.	Ventral.	Longest gill raker.	Number of gill rakers.	Distance adipose to caudal.	Distance anal to caudal.	Least depth of caudal peduncle.	Number of pores.	Number of dorsal rays.	Number of anal rays.	Sex.
mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*		*mm.*	*mm.*	*mm.*				
438	390	95	101	13.5	26	55	67	32.5	45	51	59	48	5	7+11 8+11	39	42	42	115	i,9	ii,19	♀
432	390	93	87	12	28	60	71	33	53	48	57	46	5	8+11 7+13	40	41	36	125	i,9	ii,8	♀
445	387	112	95	17	36	79	96	35	60	65	70	60	5	7+10 7+10	38	35	39	.....	11	8	♂
390	356	100	83	14	34	72	83	32	47	50	58	49	5	7+10 7+11	31	31	36	115	i,10	8	♂
374	335	93	82	13	28	61	70	27	53	51	58	45	6	6+10 8+11	35	32	34	115	i,9	7	♂

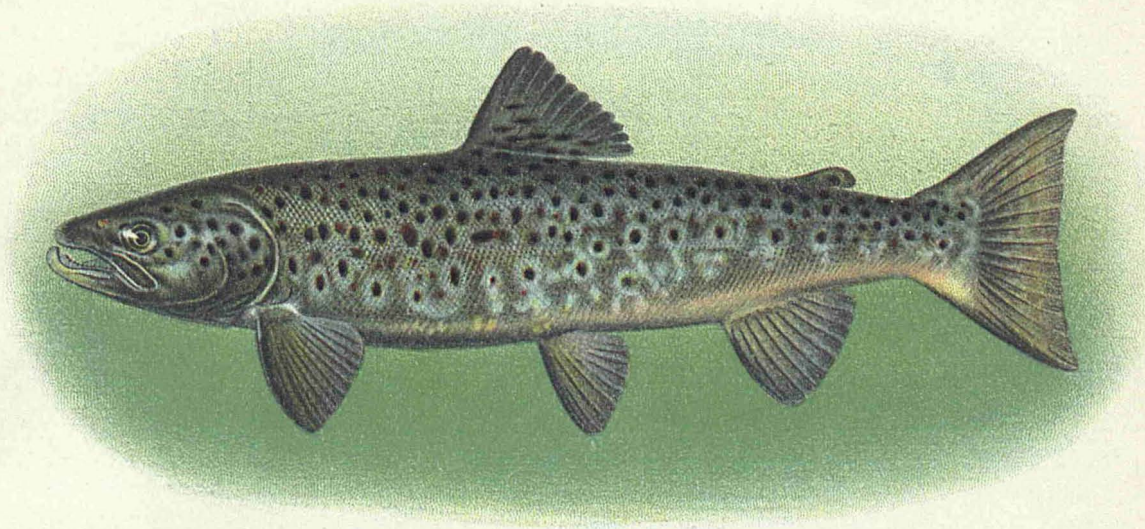
TABLE X.—PROPORTIONAL MEASUREMENTS AND COUNTS OF TWO PICKEREL [a] (ESOX RETICULATUS), EACH WEIGHING ABOUT 4 POUNDS, FROM UMBAGOG LAKE, JULY 24, 1905.

Parts measured.	No. 1.	No. 2.	Parts measured.	No. 1.	No. 2.
Total length in millimeters	584	603	Width of snout—maxillary width in head	2.93	3.24
			Longest dorsal ray in head	2.40	2.71
Depth in length without caudal	5.06	5.03	Longest anal ray in head	2.39	2.67
Head in length without caudal	3.44	3.62			
Eye in head	10.44	10.11	Number of dorsal rays	iii,15	iii,14
Tip of snout to eye in head	2.18	2.16	Number of anal rays	iii,14	iii,14
Maxillary in head	1.87	1.97	Number of scales in longitudinal series	135	134
Mandible in head	1.46	1.42	Number of rows of scales on cheek	10	12
Eye in interorbital width	2.00	2.00			

