MAINE DEPARTMENT OF INLAND FISHERIES AND GAME

FISH SURVEY REPORT NO. 1

A BIOLOGICAL SURVEY OF THE WATERS OF YORK COUNTY AND THE SOUTHERN PART OF CUMBERLAND COUNTY, MAINE

A REPORT BY

GERALD P. COOPER

Instructor in Zoology, University of Maine

TO

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GEORGE J. STOBIE, *Commissioner*

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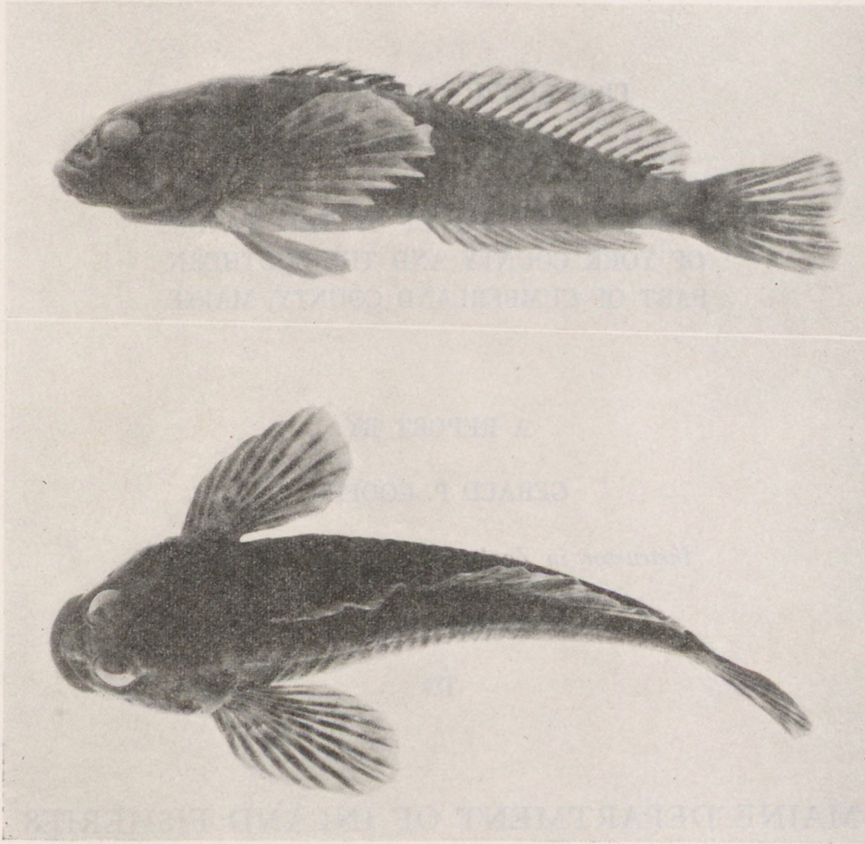
The Slimy Muddler *(Cottus cognatus)*, also sometimes called Fresh-water Sculpin or Miller's Thumb.



An adult female, 3¼ inches long, from Little Saco River in Fryeburg Township, Oxford County on June 30, 1938.

Upper: side view; lower: top view.

Streams in southern Maine which contain this fish are practically all excellent trout waters.

ANNOUNCEMENT

This report deals with the results of a lake and stream survey of a comparatively small portion of the southwestern corner of the state. However, the Fish and Game Department plans to continue this survey in the future to include most or all of those waters of the state which are important for fishing.

It is highly desirable, from the standpoint of efficiency, that the survey be made by watersheds or by other unit areas, and that most or all of the waters of a given area be studied before a study of a second area is attempted. By this procedure, the factor of transportation of the survey party is at a minimum which allows more time for the actual survey work and thus more to be accomplished in the end. Therefore, it is hoped that those sportsmen in Maine who are interested in streams or lakes which have not yet been studied will be patient in waiting until the survey party gets in their region.

It is planned that, in the future, the survey will be continued northeastward from the southwestern corner of the state. Following the completion of the Upper Saco and Presumpscot River drainages, the survey will study the Androscoggin system, then the Kennebec, and so on eastward along the coast. The study will follow each watershed back into Maine's interior wilderness just as far as the streams and lakes are heavily fished.

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A BIOLOGICAL SURVEY OF THE WATERS OF YORK COUNTY AND THE SOUTHERN PART OF CUMBERLAND COUNTY, MAINE

Survey Report No. 1

By Gerald P. Cooper

Instructor in Zoology, University of Maine

INTRODUCTION

A biological survey of the fresh-water lakes and streams of York County and the southern part of Cumberland County was undertaken[1] during the period of June 10 to September 10, 1937. The study was made through a joint agreement between the Maine Department of Inland Fisheries and Game and the University of Maine. The survey was financed almost entirely by the Fish and Game Department. Its primary purpose was to formulate a stocking policy for the streams and lakes of the area, in order to assist the Hatchery Division of the Fish and Game Department in its fish planting program; other aims were to initiate an intensive study of the distribution of the fresh-water fishes of the state, studies on the life histories of the important game fishes and studies on the inter-specific relationships that exist between the more abundant fish species in the state. The present report deals primarily with the stocking recommendations for the waters of the area and to a lesser extent with the subject of fish distribution. The results of studies on life history and inter-specific relationships will be published in later reports.

The stream systems which were studied included the entire Piscataqua-Salmon Falls, Mousam and Kennebunk river systems, the Saco River drainage up to the Ossipee River, the Presumpscot drainage up to Sebago Lake, and also all of the smaller Atlantic tributaries between the Piscataqua River at Kittery and the Presumpscot River at Portland. These drainage systems have approximately 2,100 miles of streams (including everything from the smallest creeks to the large rivers) indicated on the

[1]The field crew included R. T. Norris and H. R. Newcomb, wild-life students at the University of Maine, and the writer.

United States Geological Survey Topographic maps. The area has about 55 ponds and lakes over 25 to 50 acres in area. Most of the survey effort was spent in making a complete study of the streams. The lake studies were limited to an examination of only 6 of the 55 lakes and ponds of the area and only 2 of these were studied quite intensively.

FIELD METHODS AND EQUIPMENT

The survey unit was equipped with car, boat and trailer, tent, etc., so that headquarters could be established at advantageous points with respect to the area to be studied and could be moved from one place to another. The field studies were carried on within a radius of approximately 25 miles from each field headquarters. The survey was of the reconnaissance type[2] in which available effort was distributed over a large number of localities; it is believed that this method of procedure served the purposes of the study better than would have the method of concentrating the effort on an intensive study of a few lake and stream localities.

Observations were made on each stream at stations approximately 3 to 5 miles apart, and most stations were visited only once during the summer. Readings were taken on air and water temperatures. The general character of the stream with respect to width, depth, size and abundance of pools, types of bottom material, available cover (logs, boulders, overhanging banks, etc.) for trout, current and amount of water were determined. The abundance of bottom food organisms (largely aquatic insects) was determined, mostly by estimate after examining the stream bottom. The kinds and abundance of fishes were determined by seining. This information, together with data on water turbidity, pollution, acidity and oxygen (in streams for which there appeared to be any possibility that the water was extremely acid or oxygen was deficient), etc., was recorded on STREAM SURVEY—EXAMINATION data cards, and was used in formulating the stocking program. Survey data were obtained at 394 stations on the streams of the area, including: 154 stations on the Saco R. drainage, 64 on the Presumpscot drainage, 52 on the Piscataqua-Salmon Falls, 35 on the Mousam, and the remainder on the smaller Atlantic tributaries. Fish collections were made at 73 of the 394 stream stations.

[2]Similar types of lake and stream surveys have been conducted in New York State for many years (see Annual Reports of New York State Conservation Department for the years 1926 to 1937) and in New Hampshire during the summer of 1937 (see Survey Report No. 2 of the New Hampshire Fish and Game Department.)

STREAM SURVEY – EXAMINATION

Prepared for and by the Maine Department of Inland Fisheries and Game

In cooperation with the Fish Division of the Wild Life Department at the University of Maine

COUNTY TOWNSHIP QUADRANGLE

NAME OF STREAM TRIBUTARY TO

POINT OF EXAMINATION (IN DETAIL)

LENGTH OF STREAM EXAMINED

WIDTH: Minimum Maximum Average

DEPTH: Maximum Average

DISCHARGE cu. ft./Sec. or Gal. per Min. CURRENT

POOLS: Size and Depth Abundance: Approximately Pools per 100 ft.

BOTTOM: %, %, %, %, %,

WATER: COLOR NORMAL TURBIDITY CARBON DIOXIDE p.p.m.

OXYGEN p.p.m. pH. pH Indicator HARDNESS p.p.m. Ca CO_3

TEMPERATURES: AIR WATER TIME OF TEMPERATURES DATE

WEATHER: PRESENT

PRECEDING

COVER SHADE. STREAM % SHADED BY

VEGETATION: General Abundance Types

NATURAL FOOD: Insects Young Forage Fishes

Other Food Types

IMMEDIATE SHORE SURROUNDING COUNTRY

DAM: Location Owner Use

Head Effect on Level Passable for Fish

POLLUTION

SPRING

SPAWNING GROUNDS

PREDATORS

BEAVER

USE OF WATER: Degree Fished General Reputation

Public Fishing Wadable Easily Fished

Remarks

The survey of the 5 lakes included (in part, for some) a study of the following: depth of water; vertical distribution of temperature, oxygen and acidity; the type of bottom soil; the abundance of vegetation; the kinds and abundance of fishes, and the age and growth (by the scale method) and food habits of the more important game fishes.

The equipment and methods of stream examination and water analyses were those which have been adopted generally in lake and stream surveys by other survey parties.[3] Stream dimensions were measured in some instances, but estimated in most. Stream flow was computed from the speed of a floating object and stream dimensions in some instances, but was usually estimated. Stream temperatures were taken with pocket thermometers (a good grade). For water analyses on lakes, samples were collected by a Forest Improved Water Sampler, analyzed by the Winkler Method for oxygen and with LaMotte Color Standard Solutions for pH ("acidity"). Vertical distribution of temperature was determined by using a Taylor Maximum-Minimum Registering Thermometer. Fishes were collected from streams and lake shallows with fine-mesh minnow seines of various lengths, and from the deep water of lakes with gill nets (mesh, 2⅜ to 4 inches, stretched measure). Age and growth studies were made in the laboratory.

SYSTEM OF NUMBERING STREAMS AND PONDS

Many streams and ponds of southern Maine have no names indicated for them on available maps, some are known by several names and many different streams and ponds have the same name. In order to avoid the confusion which has resulted from this lack of universally accepted names, a system of numbering the streams and lakes has been used. The numbering system is for use along with the names, but if there is any doubt as to the identity of a stream as mentioned in this report, the numbering system should be referred to exclusively. The numbering system (see map accompanying this report) is as follows: All of the streams that empty directly into the Atlantic Ocean are called Atlantic tributaries and are numbered starting with the Piscataqua River, which is on the state line between Maine and New Hampshire, as Atlantic Tributary No. 1. Proceeding northeast from Kittery along the coast, the next stream emptying into the Atlantic Ocean is Atlantic Tributary No. 2, and the next one No. 3. Each of these Atlantic tributaries is then considered as a drainage unit by itself and the streams which empty into it are numbered, starting

[3]In New York, Michigan, New Hampshire, etc.

at its mouth. Thus the first stream that enters the Piscataqua River is called Tributary No. 1 of the Piscataqua River; the second stream is called Tributary No. 2 of the Piscataqua R. Each of these tributaries of the Piscataqua River may have streams running into it, and the same system of numbering is used for these streams. To illustrate this numbering system by an example, Bog Brook in Lebanon (see accompanying map and stream stocking table) is Trib. 7 of Little River which is Trib. 35 of the Piscataqua-Salmon Falls River which is Atlantic Trib. No. 1.

The system of numbering ponds is practically the same as that for the streams. The first pond that drains into the Piscataqua River is numbered P. 1, the second P. 2, and so on. When all the ponds and lakes in the Piscataqua drainage are thus numbered, those that flow into Atlantic Tributary No. 2 are numbered. If the pond has no outlet, as is the case for a few small ponds in the area, that pond is numbered by associating it with the stream which it would contact if it did have an outlet.

FORMULATING A STOCKING POLICY FROM STREAM SURVEY DATA

The artificial propagation and distribution of game fishes in Maine is at present, and probably will continue to be for some time in the future, concerned almost exclusively with the salmons and trouts. Therefore, the plan of the present stocking policy is an enumeration of the streams which are suitable for trout, the kinds of trout best suited to each stream and the number which should be stocked in each. The Brook Trout *(Salvelinus fontinalis fontinalis)* was given preference in the stocking recommendations over Brown Trout *(Salmo trutta)* and Rainbow Trout *(Salmo gairdnerii irideus)*. The streams for which Brown Trout were recommended were mostly too warm to be good Brook Trout waters.

The stocking recommendations were made with the idea in mind that the streams should be able to support all of the trout which are stocked in them, at all seasons of the year, making allowances for normal mortality. Trout plantings were not recommended for streams in which (1) trout planted in the spring would either have to be caught out early in the spring or killed by warm water during July and August, (2) trout stocked in the spring would have to run up into small and cold tributaries or be confined to spring holes during the hot summer months, or (3) the amount of stream flow during dry summer months is dangerously low. No stockings were recommended for streams which were known to be posted against public fishing.

