A Biological Survey of Lakes and Ponds of the Androscoggin and Kennebec River Drainage Systems in Maine

BY

GERALD P. COOPER
Assistant Professor of Zoology
University of Maine

Fish Survey Report No. 4

TO

Maine Department of Inland Fisheries and Game

GEORGE J. STOBIE, *Commissioner*
ARCHER L. GROVER, *Deputy Commissioner*

S. Williams

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COURTESY MAINE DEVELOPMENT COMMISSION

Webb Lake in Weld, looking southwest

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Pennessewassee Lake in Norway

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Thompson Lake in Oxford

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Long Pond of the Belgrades, looking west

Great Pond of the Belgrades from the east. Otter Island in the right foreground is at a distance of approximately one-half mile. In the left background is the channel between the south end of Hoyt's Island and Allen Point

A car, boat and trailer unit well adapted to reconnaissance surveys of lakes and ponds. The 14-foot Lapstrake boat can be handled by one person. A part of Garland Pond in Byron in the left background

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A BIOLOGICAL SURVEY OF LAKES AND PONDS OF THE ANDROSCOGGIN AND KENNEBEC RIVER DRAINAGE SYSTEMS IN MAINE

Fish Survey Report No. 4

By Gerald P. Cooper

Assistant Professor of Zoology, University of Maine

INTRODUCTION

The 53 lakes and ponds which were studied by the 1940 biological survey are distributed over most of Androscoggin and Kennebec counties and over small parts of Oxford, Franklin, and Somerset counties. They include most of the larger and more important fishing lakes and ponds of the Little Androscoggin River and Androscoggin River drainages up to the Maine-New Hampshire boundary, and most of the larger lakes and ponds on the east side of the Kennebec River north to the vicinity of Madison and Embden Pond. Most of these 53 lakes[1] make up a part of the great concentration of lakes which extends from the Belgrade region southwest to the Sebago and Kezar Lake areas.

These 53 lakes have a total area of approximately 59,000 acres. This total area includes most of the lake area of the entire region, since the survey studied all of the larger bodies of water and was unable to include only some of the smaller ponds. This group of lakes is highly developed as a resort and fishing area. The importance of fishing may be judged from the Fish and Game Department's records of the sale of fishing licenses. During the calendar year of 1940, there were 124,950 fishing licenses sold by the State of Maine, of which 29,031 (or 23%) were sold by agents within the area including the present group of lakes. These 29,031 fishermen included 20,526 (or 25%) of the 80,630 Maine resident fishermen, and 8,505 (or 19%) of the 44,320 all non-resident fishermen. To meet the demand of these fishermen, the lakes have been stocked heavily by the State Fish and Game Department. The fish populations of the lakes are in a rather unstable condition, partly because the area is heavily fished

[1] Throughout this report the term "lake" is often used to apply to both lakes and ponds. The names here used for individual lakes are the names most commonly used by local residents. The fact that one lake may be referred to as a "lake," and another as a "pond," has little significance with respect to differences in size of the bodies of water.

and partly because several foreign species of game fishes have been introduced into the area quite recently. The concentrated fishing, the heavy stocking, the considerable number of game species, and the diversity of the lakes and ponds themselves, are all factors which have afforded an excellent opportunity for the present biological survey to make a worth while contribution to the fishing in this region. The general aims of the present survey may be summarized as follows: to obtain information on the physical characteristics of the lakes, the character of the water, the kinds and abundance of different species of fish, and the present status of each of the game species; to determine, from such studies, the types of fishes which are best suited for stocking in each body of water; and to make recommendations which would tend to improve the status of the game fish populations and therefore to improve the fishing.

The field investigations of the 1940 survey were made by Messrs. Harry A. Goodwin, Gerald E. Spofford, Stanley P. Linscott, and Walter P. Strang (all students in Wildlife Conservation at the University of Maine), and the writer. This survey was a continuation of the general survey program started in the summer of 1937 by the Maine Department of Inland Fisheries and Game cooperating with the Zoology Department of the University of Maine. Expenses of the field survey were borne by the State Fish and Game Department; laboratory facilities were made available by the University. In the laboratory analyses of the extensive amount of data and sample material obtained during the field survey, the writer has had much valuable assistance from the following: Mr. Goodwin on qualitative and quantitative analyses of the plankton samples; Mr. Linscott on analyses of bottom samples and contents of fish stomachs, and on the tabulation of various data; and Mr. Strang on preparation of the maps presented in this report. Much valuable assistance and information were obtained in the field from several of the State Fish and Game Wardens in their respective areas.

The field survey was conducted from June 15 to September 15, 1940. The procedure of this field survey was mostly the same as used during the summers of 1938 and 1939, and described in the respective reports. This procedure is outlined very briefly at this time, and is described more fully along with the results of each phase of the survey which are given in the following sections of this report. Soundings of water depth were made on all of the lakes and ponds. The vertical distribution of temperature, oxygen, and pH (acid intensity) was determined on each lake during the latter part of the summer. From these data, calculations were made on the amount and proportion of water volume and bottom area of each body of water available to trout and salmon during the summer months. This phase of

the survey work has afforded a basis for classifying the lakes as to whether or not they are best suited to be developed as trout or salmon lakes, on the one hand; or lakes for perch, bass, pickerel, or other warm-water game fishes, on the other hand. An appraisal of the food-producing capacity of each lake was made by sampling the plankton organisms and the bottom food organisms. Collections of fishes by gill nets and by seines were made to determine the present status of the fish populations and to serve as a basis for estimating the relative numbers of the different species present. Fish population estimates, based on survey collections, were supplemented by information obtained from local Fish and Game Wardens for ponds in their respective areas. Analyses of the stomach contents of all of the game fishes which were collected have been made in order to determine their food habits; and some attempts have been made to correlate these food habits with the amount of bottom food available. Samples of scales from all of the game fishes have been examined for studies on age and growth, and a partial summary of these data is included. An analysis has been made of the records of fish stocking by the State Fish and Game Department during the past several years. On the basis of these studies, a new stocking program, together with other desirable methods of management, has been recommended for the lakes and ponds, with particular reference to the suitability of the water in individual lakes for each species and with reference to the composition of the present fish populations.

GENERAL CHARACTERISTICS OF LAKES

Physical and chemical characteristics. Lakes and ponds have certain physical and chemical characteristics in which they display a considerable degree of uniformity, but lakes possess other characteristics on the basis of which they may be classified into different types. Certain of these characteristics are of particular importance to fishes, and are thus of primary consideration in the present fisheries survey. Brief discussions of the general characteristics of lakes have been given in previous reports in the present series (Cooper, 1939b and 1940). The discussion is repeated here because the information is of utmost importance in interpreting the survey data, given in this report, on temperature and chemistry of the water; and because the previous reports may not be readily available due to the limited number which was printed. For a much more complete discussion of the physical and chemical characteristics of lakes which affect fish life, the reader is referred to the standard text on Limnology by Welch (1935).[2]

[2] See "Literature cited," on page 237.

One of the more important characteristics of lakes from the standpoint of fishes is the seasonal cyclic nature of the temperature and chemistry of the water, which factors not only vary at different seasons of the year but vary at different depths at each season. Seasonal changes in temperature are very striking, and seasonal changes in oxygen and pH are directly dependent upon, and in part the result of, the seasonal temperature cycle. Furthermore, the seasonal cycle of temperature, oxygen, and pH, and their vertical distribution, are primarily dependent upon the depth of the water, and secondarily upon the area of the lake and the amount of wind and wave action. The seasonal temperature cycle is dependent upon two factors: (1) the maximum density of water occurs at a temperature of 4° C. (39° F.), that is, a unit volume of water is heavier at 4° C. than at either a colder or warmer temperature; and (2) water in lakes is heated mostly by contact with the air at the surface.

Each year, lakes in Maine pass through four distinct stages with respect to water temperature. In a large (over 1,000 acres) and deep (100 feet or more) lake, the distribution of temperature during these four stages is approximately as follows:

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; seldom 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 overturn stage:* Begins 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 or near 39° F. 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 overturn 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, or *epilimnion,* in which the water is quite uniformly warm; in large lakes this layer extends down about 18 to 25 feet or more (the temperature at 20 feet would be perhaps 2 or 3 degrees colder than at the surface); (b) a middle layer, the *mesolimnion* or *thermocline,* extending from a depth of about 20 feet to 30 or 35 feet, 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, or *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 as the summer progresses and the depth to which it does finally descend depends upon the strength of the waves and of water currents, which in turn depend upon the size and shape of the lake and the amount of wind action.

4. *Fall overturn 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 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 to another, of these above stages in lakes, is mostly quite gradual, due to the high specific heat of water. After the ice disappears in the spring, the 32° 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 warmer water now stays on top, and continues to do so as the lake warms up during the summer. There is then 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 of 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 "1" 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, and largely by the plant plankton in most Maine lakes 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 and suspended in the deep water; 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 in most Maine lakes. When water comes in contact with air at the surface, 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 overturn 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 overturn, 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 during the past four years on about 100 Maine lakes have indicated that most of the natural lakes in southern Maine are more or less acid, even the upper water in the epilimnion. Summer tests on the deep lakes have indictaed 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 Maine, as a fairly good general index of the amount of carbon dioxide in the deeper water.

The depth to which warm surface water will be driven in lakes by the end of the summer depends mostly upon the size and shape of the lake and upon the amount of wind and wave action. The warm water will be driven down to about the same depth in large lakes, whether they are shallow or deep. This makes the factor of depth in large lakes very important in determining whether or not a lake will have cold water for trout or salmon during the hot part of the summer. Warm water is driven down to a greater depth in large lakes than in small ones, and this makes the size of the lake and the amount of protection which it has against the wind of considerable importance in determining the amount of trout water. In brief, it might be stated that the ratio of size to depth is the most important factor in determining how deep the warm water will be driven during the summer time and, therefore, how far down the trout and salmon will have to go to find a suitable temperature. Considerable information on this relationship between the size of a lake and the depth to which the upper uniform layer of warm water (epilimnion) will extend by August in Maine lakes has been obtained from the surveys during the past three summers. Such information was summarized (Cooper, 1939b) for 29 lakes and ponds of the upper Saco River and Sebago Lake drainage systems in Maine, on the depth to which the upper warm-water layer extended by late summer, as follows:

17 feet in ponds of 56 to 100 acres in area (average for 5 ponds).

18.7 feet in ponds of 101 to 500 acres in area (average for 15 ponds).

23.3 feet in ponds of 501 to 1,000 acres in area (average for 3 ponds).

25.3 feet in ponds of 1,001 to 2,000 acres in area (average for 4 ponds).

25 feet in one lake of 4,867 acres.

30 feet in one lake of 28,771 acres.

From our study of the Rangeley Lakes in 1939 (Cooper, 1940) it was found that this upper warm-water layer extended down to depths of:

30 feet in 3 lakes of 1,700, 4,200, and 6,700 acres.

35 feet in 3 lakes of 2,900, 6,000, and 16,300 acres.

From the present study of 53 lakes and ponds in the Androscoggin and Kennebec River drainages, it was estimated that during late summer the warm (70° F.) water of the epilimnion extended down to various depths in the different lakes, and these depths were definitely correlated with the size of the lake. The depths to which the warm-water layer extended in the lakes of this area were as follows:

17.3 feet in ponds of 107 to 500 acres in area (average for 24 ponds).

To the bottom at maximum depths of 22, 27, and 28 feet in 3 ponds of 366, 385, and 486 acres.

21.4 feet in ponds of 501 to 1,000 acres (average for 8 ponds).

To the bottom at a maximum depth of 20 feet in one pond of 587 acres.

23.4 feet in ponds of 1,001 to 2,000 acres (average for 7 ponds).

To the bottom at maximum depths of 19 and 27 feet in 2 ponds of 1,705 and 1,787 acres.

25.5 feet in ponds of 2,001 to 3,000 acres (average for 2 ponds).

To the bottom at a maximum depth of 20 feet in one pond of 2,115 acres.

30 feet in one pond of 3,510 acres.

To the bottom at a maximum depth of 38 feet in one pond of 3,826 acres.

25 feet in one pond of 4,426 acres.

23 feet in one pond of 5,543 acres.

33 feet in one pond of 8,239 acres.

These above figures on the depth to which the uniform warm-water layer extends in lakes of various sizes apply to late summer, mostly about the middle of August. At earlier dates the depths would be less, whereas later on in the season the uniform upper layer would extend to greater depths; but after late summer the temperature of the water in this upper uniform layer tends to be cooler. There comes a time during early fall, while this upper layer is cooling and also being extended deeper into each lake, when cold-water fishes find the temperature of this upper uniform layer very favorable and thus are free to rise to the surface. A similar condition exists in the spring, but the direction of the temperature change is just the opposite from that in the fall. This uniform upper layer of water is continually circulating, coming in contact with air at the surface, and therefore maintains a high oxygen content. When this upper layer is cool enough for cold-water fishes, there is, in general, no danger of these fishes suffering from lack of oxygen. Oxygen deficiency usually occurs, if at all, in the deep-water layer which is not circulating in contact with air at the surface. Thus, temperature and the related oxygen content of the deep water are important limiting factors for salmonid fishes only when the upper warm-water layer is too warm for them.

The depths of warm-water penetration in lakes may be of interest to fishermen in indicating suitable depths for fishing by trolling during summer months. Their primary value in connection with the survey, however, is that they indicate how deep lakes of various sizes must be in order to have cold water during that part of the summer when the upper water layer is too warm for salmonids. A small amount of this deep cold water, whether distributed evenly in a thin layer over the bottom of the lake or concentrated in a small depression, is apparently not enough to produce a good trout or salmon lake. Those lakes and ponds in Maine, which have been studied by the survey and have been found to be best adapted from the standpoint of the water supply for trout or salmon, have more water volume and more bottom area below the thermocline than above it. In general, as the proportion of the amount of water in the deep layer to that in the surface layer decreases, the value of the lake for salmonid fishes decreases. If a lake is shallow to the point where only a small volume of water remains in the deep zone or hypolimnion, this small reservoir of cold water is heated during the summer time by the circulating warm water above; and this cold water may be mostly, if not entirely, eliminated by the effect of this contact and counter circulation. Thus, warm water may extend somewhat farther down (and to the bottom) in a shallow lake than in a deep lake of the same area and surface disturbance, because the deeper lake has a larger reservoir of deep cold water to maintain temperature stratification.

The factor of dissolved oxygen in the water, which is, along with temperature, of primary importance to salmonid fishes, has its effect superimposed upon that of temperature. Oxygen deficiency works up from the bottom, as temperature increase extends downward from the surface. The amount of organic decomposition and the resultant removal of oxygen depend upon the amount of organic material in the lake. The effect of this decomposition and oxygen removal depends mostly upon the amount of this loss, but also to a considerable extent upon the volume of the isolated deep-water layer through which this loss of oxygen is distributed. Thus a uniformly deep lake has a larger reservoir of cold water to absorb this oxygen depletion. In a more shallow lake the same amount of oxygen depletion may have an adverse effect upon the entire cold-water layer. Thus the factors affecting oxygen depletion in lakes are: (1) the type of lake with respect to the distribution of depth according to area, and (2) the amount of organic decomposition of mud and organic material suspended in the deep water. The ratio of size of the lake to its depth is important to the oxygen content only indirectly, in that it determines the amount of the deep water; if the amount of deep cold water is large, then a large amount of decomposition of the bottom mud might still not be sufficient to remove all of the oxygen, and there might still remain some suitable trout and salmon water. One fact of particular interest at this point is that temperature, oxygen content, and pH content of water in lakes (except during spells of very windy weather) are quite uniformly stratified; that is, temperature, oxygen, and pH are each usually about the same at the same depth over the whole lake.

Stability of lakes and ponds. The physical, chemical, and, to some extent, biological 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 the process of rapid extinction because the lake basins are being filled 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, by ordinary standards of time, 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 bodies of water as Sebago Lake, the Rangeley lakes, and Auburn Lake, have not changed appreciably in their physical and chemical properties for the past several hundred years or much longer. Probably, also, such bodies of water will not change much for centuries to come, assuming that no large amount of organic pollution will enter the lakes. The data on temperature, oxygen, and pH, obtained during the 1940 survey, should be applicable to these lakes for many years in the future; and the lakes, which are now good trout waters from the standpoints of temperature and oxygen, will probably continue to be so for centuries. The fish populations in lakes, on the other hand, are subject to much more rapid changes, especially when new species are introduced. A continual knowledge of these changes in each lake is necessary for efficient fisheries management.

Classification of lakes. European limnologists have classified lakes[3] according to their physical, chemical, and biological characteristics into three types: *oligotrophic*, *eutrophic*, and *dystrophic*. Some of the important characteristics of these three types of lakes are as follows:

Oligotrophic lakes

Relatively large amount of deep cold water.
Water blue to green and very transparent.
Little or no organic material on the bottom in deep water.
Oxygen content high at all depths and at all seasons.

[3] See Welch: 1935. Limnology, pp. 310–315.

Aquatic plants rare.
Basic fertility: low in plankton, fairly rich in bottom food organisms.
Excellent for trouts and salmons and other "cold-water" fishes.

Eutrophic lakes

Lake shallow with relatively small amount of deep cold water.
Water green to yellow or brownish green and not very transparent.
Large quantity of organic material on the bottom and suspended in the water.
Little or no oxygen in deep water during the summer.
Aquatic plants abundant.
Basic fertility: very rich in both plankton and bottom food organisms.
Usually not good trout or salmon water.

Dystrophic lakes

Deep to shallow; in bog surroundings or in old (geologically speaking) mountains.
Water yellow to brown and with low transparency.
Large quantity of organic mud on the bottom.
Little or no oxygen in deep water during the summer.
Aquatic plants rare.
Basic fertility: low in both plankton and bottom food organisms.
Occasionally trout (probably never salmon) in deep *dystrophic* lakes; never trout or salmon in shallow or advanced *dystrophic* lakes.

All of the good salmon lakes, and most, if not all, of the better trout lakes, in Maine, which have been studied by the survey since 1937, resemble the *oligotrophic* type in that they (a) are deep with more water in the hypolimnion than in the epilimnion, (b) have white (as opposed to brown) and transparent water, (c) have relatively little organic material on the bottom in deep water, (d) have high content of dissolved oxygen in the water at all depths during the summer, and (e) have scanty aquatic vegetation. The lakes in Maine of this type are referred to as the best trout and salmon lakes, since these lakes are the ones in which the survey netting has taken the greatest numbers of salmon and trout, and since these lakes are the ones which have the reputation of affording the best salmon and trout fishing. These better trout and salmon lakes of Maine differ from the *oligotrophic* type of lake as characterized by Welch (1935) principally in that most of them have a scanty bottom fauna.

Some of the lakes and ponds studied by the survey in Maine are not good trout or salmon waters. These lakes are, in general, of the type which are more shallow, have less water in the hypolimnion than in the epilimnion, have considerable oxygen depletion in the deeper water, and have scanty aquatic vegetation. Many have brown water, are low in plankton, have considerable organic material on the bottom, and, in these respects, resemble the *dystrophic* type as characterized above. Most of these lakes have only a few hundred bottom organisms per square meter, thus resembling the *dystrophic* type; while only a few have the bottom fauna quantitatively approaching that characteristic of *eutrophic* lakes. Many represent borderline types which are in the process of transition from an *oligotrophic* type of lake to something with characteristics of both *eutrophic* and *dystrophic* lakes. These are lakes of moderate depths, with less water in the hypolimnion, and with a considerable oxygen deficiency, but with "white" water unlike the *dystrophic* type, and with low fertility unlike the *eutrophic* type. Thus, while the *oligotrophic* type of lake is quite readily recognizable among Maine lakes, most of the additional lakes seem to be more like the *dystrophic* type but have some features not unlike the *eutrophic* type. Our study of Maine lakes has not, however, been critical enough for a detailed attempt at classification. Much more data would be necessary, particularly on the chemistry of the water. It is possible, however, to classify them on the basis of depth, temperature, and oxygen content of the water into an *oligotrophic* type which is well suited for trout and salmon, and a second type which is not well suited for these fish and may be either shallow and warm or may be fairly deep but with considerable oxygen deficiency in this deep water. Apparently, there is also an advanced stage of the *oligotrophic* type of lake representing marginal trout and salmon water and being characterized by partial oxygen deficiency in the deeper water.