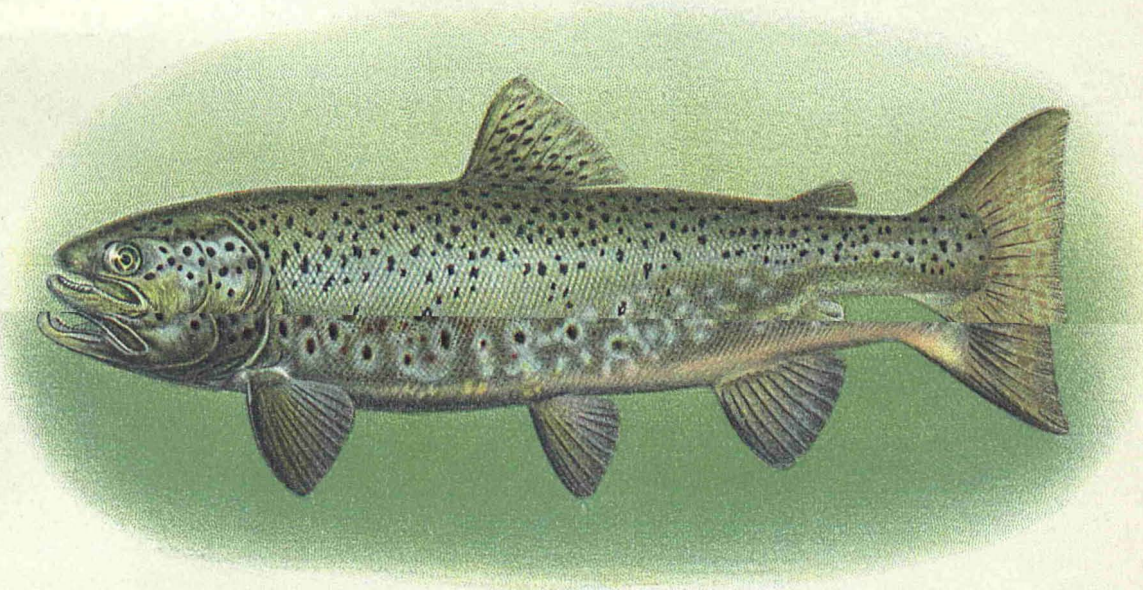
[a] The color was green and gold, finely reticulated with black.

TABLE XI.—PROPORTIONAL MEASUREMENTS AND COUNTS OF SIX SPECIMENS OF MILLER'S THUMB (COTTUS GRACILIS), FROM BEAR RIVER, NEWRY, ME.

Parts measured.	Range of measurements.	Average.	Parts measured.	Range of measurements.	Average.
Total length in millimeters	25–76	38	Longest dorsal ray in head	1.78–2.35	2.05
			Length of pectoral in head	.89–1.11	.99
Depth in length without caudal	4.91–5.60	5.23	Length of ventral in head	1.29–1.50	1.39
Eye in head	3.00–4.00	3.76			
Tip of snout to eye in head	3.40–5.35	4.00	Number of dorsal rays	vii,16–viii,17	vii,$\frac{3}{6}$,16$\frac{1}{6}$
Maxillary in head	2.25–2.50	2.38	Number of anal rays	11–14	11$\frac{3}{6}$
Mandible in head	1.89–2.22	2.15	Number of ventral rays	3	3
Interorbital in head	8–10	8.87			
Longest dorsal spine in head	3.00–3.90	3.61			



Landlocked salmon, *Salmo sebago* (Girard). Breeding male, 19 inches long. From Rangeley Stream, Oquossoc, Me.