The factors studied by the survey and used to determine the stocking policy for streams were as follows:

1. Amount of stream flow
2. Seasonal distribution of rainfall
3. Water and air temperatures
4. Average width of the stream
5. Character of pools and "cover"
6. Abundance of bottom food organisms
7. Oxygen
8. Acidity
9. Pollution
10. Present fish population

Amount of stream flow: Practically all streams having a flow of less than 25 gallons-per-minute were so small (narrow and shallow) as to be entirely out of the question as far as trout stocking is concerned, and no trout were recommended for them. A few streams consisted of a series of large pools connected by narrow riffles carrying from 25 to 50 g. p. m. of water, and if they were maintaining this flow during the driest part of the summer, the flow was considered to be adequate. In general, 25 g. p. m. was considered as the minimum flow for any type of stream, 50 g. p. m. as the minimum for streams with shallow and unshaded pools. In anticipating the minimum summer flow, the preceding weather conditions were taken into account. Some streams visited a few days after a heavy rain had plenty of water but it was obvious from the character of the stream bed and the presence of land plants under water that the flow was abnormally high.

Water and air temperatures: The utmost importance in deciding whether or not a stream was suitable for trout was placed on the readings of water temperatures. Fish culturists, generally, have found that 75° Fahrenheit is about the maximum temperature which Brook Trout can survive; 80° F. for the Brown and Rainbow trouts. Whereas these are about the maximum temperatures which these three trouts will survive, they prefer colder water. The results of our fish collecting in the streams of the area which were surveyed, indicate that the Brook Trout prefers water much below 75° F. in temperature. During the period from July 7 to September 4, 1937, fish collections were taken by seining, and water temperatures were taken at the same time, at 73 localities on streams in York County (scattered over entire county) and the southern part of Cumberland County (the Presumpscot River and its tributaries up to

Sebago Lake, the streams south of Presumpscot River, and a section of the Saco River and its tributaries up to Ossipee River). The streams from which these 73 collections were made varied in size from the larger rivers (Piscataqua, Saco, Mousam, Presumpscot) to small creeks with a flow of water less than 100 gallons-per-minute. Most water temperatures were taken between 10 A. M. and 5 P. M. In 39 of these stream localities, the water temperature at the time of seining was 69° F. or warmer, and no Brook Trout were collected. In the 34 other localities the water was 68° F. or colder and Brook Trout were collected from half (17) of these streams. Brook Trout were taken from 5 localities at 64° to 68° F. but averaged only 1.6 trout per collection. Brook Trout were taken from 12 localities at 47° to 62° F. and averaged 12 trout per collection.

In setting up the present stream stocking recommendations, 75° F. has been used as the maximum temperature for Brook Trout waters, and 80° F. for Brown and Rainbow Trout waters. (Possibly it might have been better to set the maximum for Brook Trout waters at 69° F., as suggested by the results of our seining in the streams of the area.) Brook Trout were recommended only for streams in which the water temperature was found to be below 75° F. or in which the water temperature presumably would not have exceeded 75° F. at any time during the hottest part of the summer. Estimating the maximum temperature which might be expected in a stream during the hottest part of July or August from temperatures taken during cooler parts of the summer requires experience on the part of the observer, but it can be done fairly accurately. For assistance in estimating the probable, mid-day, summer, maximum, water temperature, data prepared by Dr. G. C. Embody[4] for streams of the Genesee valley in New York have been utilized (see Table I). The figures

TABLE I. Comparison of air and water temperatures in a Brook Trout stream (from Embody; 1927)

Max. air temp. deg. Fahr.	80.0	82.0	84.0	86.0	88.0	90.0	94.0
Max. water temp. deg. Fahr. ...	65.0	66.6	68.2	69.8	71.4	73.0	75.0

in this table indicate the maximum water temperatures in a Brook Trout stream at various air temperatures. As examples, the water should not exceed 65° F. when the air is 80° F. or less, and the water should not exceed 73° F. when the air is 90° F. or less. Dr. Embody[4] also gives

[4]Embody, G. C.; 1927. Stocking policy for the Genesee River system. *In* A biological survey of the Genesee River system. Suppl. to 16th Ann. Rept., N. Y. S. Conserv. Dept., Albany.

data on maximum water temperatures at various air temperatures for Brown and Rainbow Trout streams (Table II), which were used in formulating the present stocking policy. According to these figures, the

TABLE II. Comparison of air and water temperatures in a stream tolerated by Brown and Rainbow Trout (from Embody; 1927)

Max. air temp. deg. Fahr.	80.0	82.0	84.0	86.0	88.0	90.0	92.0	94.0
Max. water temp. deg. Fahr.	69.0	70.5	72.0	73.5	75.0	76.5	78.0	80.0

water in a Brown or Rainbow Trout stream should not exceed 69° F. when the air temperature is 80° F., and should not exceed 75° F. when the air is 88° F.

Pools and cover: The streams were given a grade as to their carrying capacity for trout from the standpoints of pools and cover. In order for a stream to produce its maximum of large trout, it must have suitable pools in which the trout can live and it must have hiding places or "cover." Very deep water is cover in itself; other types of cover include such things as large boulders, logs, brush, overhanging banks and overhanging alder clumps. Since average stream width is taken into direct account in calculating stream carrying capacity, pools are graded in part with respect to stream width. Pools are graded as follows:

Pool grade A—pools wider than average width of the stream, with good cover and deep water.

Pool grade B—pools about same width as average width of stream, with fair cover and depth.

Pool grade C—pools either small pockets in stream bed, or wide and very shallow and generally with very poor cover.

The above pool and cover characteristics occur in various combinations. Some pools no wider than the average width of the stream might be very deep and have excellent cover and thus be given an A grade. Pools much wider than the average width of the stream but shallow and with poor cover would not be given an A grade.

Food: Bottom organisms constitute the great bulk of the food of trout in streams. Most important of the bottom organisms are the immature or larval stages of such insects as the mayflies, caddisflies, stoneflies, midges,

dragonflies, damselflies and certain beetles; another important form is the fresh-water shrimp or amphipod. The streams were graded (estimated) according to the abundance of bottom food organisms as follows: grade 1—very abundant, grade 2—common, grade 3—rare. It is believed that our estimates on food abundance conformed quite closely to the values of food grades as given by Davis[5] (1938:12), namely:

Grade 1. Rich; weight or volume of food organisms greater than 2 gr. or 2 c. c. per sq. ft.

Grade 2. Average; weight or volume from 1 to 2 gr. or 1 to 2 c. c. per sq. ft.

Grade 3. Poor; weight or volume less than 1 gr. or 1 c. c. per sq. ft.

The abundance of bottom food organisms depends largely on the type of bottom, i. e., certain types of bottom are much more productive than

TABLE III. The average weight in grams of bottom organisms per square foot on various types of bottom in Adirondack streams in New York during the summers of 1932 and 1933 (from Pate; 1934).

Bottom Type	1932	1933
Silt and mud	3.07	3.63
Rubble	2.47	2.96
Large	1.55	2.27
Small	3.53	4.11
Coarse gravel	1.51	1.35
Fine gravel	0.93	1.08
Sand	0.1	0.55

others . Dr. V. S. L. Pate[6], working on Adirondack streams in New York during the summers of 1932 and 1933, found that the average weight (in grams per square foot) of bottom organisms was greatest on small rubble

[5]Davis, H. S.; 1938. Instructions for conducting stream and lake surveys. U. S. Bur. Fish., Fishery Circular No. 26.

[6]Pate, V. S. L.; 1934. Studies on the fish food supply in selected areas of the Raquette watershed. *In* A biological survey of the Raquette watershed. Suppl. to 23rd Ann. Rept., N. Y. S. Conservation Dept., Albany.

bottom, second in rank on silt and mud bottom, and very low on sand bottom (Table III). Behney[7], working on streams in New Hampshire, likewise found that different types of bottom have different capacities for producing fish-food organisms: of three types of bottom, rubble was most productive, gravel was second, and sand was by far the least productive (Table IV).

TABLE IV. The average volume of bottom organisms in cubic centimeters per square foot on different types of bottom in streams of the Saco watershed in New Hampshire (from Behney; 1937)

Type of bottom	Vol. in c.c. per sq. ft.
Rubble	0.495
Gravel	0.357
Sand	0.15

Oxygen and pH: Oxygen tests were made on a few swift-water streams and in every instance the oxygen content was high—above 6 parts per million, mostly between 7 and 9 p. p. m. There is no reason to believe that any fast-flowing, unpolluted stream in Maine lacks oxygen. Tests on the deep and cold water in certain stillwaters (on streams, impounded by dams) revealed a deficiency of oxygen. Stillwaters on streams were usually found to be stratified, with cold water near the bottom (suitable for trout, from the standpoint of temperature); but in some instances decomposition of bottom material had removed the oxygen from this deep water and the stillwater was therefore not suitable for trout. No water was considered to be suitable for trout where the oxygen was found to be less than 5 p. p. m. Tests on pH[8] ("acidity") were made at approximately one-third of all stream stations. Most tests revealed a hydrogen-ion concentration of between 6.0 and 7.0; a few were below 6.0, a few above 7.0. In only one instance (the stillwater at the head of Goodwins Mill Br. in Lyman) was the water so acid (considerably below 5.2) that no stocking was recommended on this account.

[7]Behney, W. H.; 1937. Food organisms of some New Hampshire trout streams. *In* A biological survey of the Androscoggin, Saco and coastal watersheds. New Hampshire Fish and Game Dept., Survey Report No. 2.

[8]pH value of 7.0, water is neutral; above 7.0, alkaline; below 7.0, acid. In general trouts can tolerate water considerably acid.

Pollution: In general the smaller rivers and the streams of the area (only the smaller rivers and the streams are cold enough for trout) were relatively free from pollution. A few instances of serious sawdust pollution existed but most of the sawmills were keeping most of their sawdust out of the streams. No stocking was recommended for those streams which were seriously polluted by sawdust or other industrial wastes. Records of stream pollution are given in the table on stocking recommendations.

Present fish population: Where Small-mouthed Bass, Yellow Perch or Chain Pickerel were abundant in streams which were otherwise good trout waters, the number of trout recommended is one-half the number which would have been recommended had not the predacious bass, perch and pickerel been present. Several streams were encountered where the water was so cold, food so scarce and small trout so abundant that the trout were making a very slow growth. Such streams were known locally as "short trout" streams, and no stocking was recommended for them. The proper management for such "short trout" streams would probably include one or all of the following: (1) construction of a series of dams, either artificial or by introducing beaver, in order to warm up the water to some extent, (2) stream improvement to change the character of the bottom from sand to silt or gravel and assist in increasing the number of bottom organisms, and (3) removal of part of the present large population of small trout in order to give the remaining fish a better chance of growing to a larger size. The "short trout" streams and the streams with bass, perch and pickerel present are so indicated in the stocking table.

Stocking recommendations: Trout were recommended for those streams which were suitable from the standpoint of stream flow, water temperature, oxygen, acidity and absence of pollution, which were not posted and which were not classed as "short trout" streams. The number of trout recommended was governed by the three factors which determine the carrying capacity of the streams, namely: average width, pool grade and food grade. Embody's stocking table (Table V) for trout streams was used as a basis for the present stocking policy for the streams of York and Cumberland counties. Embody's table was made to be applicable to the heavily fished streams of central New York and the results by other investigators have subsequently indicated that his stocking figures are not necessarily applicable to other areas. It is realized that further study on Maine trout streams will probably reveal the necessity to set up a stocking table for the waters of Maine (probably different tables for different parts

of the state). In the absence of such a stocking table for Maine, it was believed that Embody's table was the one most applicable to the waters of York and Cumberland counties.

TABLE V. Stocking table for trout streams

As proposed by G. C. Embody[4] (1927) for streams of the Genessee River System in New York State, and as used as the basis for the present stocking recommendations

Stream width, in feet	Number of 3-inch* fingerlings per mile								
	Pools A Food 1	Pools A Food 2	Pools A Food 3	Pools B Food 1	Pools B Food 2	Pools B Food 3	Pools C Food 1	Pools C Food 2	Pools C Food 3
1	144	117	90	117	90	63	90	63	36
2	288	234	180	234	180	126	180	126	72
3	432	351	270	351	270	189	270	189	108
4	576	468	360	468	360	252	360	252	142
5	720	585	450	585	450	315	450	315	180
6	864	702	540	702	540	378	540	378	216
7	1,008	819	630	819	630	441	630	441	252
8	1,152	936	720	936	720	504	720	504	284
9	1,296	1,053	810	1,053	810	567	810	567	324
10	1,440	1,170	900	1,170	900	630	900	630	360

*In the above table the values refer to 3-inch fingerlings only. In order to apply them to fish of various sizes, multiply the values in the table by the following:

For fish of:	1″	2″	3″	4″	5″	6″
	x12	x1.7	x1	x0.75	x0.63	x0.6

INTRODUCTION TO STOCKING RECOMMENDATIONS FOR STREAMS

In the following table on stocking recommendations for streams, each stream system draining independently into the Atlantic Ocean (Atlantic tributary) is considered to be a watershed by itself, and the watersheds are arranged in sequence starting with the Piscataqua-Salmon Falls River

at Kittery and ending with the Presumpscot R. at Portland. After each Atlantic tributary (Atl. Trib.), its own tributary streams are listed in sequence. The number and name of each stream are indented in the first column of the table to indicate stream systems, i. e., the Atlantic tributaries are placed at the extreme left-hand margin of the column; the streams (secondary tributaries) entering these Atl. Tribs. directly are indented under the Atl. Tribs.; the tributaries of tributaries of Atl. Tribs. are indented still farther; etc. As an example (see first part of the stocking table), the Piscataqua R. is Atl. Trib. 1; 12—Sturgeon Cr., 18—Shoreys Br., 20—Quamphegan Br. and 24—Great Works R. are all tributaries of the Piscataqua R. and are indented (all on the same level) under the Piscataqua; 9—Loves Br., 15—(no name) and 16—Beaver Dam Br. are all tributaries of the Great Works R. and are indented under it; and, finally, 1—Frost Br. is a tributary to, and indented under, Beaver Dam Br.