REQUIREMENTS OF TROUT, SALMON, AND OTHER GAME FISHES

This present section on the requirements of some of the common game fishes in Maine has been extracted with slight alterations from Survey Report No. 2 (Cooper, 1939b) for the benefit of fishermen who might find this bulletin useful, because a knowledge of the requirements of the different species of game fishes is of fundamental importance in evaluating the survey data given in the following sections of this report, and because this previous publication is no longer available.

The development of a scientific stocking policy must of necessity consider the requirements of the food and game species concerned.

These basic requirements of individual species naturally vary somewhat in different parts of the country, as, for example, the requirements of the Brook Trout in Maine waters are probably somewhat different from those of Brook Trout in states farther south and west. The requirements of our game species are not completely known by any means; however, many of the basic requirements are understood in a general way and these may be summarized (based largely on the literature; to some extent on survey results) for some of the more important fish species in southern Maine as follows:

Land-locked Salmon or Lake Salmon, Brook Trout, Brown Trout and Rainbow Trout. (These species are here considered as a unit since most of their requirements are very similar.) 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 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 game 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 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 many other game fishes. However, a low pH in deep water reflects low oxygen and high carbon dioxide which trout and salmon cannot tolerate.

4. *Adequate food supply:* Trout and salmon up to a length of about eight inches feed mostly on 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 Land-locked Salmon[4] 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 before they are planted in a lake.

Togue or Lake Trout. Most of the requirements of Togue are similar to those of trouts and salmons but there are some important differences. The Togue is preeminently a deep-water species and is seldom if ever found in lakes less than 50 feet deep. They usually live in lakes at a depth of over 60 to 80 feet except during the spawning season or when the surface water is very cold. At a depth of 60 feet or more in Maine lakes the water temperature is invariably below 60° F. and usually less than 55 or 50° F. at all seasons; thus the Togue lives, and presumably prefers to do so, in colder water than do other trouts and salmons.

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[4] 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 oxygen and pH requirements of Togue are presumably somewhat similar to those of other trouts — at least 5 p.p.m. of oxygen and a pH preferably between 6.0 and 8.0. The deep water in most Maine lakes probably rarely, if ever, becomes alkaline, that is, with a pH above 7.0. The food of the adult Togue is chiefly fish, although they have been accredited with eating a great variety of different types of foods. Togue occur in lakes of southern Maine mostly if not entirely in lakes which have smelts, and smelts are known to be their chief food. The food of the young is not known, although it is presumably mostly insects. Togue are unlike most other trouts and salmons in that they normally spawn in lakes on gravel and in shallow water. Also, presumably, the young go to deep water shortly after they hatch, for extensive seining in shallow water of lakes in the summer time has never (to the writer's knowledge) produced any young Togue.

Smelt. Smelt, like the trouts and salmon, live in deep cold water during most of the summer at temperatures mostly less than 60° F. However, there are some authentic records which indicate that smelts do occasionally school at the surface of lakes during the warm summer months. Judging from the distribution of smelts in the lakes covered by the present survey, it is believed that their oxygen requirement is similar to that of trouts and salmon, presumably at least 5 p.p.m. The adults of the larger race of smelts feed mostly on small fish; on the other hand, the young smelts and the adults of the small race feed largely on plankton or micro-organisms in the water.

Smelt spawning occurs mostly in streams; however, smelts are known to spawn normally in some lakes, as for instance Lake Champlain on the New York-Vermont line. Possibly also some populations of our smallest race of smelts here in Maine spawn only in lakes. Smelts spawn from late March to early May and the larger race usually spawns earlier than the smaller one. The eggs are adhesive and are stuck on sticks and stones on gravel or rubble bottom.

Chinook Salmon. This species has been introduced into Maine from the streams on the Pacific Coast of North America where it is native. Its temperature and oxygen requirements are presumably similar to those of our native salmon. Adult Chinooks feed mostly on fishes; the young feed on insects. All evidence available thus far indicates that the Chinook Salmon in Maine lakes would compete directly with our native salmon for food. However, the stocking of Chinooks in some Maine lakes appears to have one distinct advantage in that it preys more readily on young warm-water game fishes such as the White Perch and Yellow Perch. The Chinook has thrived well in some Maine lakes where the warm-water game fishes have crowded out the native salmon.

On the west coast the Chinook runs up from the ocean to spawn in streams and, like our native sea salmon, the young stay in streams for a period of 1 or 2 years after which they return to the ocean to make most of their growth. They then come back as 4- or 5-year-old fish to the streams to spawn. In all of the species of salmons native to the west coast of the United States, all of the adults die after their first spawning. Other fisheries investigators have expressed the belief that their introduction into the waters of Maine would never result in the permanent establishment of the species. However, there is some indication that the species might become established eventually in some Maine localities. Chinook Salmon have been planted in a considerable number of Maine lakes during the last few years, and many of these planted fish have grown to maturity while confined entirely to fresh water. Cobbosseecontee Lake near Augusta might be cited as an example. During the first part of October, 1937, about 100 adult Chinooks migrated down out of Cobbosseecontee Lake for about one-fourth mile into the outlet where they were stopped by a permanent screen. On October 15 the writer observed several adult females digging their nests in a gravel bottom in about four feet of water, and dissection of 8 dead adult female Chinooks found at this same locality indicated that all of them had recently dropped their eggs. A few unspawned eggs in each of the females indicated that they had been able to develop normal-sized eggs while being confined to this fresh-water lake.

Warm-water Game Fishes. The four species of warm-water game fishes most important in Maine are the White Perch, Small-mouthed Bass, Common Pickerel, and Yellow Perch. These species do not require cold water but rather they apparently require warm water to make their best growth, and the bass, at least, requires relatively warm water in order to spawn. Therefore these species presumably could live in practically all lakes of the state in which they might be introduced. The water in Maine lakes probably never becomes so hot as to be detrimental to any of them; in fact Pickerel probably relish the warmest waters in Maine. On the other hand, there is some evidence that large bass and large White Perch spend at least part of their time in deep cold waters during the hot part of the summer, but the young of these same species live in the warm surface water during the entire summer. The oxygen requirements of these warm-water game species are probably somewhat less than the requirements of trout and salmon, but oxygen deficiency is rarely, if ever, an important factor to these warm-water species since the upper warm water of lakes is practically always saturated with oxygen during the entire period when the lake is free of ice. In other requirements these warm-water game species differ considerably.

White Perch. White Perch become abundant in a great variety of different types of lakes, and they seem to become just as abundant in deep and cold trout lakes as they do in warm and shallow lakes (however, among the lakes of the present 1940 survey, our gill net records indicated that the White Perch might be more abundant in shallow lakes). The food of the White Perch consists mostly of bottom insects and small fishes, including the Smelt. They also feed to some extent on plankton crustaceans. Spawning habits of the White Perch are largely unknown to the writer. The spawning season occurs in May and June in some localities, and there are large spawning runs in the major inlet and outlet streams of some lakes. Since perch also occur abundantly in ponds which have no tributary streams at all, it is assumed that they also spawn in lakes to a considerable extent. Reports by several Fish and Game Wardens and by local fishermen indicate that the White Perch drops its eggs on gravel bottom in shallow water.

Small-mouthed Black Bass. Bass do best in fairly deep, cold lakes with little vegetation, rocky shorelines, and gravel or rubble shoals. Its food is mostly fish, crayfish when available (crayfish are generally rare in Maine), and insects; large bass feed mostly on fish.

Bass spawn on gravel shoals mostly in from 2 to 4 feet of water. The spawning season occurs in the early part of the summer and mostly in June in Maine. It has been found that bass require a water temperature above about 65° F. for spawning. The male guards the nest of eggs and fry, and if the male is caught off the nest and the eggs are left unguarded they are usually destroyed.

Common Pickerel. The Pickerel is found in a variety of lakes, both shallow and deep, but the species is best adapted to shallow, weedy lakes with mud bottom. Its food is almost entirely fish after it reaches a length of about 8 to 10 inches, and even small pickerel less than 5 inches long will feed on fish to some extent. The Pickerel eats mostly warm-water minnows and the young of warm-water game fishes in shallow water, but we have evidence of larger pickerel in deep waters feeding on young salmon. Pickerel spawn early in the spring, mostly in May in Maine, in shallow, weedy areas of lakes or in similar places in quiet tributary streams.

Yellow Perch. The Yellow Perch is best adapted to weedy lakes where the young occur mostly in shallow water, but the adults are to be found in deeper waters particularly in the summer time. Its food is largely bottom insects, small fish, and plankton crustaceans. The Yellow Perch spawns in the early spring, probably during May in Maine. It lays a string of eggs embedded in a jelly-like ribbon which it drapes over vegetation and sticks.

GENERAL DESCRIPTION OF THESE LAKES AND PONDS OF THE ANDROSCOGGIN AND KENNEBEC RIVER DRAINAGES

The 53 lakes considered in this report are distributed over an area of about 3,500 square miles of southwestern Maine. Most of these lakes, however, are confined to an area of about one-half this size, extending from the Belgrade Chain southwest to Thompson Lake. The whole area containing these 53 lakes and ponds involves all of Androscoggin and Kennebec counties and the southern parts of Oxford, Franklin, and Somerset counties; a very small part of Cumberland County is included in Thompson Lake. Of these 53 lakes, 29 are in the Androscoggin River drainage and 24 in the Kennebec. (See map attached to the inside of the back cover of this report.) Further detailed information on pond numbers, locations, elevations, areas, and maximum depths, for these 53 bodies of water, is given in Table I and further explained and summarized in the following paragraphs.

A pond number has been ascribed to each lake. This has been done to avoid errors of identification of a given lake, especially for those lakes and ponds with names which are commonly duplicated, as, for example, South, North, and Long. This numbering system has been described in Survey Report No. 1 (Cooper, 1939a). It should be sufficient to point out at this time that the ponds are numbered in sequence according to drainage systems and in sequence relating to the tributary streams, starting from the mouth of each drainage system. Each pond has a separate number, so that the pond number can be used as positive identification to supplement the name of the pond.

The majority of these lakes are at a low elevation due to the fact that they are located in the lower parts of the Androscoggin and Kennebec drainage systems. Forty of the 53 bodies of water are at elevations of between 100 and 400 feet above sea level. Garland Pond in Byron is the highest at an elevation of 1,141 feet above sea level; the nearby Silver Lake is next in altitude at 896 feet. The four ponds at Locke's Mills are next in altitude at 694 to 763 feet. Webb Lake is 678 feet above sea level. All figures on elevation, as given in Table I, are taken directly from the United States Geological Survey Topographic Sheets.

The areas of these lakes have been calculated for the present survey studies by using a planimeter on the lake outlines as given on the United States Geological Survey Topographic Sheets. Our figures on areas are assumed to be only approximately accurate, and may

well differ from acreage figures obtained by local surveys of individual bodies of water. The present figures should not be quoted without this reservation. These area figures are, however, sufficiently accurate for the use made of them for the present study of the suitability of the water for trout and salmon and for the present recommendations for stocking various game species. The 53 lakes have a combined area which we calculated to be 59,432 acres. The largest individual lakes are Great Pond of the Belgrades with 8,239 acres, Cobbosseecontee Lake with 5,543 acres, Thompson Lake with 4,426 acres, Androscoggin Lake with 3,826 acres, and Snow Pond with 3,510 acres. Together these 5 lakes total 25,544 acres, or 43 per cent of the total acreage of the entire 53 lakes and ponds. In addition, 12 others of the lakes are over 1,000 acres in area.

The maximum depth of any lake or pond is a matter of considerable interest to the local people, and is also the source of much controversy. While the extreme depth of a very restricted area of a lake may be of considerable interest purely from the standpoint of fact, it is not of any great importance from the standpoint of the survey. A considerable depth of water is especially important, however, from the standpoint of the survey, if it involves a considerable percentage of the entire area of the lake. The depth soundings made by the survey were adequate to reveal the general trend in depth with sufficient accuracy for the evaluation of the water for trout and salmon. Many of the maximum depths found by these soundings, however, are probably not the real maximum depths of these bodies of water. It is, in fact, quite possible that in a few lakes the actual maximum depth is considerably greater than our figures indicate; but in most lakes the maximum depths probably would not exceed the present figures by more than a few feet. Furthermore, areas of greater depth are probably very limited in their size as compared to the whole lake, and are thus of little general importance. Also, since oxygen deficiency does occur in the deep water of many of the lakes, any deep water missed by the survey would not greatly alter our evaluation of the lakes for trout and salmon.

Most of the lakes are deep enough (over 18 to 30 feet) to maintain thermocline stratification during the summer, and only 8 are so shallow that warm water extends to the bottom during the summer. The greatest depth of water, i.e., 158 feet, was found in Embden Pond. Other notably deep lakes were Clearwater Pond with 120 feet of water, Maranacook Lake with 118 feet, Snow Pond with 113 feet, Auburn Lake with 112 feet, Echo Lake with 111 feet, Thompson Lake with 109 feet, Narrows Pond (south part) with 105 feet, and Cobbosseecontee Lake with 100 feet. An additional 14 lakes and ponds were found to be over 50 feet deep. Several of these deep lakes have

TABLE I. The locations, elevations, and areas, and a partial summary of data on depth, temperature, and dissolved oxygen, for the lakes and ponds of the 1940 survey

Name of Pond	Pond* number	Township and county, or county	Elevation** above sea level: feet	Area:**** acres	Date of analyses (1940)	Maximum depth of pond: feet	Depth in feet above which temperature in excess of 70° F.: As of analyses	Depth in feet above which temperature in excess of 70° F.: During most critical summer period (estimated)	Depth in feet above which oxygen more than 5 p.p.m.: As of analyses	Depth in feet above which oxygen more than 5 p.p.m.: During most critical summer period (estimated)
Sabattus Pond	389	Greene, Wales, and Webster in Androscoggin County	243	1,787	June 21	19	Surface	Bottom	Bottom	Bottom
Taylor Pond	392	Auburn in Androscoggin	239	625	Aug. 22	44	17	18	22	20
Lower Range Pond	398	Poland in Androscoggin	304	290	Aug. 21	41	16	17	23	22
Middle Range Pond	400	Poland in Androscoggin	305	366	Aug. 10	66	16	18	60 (bottom)	Bottom
Upper Range Pond	401	Poland in Androscoggin and New Gloucester in Cumberland	305	391	Aug. 10	38	13	15	30 (bottom)	Bottom
Hogan Pond	403	Oxford in Oxford	301	177	Aug. 21	34	10	14	14	14
Whitney Pond	404	Oxford in Oxford	301	170	Aug. 21	24	16	18	20 (bottom)	Bottom
Tripp Pond	408	Poland in Androscoggin	306	732	Aug. 9	32	17	17	15	15
Thompson Lake	409	Cumberland, Oxford, and Androscoggin counties	325	4,426	Aug. 20	109	22 (average)	25	90 (bottom)	Bottom
Pennesseewassee Lake	416	Norway in Oxford	398	922	Aug. 20	48	22	20	30	27
Twitchell Pond	425	Greenwood in Oxford	763	158	Sept. 5	47	Surface	20	29	29
Bryant Pond or Christopher Lake	427	Woodstock and Greenwood in Oxford	694	278	Sept. 4	60	Surface	20	25	25
Auburn Lake	428	Auburn in Androscoggin	259	2,260	Aug. 22	112	26	26	110 (bottom)	Bottom
Allen Pond	437	Greene in Androscoggin	342	[illegible]	Aug. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pleasant Pond	443	Turner in Androscoggin	383	177	Aug. 17	68	17	15	[illegible]	[illegible]
Androscoggin Lake	464	Wayne in Kennebec and Leeds in Androscoggin	269	3,826	Aug. 26	38	Surface	Bottom	30 (bottom)	Bottom
Pocasset Lake	466	Wayne in Kennebec	284	587	Aug. 26	20	Surface	Bottom	17 (bottom)	Bottom
Lovejoy Pond	470	Fayette, Readfield, and Wayne in Kennebec	301	366	Aug. 26	22	Surface	Bottom	17 (bottom)	Bottom
Echo Lake or Crotched Pond	472	Fayette, Mount Vernon, and Readfield in Kennebec	318	1,061	Aug. 24	111	16	16	53	53
Parker Pond	474	Fayette and Vienna in Kennebec	358	1,610	Aug. 23	72	23	23	33	30
David Pond	476	Fayette in Kennebec	393	284	Aug. 28	37	Surface	20	17	17
Tilton Pond	478	Fayette in Kennebec	403	114	Aug. 28	44	Surface	13	13	13
Flying Pond	481	Vienna and Mount Vernon in Kennebec	335	360	Aug. 23	80	12	15	55	55
Worthley Pond	499	Peru in Oxford	571	354	Sept. 6	49	Surface	20	36	36
Webb Lake	503	Weld in Franklin	678	2,146	Sept. 11	42	Surface	25	32	28
Silver Lake or Big Ellis Pond or Roxbury Pond	515	Roxbury and Byron in Oxford	814	896	Sept. 9	43	Surface	25	40 (bottom)	Bottom
Garland or Little Ellis Pond	516	Byron in Oxford	1,141	297	Sept. 9	41	Surface	20	29	29
North Pond	521	Woodstock and Greenwood in Oxford	719	284	Sept. 5	37	Surface	22	22	22
South Pond	522	Greenwood in Oxford	719	284	Sept. 4	71	Surface	20	60 (bottom)	Bottom
Purgatory or Woodbury Pond of Tacoma Lakes	659	Litchfield in Kennebec	172	436	Aug. 26	62	Surface	20	22	20

TABLE I. The locations, elevations, and areas, and a partial summary of data on depth, temperature, and dissolved oxygen, for the lakes and ponds of the 1940 survey — Concluded