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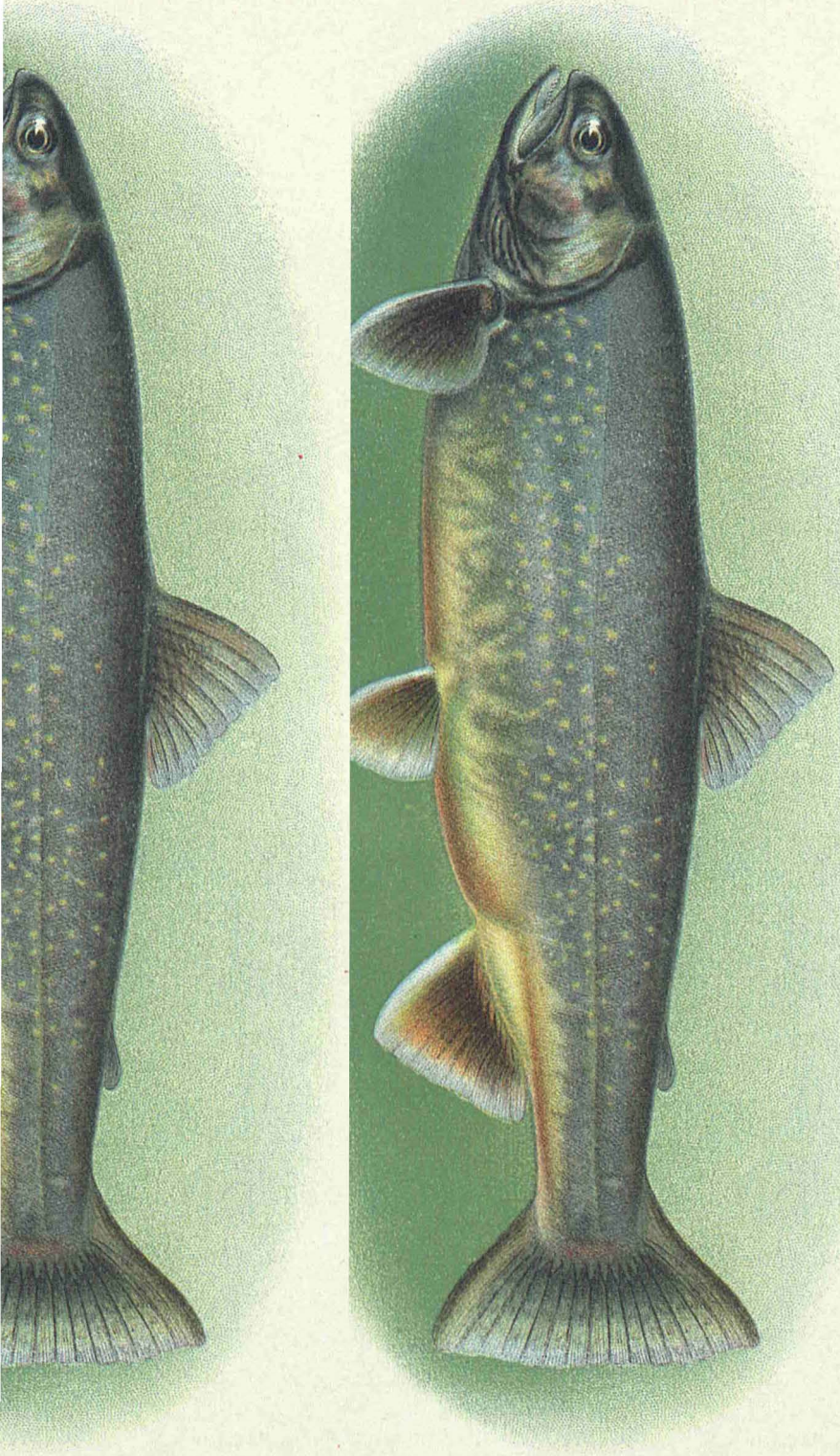