No names were available for some of the streams, but these can be located from their drainage number and the township by reference to the map accompanying this report. Where more than one township is given for a stream, the first one usually covers the lower sections of the stream.

The column of the table, headed "General character of stream, if not well suited for trout" gives the reasons why no stocking of trout is recommended for certain streams and the reasons why, for other streams, the number recommended is relatively small as compared to the size of the stream. Streams designated as "warm" are those in which the water temperature was found to be between 75° and 80° F. or, judging from the water temperature together with air temperature, time of day, weather etc., would presumably have been at least 75° F. during a warm and dry weather period. Streams designated as "very warm" are those in which the water temperature was found to be above 80° F. or would presumably have reached 80° F. on very warm days. Streams designated as "small" either had less than 25 to 50 gallons-per-minute flow or had an average width of less than 2 to 3 feet. Streams designated as "very small" usually had less than 15 to 25 gallons-per-minute flow or had an average width of less than 2 feet.

Stocking recommendations are made separately for each stream and each of its tributaries. The length and location are given for the section of each stream for which stocking is recommended. The number of fish recommended is on a *per mile basis;* as an example, for Shoreys Brook with a stocking recommendation as follows: "Lower 2 miles—200 F. Brown Trout," the two miles of this stream just above its mouth should be

STOCKING RECOMMENDATIONS FOR THE STREAMS OF YORK COUNTY AND THE SOUTHERN PART OF CUMBERLAND COUNTY, MAINE

Stream Number — Name	Location (township)	General character of stream if not well suited for trout	Recommendations for yearly trout stocking (fish per mile) or other management
Piscataqua–Salmon Falls R. (Atlantic Trib. 1)	Maine–N. H. Line; York County	Stream warm; bass and pickerel abundant — from Great East Pond to South Berwick	
12 — Sturgeon Cr.	Eliot	Stream warm; pickerel abundant	
18 — Shoreys Br.	Eliot	Stream very limited in carrying capacity	Lower 2 miles — 200 F. Brown Trout. Success of stocking doubtful
20 — Quamphegan Br.	South Berwick	Stream small and warm	
24 — Great Works R.	Source in Sanford, mouth at South Berwick	Perch, bass and pickerel present	Ten miles of stream below, and starting from, Bauneg Beg Pond — 600 F. Brown Trout
9—Loves Br. and tribs.	South Berwick, Berwick	Stream warm	
15 — (no name)	South Berwick	Stream small and warm	
16 — Beaver Dam Br.	Berwick, South Berwick	Stream warm	
1—Frost Br.	North Berwick–Berwick line	Stream small and warm	
17 — Negutaquet R.	North Berwick	Too warm for Brook Trout	Lower 5 miles—400 f. Brown Trout
18 — Sherborn Br.	North Berwick, Wells	Stream warm	

Great Works R. (the upper section) above Bauneg Beg Pond, Trib. 1 of Bauneg Beg Pond	Sanford, North Berwick	Perch and pickerel present	Six miles of stream above Bauneg Beg Pond—500 F. Brook Trout
1 — (no name)	North Berwick	Water suitable for trout, but stream too small	
6 — (no name)	Sanford	Stream small	
27 — Driscoll Br.	Berwick	Water suitable for trout, but stream too small	
32 — Worster Br.	Berwick	Stream very warm	
35 — Little R.	Berwick, North Berwick, Lebanon	Stream very warm from a point east of North Lebanon village to its mouth. Stream bed spread out; many exposed boulders heat up the water	Stream improvement necessary before stocking. Width of stream bed should be reduced; more shade necessary
3 — Togue Br.	Berwick, North Berwick	Very warm	
4 — (no name)	Berwick, Lebanon	Very small	
6 — Abbott Br.	Lebanon, North Berwick	Good trout stream	Lower 1½ miles of stream—540 f. Brook Trout
7 — Bog Br.	Lebanon	Stream warm	
10— Outlet of Deering Pond in Sanford	Lebanon, Sanford	Stream very warm	
1 — Mine Br.	Lebanon	Very small	
Goding Br. (the upper end of Little R.)	Lebanon	Water approaches upper temp. limit for trout	Two miles of stream above the main road going northeast from North Lebanon village—300 F. Brown Trout. Success of stocking doubtful

STOCKING RECOMMENDATIONS—Continued

Stream (Number — Name)	Location (township)	General character of stream if not well suited for trout	Recommendations for yearly trout stocking (fish per mile) or other management
36 — Keay Br. (or Plains Br.)	Berwick, Lebanon	Food organisms rare; water quite acid (pH below 6.0) Pickerel present	Lower 4 miles of stream—300 F. Brown Trout. Success of stocking doubtful
37 — Great Br.	Lebanon	Stream warm; pickerel abundant	
Trib. 2 of Wilsons Pond (P. 22)	Acton. Stream enters south end of Wilsons Pond	Brook Trout very abundant. Water very cold (54°F.); food rare; trout grow very slowly. Stream partly posted against fishing	No stocking. Natural spawning adequate
York R. (Atl. Trib. 4)	York, Eliot	Lower 8 miles brackish; upper 2 miles below York Pond fresh water	Upper 2 miles below York Pond—200 F. Brown Trout. Success of stocking doubtful
6 — Cider Hill Cr.	York	Stream small and precipitous; 1½ miles of stream suitable for stocking	One and one-half miles of stream just above brackish water—600 f. Brook Trout. Success of stocking doubtful
7 — Dolly Gordon Br.	York	Stream small	
9 — Bass Cove Cr.	York		Lower 2½ miles above brackish water—500 f. Brook Trout
13 — Smelt Br.	York	Less than one mile suitable trout water	
Cape Neddick R. (Atl. Trib. 13)	York	Stream warm	
Josias R. (Atl. Trib. 15)	Wells, York	Stream warm	

Ogunquit R. (Atl. Trib. 16)	Wells, York, South Berwick	Stream warm	
Webhannet R. (Atl. Trib. 17)	Wells	Stream warm	
Merriland R. (Atl. Trib. 18)	Wells, Sanford	A dam and stillwater 2 miles east of Wells Depot. Below this stillwater, stream is very warm; above this stillwater, Merriland River is good trout water but has pickerel present. The stillwater is not suitable for trout— the deep, cold water had no oxygen (0.0 p.p.m.)	The lower 5 miles of the Merriland R. below the stillwater–no stocking. No stocking recommended for the stillwater. The upper 4½ miles of the Merriland R. above this stillwater—500 F. Brook Trout
1 — Branch R. or Little R.	Wells—Kennebunk line	From its headwaters to its mouth this stream is good trout water (temperatures 51°, 56°, 59° and 62°F.) with good pools, but the bottom is almost entirely sand and trout foods are generally rare. Young trout were abundant but growth by trout in this stream is slow	Stream improvement recommended —deflectors to concentrate current and expose gravel. Under present conditions, no stocking recommended; natural spawning adequate
Mousam River (Atl. Trib. 19)	Kennebunk, Sanford, Shapleigh	Stream warm, from Mousam Pond to its mouth. The stillwater on the Mousam R., 4½ miles southeast village of Alfred, is not suitable for trout—on July 20, the water at 22 feet deep (just above the bottom) was 70°F. but had too little (1.8 p.p.m.) oxygen for trout	
6 — (no name)	Kennebunk, Sanford		Lower 2½ miles—300 f. Brook Trout
9 — Middle Branch R.	Alfred	From its mouth at Mousam River to village of Alfred stream warm; pickerel present; no stocking	From village of Alfred to 1 mile above North Alfred (5½ miles of stream)—300 f. Brook Trout

STOCKING RECOMMENDATIONS—Continued

Stream Number Name	Location (township)	General character of stream if not well suited for trout	Recommendations for yearly trout stocking (fish per mile) or other management
2 — Hay Br.	Alfred—Sanford line	Stream very small; pickerel present	
3 — Outlet of Shaker Pond	Alfred	Stream warm; pickerel and bass present	
Trib.2 of Shaker Pond (P.52)	Alfred	Stream very small	
Shaker and Carll Brooks, together Trib. 3 of Shaker Pond	Alfred, Waterboro	Lower mile of Shaker Br. above Shaker Pond has pollution which comes from Branch Br. through the village of Waterboro. Carll Br. not polluted	Three miles of Carll Br. (the upper part of Shaker Br.) above the village of Waterboro—450 F. Brook Trout.
1 — Branch Br. and Hamilton Br.	Waterboro	Pollution present	
1 — Nason's Br.	Waterboro, Lyman	Stream small and enters the polluted Branch Br.	
2 — Smith Br.	Waterboro	Stream small	
11 — (no name)	Sanford, Shapleigh	Stream small	
Heath Br.—Trib. 1 of Loon Pond (P. 62)	Acton		Lower 1½ miles 200 F. Brook Trout
Pump Box Br.—Trib. 3 of Mousam Pond	Shapleigh	Lower mile of stream warm with pickerel abundant; upper section very small	
Kennebunk River (Atl. Trib. 20)	Kennebunk, Kennebunkport, North Kennebunkport Lyman	From Kennebunkport village to the mouth of Carlisle Brook—stream warm; pickerel abundant	

3 — Jones Br. (also called Haynes Br. or Dormans Mill Br.)	North Kennebunkport	Stream warm; pickerel present	
4 — Alewive Br., the outlet of Alewives Pond (P. 67)	Kennebunk	Stream quite fertile; possibly gets too warm for trout	Lower 3 miles—450 F. Brook Trout. Success of stocking doubtful
5 — Duck Br.	North Kennebunkport	Stream very small	
7 — Carlisle Br.	Lyman		Lower 3 miles—550 F. Brook Trout
9 — (no name), the western outlet of Kennebunk Pond	Lyman		Lower 2½ miles—350 F. Brook Trout
Lord Br.—the headwaters of the Kennebunk River and the eastern outlet of Kennebunk Pond	Lyman		Three miles of Lord Br. above the the mouth of Carlisle Br.—550 F. Brook Trout
Batson R. (Atl. Trib. 25)	Kennebunkport	The stillwater on the Batson R. ½ mile above tidewater is unsuitable for trout—on Aug. 3, water temp. 75°F. at surface and 59°F. at bottom (7 ft.), oxygen 5.8 p.p.m. at surface but 0.0 p.p.m. at 7 ft. The river above this stillwater is too small to stock	
3 — Smith Br.	Kennebunkport	Stream warm	
Little R. (Atl. Trib. 26)	Biddeford	Stream small	
Saco R. (Atl. Trib. 28)	York and Cumberland Counties	From Biddeford to the mouth of the Ossipee R., stream is warm and pickerel and bass are abundant	

STOCKING RECOMMENDATIONS—Continued

Stream Number	Stream Name	Location (township	General character of stream if not well suited for trout	Recommendations for yearly trout stocking (fish per mile) or other management
7	West Br.	Biddeford	Stream warm	
9	Thatcher Br.	Biddeford	Stream warm	
11	Deep Br.	Saco	Pickerel present	Three miles of stream—350 F. Brook Trout
9	Sandy Br.	Saco	Stream small	
15	Black Br. (or Swan Pond Br.) or Goodwins Mill Br.	Biddeford, Lyman	The section of this brook in Biddeford township (Black Br. or Swan Pond Br.) is too warm for trout. The 3-mile stillwater at the head of Goodwin's Mill Br. in Lyman is very acid (pH below 5.2); recommend no stocking for this stillwater	The 4½ miles of Goodwins Mill Br. in Lyman—450 F. Brook Trout
1	Buzzel Br. or Smith Br.	Biddeford, Dayton		Four miles of stream—275 F. Brook Trout
2	Lunt Br. and Green Br.	North Kennebunkport	Water very turbid; stream quite warm	Two miles of stream—350 F. Brook Trout. Success of stocking doubtful
3	Desart Br.	Biddeford, Dayton, Lyman	Stream small	
25	Houston or Mill Br.	Saco, Buxton	Lower 2 miles of stream warm; pickerel present. Upper 1½ miles of stream quite small	

26 — Pothook Br.	Dayton	Stream small	
27 — (no name)	Dayton	Stream very small	
29 — Red Br.	Dayton	The lower 1 mile of Red Br. approaches maximum temperature limit for trout	Two miles of stream—200 F. Brook Trout
31 — Cooks Br.	Dayton, Hollis, Lyman, Waterboro	Stream warm up to Clarks Mills	Four miles of stream above Clarks Mills—500 F. Brook Trout
4 — Stoney Br.	Hollis	Stream warm	
39 — (no name)	Buxton	Stream small	
42 — Junkins Br.	Hollis		Lower 2½ miles of stream—550 F. Brook Trout
53 — Martin Br.	Hollis	Stream warm	
55 — Outlet of Eagle Pond (P. 93)	Buxton	Stream small and warm	
63 — Jose Br.	Standish (in Cumberland Co.)	Stream warm in lower part; small in headwaters	
68 — Kellick Br.	Limerick, Hollis, Waterboro		Four miles of stream (2 miles above and 2 miles below North Hollis) 420 F. Brook Trout
70 — Little Ossipee R.	Source in Balch Pond in Newfield and Acton; empties into Saco R. at East Limington	Entire stream too warm for trout; temperatures at 8 stations from source to mouth were mostly between 75° and 80°F. Bass present in most sections; bass abundant but grow slowly in lower section in Limington	