Name of pond	Pond* number	Township and county, or county	Elevation** above sea level: feet	Area:**** acres	Date of analyses (1940)	Maximum depth of pond: feet	Depth in feet above which temperature in excess of 70°F.		Depth in feet above which oxygen more than 5 p.p.m.	
							As of analyses	During most critical summer period (estimated)	As of analyses	During most critical summer period (estimated)
Sand Pond of Tacoma Lakes	660	Monmouth and Litchfield in Kennebec	172***	177	Aug. 26	82	Surface	18	63	63
Cobbosseecontee Lake or Cobbossee Lake	668	Kennebec County	168	5,543	Aug. 8	100	21	23	28	26
Annabessacook Lake	671	Monmouth and Winthrop in Kennebec	171	1,420	Aug. 27	49	Surface	28	32	30
Cochnewagan Pond	672	Monmouth in Kennebec	271	385	Aug. 16	28	21	Bottom	24 (bottom)	Bottom
Wilson Pond	673	Monmouth, Wayne, and Winthrop in Kennebec	242	574	Aug. 23	42	20	22	22	22
Dexter Pond	674	Wayne and Winthrop in Kennebec	242	120	Aug. 23	25	11	12	12	12
Berry Pond	675	Wayne and Winthrop in Kennebec	242	170	Aug. 23	25	12	12	16	15
Maranacook Lake	676	Readfield and Winthrop in Kennebec	212	1,673	Aug. 27	118	Surface	25	Bottom	Bottom
Torsey or Greeley Pond	678	Mount Vernon and Readfield in Kennebec	290	770	Aug. 24	45	15	20	18	18
Narrows Pond South Part	681	Winthrop in Kennebec	175***	278	Aug. 29	105	Surface	17	95	95
North Part	682	Winthrop in Kennebec	175***	259	Aug. 29	56	5	17	38	38
Snow Pond or Messalonskee Lake	698	Belgrade, Sidney, and Oakland in Kennebec	232	3,510	Aug. 22	113	30	30	30	[illegible]
Long Pond of Belgrade Lakes South Part	712	Mount Vernon and Belgrade in Kennebec	238	1,376	Aug. 22	97	23	23	Bottom	80
North Part	713	Rome and Belgrade in Kennebec	238	1,338	Aug. 22	60	26	26	33	33
Great Pond of Belgrade Lakes	719	Rome and Belgrade in Kennebec	247	8,239	Aug. 21	69	33	33	33	33
North Pond of Belgrade Lakes	720	Mercer and Smithfield in Somerset and Rome in Kennebec	250	2,115	Aug. 22	20	17 (bottom)	Bottom	17 (bottom)	Bottom
East Pond of Belgrade Lakes	724	Smithfield in Somerset and Oakland in Kennebec	257	1,705	Aug. 22	27	25 (bottom)	Bottom	Bottom	Bottom
Salmon Lake or Ellis Pond	725	Belgrade and Oakland in Kennebec	270	562	Aug. 21	57	26	27	31	30
McGrath Pond	726	Belgrade and Oakland in Kennebec	270	486	Aug. 21	27	Bottom	Bottom	Bottom	Bottom
Clearwater Pond	815	Industry and Farmington in Franklin	565	751	Sept. 3	120	Surface	22	85 (bottom)	Bottom
Wilson Pond	833	Wilton in Franklin	569	480	Sept. 3	88	Surface	20	85 (bottom)	Bottom
Sandy Pond	883	Embden in Somerset	410	107	July 27	41	9	12	23	18
Embden Pond	887	Embden in Somerset	419	1,547	July 27	158	21	23	140 (bottom)	Bottom

*Ponds numbered 389 to 522 are in the Androscoggin River drainage; nos. 659 to 887 are in the Kennebec.
**Obtained from United States Geological Survey Topographic Sheets.
***Figures approximate.
****Obtained by planimeter readings from lake outlines on United States Geological Survey Topographic Sheets. These figures on areas are presumably only approximately accurate.

the deep water distributed over a considerable portion of the lake; notable examples are Thompson and Auburn lakes and Clearwater and Embden ponds. In the case of Embden Pond, 15 per cent of the lake area, or 232 acres, has a depth of over 100 feet; and in Thompson Lake, 19 per cent of the lake area, or about 840 acres, is over 75 feet deep. It is more common, however, to find the deeper area of a lake relatively very small, as was found to be true for Echo, Silver, Cobbosseecontee, and Maranacook lakes and Snow Pond. Of the 1,673 acres of Maranacook Lake which has a maximum depth of 118 feet, only a very small area is over 60 feet deep; in Snow Pond of 3,510 acres and a maximum depth of 113 feet, most of the lake is less than 60 feet deep; in Cobbosseecontee Lake of 5,543 acres and a maximum depth of 100 feet, only 2 per cent of the lake area, or 111 acres, is over 75 feet deep; and Silver Lake represents the extreme in the restriction of the deeper area, being a lake of 896 acres with a maximum depth of 41 feet but with only 4 per cent, or 36 acres, over 25 feet deep, and with over four-fifths of its area less than 11 feet deep. Several lakes are notable in being very shallow in spite of the fact that they are of a large area. Notable among this type are Sabattus Pond of 1,787 acres and a maximum depth of 19 feet, North Pond of the Belgrades of 2,115 acres and a maximum depth of 20 feet, Pocasset Lake of 587 acres with a maximum depth of 20 feet, and East Pond of the Belgrade Lakes of 1,705 acres and a maximum depth of 27 feet. Also notable in being large and relatively very shallow are Webb and Androscoggin lakes and Great Pond of the Belgrades. Androscoggin Lake of 3,826 acres and a maximum depth of 38 feet, has only 7 per cent of its area, or 268 acres, over 30 feet deep and has only 22 per cent, or 842 acres, over 22 feet deep. Great Pond is of particular interest because it is the largest of the 53 lakes which were studied; but it is far from the deepest, however, with a maximum depth of only 69 feet. Over half of Great Pond is less than 15 feet deep; only 20 per cent, or 1,648 acres, is over 33 feet deep; and only 4 per cent, or 330 acres, is over 50 feet.

The shore margins of most of these lakes and ponds are mostly wooded. The shore lines and shore shallows are predominantly rocky, more of the boulder type than of gravel. Sand beaches are very limited, or entirely absent on some lakes. There are relatively few quiet bay areas, free from wave erosion and thus with mud bottom. The type of bottom in the deeper water beyond the shore shallows was found to vary considerably between the different lakes, from mostly sand with a little inorganic silt in some lakes, to mostly organic mud in others. There was in general much more organic mud in the deeper waters than in the shallow. This organic mud was more of a flocculent nature in a few lakes, but was more finely and uniformly broken up in the deep waters of most lakes. More information on the type of bottom in the deep waters of these lakes is

given in a later section dealing with the bottom fauna (see page 82).

The aquatic vegetation in the lakes as a whole was found to be generally very scanty. The vegetation present was mostly of such emergent types as bullrushes, pickerel weed, water lilies, and some cattails. There was very little submergent vegetation. The emergent vegetation was encountered in a few scattered areas such as along the south ends of Great and Snow ponds. There was also considerable aquatic vegetation in some of the sluggish waterways running between ponds, or concentrated around inlets and outlets. The general scarcity of vegetation in the lakes themselves is apparently due mostly to the rocky nature of the bottom in the shallow water and to the disturbing effect of the wave action in the larger lakes.

Many of the lakes have no dams at their outlets; some have low dams; and none have high dams for water storage with resultant changes in water level of more than 5 feet. The color of the water in most of the lakes was found to be "white," meaning greenish to bluish, and being so characterized in 44 of the lakes and ponds. This included almost all of the larger lakes. In 9 lakes the water was found to be mostly a light shade of brown, and these lakes were mostly the shallower and/or the smaller ones.

SUITABILITY OF THE WATER IN THESE LAKES AND PONDS FOR TROUT AND SALMON

It has been pointed out in a previous section of this report that trout and salmon require cold water and a high content of dissolved oxygen in the water. A maximum temperature of 70° F. has been set as the critical temperature limit, and 5 p.p.m. has been set as the critical limit for dissolved oxygen. Previous survey experience on Maine lakes has indicated that these limits are approximately correct for defining good trout or salmon waters. Also, these limits are approximately the same as those set by investigators in other parts of the country.

The vertical distribution of temperature and oxygen in lakes during the summer has been discussed previously (see page 11), but should be summarized briefly at this point. During the summer the warm water remains at the surface and upper part of the lake, and the cold water remains in the lower part. Heating of the water at the surface, and wave action with the resultant circulating currents, continually warm up the upper layer of water, and extend this warm-water layer to greater depths. Oxygen consumption takes place continually at all depths, but the water of the upper layer is continually reaerated at the surface. The deep water does not come in contact with the surface, and therefore cannot be reaerated in this way.

Thus oxygen depletion usually takes place only in the deeper water, and the degree of depletion is usually in proportion to the depth. Furthermore this oxygen depletion in the deep water continues from just after the spring overturn until the next complete overturn takes place in the fall. This oxygen depletion becomes critical only in late summer, as is also the case of the effect of the upper warm-water layer on trout and salmon. The upper warm-water layer continually extends down from the surface, and the oxygen-deficient layer continually works up from the bottom; thus the two converging forces tend to "eat away" at the middle trout and salmon zone, confining the fish of this zone more and more to a narrow depth stratum as the summer progresses. With extreme oxygen depletion in a moderately deep lake, this middle trout or salmon zone may completely disappear; in some lakes it may be only partially destroyed; or in other lakes it may not be affected at all because of complete absence of oxygen depletion in the deeper water. This would depend upon the individual lakes. The oxygen depletion in the deep water continues through late summer and into early fall, but by early fall the surface water may be cool enough to let trout and salmon come up to the surface, and at this time the bottom oxygen deficiency would not be a limiting factor.

Methods. Analyses on temperature, dissolved oxygen, and pH of the water were made during late summer, mostly in August, on all of the lakes and ponds. In addition, such tests were made on Great, Long, and East ponds of the Belgrades, on Salmon and Auburn lakes, and on Snow, Pleasant and Cochnewagan ponds, during the previous months of June and July, so that data on these lakes were available for three separate dates during the summer. These eight lakes represented several distinct types with respect to depth, temperature, and oxygen content of the water; and these tests made during the early, middle, and late parts of the summer revealed the degree of change of temperature and oxygen in these different types of lakes during this period. The results of the water analyses on all 53 lakes and ponds are given completely in Table II. The methods used in these analyses on depth, temperature, oxygen, and pH may be described briefly as follows:

Lakes were sounded by using two water-resistant (non-shrinking) sounding lines: a braided tiller rope with bronze wire core, and a brass chain. The two lines were marked in depth at intervals of 5 and 2 feet, respectively. A two-pound lead weight was used on the end of each. The depth soundings were distributed along lines between various land marks such as points, islands, buildings, roads, etc., and these were lines which could be located on our field maps. These maps (see Figures 7 to 51), as prepared by the survey, were

copied by pantograph from the United States Geological Survey Topographic Sheets. Soundings were distributed evenly along each line, either by estimating the distance between soundings or by timing this distance with the motor-boat traveling at a constant speed. All of the lakes were sounded by the present survey with the exception of Great Pond of the Belgrades. Soundings on Great Pond are from a depth survey and map by E. S. Lincoln, Consulting Engineer of New York City, and herewith printed with his permission.

The analyses on temperature, oxygen, and pH were made at one or more stations on each lake and at only one station on most of the smaller lakes. These water analyses stations are indicated by the symbol ⊗ on the accompanying maps of the lakes (Figures 7 to 51). These stations were selected after the lakes were sounded, and in most instances were located at or near the deepest part of the lake. Tests on temperature, oyxgen, and pH were made at various depth intervals distributed so as to determine the points of depth at which each of these factors might change considerably. Tests on temperature were made with two types of deep sea reversing thermometers: a recent type of Negretti and Zambra instrument; and a second instrument, without an auxiliary thermometer, obtained from the H-B Instrument Company of Philadelphia. Also, three series of temperatures on Great Pond of the Belgrades were made in 1937 with a Taylor Maximum and Minimum Thermometer. A few surface temperatures were taken with a pocket thermometer, when these temperatures were above the range of the Negretti and Zambra instrument; these pocket thermometers were checked against the Negretti and Zambra thermometer and were found to be accurate within ±1° F. The type of thermometer used in each series of temperatures is indicated in Table II. Samples of water for analyses on oxygen and pH were obtained from the desired depths with a Foerst Improved Water Sampler of 2,000 c.c. capacity. All oxygen tests were made by the Winkler Method. All pH tests were made with LaMotte Indicator Solutions and LaMotte Color Standard Solutions, and were made immediately after the water samples were taken. The oxygen tests were also run immediately up to the final titration, and this titration was completed within two to six hours after sampling. The results of oxygen analyses as given in this report (Table II) are expressed in parts-per-million by weight of dissolved oxygen in the water.

A study was made of the morphometry of the lakes in connection with the results of tests on temperature and dissolved oxygen, for an evaluation of the amount of water volume and bottom area in each lake available to trout or salmon or other cold-water fishes during late summer. The critical depths above which the temperature exceeded 70° F., and the depths below which the dissolved oxygen was less than 5 p.p.m., during late summer, were determined from the water analysis data. Depth soundings were located on each map; depth contours including those for the critical temperature and oxygen depths were drawn on each; and the lake area within each depth contour was determined by planimeter. Bottom areas between depth contours in the lakes were assumed to be in the same proportion as areas within depth contours on our prepared maps. The volume of water within each depth stratum corresponding to consecutive depth contours was calculated by assuming the lake to be a series of frustums and by using the following formula:

Volume of water in acre feet between two given depth levels $= 1/3\ H\ (A_1+A_2+\sqrt{A_1A_2})$, where

H = depth of the water layer in feet.

A_1 = area in acres within the depth contour representing the upper limit of the frustum.

A_2 = area in acres within the depth contour representing the lower limit of the frustum.

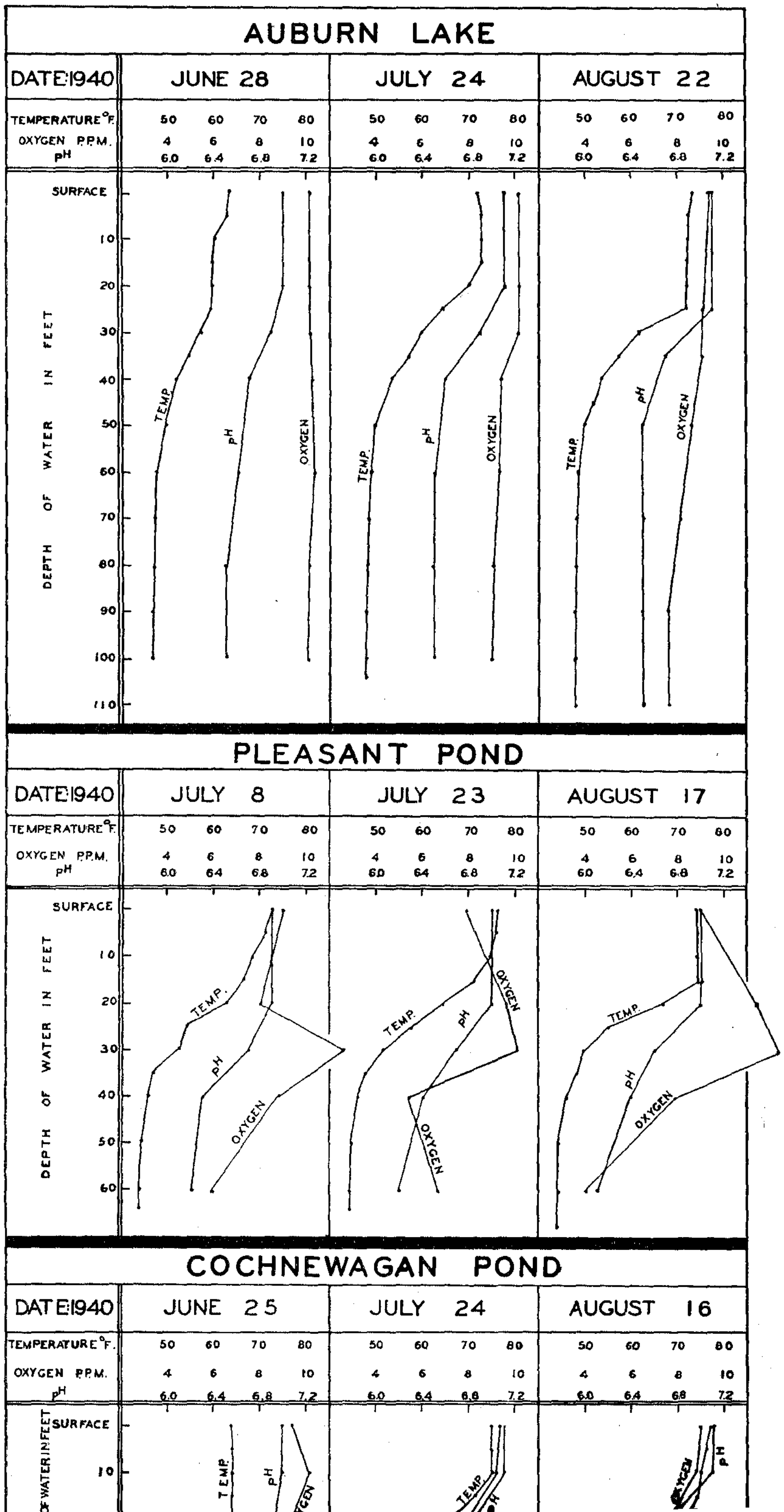
The total volume of each lake was obtained by adding the figures for the separate parts. From this procedure, figures were obtained for the volume of water in the upper warm-water layer (above 70° F.); the volume of water, if any, in the deeper part of each lake where the dissolved oxygen was less than 5 p.p.m.; and the volume of good trout or salmon water, if any, between these warm and oxygen-deficient layers. Similar figures were obtained for the area of lake bottom directly in contact with the water of these three zones. The area in contact with the water of the good trout and salmon zone is presumably the only lake bottom area available to these fishes during late summer. The above procedure in evaluating data on depth, temperature, and dissolved oxygen for trout and salmon, and several possible sources of error of the procedure, have been discussed more fully in a previous report (Cooper, 1939b). These sources of error are not believed to be serious, and the method is presumably sufficiently accurate for the purposes of the present survey.

Results. In those 8 lakes and ponds on which water analyses were made on three separate dates during the summer, a considerable degree of seasonal change in temperature was encountered in all of them, and considerable change in dissolved oxygen content was encountered in some (See Table II and Figures 1 to 3). Several rather distinct types of lakes or ponds, with respect to these conditions of depth, temperature, and dissolved oxygen, could be identified among these 8 bodies of water. East Pond of the Belgrades and Cochnewagan Pond were of the shallow type with quite uniform vertical distribution of temperature, dissolved oxygen, and pH from the surface to

70°F = 21°C

the bottom during the entire summer; there was a notable seasonal increase in temperature throughout all depths but there was very little seasonal change in dissolved oxygen or pH. The other six lakes were deep enough to have a thermocline; and all revealed a general seasonal increase in temperature, especially throughout the upper warm-water layer (epilimnion). These deep-water lakes, however, were of at least three distinct types with respect to the amount of dissolved oxygen in the deep water. In Great Pond, Salmon Lake, and Snow Pond there was a high oxygen content at all depths at the June analyses; this oxygen content was considerably reduced in the deep water by July, and was critically low (from the standpoint of fishes) in the deep water by August. This deep-water oxygen depletion in August was most extreme in Great Pond and Salmon Lake and somewhat less so in Snow Pond. A second possible type with respect to oxygen depletion in deep water was represented by Pleasant Pond, in which the oxygen content within the thermocline was unusually high, but was considerably reduced in the deepest water. The oxygen distribution in Auburn Lake represented a third rather distinct type, with practically uniform distribution from top to bottom at each summer analysis, and with a slight but uniform seasonal decrease from top to bottom. In Long Pond of the Belgrades (south part) a somewhat complicated oxygen curve was encountered at the analyses of July and August; there was the usual high oxygen content at the surface, a marked decrease throughout the thermocline, a considerable increase in the deep water just below the thermocline, and finally a notable decrease of oxygen at the bottom. This oxygen distribution in Long Pond might represent a rather distinct and common type of oxygen distribution, or it might have been a stage in oxygen depletion which was approximating the conditions of oxygen distribution as found during the August analysis on Snow Pond. These 8 lakes and ponds represent all of the distinct types of lakes with respect to distribution of depth, temperature, and oxygen which were encountered among the remaining 45 lakes and ponds.