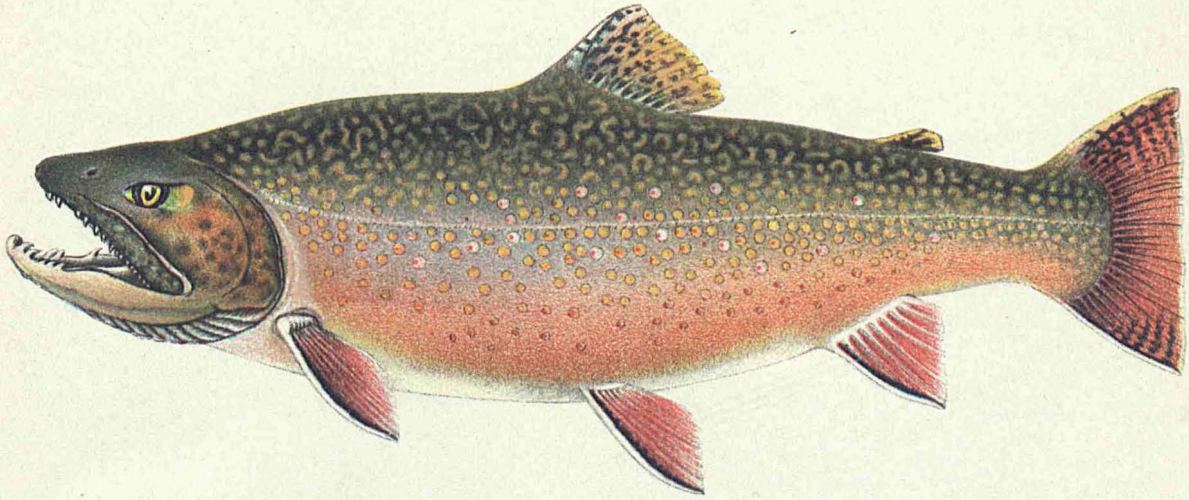
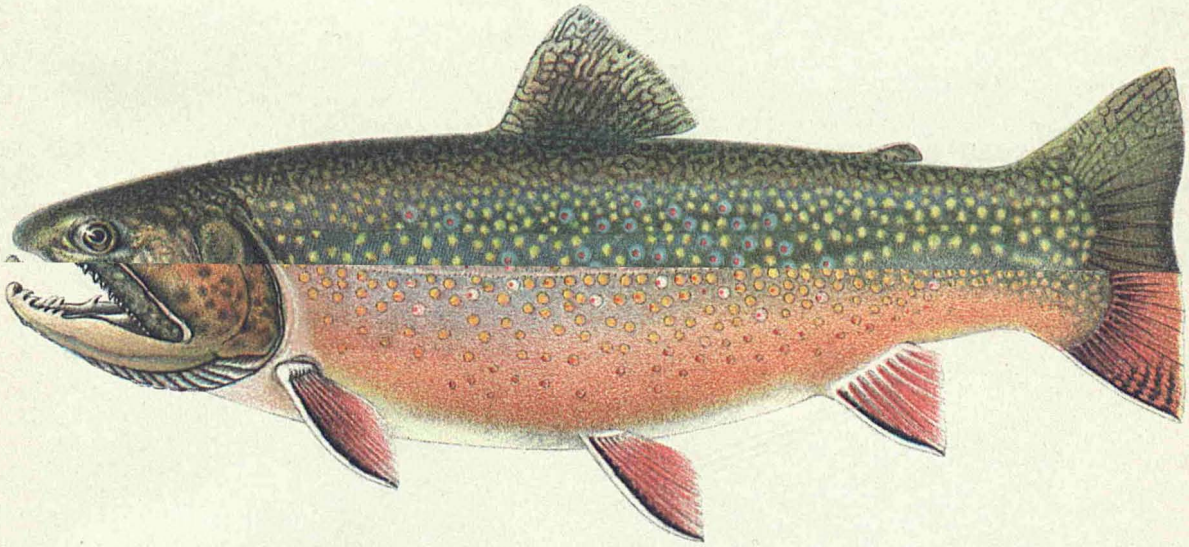