STOCKING RECOMMENDATIONS—Continued

Stream: Number — Name	Location (township)	General character of stream if not well suited for trout	Recommendations for yearly trout stocking (fish per mile) or other management
1 — Outlet of Horne Pond (P. 101)	Limington	Stream warm	
2 — (no name)	Limington	Stream small, probably warm	
4 — (no name)	Limington	Stream small and warm	
15 — Yoho Br. (the upper sections Called Clark Br. and Allen Br.)	Limerick	Yoho, Clark and Allen Brooks all warm	
Fulsom Br., the main inlet of Holland Pond	Limerick, Cornish	Stream warm	
16 — (no name)	Waterboro	Stream small	
17 —Outlet of Little Ossipee Pond	Waterboro	Stream very warm	
21 — Spencer or Thyng Br. (the headwaters called Heath Br.)	Limerick, Parsonsfield	Spencer or Thyng Br. in Limerick is very warm; Thyng and Heath Brooks in Parsonsfield are warm	Lower 5 miles—640 F. Brown Trout. Three miles of Heath Br.—540 f. Brown Trout.
3 —Lord or Fenderson Br.	Parsonsfield	Stream warm	
26 — Buff Br.	Waterboro	Stream warm as it leaves Northwest Pond at Ross Corner. Pickerel and Yellow Perch present	Lower 3 miles of Buff Br. up to mouth of Branch Br.—1,200 F. Brook Trout.
3 — (no name)	Waterboro	Stream small	
4 — Branch of Buff Br.	Waterboro		Lower 1½ miles—420 F. Brook Trout

29 — Plummer Br.	Newfield, Parsonsfield	Stream warm from South Parsonsfield to mouth. Pickerel present	
30 —Outlet of Symmes Pond	Newfield	Stream warm	
31 — Fairground Br.	Newfield	Badly polluted by sawdust at West Newfield	
The main inlet to Adams Pond (P. 133)	Newfield	Warm and with Yellow Perch and pickerel present in lower section; stream small in headwaters	
32 — Big Davis Br.	Shapleigh		Lower 2½ miles—1,100 F. Brook Trout
1 — Norton Br.	Shapleigh	Lower section posted against fishing; upper sections small	
34 — (no name)	Newfield	Stream small and warm	
Trib. 2 of Balch Pond	Most of Stream in N.H.; part in Newfield Twp. in Maine	Section of stream in Maine is small	
Maine inlet of Hidden Lake	Newfield		Lower 1½ miles—220 F. Brook Trout
74 — Outlet of Watchic Pond	Standish Twp. in Cumberland Co.	Stream warm; pickerel present	
75 — (no name)	Standish	Stream small	
77 — Strout Br.	Standish		Lower 2 miles—310 F. Brook Trout
1 — (no name)	Standish	Stream small	
2 — Town Dump Br.	Standish	Stream very small	

STOCKING RECOMMENDATIONS—Continued

Stream Number	Stream Name	Location (township)	General character of stream if not well suited for trout	Recommendations for yearly trout stocking (fish per mile) or other management
78 —	(no name)	Standish	Stream small	
80 —	Quaker Br.	Baldwin Twp. in Cumberland Co.	Lower 1 mile of stream warm and with some sawdust pollution	Two miles of Quaker Br. below the mouth of Heath Br.—430 F. Brook Trout
5 —	Heath Br.	Baldwin		Lower 1 mile—360 f. Brook Trout
84 —	Pigeon Br.	Baldwin	Stream small and warm	
86 —	Back Br.	Limington Twp. in York Co.	Trout very abundant; growth by trout is slow	Natural spawning adequate; no stocking recommended
89 —	Pugsley Br.	Limington, Cornish	Trout very abundant; growth by trout is slow	Natural spawning adequate; no stocking recommended
1 —	Merrifield Br.	Cornish, Limington	Stream small	
2 —	Pease Br.	Cornish	Trout abundant; growth by trout is slow	Natural spawning adequate; no stocking recommended
91 —	(no name)	Cornish	Stream very small	
	Goosefare Br. (Atl. Trib. 29)	Saco, Old Orchard		Three miles of stream above tidewater—320 F. Brook Trout
	Scarboro R. (Atl. Trib. 31)	Scarboro Twp. in Cumberland Co.	Brackish	
2 —	Nonesuch R.	Scarboro in Cumberland. and Saco in York Co.	Entire stream too warm for Brook Trout. The headwaters in Saco are small; for 3 miles above tidewater the stream is too warm	The upper 5 miles of stream in Scarboro (only)—430 F. Brown Trout

42 — Foss Br.	Saco	Stream small	
44 — (no name)	Saco	Stream small	
48 — (no name)	Saco	Stream small	
4 — Mill Br. or Millikin Mill Br.	Old Orchard and Saco in York Co.		Two miles of stream above tidewater—550 F. Brook Trout
6 — Mill Br.	Scarboro in Cumberland Co.	Stream small	
11 — Dunstan R.	Scarboro	Brackish	
4 — Phillips Br.	Scarboro	Stream very small	
Beaver Br.—the headwaters of the Dunstan R.	Scarboro	Stream small	
18 — Stuart Br. or Larry Br.	Scarboro, Saco		Lower 2 miles of stream—85 F. Brook Trout
Cascade Br.—the headwaters of the Scarboro R.	Scarboro, Saco		Lower 1½ miles just above tidewater—270 F. Brook Trout
Fore R. and Stroudwater R. (together Atl. Trib. 46)	Portland, Westbrook and Gorham in Cumberland Co.; Buxton in York Co.	From village of Stroudwater to South Gorham, Stroudwater R. is warm and water is very turbid. Fore R. is an estuary	Two miles of Stroudwater R. just above South Gorham—490 F. Brook Trout
5 — Red Br.	South Portland and Scarboro in Cumberland Co.		Two miles of stream above Rye Pond—160 F. Brook Trout
4 — (no name)	South Portland	Stream very small	
8 — Capsic Br.	Portland	Stream very small	
25 — Indian Camp Br.	Gorham	Stream small	

STOCKING RECOMMENDATIONS—Continued

Stream Number	Stream Name	Location (township)	General character of stream if not well suited for trout	Recommendations for yearly trout stocking (fish per mile) or other management
28	South Branch of Stroudwater R.	Gorham, Scarboro	Pickerel present. Harmon Br. (the headwaters of South Branch) is too small to stock	The 2½ miles of South Branch from South Gorham to the mouth of Silver Br.—370 F. Brook Trout
9	Silver Br.	Scarboro	Stream quite small	Lower 2 miles—220 F. Brook Trout. Success of stocking doubtful
Presumpscot R. (Atl. Trib. 48)		Cumberland Co.	Stream mostly warm (mostly as high as 78°F.)	Three miles of Stream from Dundee Falls to South Windham—1,000 legal Brown Trout Success of stocking doubtful
16	Piscataqua R.	Falmouth, Cumberland	Stream quite warm, water turbid. A small amount of sawdust pollution present	The 5½ miles of stream just above West Falmouth—540 F. Brown Trout. Success of stocking doubtful
1	East Branch Piscataqua R.	Falmouth and Cumberland Twps.	From Falmouth Station to Cumberland Station, stream warm and water very turbid	Two miles of stream above Cumberland Station—360 f. Brook Trout
12	White's Br.	Cumberland Twp.	Water very turbid	
18	(no name)	Cumberland Twp.	Stream small	
24	Meader Br.	Falmouth	Stream very small	
25	(no name)	Portland	Stream dry to pools	
29	Minnow Br.	Westbrook, Falmouth	Stream bed dry	

30 — Mill Brook	Westbrook	Stream small and warm	
49 — Inkhorn Br.	Windham	Stream warm and mostly small	
58 — Little R.	Gorham in Cumberland Co. and Buxton in York Co.	Entire stream quite warm, bass and pickerel present, water very turbid	
6 — Tannery Br.	Gorham	Stream small, water turbid	
8 — North Branch of Little R.	Gorham, Standish		The 4½ miles of stream in Gorham Twp.—660 F. Brook Trout
6 — (no name)	Gorham		Lower 2 miles—250 f. Brook Trout
12 — (no name)	Gorham	Stream very small	
15 — (no name)	Gorham	Partly posted against fishing	Lower mile of stream—420 F. Brook Trout
18 — (no name)	Gorham	Posted against fishing	
59 — Colley Wright Br.	Windham	Stream warm and mostly very small	
61 — (no name)	Gorham	Stream small	
64 — Black Br.	Windham	Stream very small and warm	
71 — Pleasant R.	Windham, Gray	Stream warm below the outlet of Little Sebago Lake and quite warm above	Four miles of stream above the mouth of Ditch Br. (outlet of Little Sebago Lake)—710 F. Brown Trout
7 — Ditch Br. (outlet of Little Sebago L.)	Windham	Stream warm	
12 — (no name)	Windham	Stream very small	
76 — (no name)	Windham (enters Presumpscot R. at Whitney Falls)	Stream small but good trout water	Lower 1½ miles of stream—270 F. Brook Trout

stocked with 400 (2 miles x 200 per mile) Brown Trout. The recommendations include stocking of 2 to 3 inch fingerlings (designated as "f") and 5 to 7 inch fingerlings (designated as "F"). Recommendations for stocking certain streams are followed by the remark "Success of stocking doubtful"; such streams are second-class trout waters and should be given second choice in the stocking program.

SUMMARY OF STOCKING RECOMMENDATIONS

Of the approximately 2,100 miles of creeks, brooks and rivers in the area, 164 miles are recommended as suitable for and in need of trout stockings. This includes 131 miles of first class trout waters for which the total number of fish to be stocked yearly (see Table VI) is 15,730 Brook Trout and 3,320 Brown Trout; and 33 miles of second class trout waters (in stocking table, recommendations are followed by "success of stocking doubtful") for which the total number of fish recommended for yearly stocking (see Table VII) is 1,020 Brook Trout and 2,840 Brown Trout.

TABLE VI. Yearly stocking recommendations for 131 miles of first-class trout streams in the area

Kind of trout	Size of fish to be planted			
	F. – 5″ to 7″		f. – 2″ to 3″	
	Miles of stream	No. fish	Miles of stream	No. fish
Brook Trout	84.0	13,480	15.0	2,250
Brown Trout	24.0	2,380	8.0	940

TABLE VII. Yearly stocking recommendations for 33 miles of "second-class" trout streams in the area

Kind of trout	Size of fish to be planted			
	F. – 5″ to 7″		f. – 2″ to 3″	
	Miles of stream	No. fish	Miles of stream	No. fish
Brook Trout	7.0	1,020	1.5	600
Brown Trout	24.5	2,840	——	——

The total number of trout (Brook and Brown together) recommended as yearly stocking for the 164 miles of stream is 23,510 (19,720 5- to 7-inch fingerlings and 3,790 2- to 3-inch fingerlings). According to records in the office of the Fish and Game Department, the streams in this same area were stocked during the fiscal year of July 1, 1936 to June 30, 1937 with the following:

Brook Trout	1,000	adults
" "	11,000	4- to 6-inch fingerlings
" "	42,000	fry
Brown Trout	12,100	adults
Total	66,100	

On the basis of expected normal mortality the 42,000 Brook Trout fry (averaging approximately 1 inch long) would be equivalent to a stocking of approximately 3,500 3-inch fingerlings or approximately 2,000 6-inch fingerlings. The total 1936-37 stocking of 66,100 fish was thus equivalent to somewhat over 25,000 6-inch fingerlings. On the basis of the present stocking recommendations, the streams of this area received somewhat more fish than they should have during 1936-37.

The 2,100 miles of streams in the area include an additional 27.7 miles which were found to be "short trout" streams where either the water was so cold, food so rare or young trout so abundant that the trout were growing very slowly and further stocking is very undesirable. These "short trout" streams are as follows:

Trib. 2 of Wilson's Pond (P. 22) in Acton	0.5 miles
Branch Br. or Little R. in Wells	9.7 "
Back Br. in Limington	6.3 "
Pugsley Br. in Limington and Cornish	2.9 "
Merrifield Br. in Limington and Cornish	4.9 "
Pease Br. in Cornish	3.4 "

STREAM IMPROVEMENT

The two streams of the area most outstandingly in need of stream improvement are the Little River (Trib. 35 of Salmon Falls-Piscataqua River) in Lebanon and Berwick and the Branch Brook or Little River on the Wells-Kennebunk Township line. The two streams are almost opposite in character and require different types of improvement.

The entire Little River in Lebanon becomes much too warm (close to 80° F.) for trout during summer. The stream bed is very wide and contains many large boulders which protrude above the surface of the water, absorb heat from the sun and transmit this heat to the water. Proper stream improvement would include the removal of many of the large boulders from the stream bed and the construction of boulder deflectors to confine the current to a more narrow channel, dig out deeper pools and speed up the current.

Most of Branch Brook (on the Wells-Kennebunk Twp. line), starting about 2 miles above its mouth, could be greatly improved. At present it is a "short trout" stream with very cold water, almost entirely of sand bottom with food organisms rare, and with too large a population of small trout which are growing very slowly. What the stream needs is somewhat warmer water, more silt, gravel or rubble bottom which presumably would be more productive of food, and possibly a removal of part of the trout population. It is recommended that the stream be used as an experimental project, under supervision of the local Game Warden, and a series of small dams and ponds be created at advantageous points. Such small ponds would warm up the water and would develop a productive silt or mud bottom. Possibly the introduction of a few beaver colonies at certain points would be effective. Only a few such ponds should be constructed at first, and their effect should be determined before further impounding is attempted.

LAKE AND POND SURVEY

Introduction to pond survey[9]*:* It is a safe assumption that practically all ponds and lakes in Maine experience a regular, seasonal cycle of change in their physical and chemical properties. These physical and chemical properties, and the changes thereof, are of utmost importance to fish life, especially to such "cold-water" species as the salmons and trouts. The yearly, water-temperature cycle in lakes and ponds is the most conspicuous, and probably also the most important to trouts, of the changes in physical conditions. Most or all of the other seasonal changes in lakes are either directly the result of, or closely dependent upon, the water temperature cycle.