The depth to which the upper warm-water layer (above 70° F.) had extended by August was definitely related to the size of the particular lake or pond; the warm layer extended to greater depths in the larger ponds (see Table I). These depths ranged from a minimum of 12 feet in the smallest pond (Sandy) to 33 feet in the largest (Great Pond). The averages of depths for lakes of various size-groups ranged from 17.3 feet for lakes of 107 to 500 acres in area, to 25 to 33 feet in the largest of the lakes (see page 16). In addition to East Pond of the Belgrades and Cochnewagan Pond, both cited in the preceding paragraph, six other ponds were so shallow that the upper warm-water layer extended to the bottom of the entire pond area, namely: Sabattus, Lovejoy, and McGrath ponds, North Pond of Belgrades, and Androscoggin and Pocasset lakes. The remaining 45 lakes, i.e.,



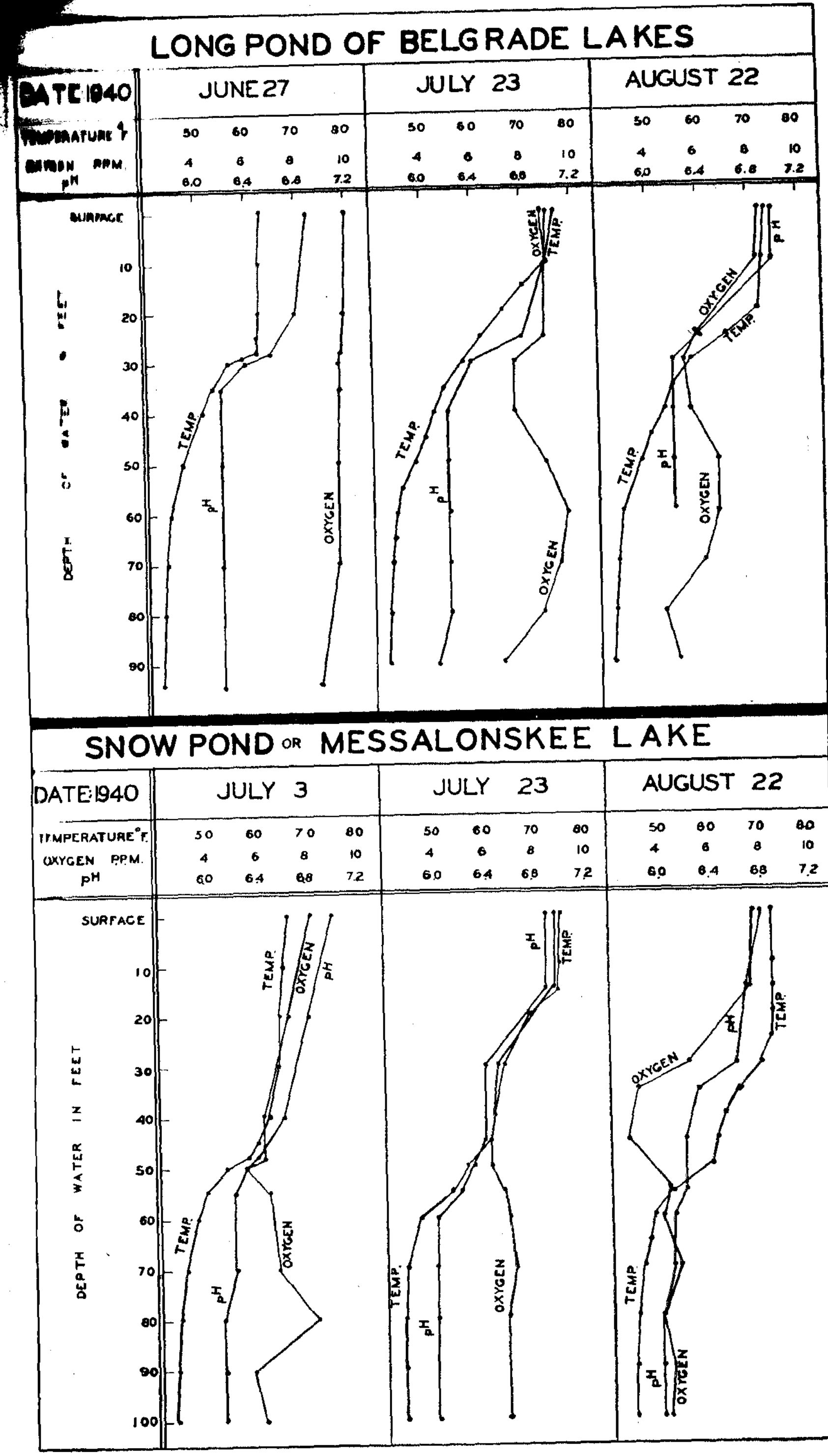


Figure 1. The vertical distribution of temperature, dissolved oxygen, and pH of the water in Auburn Lake, Pleasant Pond, and Cochnewagan Pond, as determined by analyses made at three dates during the summer. Data are from Table II. Figure 1 is on opposite page.

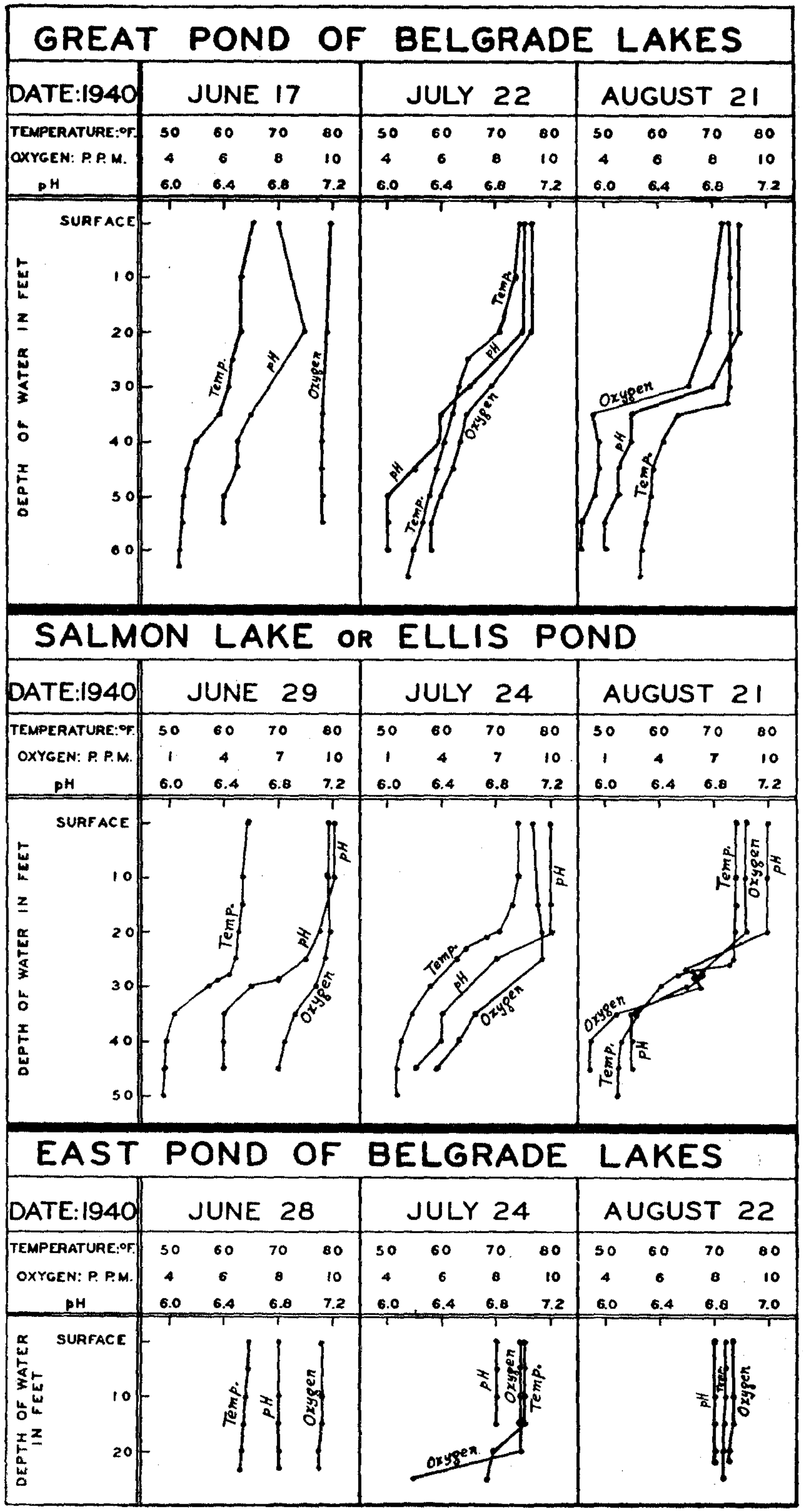


Figure 3. The vertical distribution of temperature, dissolved oxygen, and pH of the water in Great Pond, Salmon Lake, and East Pond, as determined by analyses made at three dates during the ...

C = 5/9(F − 32)

TABLE II. Water analyses. Vertical distribution of temperature, oxygen, and pH in the lakes and ponds, from analyses* made during the summer of 1940**

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature:*** °F.	Oxygen: p.p.m.	pH****
SABATTUS POND, P.389.	Surface	66.7N 19.3	8.9	7.5
Greene Twp.,	5	66.5 19.2	...	...
Androscoggin Co.	10	66.3 19.1	8.9	7.6
June 21, 2:00 to 2:15 P.M.	15	66.3 19.1	...	...
Station: ¼ mile west of Marr Point.	17	....	8.6	7.7
Depth of water: 18 ft.	18	66.1 19.0	...	...
Northwest breeze. Waves: 4 inches high.				
TAYLOR POND, P. 392.	Surface	74.8N	8.3	7.1
Auburn Twp., Androscoggin Co.	5	71.9	...	...
Aug. 22, 10:00 to 10:45 A.M.	10	71.9	...	...
Station: 200 yds. north of center of the pond.	15	71.9	8.1	7.1
	20	68.3	...	...
Depth of water: 44 ft.	25	57.3	4.5	6.5
North breeze. Waves: 3 inches high.	30	54.7	1.6	6.2
	35	53.9	...	...
	40	53.6	1.1	6.2
	44	53.6	...	...
LOWER RANGE POND, P. 398.	Surface	73.2N 22.9	9.1	7.1
Poland Twp., Androscoggin Co.	5	73.2 22.9	...	...
Aug. 21, 1:00 to 1:45 P.M.	10	73.0 22.8	...	...
Station: 1/3 mile from east end of pond.	15	72.6 22.6	9.3	7.1
	20	56.8 13.8	7.8	6.6
Depth of water: 36 ft.	25	53.1 11.7	3.6	6.2
North wind. Waves: 10 inches.	30	49.4 9.7	...	...
	35	48.0 8.9	0.3	6.1
MIDDLE RANGE POND, P.400.	Surface	80P 26.7	8.8	7.1
Poland Twp., Androscoggin Co.	13	75.4N 24.1	...	...
Aug. 10, 11:00 A.M. to 12:30 P.M.	15	70.7 21.5	9.8	7.1
Station: ¼ mile north of center of pond.	20	57.6 14.2	...	...
	25	48.9 9.4	...	...
Depth of water: 60 ft.	30	46.2 7.9	8.4	6.4
No wind. No waves.	35	44.4 6.9	...	...
	40	43.3 6.3	...	...
	45	42.4 5.8	7.9	6.2
	50	42.1 5.6	...	...
	55	42.1 5.6	7.1	6.1
	60	41.9 5.5	...	...

* The location of each water-analysis station is indicated by the symbol ⊗ on the accompanying outline maps of these lakes.

** All analyses were made during the summer of 1940, except for three series of analyses on Great Pond of the Belgrade Lakes made during June 1937 and so indicated.

*** All 1940 temperatures, with the exception of a few surface temperatures of over 75° F., were taken with Deep Sea Reversing Thermometers, of two types: Negretti and Zambra Deep Sea Reversing Thermometer, and a Deep Sea Reversing Thermometer obtained from H-B Instrument Company, Philadelphia. The few surface temperatures of over 75° F. were taken with a pocket thermometer. Temperatures on Great Pond of the Belgrades in June, 1937, were taken with a Taylor Maximum and Minimum Thermometer. To the first temperature reading of each vertical series is appended a symbol indicating the type of thermometer used for that particular series, as follows: N = Negretti and Zambra thermometer, H = Deep Sea Reversing Thermometer obtained from H-B Instrument Company, and T = Taylor Maximum and Minimum Thermometer. The symbol P is appended to surface temperatures taken with a pocket thermometer.

**** With few exceptions, all pH values of 5.6 to 6.3 inclusive were from tests made with Bromcresol Purple Indicator; all values of 6.4 to 7.2 were with Bromthymol Blue, and values of 7.3 to 7.7 were with Phenol Red Indicator. The exceptions are so indicated in the table.

Summer 1940

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
UPPER RANGE POND, P.401.	Surface	77P	9.0	7.2
Poland Twp., Androscoggin Co.	5	Over 75	...	...
Aug. 10, 2:30 to 3:30 P.M.	10	Over 75	...	...
Station: near center of the pond.	15	66.6N	9.7	7.2
Depth of water: 35 ft.	20	53.1	9.1	6.3
East breeze. Waves: 2 inches high.	25	47.7	8.2	6.3
	30	45.9	6.1	6.1
	35	44.8	...	...
HOGAN POND, P.403.	Surface	71.0N	7.4	6.9
Oxford Twp., Oxford Co.	5	70.5	...	...
Aug. 21, 10:15 to 10:45 A.M.	10	70.1	7.4	7.0
Station: 1/3 mile from north end of pond.	15	63.3	4.5	6.6
	20	55.9	2.2	6.2
Depth of water: 31 ft.	25	51.4	...	...
North wind. Waves: 8 inches high.	28	....	0.1	6.1
	30	50.2	...	...
WHITNEY POND, P.404.	Surface	72.8N	8.5	7.1
Oxford Twp., Oxford Co.	5	72.8	...	...
Aug. 21, 11:00 to 11:30 A.M.	10	72.6	8.5	7.0
Station: ½ mile from north end of pond.	15	72.1	8.4	7.0
	20	60.8	8.5	7.0
Depth of water: 24 ft.	24	57.7	...	...
North wind. Waves: 10 inches.				
TRIPP POND, P.408.	Surface	81P	8.9	7.0
Poland Twp., Androscoggin Co.	10	....	8.9	7.0
Aug. 9, 3:00 to 3:45 P.M.	15	72.3N	5.1	6.3
Station: ½ mile north of south end of the pond.	20	67.5	2.5	6.1
	25	65.3	2.4	6.1
Depth of water: 28 ft.	28	64.2	...	...
West breeze. Waves: 4 inches.				
THOMPSON LAKE, P.409.	Surface	74.0N	9.1	7.0
Oxford Twp., Oxford Co.	5	73.7	...	...
Aug. 20, 12:15 to 1:15 P.M.	10	72.8	...	...
Station: 150 yds. west of Haye's Point.	15	66.0	9.5	6.9
Depth of water: 99 ft.	20	59.3	...	...
Strong north wind. Waves: 3 ft. high.	25	59.2	9.1	6.5
	30	53.9	...	...
	35	50.5	9.8	6.5
	40	49.1	...	...
	45	48.3	...	...
	50	48.2	9.0	6.4
	60	48.0	...	...
	70	47.5	9.1	6.4
	80	47.3	...	...
	90	46.5	9.2	6.4

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
THOMPSON LAKE, P.409.	Surface	73.0N	9.2	7.0
Poland Twp., Androscoggin Co.	5	73.0	...	...
Aug. 20, 2:15 to 3:15 P.M.	10	73.5	...	...
Station: ¾ mile northeast of Birch Island.	15	73.5	...	...
	20	73.4	...	...
Depth of water: 78 ft.	25	73.4	...	...
Strong north wind. Waves: 4 ft. high.	30	72.8	9.2	7.0
	35	62.6	...	...
	40	53.7	9.2	6.5
	45	50.0	...	...
	50	49.4	9.2	6.9
	60	48.0	...	...
	70	48.0	...	...
	75	.....	9.2	6.9
	78	47.4	...	...
PENNESSEEWASSEE LAKE, P.416.	Surface	74.0N	9.0	7.1
Norway Twp., Oxford Co.	5	74.1	...	...
Aug. 20, 9:45 to 10:30 A.M.	10	74.1	...	...
Station: ½ mile west of island at south end of the lake.	15	74.3	...	...
	20	74.3	8.5	7.1
Depth of water: 47 ft.	25	66.3	7.3	6.9
Strong north wind. Waves: 2 ft. high.	30	60.6	...	...
	35	56.5	3.0	6.5
	40	56.5	...	...
	47	51.2	0.3	6.1
TWITCHELL POND, P.425.	Surface	68.2H	9.7	6.8
Greenwood Twp., Oxford Co.	10	68.2	...	...
Sept. 5, 4:30 to 5:10 P.M.	15	68.0	...	...
Station: 300 yds. west of Payne Ledge.	20	68.0	8.5	6.5
Depth of water: 47 ft.	25	60.1	7.2	6.0
Northwest breeze. Waves: 5 inches high.	30	52.2	4.5	5.8
	35	49.5	...	...
	40	48.2	1.1	5.7
	45	47.8	0.7	5.6
BRYANT POND, P.427.	Surface	67.8H	9.7	7.0
Woodstock Twp., Oxford Co.	10	67.6	...	...
Sept. 4, 3:00 to 4:15 P.M.	15	67.3	9.6	6.9
Station: 50 yds. out from the foot of Mt. Christopher.	20	66.1	8.0	6.8
	23	61.7	7.0	6.2
Depth of water: 40 ft.	25	54.7	4.9	6.0
Strong northwest wind.	30	50.0	4.1	6.0
Waves: 7 inches high.	35	49.6	3.4	6.0
	38	49.3	...	...

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
AUBURN LAKE, P.428. Auburn Twp., Androscoggin Co. June 28, 12:00 to 2:15 P.M. Station: ¼ mile east of Pine Point. Depth of water: 100 ft. Strong west wind. Waves: 6 inches high.	Surface	63.5[N]	10.1	7.0
	5	63.1	...	...
	10	60.1	...	...
	15	59.9	...	...
	20	59.9	10.1	7.0
	25	59.5	...	...
	30	57.2	10.1	6.9
	35	54.7	...	...
	40	52.0	10.2	6.7
	50	49.3	...	...
	60	47.8	10.3	6.6
	70	47.3	...	...
	80	47.1	10.1	6.5
	90	46.9	...	...
	100	46.8	10.0	6.5
AUBURN LAKE, P.428. Auburn Twp., Androscoggin Co. July 24, 9:45 to 11:00 A.M. Station: ¼ mile east of Pine Point. Depth of water: 104 ft. South breeze. Waves: 6 inches high.	Surface	72.0[N]	10.2	7.1
	5	72.9	...	...
	10	72.9	...	...
	15	72.9	...	...
	20	70.2	10.2	7.1
	25	64.4	...	...
	30	59.9	10.2	6.9
	35	57.0	...	...
	40	53.6	9.4	6.6
	50	49.8	...	...
	60	48.9	9.3	6.5
	70	48.4	...	...
	80	48.2	9.1	6.5
	90	47.8	...	...
	100	47.8	9.0	6.5
	104	47.8	...	...
AUBURN LAKE, P.428. Auburn Twp., Androscoggin Co. Aug. 22, 12:30 to 1:45 P.M. Station: ¼ mile east of Pine Point. Depth of water: 112 ft. Southwest breeze. Waves: 5 inches high.	Surface	73.4[N]	9.4	7.1
	5	72.4	...	...
	10	72.4	...	...
	15	72.3	...	...
	20	72.1	...	...
	25	72.0	9.1	7.1
	30	61.5	...	...
	35	57.3	9.1	6.7
	40	53.6	...	...
	45	52.0	...	...
	50	49.8	8.6	6.5
	60	48.9	...	...
	70	48.5	8.1	6.5
	80	48.2	...	...
	90	48.0	7.6	6.5
	100	48.0	...	...
	110	47.8	7.6	6.5

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
[illegible]EN POND, P.437. [illegible] Twp., Androscoggin Co. [illegible] 10, 10:15 to 11:00 A.M. [illegible] ½ mile from south end of pond, and 100 yds. off east shore. Depth of water: 44 ft. No wind. No waves.	Surface	75.0[N]	9.0	6.8
	5	74.3	...	...
	10	73.8	8.6	6.8
	15	73.4	...	...
	20	58.0	7.3	6.1
	25	49.3	...	...
	30	45.7	6.1	6.0
	35	44.1	...	...
	40	42.8	4.0	5.8
	44	42.6	...	...
PLEASANT POND, P.443. Turner Twp., Androscoggin Co. July 8, 10:30 A.M. to 12:30 P.M. Station: 1/3 mile north of south end of pond. Depth of water: 66 ft. No wind. No waves. *The pH value of 6.3 was with Bromthymol Blue indicator	Surface	72.7[N]	9.0	6.9
	5	71.2	...	...
	10	68.5	...	...
	15	66.4	...	...
	20	63.0	8.0	6.9
	25	54.0	...	...
	30	52.5	11.6	6.7
	35	46.8	...	...
	40	45.7	8.8	6.3*
	50	44.4	...	...
	60	43.7	5.9	6.2
	64	43.7	...	...
PLEASANT POND, P.443. Turner Twp., Androscoggin Co. July 23, 4:15 to 5:15 P.M. Station: 1/3 mile north of south end of pond. Depth of water: 66 ft. South breeze. Waves: 2 inches high.	Surface	76[P]	7.9	7.0
	5	75.7[N]	...	...
	10	74.4	...	...
	15	71.2	...	...
	20	64.4	9.6	7.0
	25	57.3	...	...
	30	51.4	10.1	6.7
	35	47.8	...	...
	40	45.8	5.4	6.4
	50	44.4	...	...
	60	44.4	6.7	6.2
	64	44.4	...	...
PLEASANT POND, P.443. Turner Twp., Androscoggin Co. Aug. 17, 8:45 to 9:30 A.M. Station: 1/3 mile north of south end of the pond. Depth of water: 68 ft. No wind. No waves.	Surface	74.8[N]	8.9	7.0
	5	74.8	...	...
	10	74.5	...	...
	15	74.5	...	...
	20	66.9	11.4	7.0
	25	54.9	...	...
	30	49.8	12.3	6.6
	35	48.2	...	...
	40	45.9	7.9	6.4
	50	44.2	...	...
	60	44.1	4.0	6.1
	68	43.8	...	...