BREUKER & KESSLER CO. PHILA.



Brook trout; speckled trout, *Salvelinus fontinalis* (Mitchell). Nearly ripe male, 6¾ pounds. From Parmacheenee Falls, Magalloway River, Me.



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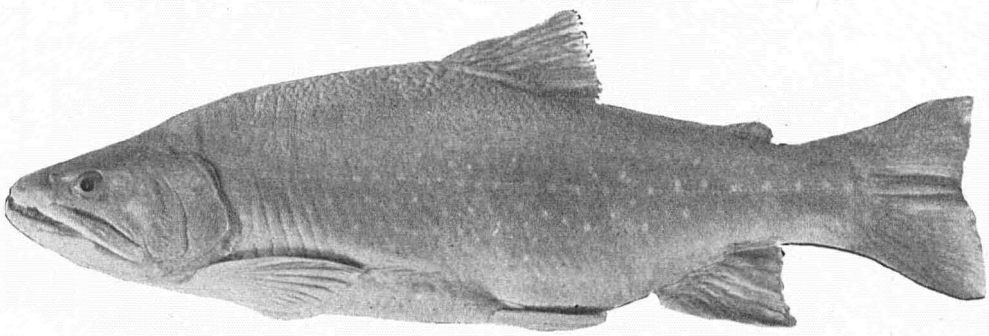
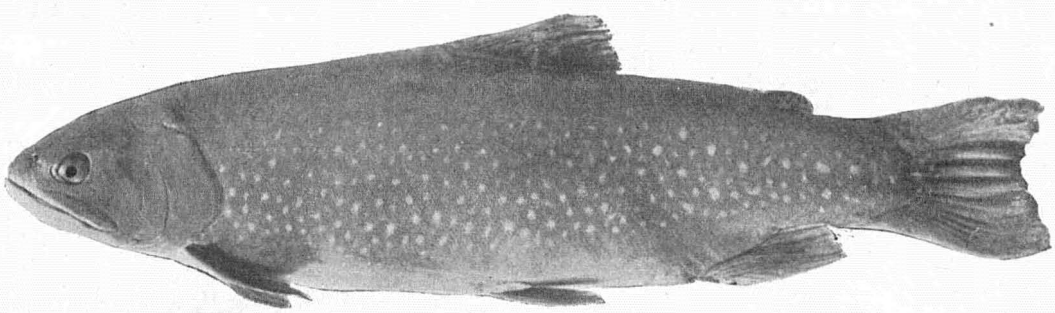
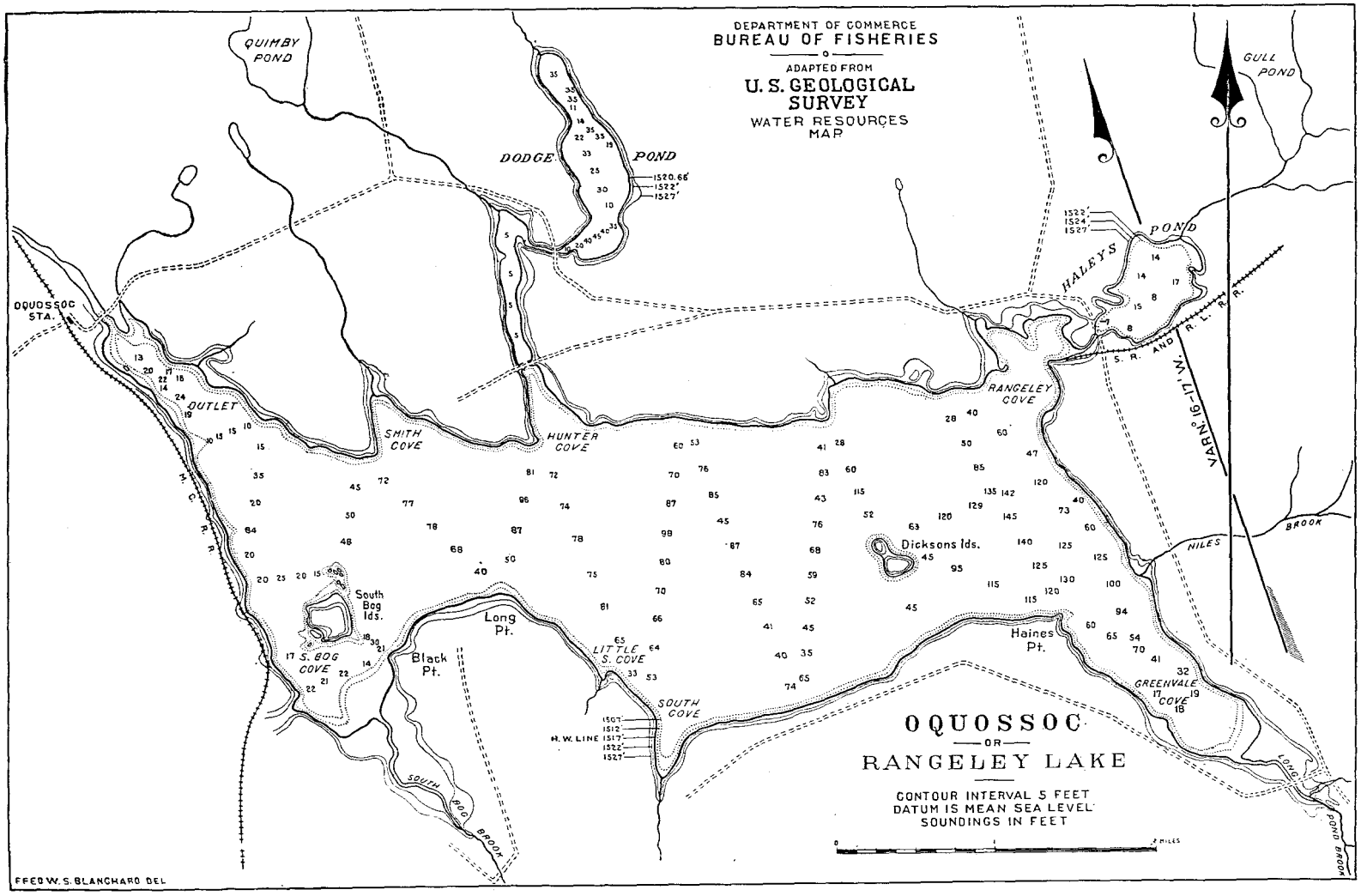