The water temperature cycle in lakes is dependent mostly upon two conditions: (1) that the maximum density of water is at 4° Centigrade

[9]For a complete discussion of the physical and chemical characteristics of lakes, see Welch, Paul S.: 1935, Limnology. McGraw-Hill Book Co., New York, 471 pp.

(39° Fahrenheit), i. e., that a unit of volume of water at 4° C. is heavier than at temperatures of either more or less than 4° C.; and (2) that water in lakes is heated and cooled mostly by direct contact with air at the surface. The importance of these two factors can be illustrated by supposing a typical Maine salmon lake 100 feet deep and over 1,000 acres in area, and describing the seasonal changes in temperature which would take place. There are four distinct stages in the seasonal temperature cycle of lakes; and, during these four stages, one might expect to find, in a lake of this depth and size, approximately the following temperature distribution:

1. *Mid-winter stagnation stage:* Lasting from December until the ice "goes out" in early spring. Water temperature 32° F. just below the ice and becoming gradually warmer toward the bottom; never any warmer than 39° F. on the bottom and usually not over 36 to 38° F. During this period there is practically no movement of the water.

2. *Spring turnover stage:* Occurring usually only a few days after the ice disappears in the spring, and lasts only a few days depending upon the amount of wind and the air temperature. Water temperature uniform from top to bottom and at 39° F. or slightly warmer. Wind action produces water currents which roll and mix the water completely from top to bottom.

3. *Summer stagnation stage:* Commences immediately after the spring turnover stage and continues as long as warm weather lasts, usually into September. During this period the lake water may be divided into three distinct depth regions on the basis of temperature: (a) An upper layer (epilimnion) in which the water is quite uniformly warm (in large lakes this layer extends down about 18 to 25 feet; the temperature at 20 feet would be perhaps 2 or 3 degrees colder than at the surface), (b) a middle layer (mesolimnion or thermocline), extending from a depth of about 20 feet to 30 or 35 ft., through which there is a very sharp drop in temperature with increase in depth (for example: the temperature might be 76° F. at 20 feet and 50° F. at 35 feet), and (c) a lower layer (hypolimnion), extending from 30 or 35 feet to the bottom, through which the drop in temperature is very slight compared to depth (for example: 50° F. at 35 feet, and 44° F. at 100 feet). During this summer stagnation period, the warmer water is on top because it is the lighter, and this difference in weight between the upper warm and deep cold

water is very great. Summer wave action and water currents tend to force the warm water down to mix with the cold water below, while the greater weight of the cold water tends to work against this mixing; the warm water extends down farther and farther as the summer progresses and the depth to which it does finally descend depends upon the strength of the waves and water currents which in turn depend upon the size and shape of the lake and the amount of wind action.

4. *Fall turnover stage:* Commences after the lake water has cooled down to 40° to 45° F. in the fall and lasts for several days to a week or more (in October or November) depending upon general weather conditions of air temperature and wind. Water temperature uniform from top to bottom until the water cools to 39° F. or slightly less. Water "rolls" and mixes from top to bottom due to wind action.

The change from one stage to another is mostly quite gradual due to the high specific heat of water. After the ice disappears in the spring, the 0° F. water at the surface in contact with warmer air begins to heat up. As it does so it becomes heavier and sinks to mix with and displace the colder water below. This process continues until all the water in the lake is at 39° F. and at its maximum density. Since there is then no difference in weight between different layers of the water, a moderate wind can roll the water from top to bottom. As the surface water now comes in contact with the warmer air, its temperature rises above 39° F. and its weight per unit volume decreases. This warm water now stays on top, and continues to do so as the lake warms up during the summer. We then have the summer stagnation stage as described under 3 above. When the water begins to cool in the fall the process is reversed. The water cooling at the surface becomes heavier and sinks to displace the warmer water just below. This continues until all the water is of a uniform temperature from top to bottom. The water will then remain uniform in temperature from top to bottom until it cools to 39° F. Thereafter, as the surface water cools below 39° F., it becomes lighter than the warmer water just below and therefore stays on top; this process continues until ice forms on the lake and conditions are as described under 4 above.

The yearly cycle of dissolved oxygen, pH ("acidity"), and free carbon dioxide content of lake water depends upon the temperature cycle, and also upon other factors, namely:

1. The inherent ability of cold water to contain more dissolved oxygen than warm water.
2. The production of oxygen in water by aquatic plants, in Maine lakes mostly by the plant plankton since the higher plants are generally rare.
3. The absorption of oxygen from the air by water at the surface.
4. The liberation of carbon dioxide into the air by water at the surface.
5. The amount and rate of decomposition of organic mud on the bottom—this decomposition at the bottom removes oxygen and produces carbon dioxide.
6. The removal of oxygen from water by both animal and plant life, including bacteria.
7. The liberation of carbon dioxide into water by both animals and plants.

Of the above factors, Nos. 1, 3, 4 and 5 are probably the most important in the changes of the chemical properties of lake water (at least in most Maine lakes). When water comes in close contact with the air it rapidly becomes saturated with oxygen and rapidly loses most of its carbon dioxide. Thus, when lake water is being mixed from top to bottom during the spring and fall turnover stages, the oxygen content of the water from the surface to the bottom is high and the carbon dioxide content is low. Following the spring turnover, however, temperature stratification makes it impossible for the deeper water to come in contact with the surface. Whether or not this deeper water will retain enough oxygen for trout and salmon throughout the summer, and not accumulate too much carbon dioxide, depend mostly upon the amount of water in the hypolimnion and the rate of decomposition of the bottom material. In a deep lake a moderate amount of decomposition might not be very serious because of the presence of a large amount of deep cold water; in a more shallow lake, the same amount of bottom decomposition might be sufficient to make all of the deep water unsuitable for fishes.

Under natural conditions in lakes, the oxygen content and carbon dioxide content tend to be complementary in their vertical distribution since those processes which take up oxygen liberate a somewhat corresponding amount of carbon dioxide. Thus, where the oxygen content is high, the carbon dioxide is usually low; and vice versa.

Tests made by the writer up to the present time on about forty lakes indicate that most of the natural lakes in southern Maine are more or less

acid—even the upper water in the epilimnion. Summer tests on all of these lakes indicated that the deep water during summer is much more "acid" (a higher hydrogen ion concentration) than the upper water. This variation in vertical distribution of pH reflects the variation in vertical distribution of carbon dioxide; that is, the deeper water is more acid due to the presence of more carbon dioxide produced by decomposition of bottom material and of organic material suspended in the hypolimnion. Thus comparative pH tests are regarded, for most lakes of southern Maine, as a fairly good general index of the amount of carbon dioxide in the deeper water.

Requirements of trout and salmon in ponds: The requirements of trout and salmon are much the same in lakes and ponds as in streams. The most important of these requirements are:

1. *Cold water:* at least below 75° Fahrenheit, preferably below 70° F. There is considerable evidence that Brook Trout, at least, will live and do well in water 75° F. and warmer in shallow ponds where competing warm-water game fishes, such as the perches, bass and pickerel, are not present; recent studies on Quimby Pond near Rangeley, and reports by Game Wardens from the northern part of Maine substantiate this statement. It appears that in most of the lakes of southern Maine, trout and salmon occupy the deep and cold water probably partly because of preference but also partly because they cannot tolerate the competition of the warm-water species which live mostly in the upper water. The maximum temperature limit of 70° F. is, therefore, tentatively set for those lakes of the southern part of Maine where warm-water fishes are present.
2. *Oxygen:* at least 5 p. p. m. (parts per million) of dissolved oxygen in the water. The minimum oxygen requirement is set by some investigators at 4 p. p. m.; however our studies on Maine lakes indicate that trout and salmon do best in water with much more than 5 p. p. m. of oxygen. In determining the amount of trout or salmon water in a lake during late summer, it would make little difference whether the minimum was set at 5 p. p. m. or 4 p. p. m., because, in those regions where the oxygen is as low as 5 p. p.m., the oxygen content usually varies markedly with slight change in depth.
3. *pH (acid intensity):* of approximately 5.0 to 9.0 for trout, best above 6 for salmon. Trouts can tolerate much more acid water than most other game fishes. However, a low pH in deep water

reflects low oxygen and high carbon dioxide which trout and salmon can not tolerate.

4. *Adequate food supply:* Trout and salmon up to a length of about eight inches feed mostly upon insects. These must be mostly bottom insects when trout and salmon are confined to the deep water during the summer months. Thus the amount of bottom area available to these fish, and the abundance of bottom food organisms are important. Larger trout and salmon feed mostly upon small fishes and, in Maine lakes, the Smelt is the only small fish which is abundant in deep water during the summer. Thus the Smelt is an absolute necessity to the production of large Landlocked Salmon[10] and is probably also important to large Brook Trout and togue (Lake Trout).

5. *Spawning grounds:* Brook Trout and salmon are inherently stream spawners. (Possibly they do spawn in lakes under certain conditions, but this occurs rarely and is of little general importance.) Therefore, if stocking of a lake is done with the idea of establishing a partially or entirely self-sustaining population of trout or salmon, the lake should have tributary streams which offer suitable spawning conditions for the adults and conditions favorable for good growth of the young for at least two years. However, there are many lakes which lack trout-stream tributaries but which are good enough as trout lakes to justify continued yearly stocking with the realization that fishing will harvest only the stocked fish.

6. *Stream habitats:* Young Brook Trout and salmon (also Browns and Rainbows, not togue) normally live in streams for two years or more and until they reach a length of at least six to eight inches. It is biologically unsound to plant trout and salmon fry (not togue) in lakes and ponds. Fry should be planted only in suitable tributary streams. If the lake has no such streams, the fish should be reared in the hatchery to a length of at least six to eight inches (preferably more) before they are planted in the lake.

Stability of lakes and ponds: The physical, chemical and biological (to some extent) conditions in lakes and ponds change from year to year only in proportion to the rate at which bottom material accumulates in the basin of the lake. From the geologist's point of view, all lakes are in

[10]Kendall, W. C.: 1935. The fishes of New England. The Salmon family. Part 2.—The Salmons. Memoirs Boston Society Natural History, Vol. 9, No. 1, see p. 146.

the process of extinction by filling in of the lake basin with eroded soil and organic materials from aquatic plants and animals. In deep and relatively unproductive lakes with little plant life this process of filling in is extremely slow; but in the final stages in very shallow lakes, the process is much more rapid. Fortunately most of Maine's good trout and salmon lakes are of the former type, and are changing very little from year to year. Probably such a body of water as Sebago Lake (see a later lake survey report) has not changed appreciably in its physical and chemical properties for the past several hundred years or much longer. Probably, also, such a body of water will not change much for centuries to come, assuming that no large amount of organic pollution will enter the lake. Therefore, the temperature, oxygen and pH data given below should be applicable to these lakes and ponds for many years in the future, and the lakes which are now good trout waters from the standpoint of temperature and oxygen will probably continue to be so for centuries. The fish populations in lakes, however, are subject to a much more rapid change, especially where new species are introduced. A continual knowledge of these changes in each lake is necessary to efficient fisheries management.

Data obtained by survey: The limited amount of lake survey which was conducted during the summer of 1937 was made mostly with the purpose of determining the suitability of each lake for trout and salmon. The survey was conducted during the summer months because that is the period during which conditions affecting the distribution of trout and salmon in lakes are most critical. Vertical series of water samples were analyzed and the data are presented in table form in the following discussion of each lake. The kinds and abundance of fishes were determined by collections made with gill nets (having a variety of mesh sizes) and seines. Soundings were made to determine the maximum and general average depth of water. The data on pond areas (probably not very accurate) were obtained by using a planimeter on the lake outlines as given on the United States Geological Survey Topographic Sheets.

Since the study of these ponds was very limited, the data can answer only a few of the many important problems involved, but some of the questions which can be answered at the present time are of sufficient importance to the state's fish planting program to justify the presentation of the few data obtained.

PONDS OF THE AREA

BUNGANUT POND (P. 56) is located in Lyman Township, York County, and is tributary to Shaker Pond and Middle Branch River. It is

1¾ miles long and ½ mile wide, and has an area of 280 acres. The water is clear and white. The bottom is mostly sand and rubble near shore, but there are thick deposits of mud in the deeper portions of the pond. The maximum depth sounded was 34 feet, but most of the pond was less than 28 feet deep.

Vertical series of water samples were analyzed on August 5 and on August 9 (data are given in Table VIII). At this time the warm water extended down to a depth of 12 feet, and there was not enough oxygen for trout or salmon below about the 14-foot level. The low pH below 15 feet also indicated excessive decomposition in the deep water. At best,

TABLE VIII. Vertical distribution of temperature, oxygen and pH in Bunganut Pond (1937)

August 5 (11 A.M. to 1 P.M.) near the center of the pond in water 32 feet deep				August 9 (4 to 6 P.M.) near the center of the pond in water 26 feet deep			
Depth in feet	Temp.: °F.	Oxygen: p.p.m.	pH*	Depth in feet	Temp.: °F.	Oxygen: p.p.m.	pH*
Surface	82	7.9	6.9	Surface	80	8.0	6.8
5	75	...	6.8	5	80	...	...
10	74	...	...	10	75	7.3	6.6
12	73	7.1	6.5	12	72	...	...
15	65	...	5.7	14	68	...	...
20	58	1.2	5.6	15	64	3.1	6.0
25	53	2.0	5.6	16	62	...	...
30	49	...	5.6	17	60	...	...
32	49	1.7	5.6	18	59	...	...
..	..	...	...	19	56	...	...
..	..	...	...	20	55	1.9	5.9
..	..	...	...	22	53	...	...
..	..	...	...	25	51	1.9	5.6
..	..	...	...	26	51	...	...