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
ANDROSCOGGIN LAKE, P.464.	Surface	68.3N	10.4	6.7
Wayne Twp., Kennebec Co.	5	68.3	...	...
Aug. 26, 9:30 to 10:15 A.M.	10	68.3	...	...
Station: ½ mile northeast of Norris Island.	15	68.3	...	...
Depth of water: 32 ft.	20	68.3	9.1	7.0
No wind. No waves.	25	68.3	9.1	7.0
	30	68.3	5.6	7.0
	32	67.1	...	...
POCASSET LAKE, P.466.	Surface	69.4N	11.3	7.1
Wayne Twp., Kennebec Co.	5	69.4	...	...
Aug. 26, 11:15 to 11:45 A.M.	10	68.9	11.1	7.1
Station: 2/3 mile northeast of the outlet.	15	68.9	...	...
Depth of water: 19 ft.	17	....	9.5	7.3
Northwest breeze. Waves: 8 inches high.	19	68.3	...	...
LOVEJOY POND, P.470.	Surface	68.9N	9.1	6.9
Wayne Twp., Kennebec Co.	5	68.9	...	...
Aug. 26, 12:30 to 1:00 P.M.	10	68.9	9.1	6.9
Station: 1 mile north of the outlet.	15	68.7	...	...
Depth of water: 19 ft.	17	....	9.1	6.9
Northwest breeze. Waves: 3 inches high.	19	68.5	...	....
ECHO LAKE, P.472.	Surface	70.9H	8.8	7.0
Fayette Twp., Kennebec Co.	5	70.9	...	...
Aug. 24, 11:45 A.M. to 1:15 P.M.	10	70.9	...	...
Station: 200 yds. north of Echo Island.	15	70.7	8.8	7.0
Depth of water: 111 ft.	20	63.0	7.1	6.4
Northwest breeze. Waves: 4 inches high.	23	59.5	...	...
	25	56.3	6.1	6.2
	30	51.8	...	...
	35	48.6	6.9	6.1
	40	45.3	...	...
	45	44.2	7.9	6.1
	50	43.8	...	...
	55	43.6	4.6	6.1
	65	43.3	4.6	6.1
	75	43.2	4.6	6.1
	85	42.8	...	...
	95	42.6	...	...
	100	42.4	4.2	6.1
	109	42.4	...	...

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
PARKER POND, P.474.	Surface	72.0H	8.8	7.0
Fayette Twp., Kennebec Co.	5	72.0	...	...
Aug. 23, 9:45 to 11:00 A.M.	10	72.0	9.0	7.0
Station: ¾ mile north of the Headland.	15	71.8	...	...
Depth of water: 70 ft.	20	71.6	...	...
Southwest breeze. Waves: 3 inches high.	23	71.6	7.8	6.6
	25	63.0	6.8	6.4
	30	58.3	5.8	6.1
	35	55.6	...	...
	40	54.0	3.6	6.0
	45	52.2	...	...
	50	51.6	3.1	6.0
	55	51.4	...	...
	60	51.3	2.8	6.0
	65	51.1	...	...
DAVID POND, P.476.	Surface	68.0H	9.1	6.8
Fayette Twp., Kennebec Co.	5	67.5	...	...
Aug. 28, 10:00 to 10:45 A.M.	10	67.1	8.9	...
Station: 1/3 mile northeast of the narrows, in the northern half of the pond.	15	66.6	...	...
Depth of water: 25 ft.	20	66.6	8.2	6.4*
No wind or waves.	21	63.0	...	...
	23	59.9	8.2	6.4*
	25	58.1	5.5	6.2
**pH values of 6.4 were with Bromcresol Purple indicator.*				
DAVID POND, P.476.	Surface	68.7H	8.5	6.8
Fayette Twp., Kennebec Co.	10	67.6	8.3	6.8
Aug. 28, 11:15 to 11:45 A.M.	20	66.2	3.3	6.4
Station: ½ mile north of south end of the pond.	21	64.0	...	...
Depth of water: 37 ft.	25	54.7	0.2	6.0
No wind or waves.	30	50.4	0.0	6.2
	35	48.0	0.0	6.4*
	37	47.8	...	...
**This pH value of 6.4 was with Bromcresol Purple indicator.*				
TILTON POND, P.478.	Surface	69.4H	8.9	6.8
Fayette Twp., Kennebec Co.	10	66.2	8.8	6.8
Aug. 28, 2:45 to 3:15 P.M.	15	62.2	2.8	5.8
Station: ¼ mile north of south end of the pond.	20	53.1	3.3	5.8
Depth of water: 42 ft.	25	48.6	...	...
No wind or waves.	30	46.4	1.2	5.8
	40	43.0	0.4	5.8

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
FLYING POND, P.481. Mount Vernon Twp., Kennebec Co. Aug. 23, 12:45 to 1:30 P.M. Station: ½ mile north of the outlet. Depth of water: 80 ft. Southwest breeze. Waves: 4 inches high.	Surface	71.2[H]	8.6	7.2
	10	71.2	8.9	7.2
	15	67.7	8.9	7.0
	20	61.6	...	...
	25	50.0	4.8	6.1
	30	46.0	5.6	6.1
	35	45.5	...	...
	40	45.0	5.5	6.1
	50	44.6	5.4	6.1
	60	44.2	4.5	6.0
	70	43.9	4.2	6.0
	75	43.9	...	...
WORTHLEY POND, P.499. Peru Twp., Oxford Co. Sept. 6, 1:00 to 1:40 P.M. Station: ½ mile north of south end of the pond. Depth of water: 48 ft. No wind or waves.	Surface	68.7[H]	9.9	6.8
	10	68.4	...	...
	15	68.2	9.6	6.8
	20	67.5	9.6	6.8
	25	58.3	8.2	6.0
	30	51.1	...	...
	35	47.8	5.3	5.8
	40	46.0	...	...
	45	43.0	1.1	5.8
WEBB LAKE, P.503. Weld Twp., Franklin Co. Sept. 11, 10:45 A.M. to 12:00 Noon Station: ½ mile east of mouth of Showman Brook. Depth of water: 42 ft. Strong west wind. Waves: 1 ft. high. **pH of 6.4 was with Bromcresol Purple indicator.*	Surface	64.0[H]	9.2	6.8
	5	63.9	...	...
	10	63.9	9.1	6.8
	15	63.5	...	...
	20	63.3	8.8	6.7
	25	63.3	8.8	...
	30	63.1	7.0	6.4*
	35	62.9	1.4	6.2
	37	57.7	...	...
	40	....	0.3	6.2
	42	57.0	...	...
SILVER LAKE, P.515. Roxbury Twp., Oxford Co. Sept. 9, 2:50 to 4:00 P.M. Station: 1/8 mile southwest of French Island. Depth of water: 43 ft. Light breeze. No waves.	Surface	63.7[H]	9.6	6.8
	10	63.0	...	...
	15	62.6	...	...
	20	62.6	9.4	6.7
	25	62.6	...	...
	30	62.4	9.4	6.7
	35	62.4	...	...
	40	62.4	9.6	6.7
GARLAND POND, P. 516. Byron Twp., Oxford Co. Sept. 9, 11:25 A.M. to 12:30 P.M. Station: 1/5 mile off the middle of the east shore. Depth of water: 41 ft. No wind or waves.	Surface	63.0[H]	9.6	6.8
	10	62.6	...	...
	15	62.2	...	...
	20	62.1	9.6	6.8
	25	62.1	9.6	6.4
	30	57.7	4.4	5.8
	35	52.7	...	...
	40	51.6	1.1	5.8

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
NORTH POND, P.521. Woodstock Twp., Oxford Co. Sept. 5, 1:20 to 2:15 P.M. Station: 100 yds. off middle of the east shore. Depth of water: 37 ft. Northwest wind. Waves: 5 inches high.	Surface	68.4[H]	9.3	6.8
	10	68.4	...	...
	15	68.4	...	...
	20	68.0	9.0	6.8
	25	64.6	3.3	6.4
	30	58.3	...	...
	35	55.8	0.0	6.2
SOUTH POND, P.522. Greenwood Twp., Oxford Co. Sept. 4, 11:50 A.M. to 1:20 P.M. Station: near the center of the pond. Depth of water: 65 ft. Northwest wind. Waves: 5 inches high.	Surface	68.0[H]	9.6	6.8
	10	67.6	...	...
	15	66.9	9.5	6.7
	20	66.2	...	...
	25	64.8	9.5	6.6
	28	63.7	...	...
	30	61.0	8.7	6.0
	35	53.4	8.7	6.0
	40	49.6	8.7	6.0
	45	46.9	...	...
	50	45.0	8.3	6.0
	60	43.9	6.5	5.9
	63	43.7	...	...
PURGATORY POND, P. 659. Litchfield Twp., Kennebec Co. Aug. 26, 12:15 to 1:15 P.M. Station: ¾ mile northeast of the south end of the pond. Depth of water: 62 ft. Northwest breeze. Waves: 5 inches high.	Surface	69.1[H]	8.8	7.0
	5	69.1	...	...
	10	69.1	8.7	7.0
	15	68.4	...	...
	20	67.3	7.1	6.8
	21	65.8	...	...
	22	62.6	...	...
	23	59.4	...	...
	25	56.1	1.5	6.2
	30	51.6	2.6	6.2
	35	46.8	...	...
	40	44.6	4.3	6.2
	50	43.2	2.8	6.1
	55	42.8	0.6	6.1
	60	42.4	...	...
SAND POND, P.660. Monmouth Twp., Kennebec Co. Aug. 26, 9:30 to 11:00 A.M. Station: 1/5 mile north of south end of the pond. Depth of water: 82 ft. Northwest breeze. No waves.	Surface	68.4[H]	8.8	7.0
	5	68.2	...	...
	10	68.0	...	...
	15	67.8	8.8	7.0
	18	67.3	...	...
	20	55.4	5.9	6.2
	25	48.9	5.5	6.2
	30	45.3	6.1	6.2
	35	44.1	...	...
	40	42.6	7.3	6.2
	45	41.7	...	...
	50	40.7	7.5	6.2
	55	39.9	...	...
	60	39.7	5.8	6.2
	65	39.5	...	...
	70	39.3	2.9	6.1
	75	....	1.1	6.0
	80	39.2	...	...

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
COBBOSSEECONTEE LAKE, P.668.	Surface	77.2^{H}	8.8	7.2
Monmouth Twp., Kennebec Co.	5	76.1	...	...
Aug. 8, 12:00 Noon to 3:30 P.M.	10	75.6	...	...
Station: 1 mile southwest of Cram Point.	15	75.0	...	...
Depth of water: 100 ft.	20	71.6	7.3	6.7
No wind or waves.	25	65.7	...	...
	30	61.3	4.6	6.4
	35	58.3	...	...
	40	56.7	4.0	6.2
	45	55.4	...	...
	50	54.1	4.4	6.2
	60	50.5	4.7	6.2
	70	48.7	4.8	6.2
	80	48.2	4.4	6.2
	90	47.5	4.0	6.2
	95	47.3	3.9	6.2
	100	47.1	...	...
ANNABESSACOOK LAKE, P.671.	Surface	68.0^{H}	8.2	7.0
Monmouth Twp., Kennebec Co.	5	68.0	...	...
Aug. 27, 9:45 to 10:45 A.M.	10	68.0	...	...
Station: ¼ mile west of south end of Cole's Island.	15	67.8	8.2	7.0
	20	67.6	...	...
Depth of water: 47 ft.	25	67.3	8.0	6.8
Northwest breeze. Waves: 3 inches high.	30	65.3	6.0	6.8
	35	61.2	0.2	6.4
**This pH value of 6.4 was with Bromcresol Purple indicator.*	40	60.1	0.0	6.4*
	45	59.2	...	...
COCHNEWAGAN POND, P.672.	Surface	63.9^{N}	9.4	7.0
Monmouth Twp., Kennebec Co.	5	64.2	...	...
June 25, 1:45 to 2:45 P.M.	10	64.2	10.1	7.0
Station: near center of the pond.	15	64.2	...	...
Depth of water: 28 ft.	20	64.2	...	...
East wind. Waves: 3 inches.	25	63.0	9.0	6.9
COCHNEWAGAN POND, P.672.	Surface	75.0^{N}	9.3	7.1
Monmouth Twp., Kennebec Co.	5	75.0	...	...
July 24, 1:15 to 1:45 P.M.	10	75.0	9.2	7.1
Station: near center of the pond.	15	71.7	...	...
Depth of water: 27 ft.	20	66.0	...	...
South wind. Waves: 6 inches.	25	63.3	7.4	6.7
COCHNEWAGAN POND, P.672.	Surface	77^{P}	9.0	7.1
Monmouth Twp., Kennebec Co.	5	75.9^{N}	...	...
Aug. 16, 12:15 to 12:45 P.M.	10	74.6	8.8	7.1
Station: near center of the pond.	15	74.0	...	...
Depth of water: 26 ft.	20	71.5	...	...
South breeze. Waves: 3 inches.	24	....	7.2	6.6
	25	65.6	...	...

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
WILSON POND, P.673.	Surface	71.8^{N}	8.9	7.1
Monmouth Twp., Kennebec Co.	5	71.8	...	...
Aug. 23, 9:15 to 10:20 A.M.	10	71.8	...	...
Station: ½ mile north of south end of the pond.	15	71.8	9.6	7.1
	20	69.9	...	...
Depth of water: 42 ft.	25	60.1	2.1	6.4
South wind. Waves: 5 inches high.	30	57.6	...	...
	35	55.0	0.1	6.4*
**This pH value of 6.4 was with Bromcresol Purple indicator.*	40	53.6	0.0	...
DEXTER POND, P.674.	Surface	71.9^{N}	8.1	7.2
Wayne Twp., Kennebec Co.	5	72.1	...	...
Aug. 23, 11:45 A.M. to 12:30 P.M.	10	72.1	7.6	7.1
Station: near center of the pond.	15	63.1	3.7	6.4
Depth of water: 22 ft.	20	52.7	2.3	6.4
Southwest breeze. Waves: 2 inches high.				
BERRY POND, P.675.	Surface	71.6^{N}	8.2	7.0
Winthrop Twp., Kennebec Co.	5	71.6	...	...
Aug. 23, 1:30 to 2:20 P.M.	10	71.6	8.1	7.0
Station: near center of the pond.	15	66.9	6.4	6.9
Depth of water: 25 ft.	20	57.3	0.6	6.3
Southeast breeze. Waves: 4 inches high.	23	....	0.0	6.3
	25	55.4	...	...
MARANACOOK LAKE, P.676.	Surface	69.8^{H}	9.3	7.0
Winthrop Twp., Kennebec Co.	5	68.9	...	...
Aug. 27, 12:45 to 2:30 P.M.	10	68.4	...	...
Station: 1 mile northeast of the outlet.	15	68.4	9.3	7.0
Depth of water: 106 ft.	20	68.2	...	...
Northwest breeze. Waves: 3 inches high.	25	67.5	8.5	7.0
	30	56.3	7.6	6.4
	35	51.4	7.2	6.4*
	40	49.3	...	...
	45	47.3	8.1	6.4*
	50	46.0	...	...
	55	44.4	8.7	6.4*
	60	43.7	...	...
	65	43.3	8.5	6.4*
	70	43.2	...	...
	75	43.0	8.5	6.4*
	80	43.0	...	...
**These pH values of 6.4 were with Bromcresol Purple.*	90	42.8	8.1	6.2
	100	42.6	8.0	6.2

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
TORSEY POND, P.678.	Surface	70.9[H]	7.8	7.0
Mount Vernon Twp., Kennebec Co.	10	70.9	7.8	6.9
Aug. 24, 9:15 to 10:00 A.M.	20	69.1	2.4	6.6
Station: 1 mile south of north end of the pond.	23	61.2	0.4	6.2
Depth of water: 44 ft.	25	59.0	...	...
Northwest breeze. Waves: 3 inches high.	30	55.0	0.1	6.2
	35	52.5	0.0	6.2
	40	51.8	0.0	...
	42	51.4	...	...
NARROWS POND (South part), P.681.	Surface	69.1[H]	9.2	7.0
Winthrop Twp., Kennebec Co.	5	69.1	...	...
Aug. 29, 9:20 to 11:00 A.M.	10	68.9	...	...
Station: 200 yds. off the middle of the south shore.	15	68.4	9.2	7.0
Depth of water: 103 ft.	20	64.9	11.0	7.0
No wind or waves.	23	57.0	...	...
	25	52.2	12.3	6.8
	30	47.8	11.2	6.6
	35	44.6	...	...
	40	42.8	8.0	6.4
	45	41.7	...	...
	50	41.2	7.5	6.2
	55	41.0	...	...
	60	40.6	7.5	6.2
	70	40.3	...	...
	80	40.3	7.0	6.2
	90	40.1	...	...
	100	40.1	4.8	6.2
NARROWS POND (North part), P.682.	Surface	70.2[H]	9.2	7.2
Winthrop Twp., Kennebec Co.	10	69.1	9.2	7.2
Aug. 29, 1:00 to 1:40 P.M.	15	68.5	...	...
Station: 1/3 mile north of the narrows.	20	62.2	10.5	6.6
Depth of water: 55 ft.	25	51.4	9.1	6.4*
No wind or waves.	30	47.1	7.3	6.4*
	35	43.9	...	...
	40	42.8	4.6	6.2
*pH values of 6.4 were with Bromcresol Purple	45	42.6	...	...
	50	42.4	2.7	...
SNOW POND, P. 698.	Surface	66.2[H]	8.1	7.0
Sidney Twp., Kennebec Co.	10	65.1	...	...
July 3, 9:15 to 10:45 A.M.	20	64.2	7.2	6.8
Station: 1/3 mile northeast of Submerged Island.	30	64.0	...	...
Depth of water: 109 ft.	40	61.5	6.2	6.6
No wind or waves.	45	59.7	...	...
	48	57.6	6.2	6.4
	50	53.4	5.5	6.3
	55	49.3	6.4	6.2
	60	47.5	...	...
	70	45.1	6.7	6.2
	80	43.9	8.2	6.1
	90	43.2	5.7	6.1
	100	43.2	6.1	6.1

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
SNOW POND, P.698.	Surface	75.2[H]	8.9	6.9
Sidney Twp., Kennebec Co.	10	75.0	...	...
July 23, 8:40 to 10:40 A.M.	15	74.5	8.9	6.9
Station: 1/3 mile northeast of Submerged Island.	20	69.1	...	...
Depth of water: 107 ft.	30	63.5	6.5	6.4
No wind or waves.	40	61.7	...	...
	45	60.4	6.2	6.4
	50	56.1	6.2	6.3*
	55	53.1	6.7	6.2
	60	46.8	6.9	6.0
	70	44.2	7.1	6.0
	80	43.7	6.8	6.0
*pH of 6.3 with Bromthymol Blue.	90	43.6	...	...
	100	43.6	6.8	6.0
SNOW POND, P.698.	Surface	72.3[H]	7.8	6.8
Sidney Twp., Kennebec Co.	10	72.7	...	...
Aug. 22, 8:30 to 10:00 A.M.	15	72.7	7.6	6.7
Station: 1/3 mile northeast of Submerged Island.	20	72.7	...	...
Depth of water: 106 ft.	25	72.3	...	...
Northwest wind. Waves: 5 inches high.	30	70.2	5.1	6.6
	35	66.0	3.1	6.3
	40	63.0	...	...
	45	61.2	2.7	6.2
	50	60.1	...	...
	55	52.3	4.4	6.2
	60	48.6	4.0	6.1
	65	47.7	...	...
	70	46.2	4.7	6.1
	80	45.0	4.0	6.0
	90	44.4	4.4	6.0
	100	44.4	4.2	6.0
SNOW POND, P.698.	Surface	73.5[H]	8.3	7.0
Oakland Twp., Kennebec Co.	5	73.5	...	...
Aug. 22, 2:30 to 3:30 P.M.	10	72.5	8.3	7.0
Station: ¼ mile northeast of Brown's Island.	15	72.0	...	...
Depth of water: 50 ft.	20	71.1	6.9	6.6
Southwest breeze. Waves: 3 inches high.	25	70.7	...	...
	30	68.0	3.4	6.2
	35	60.5	3.1	6.2
	40	57.6	0.9	6.0
*pH of 6.4 with both Bromthymol Blue and Bromcresol Purple.	45	50.9	0.0	6.4*
	48	50.0	...	...