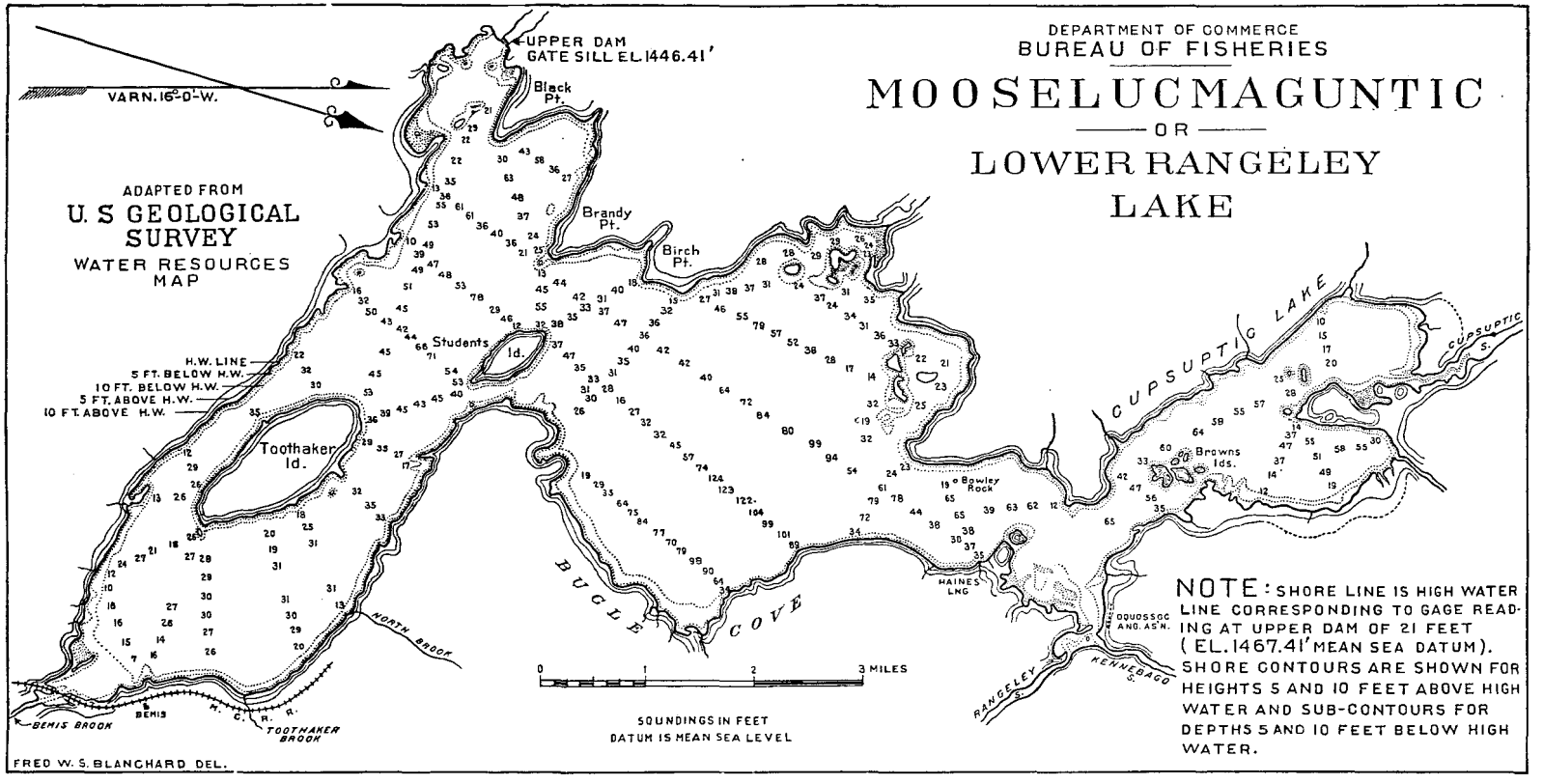
Male.