*pH tests of 6.6 and above with bromthymol blue indicator, tests of 6.5 and below with bromcresol purple.

there was an exceedingly small amount of water suitable for trout and salmon during the first part of August, and it is safe to conclude that by the end of August there was no trout water present at all.

The game fishes found to be present were White Perch (abundant)[11], Small-mouthed Bass (common), Pumpkinseed or Common Sunfish (common), and Pickerel (rare). Yellow Perch were found in the stomachs of White Perch which indicates that this species is present. No minnows or young bass were taken by our seining; thus they could not have been very abundant and were probably rare. The abundance of White Perch and the fact that they are growing rapidly (see Appendix A of this report) are sufficient evidence that Bunganut is well suited to this species. The lake is also well adapted to bass.

Bunganut Pond was stocked with 2,000 Land-locked or Lake Salmon[12] on May 21, 1934. Subsequent fishing and our fish collections indicate that the species was not established from this small experimental planting. It seems most obvious that the adverse conditions of temperature and oxygen in the pond must have been the most important causes of this failure.

Recommendations: No trout, salmon or any other species of cold-water fishes should be stocked in Bunganut Pond. It has no trout water (according to standards previously described) nor any inlet streams which could carry trout over the summer period.

It is believed that the White Perch population can maintain itself without artificial stocking. However, if White Perch are available, this pond could support more than it now has, judging from the present rapid growth of those perch which are already present.

Due to the scarcity of young bass, it is believed that bass fishing could be greatly improved by stocking this species. Recommend yearly stocking of 2,000 to 5,000 (depending upon number available) 2- to 3-inch Small-mouthed Bass.

Recommend yearly stocking of forage fishes as food for bass and perch. The Golden Shiner would be, by far, the best. This minnow was found in enormous schools at the junction of the Middle Branch and Mousam rivers in Sanford; this source is recommended. This minnow collecting should be done under the supervision of one who knows the minnow

[11]Three categories—abundant, common and rare—are here used to denote the relative abundance of the different species.

[12]All data on fish plantings are from the records of the Department of Inland Fisheries and Game.

species as it is important to obtain the kind of minnow adapted to lake conditions.

MOUSAM POND (P. 63) is located in Acton and Shapleigh townships, York County. It is approximately 4 miles long by ½ mile wide, and is 750 acres in area. The water is clear and white. The bottom slopes off gradually to the 15-foot contour and then drops rather abruptly to 100 feet or more throughout much of the pond. The bottom material is mostly sand and rubble near shore, and mostly mud in the deeper parts.

Water analyses were made on July 16 in 80 feet of water (data given in Table IX). The upper warm-water layer (epilimnion) extended down to a depth of 15 feet; and there was sufficient oxygen for trout and salmon at all depths, although both the oxygen and pH tests indicated some

TABLE IX. Vertical distribution of temperature, oxygen and pH in Mousam Pond on July 16, 1937 (11 A.M. to 3 P.M.) at a point near the center of the pond in water 80 feet deep

Depth in feet	Temp.: °F.	Oxygen: p.p.m.	pH*	Depth in feet	Temp.: °F.	Oxygen: p.p.m.	pH*
Surface	71	...	6.9	28	55	...	...
10	71	...	...	29	53	...	...
15	70	...	...	30	53	...	...
16	67	8.0	6.6	31	52	...	...
18	66	8.0	6.6	32	51	...	...
19	65	...	...	33	50	8.4	6.2
20	64	...	...	34	50	...	...
21	63	...	6.5	35	49	...	...
22	61	7.8	6.4	40	49	...	...
23	60	...	...	45	48	...	...
24	58	...	...	50	48	...	...
25	57	...	...	65	47	...	...
26	57	...	...	70	46	8.4	6.2
27	55	...	6.3	80	46	6.9	6.2

*With bromthymol blue indicator.

organic decomposition in the deep water. It was estimated that, by the end of August, the upper warm water would have extended to a depth of about 25 feet and the oxygen content of the deep water would have been reduced to somewhat below the July 16 values. However, the July 16 analyses indicate that the great bulk of the water of Mousam Pond is suitable for trout and salmon at all times; in other words, from the standpoint of the water, Mousam is an excellent trout or salmon lake.

The game fishes found to be present were White Perch (abundant), Pumpkinseed Sunfish (common), and Chinook Salmon (rare—one individual taken by a 377-foot gill net set at various depths for a total of 182 hours). The Common Sucker was common in abundance.

We found no evidence that Smelt were present. The single Chinook contained twelve small perch but no Smelt. The stomachs of forty-four White Perch contained no Smelts, although we have found in other lakes that they do feed extensively on Smelt when they are available. Local residents reported that the Smelt had recently declined in numbers almost, if not entirely, to the vanishing point.

Mousam Pond had recently been stocked with Chinook Salmon as follows: 45.800 two- to three-inch fish, and 60,000 four- to six-inch fish during 1934; and 10,000 two- to four-inch fish, and 75,000 four- to six-inch fish during 1936. Local residents reported catching some Chinooks, but these reports did not seem to indicate an abundance of this fish which might have been expected to result from the above stocking. Previous to 1934. attempts to maintain good fishing for Land-locked Salmon, by stocking. had not been very successful. Probably the relatively poor results from stocking this lake are due mostly. if not entirely, to the scarcity or absence of Smelt, which, if present, would live in the deep water and be the most important food of the salmon (both Chinook and Land-locked).

Recommendations: Continued stocking of Chinooks can be expected to produce some salmon fishing, but any great improvement of salmon fishing in Mousam Pond in the future must include the reestablishment or increase of the Smelt to accompany further salmon stocking. Furthermore. Mousam is such a good salmon pond from the standpoint of the water that a considerable amount of effort should be spent to restore the Smelt population. This restoration will require getting eggs from some other lake and planting them in the tributaries of the pond, but any great degree of success will require further fish management methods. At present the White Perch is very abundant in Mousam and it is known that perch feed extensively on Smelt. It is believed, therefore, that a great

reduction of the White Perch population is absolutely necessary to the reestablishment of the Smelt which, in turn, is necessary for the improvement of the lake for salmon fishing.

The procedures recommended for the improvement of salmon fishing in Mousam Pond are as follows:

1. Great reduction of the White Perch population. Recommend seining of young when they are congregated in large schools in shallow water during the summer. Encouraging the removal of the adult perch by fishermen by increasing the length of the fishing season on perch and by eliminating the bag limit and size limit.

2. Stocking Smelt eggs in the lower part of Pump Box Brook. Probably desirable to continue stocking for several years.

3. No open season on Smelt in the pond or its tributaries for several years and until this species becomes very abundant.

4. Continued stocking of the lake with Chinook Salmon, and, after the Smelt is reestablished, with Land-locked Salmon.

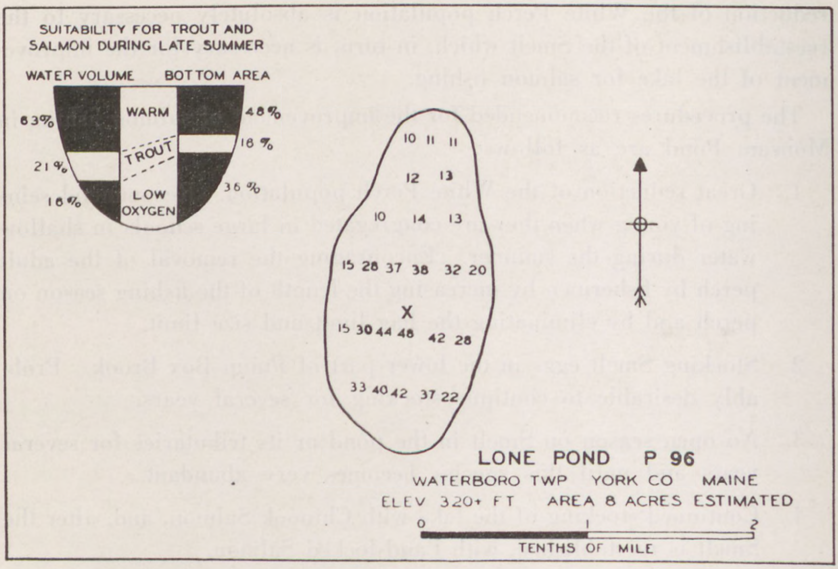
DEER POND (P. 88) is located in Hollis Township, York County. The pond is about ½ mile long and has an area of about 37 acres. The water is clear and light brown. The bottom is mostly silt and sand. Vegetation is quite abundant.

The game fishes found to be present were: Yellow Perch (very abundant), Chain Pickerel (common), and Small-mouthed Bass (rare). The Chub Sucker was also found to be very abundant.

Recommendations: Due to the great abundance of Yellow Perch plus the presence of Chain Pickerel and Small-mouthed Bass, Deer Pond deserves, at best, only a light stocking with trout. A yearly stocking of not over 300 Brown Trout is recommended (Browns would probably be better able than Brook Trout to compete with the perch). If this amount of stocking does not produce some trout fishing, then further stocking is very undesirable.

LONE POND (P. 96) was studied during the summer of 1938 (all other ponds considered in this report were surveyed during 1937). Lone Pond is located in Waterboro Township, York County. It's area is approximately eight acres.

Soundings made on August 7 (see accompanying map—depths are given in feet) revealed a maximum water depth of 48 feet. In 36.3% of the area of the pond the water is over 28 feet deep. The northern



third of the pond is shallow. The bottom is mostly mud in both shallow and deep water. Vegetation is abundant. The pond has no inlet or outlet.

Water analyses (see Table X) were made on August 7 at a point near the center of the pond (at station X on map). On this date, the water was too warm for trout above a depth of 16 feet, and there was too little oxygen for trout below approximately 32 feet. On the basis of these data it was estimated that, during the most critical period in late August, the warm water would extend down to about 18 feet, and the oxygen deficiency would extend up to 28 feet. This would leave a 10-foot layer of water where temperature and oxygen were suitable for trout during the most critical period. Calculating water volumes and bottom areas between these limiting depths of 18 and 28 feet gave the following (see also accompanying map):

Water volume: 108 acre-feet (63%) too warm, 35 acre-feet (21%) suitable for trout, and 27 acre-feet (16%) with oxygen deficiency.

Bottom area: 3.8 acres (48%) covered by water too warm for trout, 1.3 acres (16%) covered by water suitable for trout and upon which trout could feed, and 2.9 acres (36%) covered by water with an oxygen deficiency.

Thus, during the most critical summer period, trout could live in 21% of the water in Lone Pond and could feed on 16% of the bottom. Lone Pond can be called a good trout pond (considering temperature and oxygen), when compared with many ponds in southern Maine which were surveyed during 1938. The extreme acidity of the water in Lone

TABLE X. Vertical distribution of temperature, oxygen and pH in Lone Pond on August 7, 1938 (12 noon to 1:30 P.M.) at a point near the center of the pond in water 44 feet deep

Depth in feet	Temp.* °F.	Oxygen: p.p.m.	pH**	Depth in feet	Temp.* °F.	Oxygen: p.p.m.	pH**
Surface	83.0	8.0	5.6	25	48.0	9.0	5.4
15	71.4	...	...	30	44.0	...	...
18	63.3	12.7	5.5	35	42.6	3.1	5.2
20	56.8	...	...	40	41.9	0.6	5.2
22	52.0	...	...				

*Temperatures with a Negretti and Zambra deep sea reversing thermometer.
**With bromcresol purple indicator.

Pond might be a limiting factor to trout, but this is doubtful, in view of the known occurrence of Brook Trout in other very acid waters in Maine.

A gill net set in 10 to 29 feet of water caught only Pickerel. Observations revealed Pickerel to be common also in shallow water. Warden Gerald Averill reported that Pickerel and the Common Bullhead or Horned Pout were the only warm-water game fishes present, and that previous stockings with Brook Trout have produced only a few trout for the fishermen.

Lone Pond was stocked with 3,000 "mature" Brook Trout in 1934, 2,000 in 1935, and 2,862 four- to six-inch trout in 1936. Returns from the gill net set and reports on fishing indicate that these trout have not done well in the pond. The presence of Pickerel has undoubtedly been one of the important causes for the poor success from this stocking.

Recommendations: Our present plans are to poison Lone Pond to remove the Pickerel and other fishes.* A program of yearly stocking of not over 1,000 six- to eight-inch Brook Trout is recommended, but this should not be done until after the Pickerel are removed. Planting the

*Lone Pond has subsequently been poisoned, see page 56.

Golden Shiner (after the pickerel are removed) to establish a permanent population as food for trout is also recommended.

SAND POND (P. 98) is located in Limington Township, York County. It has an area of about 10 acres, no outlet, clear and white water, an almost entirely sand bottom, and vegetation is rare.

Our survey of this pond was very incomplete, but our seining revealed that bottom food organisms were very rare; and the minnows (3 species) and suckers (1 species) seined from the pond were all very emaciated, reflecting a low fertility of the water. Warm-water game fishes were rare or absent.

Sand Pond was stocked with 3,000 "mature" Brook Trout in 1934. Local reports indicate fair trout fishing.

Recommendations: Yearly stocking of not over 1,000 six- to eight-inch Brook Trout (heavier stocking not desirable due to low fertility of the water).

GRANY KENT POND (P. 128) is located in Shapleigh Township, York County. The pond is ½ mile long, and is about 25 (or more) acres in area. Water is clear and white. The bottom is mostly sand, with some fine silt in the deeper part of the lake. Soundings revealed a maximum depth of 23 feet, and that 80% of the lake is between 15 and 20 feet deep.