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
LONG POND OF BELGRADES	Surface	63.1H	10.0	6.9
(South part), P.712.	10	62.6	...	...
Belgrade Twp., Kennebec Co.	20	62.6	9.9	6.8
June 27, 3:15 to 4:45 P.M.	25	62.2	...	...
Station: 1/8 mile northeast of Green	28	62.2	9.8	6.6
Island.	29	59.0	...	...
Depth of water: 97 ft.	30	56.3	9.7	6.4
Southwest breeze. Waves: 3 inches high.	35	53.2	9.7	6.2
	40	51.1	...	...
	50	47.1	9.6	6.2
	60	44.6	...	...
	70	43.9	9.6	6.2
	80	43.3	...	...
	94	42.8	8.8	6.2
LONG POND OF BELGRADES	Surface	76.6H	8.9	7.0
(South part), P.712.	10	75.0	8.9	7.0
Belgrade Twp., Kennebec Co.	15	70.3	...	...
July 23, 2:15 to 3:30 P.M.	20	66.3	...	...
Station: 1/8 mile northeast of Green	25	61.7	8.9	6.8
Island.	30	58.3	7.7	6.4
Depth of water: 91 ft.	35	54.3	...	...
Southwest breeze. Waves: 5 inches high.	40	52.2	7.7	6.2
	45	50.7	...	...
	50	48.6	8.9	6.2
	55	45.9	...	...
	60	44.8	9.7	6.2
	65	44.2	...	...
	70	43.9	9.4	6.2
	80	43.2	8.7	6.2
	90	42.8	7.1	6.1
LONG POND OF BELGRADES	Surface	73.8H	8.5	7.0
(South part), P. 712.	10	73.0	8.5	7.0
Belgrade Twp., Kennebec Co.	20	72.3	...	...
Aug. 22, 2:30 to 3:45 P.M.	25	65.7	6.1	6.4
Station: 1/8 mile northeast of Green	30	58.8	5.5	6.2
Island.	35	55.0	...	...
Depth of water: 97 ft.	40	53.2	5.7	6.2
Northwest breeze. Waves: 2 inches high.	45	50.4	...	...
	50	48.6	6.8	6.2
	60	44.6	6.8	6.2
	70	43.9	6.2	...
	80	43.2	4.6	...
	90	42.8	5.1	...
LONG POND OF BELGRADES	Surface	73.4H	8.7	7.0
(North part), P.713.	10	72.9	8.7	7.0
Rome Twp., Kennebec Co.	20	72.5	...	...
Aug. 22, 4:00 to 5:00 P.M.	25	71.1	7.7	6.7
Station: ½ mile west of inlet from Great	28	64.0	6.6	6.4
Pond.	30	62.4	...	...
Depth of water: 60 ft.	35	55.4	4.4	6.0
No wind or waves.	40	53.6	4.1	6.0
	45	53.4	...	...
	50	51.4	3.0	6.0
	55	51.3	2.9	6.0

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
GREAT POND OF BELGRADES,	Surface	67T	9.5	7.0
P.719.	10	67	...	...
Belgrade Twp., Kennebec Co.	15	67	...	...
June 27, 1937. 3:00 to 4:00 P.M.	20	66	...	...
Station: ¼ mile west of the tip of Allen	25	65	9.2	6.8
Point.	27	63	...	...
Depth of water: 34 ft.	30	60	8.2	6.5
Strong south wind. Waves: 1 ft. high.	32	56	8.2	6.4
	33	55	...	6.4
GREAT POND OF BELGRADES,	Surface	66T	9.6	7.0
P.719.	5	66	...	...
Belgrade Twp., Kennebec Co.	10	66	...	...
June 28, 1937. 9:10 to 11:30 A.M.	15	66	...	...
Station: 200 yds. off middle of the northeast shore of Hoyt's Island.	20	65	...	...
Depth of water: 60 ft.	22	65	...	...
Southeast breeze. Waves: 4 inches high.	25	65	...	...
	27	65	...	...
	30	65	...	...
	31	65	...	...
	32	64	8.0	6.5
	33	59	...	...
	34	59	...	...
	35	59	...	...
	40	58	7.9	6.4
	45	57	...	...
	50	56	7.7	6.3*
	55	55	...	...
	58	55	7.3	6.3*
*pH values of 6.3 with Bromthymol Blue.	60	54	...	6.3*
GREAT POND OF BELGRADES,	Surface	66T	9.6	7.0
P.719.	5	66	...	...
Belgrade Twp., Kennebec Co.	10	66	...	...
June 28, 1937. 4:15 to 5:30 P.M.	15	66	...	7.0
Station: ¼ mile west of north end of	20	66	...	...
Hoyt's Island.	25	66	...	...
Depth of water: 59 ft.	28	66	9.3	6.9
South breeze. Waves: 6 inches high.	30	64	...	...
	31	62	...	...
	32	61	...	6.5
	33	60	...	...
	34	59	...	...
	35	58	8.5	6.4
	36	58	...	...
	37	56	...	...
	38	55	...	...
	39	55	...	...
	40	55	...	6.4
	42	54	...	...
	45	53	...	...
	47	53	...	...
	50	53	...	...
	55	52	...	6.3*
*pH values of 6.3 with Bromthymol Blue.	59	51	8.2	6.3*

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
GREAT POND OF BELGRADES, P.719. Belgrade Twp., Kennebec Co. June 17, 12:30 to 2:30 P.M. Station: ¼ mile off southeast shore of Hoyt's Island. Depth of water: 63 ft. Southwest breeze. Waves: 7 inches high.	Surface 10 20 25 30 35 40 45 50 55 60 63	65.1^{H} 63.3 63.1 61.5 60.8 59.0 55.0 53.3 52.7 52.3 51.9 51.9	9.9 ... 9.8 ... ... 9.6 9.6 9.6 9.6 9.6	6.8 ... 7.0 ... ... 6.6 6.5 6.5 6.4 6.4 ... ...
GREAT POND OF BELGRADES, P.719. Belgrade Twp., Kennebec Co. July 22, 10:30 A.M. to 12:30 P.M. Station: ¼ mile off southeast shore of Hoyt's Island. Depth of water: 69 ft. Southwest breeze. Waves: 4 inches high.	Surface 10 20 25 30 35 40 45 50 55 60 65	74.8^{H} 73.6 70.6 64.9 63.0 61.9 60.1 59.0 57.4 56.3 54.7 53.8	9.3 ... 9.3 ... 7.8 6.9 6.7 6.4 5.9 5.6 5.6 ...	7.0 ... 7.0 ... 6.6 6.4 6.4 6.2 6.0 6.0 6.0 ...
GREAT POND OF BELGRADES, P.719. Belgrade Twp., Kennebec Co. Aug. 21, 9:00 A.M. to 12:00 Noon. Station: ¼ mile off southeast shore of Hoyt's Island. Depth of water: 67 ft. Strong northwest wind. Waves: 16 inches high.	Surface 10 20 25 30 33 35 40 45 50 55 60 65	73.0^{H} 73.4 73.4 73.2 73.2 72.7 63.9 61.0 59.0 58.6 57.9 56.8 56.8	8.4 ... 7.9 ... 7.1 ... 3.6 3.8 3.8 3.6 3.1 3.0 ...	7.0 ... 7.0 ... 6.8 ... 6.2 6.2 6.1 6.1 6.0 6.0 ...
NORTH POND OF BELGRADES, P.720. Smithfield Twp., Somerset Co. June 28, 1:00 to 1:45 P.M. Station: 1/3 mile off mouth of Clear Brook. Depth of water: 20 ft. Northwest breeze. Waves: 6 inches high.	Surface 5 10 15 17	62.9^{H} 62.9 62.9 62.6 62.6	9.7 9.7 9.6 9.6 9.5	6.9 6.9 6.9 6.9 6.8

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH
NORTH POND OF BELGRADES, P.720. Smithfield Twp., Somerset Co. Aug. 22, 8:30 to 9:00 A.M. Station: 1/3 mile off mouth of Clear Brook. Depth of water: 19 ft. Northwest breeze. Waves: 3 inches high.	Surface 10 15 17	70.9^{H} 70.9 70.9 70.9	8.8 8.8 8.7 ...	7.0 7.0 7.0 ...
EAST POND OF BELGRADES, P.724. Oakland Twp., Kennebec Co. June 28, 2:45 to 3:10 P.M. Station: 1 mile north of south end of the pond and 200 ft. off the point on the east shore. Depth of water: 25 ft. Northwest breeze. Waves: 2 inches high.	Surface 5 10 15 20 23	64.6^{H} 64.4 64.0 63.6 63.1 63.0	9.6 ... 9.6 9.6 9.5 9.5	6.8 ... 6.8 6.8 6.8 6.8
EAST POND OF BELGRADES, P.724. Smithfield Twp., Somerset Co. July 24, 11:25 to 11:55 A.M. Station: ¼ mile northeast of center of the pond. Depth of water: 27 ft. Southwest breeze. Waves: 4 inches high.	Surface 5 10 15 20 25	74.8^{H} 74.8 74.8 74.8 69.4 68.2	8.9 8.9 8.9 8.9 8.9 4.9	6.8 6.8 6.8 6.8 ... ...
EAST POND OF BELGRADES, P.724. Smithfield Twp., Somerset Co. Aug. 22, 10:00 to 10:35 A.M. Station: ¼ mile northeast of center of the pond. Depth of water: 26 ft. No wind or waves.	Surface 5 10 15 20 22 25	72.0^{H} 72.0 72.0 71.8 71.6 .... 71.6	8.7 ... 8.7 8.7 8.5 8.5 ...	6.8 ... 6.8 6.8 6.8 6.8 ...
SALMON LAKE, P.725. Belgrade Twp., Kennebec Co. June 29, 2:00 to 3:15 P.M. Station: 1/3 mile east of the outlet. Depth of water: 57 ft. Northeast breeze. No waves.	Surface 10 15 20 25 28 29 30 35 40 45 50	64.4^{H} 63.3 63.3 62.6 62.2 60.9 59.0 57.4 50.7 49.6 49.3 48.9	9.8 9.8 ... 9.8 9.5 ... ... 9.0 7.9 7.3 7.0 ...	7.2 7.2 ... 7.1 7.0 ... 6.8 6.6 6.4 6.4 6.4 ...

TABLE II. Water analyses — Continued

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temper-ature: °F.	Oxygen: p.p.m.	pH
SALMON LAKE, P.725.	Surface	74.1[H]	9.0	7.2
Belgrade Twp., Kennebec Co.	10	74.1	...	...
July 24, 9:00 to 10:00 A.M.	15	73.0	9.3	7.2
Station: 1/3 mile east of the outlet.	20	70.5	9.6	7.2
Depth of water: 50 ft.	21	68.3	...	...
Southwest breeze. Waves: 3 inches high.	23	64.4	...	...
	25	62.6	9.6	6.8
	30	57.9	...	...
	35	54.3	5.8	6.4
	40	52.5	5.0	6.4
	45	51.4	3.7	6.2
	50	51.4	...	...
SALMON LAKE, P.725.	Surface	74.1[H]	8.8	7.2
Belgrade Twp., Kennebec Co.	10	74.1	8.7	7.2
Aug. 21, 2:00 to 3:00 P.M.	15	74.1	...	...
Station: 1/3 mile east of the outlet.	20	73.8	8.8	7.2
Depth of water: 50 ft.	25	73.6	...	...
Strong northeast wind. Waves: 16 inches.	26	73.0	...	...
	27	66.2	6.4	6.6
	28	63.3	6.0	6.7
	30	60.3	6.3	6.6
	35	55.6	1.6	6.2
	40	52.9	0.2	6.2
	45	52.2	0.1	6.2
	50	52.2	...	...
McGRATH POND, P.726.	Surface	74.1[H]	8.4	7.2
Belgrade Twp., Kennebec Co.	10	74.1	8.3	7.2
Aug. 21, 3:30 to 4:00 P.M.	15	74.1	8.3	7.2
Station: ½ mile north of the outlet into Salmon Lake.	20	73.9	8.4	7.2
Depth of water: 27 ft.	25	73.4	8.4	7.2
Strong northwest wind.				
Waves: 16 inches high.				
CLEARWATER POND, P.815.	Surface	69.6[H]	9.3	7.0
Industry Twp., Franklin Co.	10	69.1	...	...
Sept. 3, 10:15 A.M. to 12:00 Noon.	15	69.1	9.3	7.0
Station: 200 yds. off the middle of the west shore.	20	67.5	...	...
Depth of water: 89 ft.	25	65.5	10.4	7.0
Southwest breeze. Waves: 2 inches.	28	60.4	...	...
	30	54.7	13.2	6.8
	35	50.2	12.6	6.8
	40	47.5	...	...
	45	45.9	11.1	6.5
	50	44.1	...	...
	55	43.9	10.4	6.4
	60	43.2	...	...
	70	42.8	9.6	6.4
	80	42.3	...	...
	85	....	9.1	6.4
	87	42.1	...	...

TABLE II. Water analyses — Concluded

Lake, location, date, time, station, water depth, etc.	Depth in feet	Temper-ature: °F.	Oxygen: p.p.m.	pH
WILSON POND, P.833.	Surface	69.8[H]	9.5	7.0
Wilton Twp., Franklin Co.	10	68.2	9.5	7.0
Sept. 3, 2:30 to 4:00 P.M.	15	64.9	9.2	6.8
Station: near the center of the pond.	20	63.3	...	...
Depth of water: 88 ft.	25	60.1	5.8	6.0
Northwest breeze. Waves: 3 inches.	28	57.4	...	...
	30	53.6	6.6	6.0
	35	51.3	...	...
	40	48.7	7.1	6.0
	45	47.7	...	...
	50	46.8	7.6	6.0
	60	45.3	...	...
	70	45.0	5.1	5.8
	80	45.0	...	...
	85	45.0	5.0	5.8
SANDY POND, P.883.	Surface	77.4[H]	8.4	6.8
Embden Twp., Somerset Co.	5	76.4	...	...
July 27, 3:00 to 3:45 P.M.	10	69.2	8.3	6.6
Station: ¼ mile west of the outlet.	15	59.4	...	...
Depth of water: 40 ft.	20	54.7	5.7	5.9
Northwest breeze. No waves.	25	49.6	...	...
	30	48.6	3.2	5.6
	35	48.2	2.6	...
	40	48.2	...	5.6
EMBDEN POND, P.887.	Surface	76.6[H]	8.9	6.9
Embden Twp., Somerset Co.	5	76.6	...	...
July 27, 10:00 A.M. to 12:15 P.M.	10	75.0	...	...
Station: 1/5 mile off east shore, opposite Hancock Stream.	15	75.0	...	...
Depth of water: 150 ft.	20	73.0	9.1	6.9
No wind or waves.	25	61.3	...	...
	30	53.6	10.8	6.6
	35	48.2	...	...
	40	46.5	...	...
	50	45.7	11.1	6.6
	60	44.8	...	...
	70	44.1	...	...
	80	43.3	9.3	6.6
	90	42.8	...	...
	100	42.6	...	...
	110	42.6	11.7	6.5
	120	42.6	...	...
	130	42.6	...	...
	140	42.6	11.3	6.4
	150	42.6	...	...