Female.

Brook trout, *Salvelinus fontinalis*, in breeding condition.


DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES
ADAPTED FROM
U. S. GEOLOGICAL SURVEY
WATER RESOURCES MAP
QUIMBY POND
DODGE POND
1520.66'
1522'
1527'
GULL POND
1522'
1524'
1527'
HALEYS POND
OQUOSSOC STA.
OUTLET
SMITH COVE
HUNTER COVE
RANGELEY COVE
VARN. 16–17° W.
M. C. R. R.
S. R. AND R. L. R. R.
Dicksons Ids.
NILES BROOK
South Bog Ids.
S. BOG COVE
Long Pt.
Black Pt.
LITTLE S. COVE
SOUTH COVE
Haines Pt.
GREENVALE COVE
1507'
1512'
R. W. LINE 1517'
1522'
1527'
SOUTH BOG BROOK
OQUOSSOC
OR
RANGELEY LAKE
CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL
SOUNDINGS IN FEET
0 1 2 MILES
LONG POND BROOK
FRED W. S. BLANCHARD DEL


DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES
MOOSELUCMAGUNTIC
OR
LOWER RANGELEY
LAKE
ADAPTED FROM
U. S GEOLOGICAL
SURVEY
WATER RESOURCES
MAP
VARN. 16°-0'-W.
UPPER DAM
GATE SILL EL. 1446.41'
Black Pt.
Brandy Pt.
Birch Pt.
Students Id.
Toothaker Id.
H.W. LINE
5 FT. BELOW H.W.
10 FT. BELOW H.W.
5 FT. ABOVE H.W.
10 FT. ABOVE H.W.
CUPSUPTIC LAKE
CUPSUPTIC S.
Browns Ids.
Bowley Rock
BUCK COVE
HAINES LNG
QUOQSSOC ANG. AS'N.
KENNEBAGO S.
RANGELEY S.
NORTH BROOK
BEMIS BROOK
BEMIS
TOOTHAKER BROOK
M. C. R. R.
0 1 2 3 MILES
SOUNDINGS IN FEET
DATUM IS MEAN SEA LEVEL
NOTE: SHORE LINE IS HIGH WATER LINE CORRESPONDING TO GAGE READING AT UPPER DAM OF 21 FEET (EL. 1467.41' MEAN SEA DATUM). SHORE CONTOURS ARE SHOWN FOR HEIGHTS 5 AND 10 FEET ABOVE HIGH WATER AND SUB-CONTOURS FOR DEPTHS 5 AND 10 FEET BELOW HIGH WATER.
FRED W. S. BLANCHARD DEL.

UMBAGOG LAKE

NOTE: SHORE LINE IS FOR A GAGE HEIGHT OF 10 FT. AT ERROL DAM (EL. 1241.3). HIGH WATER LINE (EL. 1246.3) AND 5 AND 10 FOOT CONTOURS ABOVE HIGH WATER SHOWN. SOUNDINGS IN FEET.

NOTE: SHORE LINE IS FOR A GAGE HEIGHT OF 15 FEET AT MIDDLE DAM (EL. 1443.38). A 10 FOOT SUB-CONTOUR SHOWN BY A DOTTED LINE. HIGH WATER LINE (EL. 1446.41), 10 AND 20 FOOT CONTOURS ABOVE HIGH WATER. SOUNDINGS IN FEET.

DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES
ADAPTED FROM
U. S. GEOLOGICAL SURVEY
WATER RESOURCES MAP

ERROL DAM
EL. 1231.30'
AT GATE SILL

VARN. 15° 22' W

VARN. 17° 05' W

NEW HAMPSHIRE
MAINE

UMBAGOG LAKE

LOWER SOUTH ARM

RICHARDSON LAKE

THE NARROWS

UPPER RICHARDSON LAKE

WEST ARM

ANDROSCOGGIN RIVER

MAGALLOWAY RIVER

CAMBRIDGE RIVER

RAPID RIVER

BULLHEAD POND

THURSTONS COVE

SARGENTS COVE

BIG ID.

P.O. BROOK

WILDCAT BROOK

TYLERS BROOK

TYLERS COVE

Tidswells Pt.

Bear Id.

Blake Ids.

Metallak Id.

Block Id.

BLOCK ID. COVE

HOLL ROCK

Tyler Pt.

Moose Pt.

Pine Pt.

B. BROOK COVE

B. BROOK

GLASBY COVE

Brandy Pt.

H.W. LINE
5' ABOVE H.W.L.
10' " H.W.L.

WHALEBACK BROOK

PISTOL

STURTEVANT COVE

STURTEVANT BROOK

SUNDAY COVE

SUNDAY BROOK

TO MIDDLE DAM
8.5 MILES

MIDDLE DAM
EL. 1428.38'
AT GATE SILL

BLACK CAT BROOK

Jackson Pt.

Horse Beef Pt.

Horsesable Pt.

Spirit Id.

THE POCKET

BLACK BROOK

10' SUB-CONTOUR
H.W. LINE
10' ABOVE H.W.L.
20' " H.W.L.

HALF MOON COVE

Half Moon Id.

METALLAK BROOK

Ship Id.

Black Pt.

DUMPLING BROOK

Beaver Id.

BEAVER BROOK

HILL BROOK

UPPER DAM
EL. 1446.41'
AT GATE SILL

WELLEKENNEBACOOK
— AND —
MOLECHUNKAMUNK
OR LOWER AND UPPER
RICHARDSON
LAKES

1 2 3 MILES

Datum is mean sea level

FRED W. S. BLANCHARD DEL.