Water analyses made on July 27, 1937 near the west end of the lake in water 19 feet deep gave the following results:

Water temperature: 76° F. at surface, 74° F. at 19 feet.

Oxygen: 8.4 p.p.m. at surface, 8.2 p.p.m. at 19 feet.

pH (bromthymol blue): 6.8 at surface and at 19 feet.

During the hottest part of August, the water temperature in this pond would undoubtedly be above 75° F. from top to bottom, or entirely too warm for trout.

The pond has Yellow Perch (common), Chain Pickerel (rare), Common Sunfish (common), and Golden Shiners (rare).

Grany Kent Pond was stocked with 2,000 four- to six-inch Brook Trout during 1934 and 3,000 "mature" trout during 1935.

Recommendations: No further stocking of trout (or salmon) in the future. The pond is suitable only for warm-water fishes. Recommend yearly stocking of not more than 2,000 fingerling Small-mouthed Bass.

SABBATHDAY LAKE is located in New Gloucester Township, Cumberland County, at the headwaters of the Royal River (not in the main

area covered by the present survey.) The lake is $1\frac{1}{2}$ miles long by $\frac{1}{2}$ mile wide and has an area of approximately 400 acres. By sounding we found a maximum depth of 73 feet, and that about three-fourths of the lake is over 40 feet deep. The bottom is mostly rubble and boulders, with a thin mud deposit in the deep part of the lake. The water is white and clear. There is practically no aquatic vegetation.

Water analyses on August 13 and 14, 1937 (data given in Table XI) indicate that, from the standpoint of temperature and oxygen, Sabbathday is an excellent trout and salmon lake. The warm surface water extended only to a depth of 15 feet and oxygen deficiency existed only up to a depth of about 52 feet, leaving a 37-foot layer of good trout water throughout most of the lake. Under extremely adverse conditions this would certainly not be reduced to less than 30 feet.

The present status of the fish population was indicated by gillnetting and seining. A 317-foot gill net, fished for a total of $62\frac{1}{4}$ hours, took 34 Common Suckers, 11 White Perch, 4 Brook Trout, 1 Chain Pickerel and 1 Common Sunfish. Seining in shallow water revealed the following: young White Perch (very abundant), Chain Pickerel (common), Common Sunfish (abundant), Horned Pout (rare), Common Sucker (abundant), and "minnows"—4 species (abundant). Local fishermen reported that the White Perch was abundant.

During the past five years Sabbathday Lake has been stocked with Brook Trout as follows: 25,000 four- to six-inch fish in 1933, 10,000 four, to six-inch and 2,000 "mature" fish in 1934, and 4,000 "mature" fish in 1937. In spite of this stocking, trout fishing has greatly declined in recent years; and, during this time, White Perch (introduced into the lake about 25 years ago, according to reports of local residents) have been on the increase. The coincidence of the decline in trout fishing with the increase in abundance of White Perch, as has recently occurred in many lakes in southern Maine, leaves no doubt that perch eliminate trout by competition for food or in some other way.

Recommendations: Sabbathday Lake has so much good trout water that it should be reclaimed for trout fishing. Drastic control of the White Perch is essential before trout fishing can be greatly improved. There are several alternatives of procedures of perch control which could be employed:

(1) The entire lake could be poisoned to remove all fish; then trout could be restocked. This procedure would be expensive and success can not be predicted with absolute certainty because of the

TABLE XI. Vertical distribution of temperature, oxygen and pH in Sabbathday Lake (1937)

August 13 (12:30 to 2:15 P.M.), 1-4 mile from the south end of the lake, in water 65 feet deep				August 14 (1:35 to 3:30 P.M.), near center of lake, in water 60 feet deep				August 14 (4:30 P.M.), 3-8 mile from south end of lake, in water 37 feet deep		
Depth in feet	Temp.: °F.	Oxygen: p.p.m.	pH*	Depth in feet	Temp.: °F.	Oxygen: p.p.m.	pH*	Depth in feet	Temp.: °F.	Oxygen: p.p.m
Surface	77	8.7	7.1	Surface	75	8.8	7.1	Surface	76	...
10	76	8.9	7.1	5	75	...	...	5	76	...
12	75	...	...	10	75	...	...	10	75	...
14	72	...	...	12	75	8.9	7.1	12	75	...
15	68	...	...	13	73	...	...	13	75	...
17	61	10.0	6.6	14	71	...	...	14	72	...
19	56	...	...	15	68	...	...	15	71	...
20	54	...	...	17	62	10.3	6.7	16	66	...
22	51	...	...	19	57	...	...	17	64	...
24	49	...	...	20	54	...	...	18	62	...
25	48	6.8	6.2	22	52	...	...	19	60	...
30	47	...	...	24	49	...	...	20	57	...
40	46	...	...	25	48	...	...	21	54	...

45	46	5.4	6.1	27	47	6.7	6.1	22	53	...
55	45	4.0	6.1	30	47	...	...	23	52	...
65	45	2.1	6.1	40	46	6.3	6.1	25	50	...
..	..	...	...	50	45	5.6	6.1	27	48	...
..	..	...	...	60	45	4.4	6.1	30	47	...
..	..	...	...	..	..	...	...	34	..	6.7
..	..	...	...	..	..	...	...	37	47	...

*pH tests of 6.6 and above with bromthymol blue indicator, tests below 6.6 with bromcresol purple.

large size of the lake. If success could be guaranteed, it would probably be the best procedure.

(2) The Fish and Game Department could remove all legal restrictions of season, bag limit, and size limit on White Perch in Sabbathday Lake. The beneficial effects of this procedure would be evident in a few years.

(3) Permits could be granted to a few private individuals to seine young perch from the lake. During most of the summer, young perch congregate in shallow water in enormous schools which can be easily surrounded with a 50-foot seine. Persons designated to do the seining could be payed a reasonable bounty for the young perch which they catch, and these fish could be planted in some of the neighboring White Perch lakes. Trout or salmon would not be taken by seining in shallow water because they stay in the deep water during the summer months.

(4) The continual introduction of a non-indigenous form such as the Chinook Salmon or Brown Trout might help to keep the perch under control. There is considerable evidence indicating that these two members of the trout family can compete more successfully with the White Perch in Maine waters than can the native Brook Trout and Salmon.

FISHES OF THE AREA

Approximately 115 collections of fresh-water fishes from the streams and lakes of the area (plus the Crooked River, a tributary of Sebago Lake) were taken by seines and gill nets. These collections contained 28 species of fishes representing 13 families. Two of the 28 species—the Mud Darter *(Hololepis f. fusiformis)* and the Long-nosed Dace *(Rhinichthys cataractae)*—have not previously been recorded (to the writer's knowledge) for Maine. The distribution of these 28 species, according to 11 drainage areas of the region surveyed, is indicated in Table XII. It is not claimed that this distribution table is complete, for undoubtedly most of the species are present in more of the drainage areas than our findings indicated, and there are probably some species present in the region which were missed entirely; however, the results are probably a fairly accurate index of the general abundance of the different species over the whole region.

The Chain Pickerel (or common pickerel) was found in each of the 11 drainage areas. Next in abundance were the Common Sucker (in 10) and the Fallfish (in 8). The Creek Chub-sucker, Common Shiner and Golden Shiner were found in 7. The Brook Trout, Small-mouthed Black Bass, Pumpkinseed Sunfish (or common sunfish) and the Black-nosed Dace were found in 6. The Common Eel and the Yellow Perch were found in 5. The minnow family (Cyprinidae) was represented by 10 species—more than any other family; the trout family (Salmonidae) was represented by four species: Chinook Salmon, Land-locked Salmon, Brook Trout and Brown Trout.

It is well known that certain species of fishes require cold water while others require somewhat warmer water. The trouts are outstanding examples of cold-water species. Another predominately cold-water species is the Slimy Muddler—often called "Miller's Thumb" or fresh-water sculpin—*(Cottus cognatus)*. This is a brownish, mottled fish which never gets to be much more than 3 inches long and has a very large head, large mouth, and very large pectoral fins (see frontispiece). This species was found only in the very cold streams where Brook Trout were abundant. It is known in other states to live almost entirely in "good" trout streams. Thus the Slimy Muddler may be regarded as a fairly reliable "index species" for streams suitable for trout. Another species which was found mostly in good trout streams was the Lake Chub *(Couesius plumbeus)*, and the presence of this species may be regarded as a fair trout stream index, at least for the south-western part of Maine.

APPENDIX A

AGE AND GROWTH OF WHITE PERCH *(Morone americana)*

Studies on age and growth (by the scale method) of game fishes in Maine have been made during the past two years. The following is a partial summary on the age and growth of the White Perch (based on 353 specimens) from the following localities: Pushaw Pond in Hudson, Old Town, Glenburn and Orono townships, Penobscot County; Great Pond of the Belgrade Lakes in Kennebec County; Long Pond of the Belgrade Lakes in Kennebec County; Sabbathday Lake in New Gloucester Township, Cumberland County; Mousam Pond in Acton and Shapleigh townships, York County; and Bunganut Pond in Lyman Township, York County. The perch were collected by gill nets with the following mesh sizes: $2\frac{3}{8}$, $2\frac{7}{8}$, 3, $3\frac{1}{8}$, $3\frac{3}{4}$ and 4 inches stretched measure. The perch

TABLE XII. Distribution of fresh-water fishes in the area, by watersheds, based on collections* made during 1937. The location of the various stream systems are shown on the map accompanying this report. An x indicates that the species was present

Family Common Name, Scientific Name	Piscataqua–Salmon Falls R. (Atl. Trib. 1)	Atlantic Tribs. 2 to 18	Mousam R. (Atl. Trib. 19)	Kennebunk R. (Atl. Trib. 20)	Atlantic Tribs. 21 to 27	Saco R. (Atl. Trib. 28), mouth to Union Falls	Saco R., Union Falls to Ossipee R. (excluding Little Ossipee R.)	Little Ossipee R. (Trib. 70 of Saco)	Atlantic Tribs. 29 to 47	Presumpscot R. (Atl. Trib. 48) up to Sebago Lake	Crooked R. (Trib. 15 of Sebago Lake)
Petromyzonidae											
Sea Lamprey, *Petromyzon marinus*	..	x	..	..	..	..	..	..	..	..	..
Salmonidae											
Chinook Salmon, *Oncorhynchus tshawytscha*	..	..	x	..	..	..	..	..	..	..	..
Land-locked Salmon, *Salmo sebago*	..	..	..	..	..	..	..	..	..	..	x
Brown Trout, *Salmo trutta*	x	..	..	..	..	..	..	..	..	..	..
Brook Trout, *Salvelinus f. fontinalis*	..	x	..	..	..	x	x	x	x	..	x
Catostomidae											
Common sucker, *Catostomus c. commersonnii*	x	x	x	x	..	x	x	x	x	x	x
Creek Chub-sucker, *Erimyzon o. oblongus*	x	..	x	..	..	x	x	x	..	x	x
Cyprinidae											
Lake Chub, *Couesius plumbeus*	..	x	..	..	..	..	..	..	x	x	..
Black-nosed Dace, *Rhinichthys a. atratulus*	..	..	..	..	..	x	x	x	x	x	x
Long-nosed Dace, *Rhinichthys cataractae*	x	..	..	..	..	..	..	..	..	..	..
Fallfish, *Leucosomus corporalis*	x	..	x	..	..	x	x	x	x	x	x
Creek Chub, *Semotilus a. atromaculatus*	..	..	..	..	..	..	..	..	x	..	..
Bridled Shiner, *Notropis bifrenatus*	x	..	..	..	..	..	x	..	..	..	x
Common Shiner, *Notropis c. cornutus*	x	..	x	..	..	x	x	x	..	x	x
Golden Shiner, *Notemigonus c. crysoleucas*	x	x	x	x	..	x	x	x	..	..	..

Ameiuridae											
Brown Bullhead or "Horned Pout," *Ameiurus n. nebulosus*	..	..	..	..	..	..	x	x	..	..	x
Esocidae											
Chain Pickerel or Common Pickerel, *Esox niger*	x	x	x	x	x	x	x	x	x	x	x
Anguillidae											
Common eel, *Anguilla bostoniensis*	x	x	..	x	x	..	..	..	x	..	..
Cyprinodontidae											
Banded Killifish, *Fundulus d. diaphanus*	..	..	..	..	..	..	..	..	x	..	..
Mummichog, *Fundulus heteroclitus*	x	..	..	..	..	..	..	..	..	..	..
Moronidae											
White Perch, *Morone americana*	..	..	x	..	..	..	..	..	..	..	..
Percidae											
Yellow Perch, *Perca flavescens*	x	..	x	..	..	..	x	x	..	..	x
Mud Darter, *Hololepis f. fusiformis*	x	x	..	..	..	..	..	..	..	..	..
Centrarchidae											
Small-mouthed Bass, *Micropterus dolomieu*	x	..	x	..	..	..	x	x	..	x	x
Pumpkinseed Sunfish, *Lepomis gibbosus*	x	x	x	..	..	..	x	x	..	..	x
Cottidae											
Slimy Muddler or Fresh-water Sculpin *Cottus cognatus*	..	..	..	..	..	..	x	x	..	..	..
Gasterosteidae											
Four-spined Stickleback, *Apeltes quadracus*	x	..	..	..	..	..	..	..	x	..	..
Nine-spined Stickleback, *Pungitius pungitius*	..	x	..	..	..	..	..	..	x	..	..

*Identification of fish in collections (in part) checked by Dr. Carl L. Hubbs, Curator of Fishes, Museum of Zoology, University of Michigan.

were measured to the nearest millimeter and weighed to the nearest gram. The data presented in the following two tables (XIII and XIV) represent the average lengths and weights of fish at the time they were caught, arranged by year classes and sex. Lengths in the first table refer to length of the body only; they do not include the tail. To get the total length (including the tail) of the fish, add 1.3 inches to a body length of 6 inches; add 1.8 inches to a body length of 7 inches; and add 2.1 inches to a body length of 9 inches.