TABLE III. An evaluation of the ponds with respect to the suitability of temperature and of dissolved oxygen content of the water for trout or salmon during the most critical, late-summer period

Name of pond	Pond number	How much of pond is, and is not, available to trout or salmon during most critical late-summer period*											
		Volume of water						Area of bottom					
		Acre feet			% of total			Acres			% of total		
		Upper: warm, non-trout, above 70° F.	Middle layer: trout or salmon water	Lower: oxygen deficient, non-trout	Upper: warm, non-trout, above 70° F.	Middle layer: trout or salmon water	Lower: oxygen deficient, non-trout	Upper: warm, non-trout, above 70° F.	Middle layer: trout or salmon water	Lower: oxygen deficient, non-trout	Upper: warm, non-trout, above 70° F.	Middle layer: trout or salmon water	Lower: oxygen deficient, non-trout
Sabattus Pond	389	21,569	0	0	100	0	0	1,787	0	0	100	0	0
Taylor Pond	392	8,124	557	2,340	74	5	21	322	48	255	51	8	41
Lower Range Pond	398	3,723	597	432	78	13	9	135	68	87	47	23	30
Middle Range Pond	400	5,310	5,917	0	47	53	0	137	229	0	37	63	0
Upper Range Pond	401	4,875	3,637	0	57	43	0	128	263	0	33	67	0
Hogan Pond	403	1,923	0	948	67	0	33	76	0	101	43	0	57
Whitney Pond	404	2,171	211	0	91	9	0	99	71	0	58	42	0
Tripp Pond	408	8,585	0	2,297	84	0	22	445	0	346	61	0	47
Thompson Lake	409	94,133	107,987	0	47	53	0	1,285	3,141	0	29	71	0
Pennesseewassee Lake	416	13,613	2,254	1,593	78	13	9	453	274	195	49	30	21
Twitchell Pond	425	2,230	438	248	76	15	9	94	29	35	60	18	22
Bryant Pond	427	4,78[illegible]	[illegible]	3,2[illegible]8	53	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
Auburn Lake	428	48,386	42,123	0	53	47	0	771	1,489	0	[illegible]	[illegible]	
Allen Pond	437	2,026	865	156	67	28	5	109	45	29	59	25	[illegible]
Pleasant Pond	443	2,532	1,685	56	59	40	1	70	94	13	40	53	7
Androscoggin Lake	464	52,783	0	0	100	0	0	3,826	0	0	100	0	0
Pocasset Lake	466	8,024	0	0	100	0	0	587	0	0	100	0	0
Lovejoy Pond	470	4,642	0	0	100	0	0	366	0	0	100	0	0
Echo Lake	472	14,176	13,084	2,891	47	43	10	339	619	103	32	58	10
Parker Pond	474	28,653	5,626	9,718	65	13	22	699	210	701	43	13	44
David Pond	476	3,000	0	213	96	0	7	264	0	49	93	0	17
Tilton Pond	478	1,134	0	738	61	0	39	56	0	58	49	0	51
Flying Pond	481	4,390	3,613	288	53	44	3	130	204	26	36	57	7
Worthley Pond	499	5,967	2,720	588	64	29	7	113	133	108	32	38	30
Webb Lake	503	44,540	3,509	7,672	80	6	14	895	161	1,090	42	7	51
Silver Lake	515	8,074	309	0	96	4	0	856	40	0	96	4	0
Garland Pond	516	4,677	1,137	370	76	18	6	128	81	88	43	27	30
North Pond	521	3,496	0	166	95	0	5	242	0	42	85	0	15
South Pond	522	4,527	3,109	0	59	41	0	111	173	0	39	61	0
Purgatory Pond	659	6,070	0	1,818	77	0	23	276	0	160	63	0	37
Sand Pond	660	2,520	1,871	63	57	42	1	71	96	10	40	54	6
Cobbosseecontee Lake	668	109,242	11,380	66,128	59	6	35	1,545	406	3,592	28	7	65

TABLE III. An evaluation of the ponds with respect to the suitability of temperature and of dissolved oxygen content of the water for trout or salmon during the most critical, late-summer period — Concluded

Name of pond	Pond number	How much of pond is, and is not, available to trout or salmon during most critical late-summer period*											
		Volume of water						Area of bottom					
		Acre feet			% of total			Acres			% of total		
		Upper: warm, **non-trout,** above 70° F.	Middle layer: **trout or salmon** water	Lower: oxygen deficient, **non-trout**	Upper: warm, **non-trout,** above 70° F.	Middle layer: **trout or salmon** water	Lower: oxygen deficient, **non-trout**	Upper: warm, **non-trout,** above 70° F.	Middle layer: **trout or salmon** water	Lower: oxygen deficient, **non-trout**	Upper: warm, **non-trout,** above 70° F.	Middle layer: **trout or salmon** water	Lower: oxygen deficient, **non-trout**
Annabessacook Lake	671	25,115	632	1,660	92	2	6	1,068	71	281	75	5	20
Cochnewagan Pond	672	7,438	0	0	100	0	0	385	0	0	100	0	0
Wilson Pond	673	8,928	0	2,193	80	0	20	305	0	269	53	0	47
Dexter Pond	674	988	0	241	80	0	20	70	0	50	58	0	42
Berry Pond	675	1,270	155	185	79	10	11	106	24	40	62	14	24
Maranacook Lake	676	27,103	13,093	0	67	33	0	1,218	455	0	73	27	0
Torsey Pond	678	8,551	0	1,908	86	0	19	550	0	248	71	0	32
Narrows Pond South Part	681	4,154	5,630	60	42	57	1	66	200	12	24	72	4
North Part	682	3,700	2,625	575	54	38	8	80	101	78	31	39	30
Snow Pond	698	77,690	0	32,688	70	0	30	1,765	0	1,745	50	0	50
Long Pond of Belgrades South Part	712	25,098	10,921	114	69	30	1	628	728	20	46	53	1
North Part	713	27,999	4,625	5,319	74	12	14	519	305	514	39	23	38
Great Pond	719	144,432	0	17,140	89	0	11	6,589	0	1,650	80	0	20
North Pond	720	28,203	0	0	100	0	0	2,115	0	0	100	0	0
East Pond	724	25,662	0	0	100	0	0	1,705	0	0	100	0	0
Salmon Lake	725	11,538	830	2,211	79	6	15	265	40	257	47	7	46
McGrath Pond	726	8,207	0	0	100	0	0	486	0	0	100	0	0
Clearwater Pond	815	14,967	22,131	0	40	60	0	139	612	0	19	81	0
Wilson Pond	833	7,053	6,495	0	52	48	0	241	239	0	50	50	0
Sandy Pond	883	1,068	368	400	58	20	22	35	21	51	33	19	48
Embden Pond	887	31,985	50,843	0	39	61	0	307	1,240	0	20	80	0

*Based on depths above which water is too warm (above 70°F.) and below which oxygen is deficient (less than 5 p.p.m.) for trout and salmon. Note overlap of the upper warm-water layer with the lower oxygen- deficient layer in Tripp, David, and Torsey ponds.

those besides the eight shallow ones, were deep enough to maintain a well-defined thermocline; in other words, the warm water did not extend to the bottom at the greatest depth. Oxygen deficiency (less than 5 p.p.m.) in these 45 lakes extended upward from the bottom to different degrees in the various lakes. In 10 lakes there was no oxygen deficiency (below 5 p.p.m.) at all in the deepest water; in five other lakes there was only a relatively small stratum of the deepest water so affected. In 26 of these 45 deeper lakes, oxygen deficiency had extended upward to affect adversely not more than about half of this deep water; but in 19 of these deeper lakes oxygen deficiency had extended upward to nearly meet, just meet, or surpass the lower limit of the warm-water layer.

The application of these data on the depths at which changes in the temperature and dissolved oxygen become critical to trout and salmon, in the calculation of water volume and bottom area in each of the three important zones of vertical stratification (upper and warm layer, middle layer suitable for trout or salmon, and lower layer with a deficiency of dissolved oxygen), has given a presumably more accurate picture of the importance of these factors. The calculated water volumes in acre feet and by per cent, and the calculated bottom areas in acres and by per cent, for those zones present in each lake or pond, are given in Table III; these same data, by per cent only, are represented graphically on the individual maps of each lake, see Figures 7 to 51. It should be noted that in the 8 shallow lakes with warm water extending to the bottom, all water volume and all bottom area are, of course, included in the "Upper: warm, **non-trout**" zone. A division of the 53 lakes and ponds on the basis of the suitability of the water for trout and salmon includes:

Water warm to the bottom throughout all depths .... 8 lakes and ponds.

and the 45 deeper lakes and ponds may be divided on the basis of oxygen deficiency in deep water roughly into three categories, as follows:

No oxygen deficiency, or almost none; practically all water with more than 5 p.p.m. of dissolved oxygen .... 16 lakes and ponds.

Partial oxygen deficiency; about ½ to ¾ of the deep water with more than 5 p.p.m. of dissolved oxygen .... 12 lakes and ponds.

Extreme oxygen deficiency; less than 5 p.p.m. of oxygen is most or all of the deep water .... 17 lakes and ponds.

The dividing line between the above class of shallow lakes and the three classes of deep lakes is not sharp. In fact, all of the lakes could be arranged in a series on the basis of water depth, and they would

range quite uniformly from one extreme to the other. Several lakes, which are included in the above classification of deep-water lakes, are quite intermediate in depth, either because they are generally shallow or because they have only moderately deep water over a very limited area. Such ponds, marginal on the basis of depth, include Whitney, David, Silver, North Pond in Woodstock, Annabessacook, Torsey, and Great Pond of the Belgrades, in all of which the upper warm-water layer during August included over 85 per cent of all water in the lake; actually these lakes are so shallow that for all practical purposes they might better be included with the 8 ponds classed above as of the shallow type. Several other ponds were relatively quite shallow with at least 75 per cent of their water volume included in the upper warm-water zone, namely: Lower Range, Twitchell, Garland, Berry, and Dexter ponds, Wilson Pond in Monmouth, and Pennesseewassee, Webb, and Salmon lakes. The degree to which any good trout or salmon water might be maintained in these relatively shallow ponds during late summer is closely dependent on the amount of oxygen deficiency in what little cold water remains during late summer. In general, most lakes of this type are poor, or at best only fair, trout or salmon lakes. The preceding classification of the 45 deeper lakes into three categories on the basis of the amount of dissolved oxygen in the deep water also involves certain difficulties because the dividing lines are not sharp; and all of these waters could be arranged in a graded series from one extreme of oxygen depletion in deep water to the other extreme. There were several lakes with no oxygen depletion (i.e., oxygen below 5 p.p.m.) in deep water, such as Thompson, Auburn, South, Clearwater, and Embden; several of the deeper ponds had only a slight amount of the deepest water with less than 5 p.p.m. of dissolved oxygen, such as Pleasant, Flying, and the south part of Narrows Pond. In all of these ponds with very little or no oxygen deficiency, between 40 and 61 per cent of the total water volume was included within the trout and salmon zone, and oxygen depletion had affected only from 0 to 3 per cent of the total water volume. In some ponds, such as Allen, Worthley, and Garland, from 15 to 30 per cent of the total water volume was included in the trout and salmon zone, and oxygen depletion had affected only from 5 to 10 per cent of the total water volume. Only from 5 to 15 per cent of the total water volume remained in the trout and salmon zone in Salmon, Long Pond (north part), Berry, Cobbosseecontee, Webb, Parker, Bryant, Twitchell, Pennesseewassee, Lower Range, and Taylor; and in these ponds oxygen deficiency had affected from 9 to 37 per cent of the total water volume. In 11 of the deeper ponds oxygen deficiency, together with the effect of the upper warm-water layer, had completely eliminated the trout or salmon zone by late summer, namely, Hogan, Tripp, David, Tilton, North Pond in Woodstock, Purgatory, Wilson Pond in Monmouth, Dexter, Torsey, Snow, and Great Pond of the Belgrades. In three of these ponds, namely, Tripp, David, and Torsey, oxygen depletion was so extreme that its effect extended upward above the thermocline to overlap with the warm-water zone.

As a summary of this discussion on the suitability of the water of these 53 lakes and ponds for trout and salmon, these waters may be classified on the basis of the relative amounts of water and bottom area in the trout or salmon zone during late summer into the following categories:

Excellent trout or salmon water, with at least 40 per cent of the entire volume of the lake within the trout or salmon zone; 13 lakes and ponds: Middle Range Pond, Upper Range Pond, Thompson Lake, Auburn Lake, Echo Lake, South Pond in Greenwood, Clearwater Pond, Wilson Pond in Wilton, Embden Pond, Pleasant Pond, Flying Pond, Sand Pond of Tacoma Lakes, and the south part of Narrows Pond. Total area of these lakes is 12,558 acres.

Good trout or salmon water, with from 25 to 40 per cent of the water volume within the trout or salmon zone; 5 lakes and ponds: Maranacook Lake, south part of Long Pond of Belgrades, north part of Narrows Pond, Worthley Pond, and Allen Pond. Total area of these lakes is 3,845 acres.

Fair trout or salmon water, with 10 to 25 per cent of the water volume within the trout or salmon zone; 9 lakes and ponds: Garland Pond in Byron, Sandy Pond in Embden, north part of Long Pond of Belgrades, Lower Range Pond, Pennesseewassee Lake, Twitchell Pond, Bryant Pond, Parker Pond, and Berry Pond. Total area of these lakes is 5,170 acres.

Poor trout or salmon water, with 5 to 10 per cent of the water volume within the trout or salmon zone; 5 lakes and ponds: Taylor Pond, Whitney Pond, Webb Lake, Cobbosseecontee Lake, and Salmon Lake. Total area of these lakes is 9,046 acres.

No good trout or salmon water, or practically none, with less than 5 per cent, and mostly none, of the water volume within the trout or salmon zone. Included are 13 lakes and ponds, deep enough to maintain a thermocline, but with oxygen deficiency, namely: Hogan Pond, Tripp Pond, David Pond, Tilton Pond, Silver Lake, North Pond in Woodstock, Purgatory Pond, Annabessacook Lake, Wilson Pond in Monmouth, Dexter Pond, Torsey Pond, Snow Pond or Messalonskee Lake, and Great Pond of the Belgrades. The total area of these lakes is 17,556 acres. Also included are 8 shallow lakes and ponds in which warm water extended to the bottom in the deepest water, namely: Sabattus Pond, Androscoggin Lake, Pocasset Lake, Lovejoy Pond, Cochnewagan Pond,

North Pond of the Belgrades, East Pond of Belgrades, and McGrath Pond. The total area of these lakes is 11,257 acres. The total area for the 21 lakes in this category is 28,813 acres.

The above classification represents the first step in an evaluation of the suitability of the water in these lakes and ponds for trout and salmon. This classification is made on the basis of volume of water within the trout and salmon zone, but this classification is also generally applicable to the amount of bottom area, for the amount of water volume and the amount of bottom area within this zone were mostly in the same proportion. The same difficulties were encountered in the above classification of these lakes, as based on the volume of water in the trout and salmon zone, as would be encountered in dividing any graded series into groups. There were numerous borderline cases, as follows: Pleasant Pond had 40 per cent of the total water volume and 53 per cent of the total bottom area within the trout and salmon zone; for Sand Pond these same figures were 42 and 54, respectively; and for Echo Lake they were 43 and 58. These were among the lowest figures for ponds classified in the above as "excellent" trout and salmon waters. The best of the ponds classified as "good" trout or salmon waters included Narrows Pond (north part) for which the figures were 38 and 39, and Long Pond (south part) for which the figures were 30 and 53. The differences between the poorer of those classified as "excellent" and the best of those classified as "good" were no greater than the range among the ponds classed as "excellent" or the range among those classed as "good." Similar discrepancies are present between the classes of "fair" and "poor." The poorest among those classed as "fair" were: Bryant, 10 and 9; Pennesseewassee, 13 and 30; Twitchell, 15 and 18; Parker, 13 and 13; and Berry, 10 and 14. Among those classed as "poor" were: Webb, 6 and 7; Cobbosseecontee, 6 and 7; and Salmon, 6 and 7.

The above classification of the lakes and ponds on the basis of the suitability of the water for trout and salmon takes into account only the characteristics of the water itself. In evaluating lakes and ponds for their ability to support trout and salmon, and for the degree to which the waters should be stocked with these fishes, other factors must be considered such as the amount of competition afforded by other species of fishes, the abundance of the food supply, and the suitability of the spawning grounds. (See page 218, on "Stocking Recommendations.")

PLANKTON OF THE LAKES AND PONDS*

Lake water contains enormous numbers of microscopic animals and plants which are either free-floating or which have such a weak power of locomotion that their swimming activities are mostly ineffective against usual currents of water. This population of small and free-floating animals and plants is collectively referred to as plankton. The individual organisms of the plankton are referred to as planktonts, or preferably as plankters. The larger plankters may be collected by straining lake water through a fine-meshed cloth, and such organisms collected by plankton nets of No. 20 silk bolting cloth constitute the "net plankton."

The casual observer on a lake is usually not aware of the presence of these plankton organisms even though there may be several thousands of individuals per cubic foot in the surface layer of water. A closer than average scrutiny of lake water reveals, to the unaided eye, many of the larger and more active plankters such as the water fleas. Occasionally in some Maine lakes some species of plankton algae become so abundant as to greatly change the color of the water to a pale green. During such "algae blooms" the algae may collect in a scum on the surface or be blown up in small wind-rows along the shore line. Some of the animal plankters, also, occasionally become extremely abundant.

The plankton, within itself, is a complex community of dozens of individual species of animals and plants. The algae manufacture their own food from inorganic substances, and the animal plankters feed mostly on the plant forms. Thus there is, within the plankton, the beginning of a food chain which leads to the important food and game fishes of our lakes. The plankton and the bottom fauna (see next section of this report, page 82) are the two important basic sources of food for lake fishes. The young individuals of most fishes and the adults of some of the smaller species of fishes, including small smelts, feed mostly on plankton, and particularly upon the water fleas (copepods and cladocerans). The larger game fishes in many Maine lakes feed mostly on smelt and other small fishes, and are therefore indirectly dependent mostly upon the plankton.

There are some plankton organisms present in lake water at all times, but the total quantity of plankton varies considerably with the season. In most temperate lakes, maximum plankton production

* This report on "Plankton of the lakes and ponds" is by Mr. Harry A. Goodwin, a William Converse Kendall Fellow in fisheries research in the Graduate School of the University of Maine.

occurs during spring and autumn, and minimum plankton populations occur during late summer and late winter. The plankton population also varies greatly with depth of water, and the greatest quantity of plankton usually is found near the surface.

The present account of the plankton of the lakes and ponds studied by the 1940 survey is based on an examination of samples collected with a Birge Closing Net of No. 20 silk bolting cloth. Samples of plankton were collected mostly at only one station on each lake. On 8 lakes samples were collected at three separate dates during the summer. On all except one of the lakes at least one series of samples was collected during late summer, mostly during August. The sampling was done at the same time (mostly between 9 A.M. and 5 P.M.) and station where tests on temperature, dissolved oxygen, and pH were made. The locations of these stations are described in Table IV and are indicated on Figures 7 to 51. The plankton net was drawn vertically upward through a chosen depth range, and at most stations through the following depth ranges: 15 feet to the surface, 35 feet to 15 feet, 75 feet to 35 feet, and from the bottom up to 75 feet. The depth range of the lowest haul in certain lakes varied from the above figures, depending upon the maximum depth of water. The net was hauled at the rate of approximately one-half meter per second, and the coefficient of the net was figured at 1.2[5]; the volume of water in the sample column was multiplied by 1/1.2 to obtain the volume of water which passed through the net. Two net hauls were made within each depth range at each station. The plankton samples were preserved in 5 per cent formalin.

Laboratory analysis of the plankton samples included a determination of the total volume of all plankton, counting of the organisms by major groups, and an identification of the organisms mostly to genera. Each field sample was diluted or condensed to 100 c.c. The sample was allowed to settle for at least 24 hours in a graduated glass tube with tapered bottom, and the volume of the plankton was read to the top of the mass as it had settled to the bottom of the tube. Counts of plankters were made in a Sedgwick-Rafter cell (20 x 50 x 1 mm.). Counts were made on the total number of Cladocera and Copepoda in ten of these one-c.c. samples. For other plankters, a single one-c.c. sample was used; and ten separate counts were made of the organisms in a total of 0.01 c.c. of the sample, each of these ten counts covering one square millimeter or one cubic millimeter. These volumes and counts were used as a basis for calculating the average volume of all plankton, and the average numbers of different types and of all plankters, per cubic foot of lake water within the different depth

[5] The efficiency factor of 1.2 for this type of plankton net hauled at the rate of ½ meter per second was given by Kemmerer, Bovard, and Boorman, 1923; see page 65.