ADDITIONAL REMARKS ON LONE POND (P. 96)

Lone Pond (P. 96) in Waterboro Township, York County, was poisoned with derris root on May 3, 1939. All evidence indicated that this poisoning killed all fish with the possible exception of a few Horned Pout. After careful counts, it was estimated that the poisoning killed between 1,000 and 1,500 Pickerel *(Esox niger)* none of which were more than 12 inches long, in addition to two Horned Pout and one Yellow Perch; none of the Brook Trout stocked in 1934 to 1936 were seen. Presumably the pond had contained almost a pure culture of Pickerel which were dwarfed due to the absence of a forage-fish food supply and which had prevented the survival of stocked Brook Trout. Possibly the single Yellow Perch had been liberated as a bait "minnow."

Recommendations: Since the population of Pickerel now has been exterminated (presumably), the following program for restoration of Brook Trout fishing is recommended:

1. During late summer of 1939, stock 2,000 adult Golden Shiners to establish a forage-fish food supply for trout.
2. During the springs of 1940 and 1941, stock with 800 six- to eight-inch Brook Trout. Continue yearly stocking on this basis if it results in good fishing.
3. Close the pond to fishing during 1940, in order to give the stocked trout an opportunity to increase in size, and in order to find out definitely whether or not Brook Trout will now do well in the pond.

TABLE XIII. Average body length (does not include tail) in inches of White Perch from six lakes in Maine

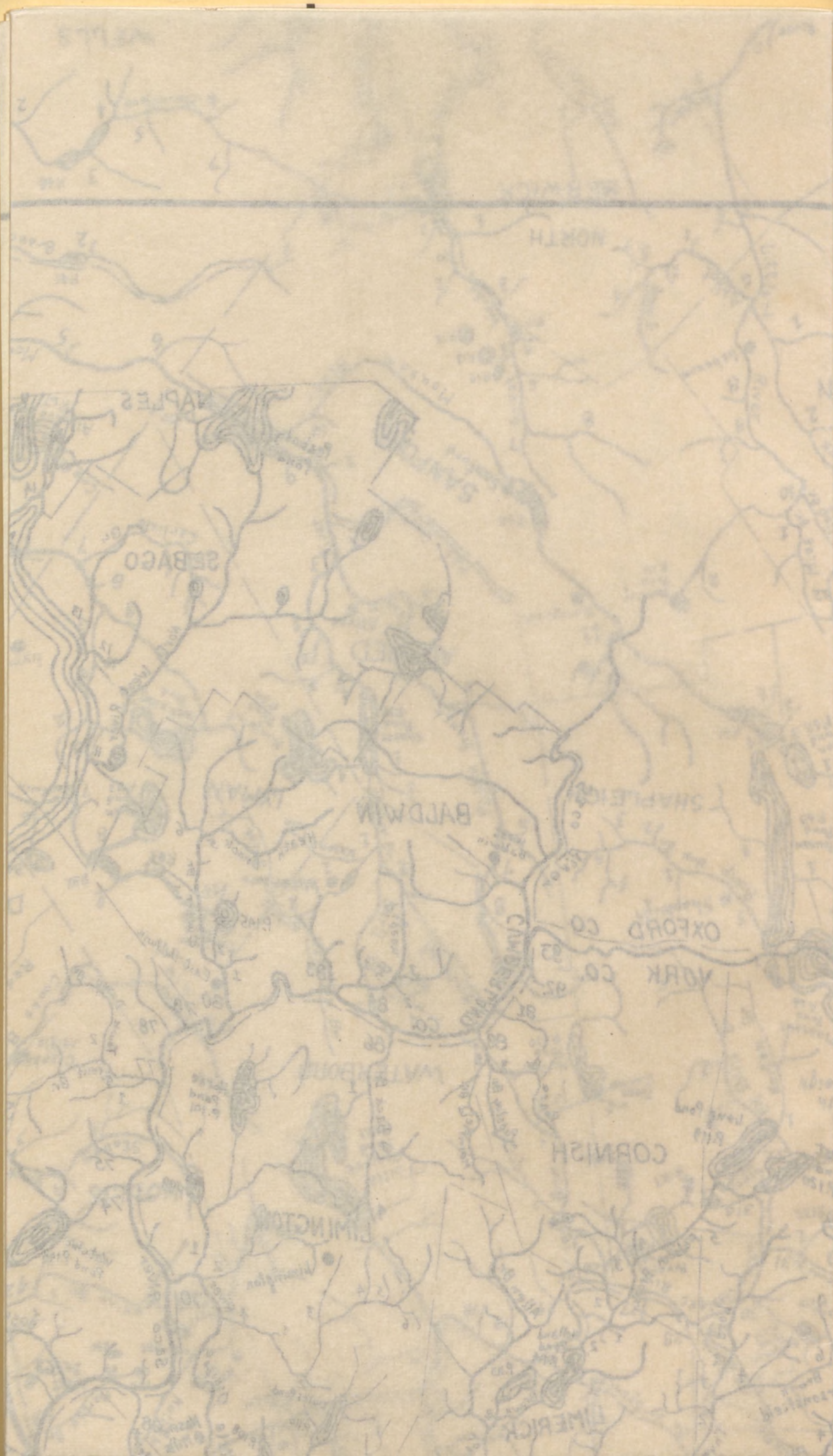
The number given in parentheses below each average is the number of specimens upon which the average is based

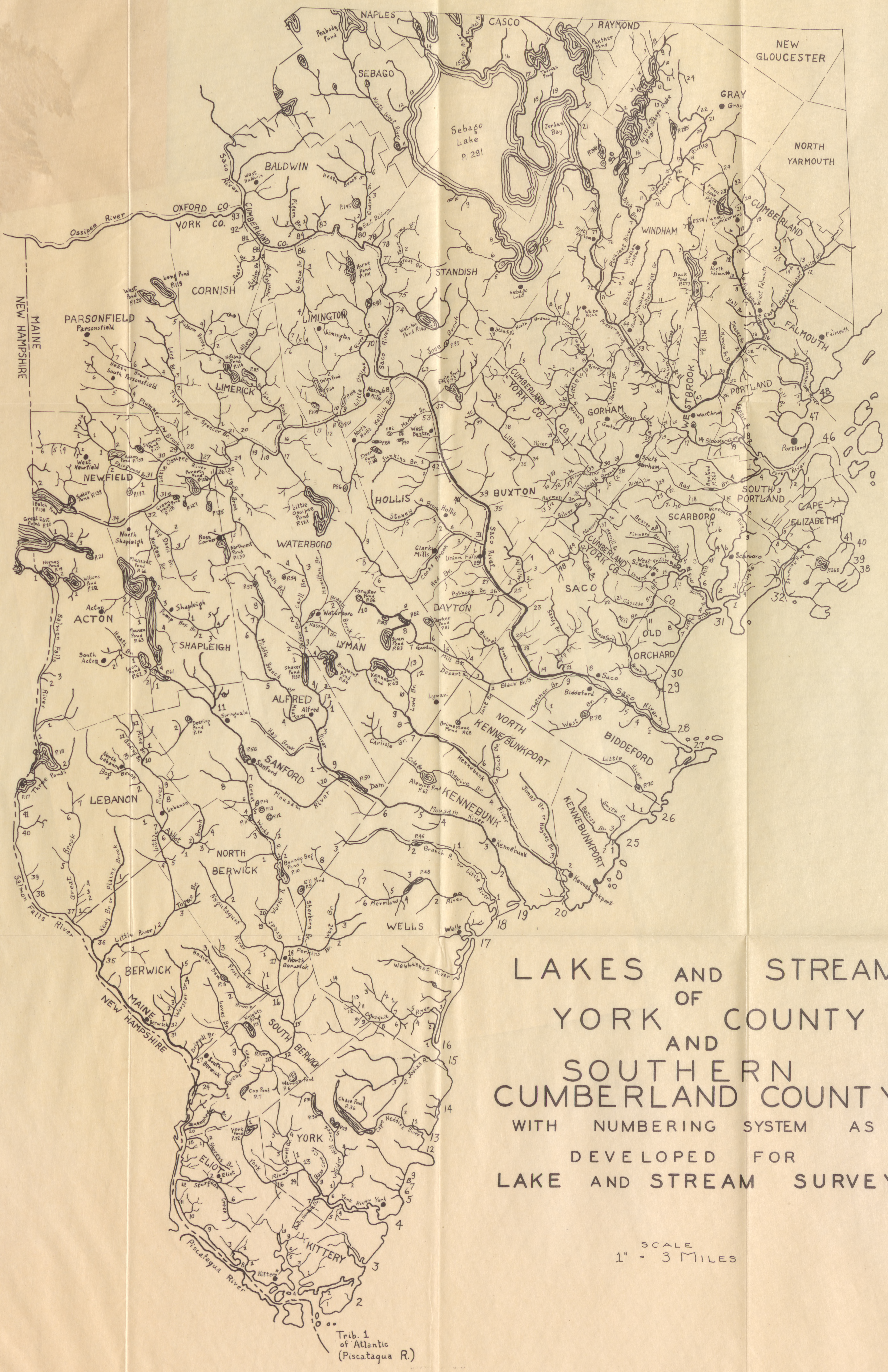
Locality	Pushaw Pond		Great Pond		Long Pond		Sabbathday Lake		Mousam Pond		Bunganut Pond	
Date	Sept. 25 to 26, 1937		June 23 to 26, 1937		Nov. 6 to 8 1936		Aug. 13 to 14, 1937		July 16 to 30, 1937		Aug. 4 to 10, 1937	
Winters of life completed / Sex	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
3	...	...	...	...	6.0 (1)	...	...	...	5.9 (1)	6.5 (7)	7.5 (1)	...
4			6.9 (1)						7.2 (1)	6.5 (3)	8.4 (6)	8.5 (5)
5	7.4 (2)	6.1 (2)	6.8 (3)	6.7 (6)	7.0 (3)	7.2 (1)	6.9 (1)	...	7.0 (1)	7.6 (6)	8.7 (28)	8.4 (20)
6	7.2 (9)	6.9 (3)	7.3 (13)	7.1 (8)	7.4 (10)	7.3 (8)	7.2 (1)	7.9 (1)	8.1 (4)	8.1 (13)	10.2 (6)	...
7	7.3 (30)	7.1 (31)	7.7 (11)	7.3 (5)	8.6 (6)	7.6 (11)			8.5 (4)	8.2 (7)	9.0 (4)	8.7 (3)
8	7.6 (11)	7.1 (11)	7.9 (3)	7.8 (5)	8.6 (1)	7.7 (1)	...	8.6 (2)	8.3 (1)	8.3 (1)	8.8 (1)	8.9 (2)
9	9.4 (1)	7.2 (1)	8.0 (1)	8.2 (1)	...	8.8 (2)	...	...	...	9.7 (1)	10.9 (1)	9.1 (1)
10	9.1 (1)	7.7 (1)	...	7.9 (1)	...	...	10.0 (3)	...	...	10.4 (2)	...	...
11				8.5 (2)		8.0 (2)				...	...	9.8 (1)
12	...	...	9.1 (2)	8.4 (1)	...	...	10.6 (1)	...	11.3 (1)	...	...	...

TABLE XIV. Average weight in ounces of White Perch from six lakes in Maine

The specimens represented here are the same fish as are represented in the preceding table of average lengths

Locality	Pushaw Pond		Great Pond		Long Pond		Sabbathday Lake		Mousam Pond		Bunganut Pond	
Date	Sept. 25 to 26, 1937		June 23 to 26, 1937		Nov. 6 to 8 1936		Aug. 13 to 14, 1937		July 16 to 30, 1937		Aug. 4 to 10, 1937	
Winters of life completed / Sex	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
3	...	...	...	...	3.0	...	...	...	3.1	3.8	6.4	...
4	...	...	4.2	...	...	...	...	...	5.9	4.1	9.8	9.8
5	5.8	2.9	4.1	3.6	6.1	5.0	4.2	...	7.0	6.7	11.2	10.0
6	5.5	4.8	5.3	4.9	6.3	6.0	4.5	5.6	7.8	7.9	12.1	...
7	5.7	5.2	6.6	5.3	8.3	6.5	...	...	9.0	8.3	12.1	10.3
8	6.7	5.4	6.5	6.6	8.9	7.6	...	8.0	9.3	8.3	10.4	9.5
9	12.1	6.1	7.1	7.8	...	11.7	...	...	...	13.1	19.3	8.9
10	11.7	6.7	...	6.8	...	...	12.5	...	...	12.0	...	...
11	...	...	...	8.0	...	7.2	...	...	...	...	...	13.1
12	...	...	10.2	6.8	...	...	16.0	...	19.6	...	...	...


NAPLES
SEBAGO
BALDWIN
CORNISH
OXFORD CO.
YORK CO.
CUMBERLAND CO.
LIMINGTON
NORTH



LAKES AND STREAMS OF YORK COUNTY AND SOUTHERN CUMBERLAND COUNTY

WITH NUMBERING SYSTEM AS DEVELOPED FOR LAKE AND STREAM SURVEYS

SCALE
1" - 3 MILES

MAP TO ACCOMPANY A BIOLOGICAL SURVEY OF THE WATERS OF YORK COUNTY AND THE SOUTHERN PART OF CUMBERLAND COUNTY MAINE BY GERALD P COOPER
MAINE DEPARTMENT OF INLAND FISHERIES AND GAME FISH SURVEY REPORT NO. 1