TABLE IV. The average numbers of different types of plankters, and the average volumes of all plankton, per cubic foot of lake water within different depth strata in the lakes and ponds, as calculated from survey collections

Name of Lake or Pond	Date: 1940 Time: A=A.M. P=P.M.	Depth range of sample in ft.	Average vol. of plankton per cu. ft. of lake water, in c.c.	Average number of plankton organisms per cu. ft. of lake water									
						In thousands — add ,000							
				Copepoda (water fleas)	Cladocera (water fleas)	Rotifera	Protozoa	Zoophyta	Desmidiaceae (desmids)	Chlorophyceae (other green algae)	Bacillarieae (diatoms)	Myxophyceae (blue-green algae)	All plankters
Sabattus	June 21 2:00 P	15–0	1.33	773	412	28	389	..	..	..	886	14	1,319
Taylor	Aug. 22 10:00 A	15–0 35–15	0.52 0.07	915 174	346 53	.. 4	.. 4	.. ..	5 ..	.. ..	9 18	9 ..	25 25
Lower Range	Aug. 21 1:00 P	15–0	0.33	346	261	5	19	..	..	..	33	..	57
Middle Range	Aug. 10 1:00 P	15–0 35–15 55–35	0.81 0.11 0.07	716 163 78	166 82 60	.. .. ..	265 7 7	.. .. ..	.. .. ..	66 4 ..	114 53 18	.. .. ..	446 64 25
Upper Range	Aug. 10 3:30 P	15–0 30–15	3.32 0.28	427 118	194 43	9 ..	5 ..	.. ..	5 5	379 14	38 62	.. ..	437 81
Hogan	Aug. 21 10:30 A	15–0 25–15	0.14 0.21	469 177	62 50	.. ..	85 43	.. ..	.. ..	.. ..	14 28	.. 21	100 92
Whitney	Aug. 21 11:00 A	15–0	0.37	412	118	5	33	..	..	..	66	..	105
Tripp	Aug. 9 3:00 P	15–0 25–0	0.43 0.23	739 434	346 192	5 3	.. 3	.. ..	5 ..	5 ..	403 104	.. ..	418 110
Thompson	Aug. 20 12:30 P	15–0 35–15 75–35 95–75	1.42 0.18 0.12 0.14	213 333 137 99	180 7 2 21	.. ..	.. 7 .. 4	.. ..	9 7	38	5 18 4 ..	.. ..	53 32 4 4
	Aug. 20 2:30 P	15–0 35–15	0.95 0.14	398 64	76 21	14 ..	.. ..	.. ..	9 4	47 11	14 4	.. ..	86 18
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						[illegible]		[illegible]
Twitchell	Sept. 5 4:45 P	15–0 35–15	0.14 0.07	242 25	51 4	.. ..	[illegible] ..	.. ..	.. ..	.. ..	14 4	[illegible] 4	[illegible] [illegible]

Name of Lake or Pond	Date: 1940 Time	Depth range of sample in ft.	Average vol. in c.c.	Copepoda (water fleas)	Cladocera (water fleas)	Rotifera	Protozoa	Zoophyta	Desmidiaceae (desmids)	Chlorophyceae (other green algae)	Bacillarieae (diatoms)	Myxophyceae (blue-green algae)	All plankters
Bryant	Sept. 4 3:45 P	15–0 35–15	3.55 0.21	370 99	867 92	24 ..	171 14	.. ..	9 4	52 4	90 28	24 ..	371 50
Auburn	June 28 2:00 P	15–0 35–15 75–35 95–75	0.66 0.14 0.05 0.07	791 411 156 110	308 32 62 43	5 4 2 4	.. ..	.. ..	.. ..	.. ..	265 96 5 7	.. ..	271 100 7 11
	July 24 10:45 A	15–0 35–15 75–35 100–75	0.43 0.11 0.09 0.08	441 305 758 186	332 74 20 17	.. 4	5 7	.. ..	.. ..	.. .. 2 ..	38 14 .. 8	.. ..	43 25 3 9
	Aug. 22 12:30 P	15–0 35–15 75–35 100–75	0.19 0.25 0.05 0.06	275 209 483 158	133 35 7 ..	9 .. 2 3	5 4	.. ..	.. 4	5	14 28 2 3	.. ..	34 36 4 6
Allen	Aug. 16 10:30 A	15–0 35–15	1.42 0.18	209 35	270 28	14 4	5 4	.. ..	.. ..	100 14	14 25	.. ..	133 46
Pleasant	July 8 12:15 P	15–0 35–15 60–35	0.28 0.18 0.11	403 28 17	493 440 166	14 7 3	9 4 3	.. .. ..	.. .. ..	9 4 ..	185 35 14	.. .. ..	219 50 20
	July 23 5:30 P	15–0 35–15 60–35	1.42 0.60 0.11	393 121 20	479 699 211	.. 7 6	47 4 ..	.. .. ..	38	213 57 ..	261 156 17	.. .. ..	560 224 23
	Aug. 17 9:00 A	15–0 35–15 60–35	0.19 0.11 0.06	256 43 25	156 78 17	5 .. 3	.. 7 ..	.. .. ..	5	28 .. 3	47 85 25	.. .. ..	86 92 31
Androscoggin	Aug. 26 10:00 A	15–0 25–15	0.28 0.21	768 213	256 50	.. ..	14 7	.. ..	.. ..	.. 7	19 121	5 ..	39 135
Pocasset	Aug. 26 11:15 A	15–0	0.19	327	142	5	..	..	..	5	47	19	76
Lovejoy	Aug. 26 12:30 A	15–0	0.19	289	128	9	5	..	..	..	19	5	38
Echo	Aug. 24 12:00 M	15–0 35–15 75–35 100–75	0.38 0.07 0.04 0.06	678 330 265 118	223 213 9 28	 3	5 7 2 3	.. ..	14	9 .. 2 3	47 21 7 6	5	81 29 11 14
Parker	Aug. 23 9:00 A	15–0 35–15 60–35	0.85 0.21 0.11	1,318 1,070 837	180 74 31	.. .. ..	14 4 ..	.. .. ..	.. .. ..	166 53 3	114 67 6	.. .. ..	295 125 9

TABLE IV. The average numbers of different types of plankters, and the average volumes of all plankton — Continued

Name of Lake or Pond	Date: 1940 Time: A=A.M. P=P.M.	Depth range of sample in ft.	Average vol. of plankton per cu. ft. of lake water, in c.c.	Average number of plankton organisms per cu. ft. of lake water: Copepoda (water fleas)	Cladocera (water fleas)	In thousands — add ,000: Rotifera	Protozoa	Zoophyta	Desmidiaceae (desminds)	Chlorophyceae (other green algae)	Bacillarieae (diatoms)	Myxophyceae (blue-green algae)	All plankters
David South Part	Aug. 28 11:15 A	15–0	2.37	957	232	28	5	..	..	66	5	..	105
		35–15	0.18	152	4	11	32	..	..	39	4	..	85
North Part	Aug. 28 10:15 A	15–0	0.28	2,735	142	28	5	..	5	38	24	..	102
		20–0	0.18	1,755	67	7	..	..	7	11	18	..	44
Tilton	Aug. 28 2:45 P	15–0	1.42	810	171	5	19	..	5	14	5	14	63
		35–15	0.14	128	21	..	4	..	4	11	14	21	53
Flying	Aug. 23 1:00 P	15–0	2.37	948	280	5	540	..	9	..	194	.	750
		35–15	0.32	170	67	7	11	7	4	..	74	..	103
		75–35	0.07	190	41	7	..	2	..	..	20	..	29
Worthley	Sept. 6 1:15 P	15–0	2.13	24	327	9	142	..	..	..	24	14	190
		35–15	0.43	103	291	18	..	14	7	..	21	..	61
Webb	Sept. 11 10:45 A	15–0	0.28	436	100	..	52	..	5	5	47	5	114
		35–15	0.11	103	4	..	14	..	4	4	35	..	57
Silver	Sept. 9 3:45 P	15–0	0.71	246	284	9	47	..	..	5	19	..	81
		35–15	0.11	78	50	..	14	..	..	..	11	7	32
Garland	Sept. 9 12:30 P	15–0	0.19	294	227	9	5	..	..	38	19	..	72
		35–15	0.11	39	578	11	..	..	4	11	18	..	43
North (P.521)	Sept. 5 2:00 P	15–0	1.33	550	227	5	336	..	..	..	9	5	356
		30–15	0.14	346	19	..	47	..	..	..	5	9	62
South	Sept. 4 12:30 P	15–0	0.24	100	38	14	..	..	..	..	..	14	29
		35–15	0.14	25	25	4	25	..	..	..	..	4	32
		60–35	0.06	11	28	3	..	..	..	..	8	[illegible]	11
[illegible]	[illegible] 12:30 P	15–0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		35–15	0.07	553	25	..	21	..	..	..	[illegible]		[illegible]
		60–35	0.06	315	20	3	3	..	..	..	3	..	[illegible]
Sand	Aug. 26 9:50 A	15–0	0.62	479	332	5	38	..	..	52	227	5	328
		35–15	0.14	238	32	..	7	4	4	..	99	4	117
		75–35	0.07	174	4	2	..	..	..	..	16	..	18
Cobbosseecontee	Aug. 8 4:30 P	15–0	0.43	815	227	5	9	..	9	24	313	..	361
		35–15	0.14	188	74	11	4	..	7	4	53	..	78
		75–35	0.09	444	21	..	..	..	..	4	4	2	9
Annabessacook	Aug. 27 10:00 A	15–0	0.66	1,678	645	9	76	..	..	43	33	5	168
		35–15	0.11	337	11	..	18	..	..	..	35	..	54
Cochnewagan	June 25 2:30 P	15–0	0.38	573	517	5	..	..	..	9	398	24	437
		25–15	0.21	106	35	7	7	..	..	..	149	..	163
	July 24 1:30 P	15–0	0.33	976	346	5	5	..	..	9	14	14	49
	Aug. 16 12:30 P	15–0	0.47	697	308	5	43	..	..	28	71	..	148
		25–15	0.14	71	64	..	..	..	..	7	71	..	78
Wilson (P. 673)	Aug. 23 9:15 A	15–0	0.38	370	171	..	123	..	..	..	5	5	133
		35–15	0.07	64	46	..	11	..	..	..	..	..	11
Dexter	Aug. 23 11:15 A	15–0	0.28	374	118	..	147	..	..	..	81	..	228
Berry	Aug. 23 1:30 P	15–0	0.28	720	142	..	33	..	..	9	5	9	58
Maranacook	Aug. 27 1:15 P	15–0	1.23	412	213	5	156	..	..	38	630	..	830
		35–15	0.11	259	46	..	21	..	..	..	25	..	46
		75–35	0.05	144	16	..	7	..	..	..	36	..	43
		100–75	0.06	149	..	..	3	..	..	..	14	..	17
Torsey	Aug. 24 9:15 A	15–0	1.18	825	1,251	33	14	..	..	57	95	..	201
		35–15	0.18	43	25	7	4	..	..	..	57	..	67
Narrows South Part	Aug. 29 9:30 A	15–0	0.43	308	90	..	24	..	..	85	24	14	147
		35–15	0.74	443	35	..	14	..	..	230	11	..	256
		75–35	0.09	194	2	2	7	..	..	9	44	4	66
		100–75	0.08	169	6	..	..	..	..	..	11	..	11
North Part	Aug. 29 1:00 P	15–0	0.66	294	133	..	52	..	19	85	128	9	294
		35–15	0.18	270	28	..	39	..	4	11	50	..	103
		50–35	0.09	62	19	..	52	..	..	..	19	..	71

TABLE IV. The average numbers of different types of plankters, and the average volumes of all plankton — Continued

Name of Lake or Pond	Date: 1940 Time: A=A.M. P=P.M.	Depth range of sample in ft.	Average vol. of plankton per cu. ft. of lake water, in c.c.	Average number of plankton organisms per cu. ft. of lake water		In thousands — add ,000							
				Copepoda (water fleas)	Cladocera (water fleas)	Rotifera	Protozoa	Zoophyta	Desmidiaceae (desmids)	Chlorophyceae (other green algae)	Bacillarieae (diatoms)	Myxophyceae (blue-green algae)	All plankters
Snow	July 3 9:30 A	15–0 35–15 75–35 100–75	0.57 0.14 0.14 0.08	1,213 174 352 287	175 32 32 31	24	62 7	.. ..	5	14	460 184 71 48	.. ..	565 192 71 48
	July 23 9:00 A	15–0 35–15 75–35 100–75	0.76 0.35 0.07 0.08	787 167 224 155	450 18 34 62	 6	71 11 2 ..	.. ..	.. ..	19	682 277 91 73	.. 4	774 291 93 79
	Aug. 22 8:30 A	15–0 35–15 75–35 100–75	0.62 0.21 0.09 0.08	559 252 277 254	332 57 64 62	14	5 7	.. ..	9	19 7	24 35 4 14	.. 4	72 54 4 14
	Aug. 22 2:45 P	15–0 35–15	0.57 0.14	483 255	384 32	9 4	.. ..	.. ..	9 ..	14 ..	62 7	.. 4	96 14
Long of Belgrades South Part	June 27 4:30 P	15–0 35–15 75–35 90–75	0.57 0.11 0.11 0.09	640 131 787 422	175 89 78 118	24 7 2 ..	9 4	.. ..	.. ..	5	109 50 23 24	14	162 61 26 24
	July 23 2:30 P	15–0 35–15 75–35 90–75	1.42 0.21 0.14 0.09	1,024 355 631 370	464 160 80 38	5 .. 4 5	9	.. ..	5	85	14 28 9 14	.. ..	120 29 13 19
	Aug. 22 2:30 P	15–0 35–15 75–35 90–75	0.33 0.11 0.09 0.14	678 468 712 701	294 99 2 28	.. ..	14 4	.. ..	.. 4 4 ..	.. 4	.. 28 11 28	5	20 40 15 29
[illegible]	[illegible] [illegible] P	[illegible] [illegible] 55–35	[illegible] [illegible] 0.11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Great of Belgrades	June 30 4:15	15–0 35–15 55–35	0.76 0.35 0.11	834 330 855	379 46 4	19	5	.. .. ..	.. .. ..	.. 11 ..	517 397 92	.. 35 ..	541 444 93
	July 22 11:00 A	15–0 35–15 60–35	0.57 0.25 0.14	592 426 549	507 78 23	 6	.. 4 ..	.. .. ..	.. .. ..	.. .. ..	294 387 25	.. .. ..	295 391 32
	Aug. 21 9:00 A	15–0 35–15 60–35	0.57 0.18 0.14	526 106 96	270 25 23	5 4 ..	9 4 ..	.. .. ..	19 .. 3	.. .. ..	28 28 11	19	81 36 14
North of Belgrades	June 28 1:30 P	15–0	0.38	867	175	9	..	..	...	5	57	19	91
	Aug. 22 9:00 A	15–0	0.33	649	237	5	5	..	..	..	128	..	138
East of Belgrades	June 28 3:00 P	20–0	0.53	642	294	7	18	..	..	50	660	4	739
	July 24 11:30 A	20–0	1.06	585	504	4	57	..	7	4	216	..	288
	Aug. 22 10:00 A	20–0	0.35	631	411	11	4	..	..	..	71	..	86
Salmon	June 29 3:00 P	15–0 35–15 45–35	0.47 0.11 0.21	929 365 617	346 32 7	.. 7 7	19 4 ..	.. .. ..	.. .. ..	5	133 60 92	5	162 71 100
	July 24 9:00 A	15–0 35–15 45–35	0.81 0.35 0.21	801 255 447	469 85 28	19 11 ..	5 21 14	.. .. ..	.. .. ..	9	52 340 92	.. .. ..	87 373 107
	Aug. 21 2:00 P	15–0 35–15 40–0	0.43 0.46 0.11	479 230 121	232 167 44	5	24 7 5	.. .. ..	9	9 50 ..	194 298 59	9	252 355 64
McGrath	Aug. 21 3:30 P	15–0 20–0	0.33 0.25	678 642	218 216	5 4	5 4	.. ..	5 ..	.. 4	161 96	.. ..	176 107
Clearwater	Sept. 3 11:15 A	15–0 35–15 75–35	0.24 0.18 0.07	716 1,131 75	43 113 21	5 .. 4	5	.. .. ..	.. .. ..	.. .. ..	33 103 11	5 7 ..	48 111 14

TABLE IV. The average numbers of different types of plankters, and the average volumes of all plankton — Concluded

Name of Lake or Pond	Date: 1940 Time: A=A.M. P=P.M.	Depth range of sample in ft.	Average vol. of plankton per cu. ft. of lake water, in c.c.	Average number of plankton organisms per cu. ft. of lake water									
						In thousands — add ,000							
				Copepoda (water fleas)	Cladocera (water fleas)	Rotifera	Protozoa	Zoophyta	Desmidiaceae (desmids)	Chlorophyceae (other green algae)	Bacillarieae (diatoms)	Myxophyceae (blue-green algae)	All plankters
Wilson (P.833)	Sept 3 3:30 P	15–0	1.66	275	128	9	336	..	5	..	5	..	356
		35–15	0.18	230	18	7	14	..	18	..	7	..	46
		75–35	0.07	233	2	4	2	..	4	9	5	..	23
Sandy	July 27 3:30 P	15–0	1.18	365	270	..	9	5	14	..	227	19	276
		35–15	0.14	138	21	4	..	..	..	..	21	..	25
Embden	July 27 10:30 A	15–0	0.95	..	95	5	100	..	..	..	43	..	147
		35–15	0.18	135	57	..	4	..	..	..	32	4	39
		75–35	0.07	110	53	..	..	..	..	..	11	..	11
		140–75	0.07	32	98	..	..	..	..	..	10	..	10

strata of each lake (data given separately for each lake in Table IV, and averaged for all of the lakes and ponds combined in Table V). It should be noted especially that the values per cubic foot represent averages for a considerable range in depth.

Records of the occurrence of different genera are based solely on those organisms encountered while making the counts as described above. Verification of the identifications of the common genera of Cladocera and Copepoda was made by Dr. Charles B. Wilson of Westfield, Massachusetts, for which the writer is grateful. These forms verified by Dr. Wilson were:

Diaphanosoma brachyurum (Lieven) from East Pond of the Belgrades.

Daphnia pulex (de Geer) from East Pond of the Belgrades.

Daphnia retrocurva from Long Pond of the Belgrades.

Polyphemus pediculus from Thompson Lake in Oxford.

Holopedium gibberum from Thompson Lake in Oxford.

Bosmina longirostris from Lond Pond of the Belgrades.

Mesocyclops leuckarti (Claus) from East Pond of the Belgrades.

Diaptomus pallidus Herrick from East Pond of the Belgrades.

The organisms collected from the 53 lakes and ponds, and as enumerated from the samples, represented nine major taxonomic groups of animals and plants. These groups and the important genera are considered in the following (Generic names follow Ward and Whipple, 1918; and Smith, 1933.):

Copepoda. The copepods, one of the groups which comprise the macroplankton of fresh-water lakes and ponds, are an important source of food for most young fish and the adults of many species. They, along with the following group, are commonly called water fleas. The two genera commonly present in the samples were *Cyclops* and *Diaptomus*. The genus *Cyclops* was more widespread and more abundant in the samples than the genus *Diaptomus*. Usually, in any particular body of water, the maximum abundance of the forms of *Cyclops* was found at a lower level than the maximum abundance of the forms of *Diaptomus*. In some instances where forms of *Diaptomus* were most abundant in the samples from upper levels of water, they disappeared from the plankton samples of lower levels, and were replaced by an almost pure culture of *Cyclops*. However, in some of the deep lakes the upper and lower levels were inhabited by forms of *Diaptomus*, and forms of *Cyclops* were found in the intermediate levels; the inference is that this peculiarity in depth distribution involved at least two species of *Diaptomus*. In some instances the immature forms of Copepods (nauplii) were extremely abundant only at intermediate depths, while the adult forms were present mostly in the surface waters and the deep waters. The maximum abundance of the Copepod population, with few exceptions, was in the upper waters; and the numbers decreased as the depth increased. As a whole, these lakes and ponds had a greater population of copepods than did the Rangeley Lakes (Cooper, 1940), and compared favorably with the lakes and ponds of the upper Saco River and Sebago Lake drainage systems in Maine (Cooper, 1939b).

Cladocera. This group, also called water fleas, along with the preceding group makes up the portion of plankton termed macroplankton. The Cladocera are important, both directly and indirectly, as food for fish. In most instances this group was outnumbered by the copepods. The common genera were *Bosmina, Daphnia, Diaphanosoma, Holopedium, Leptodora,* and *Polyphemus,* of which the first two were most widespread and most abundant. *Camptocercus* and *Leydigia* were rare. In general, *Diaphanosoma, Holopedium, Leptodora,* and *Polyphemus* were inhabitants of the upper levels of water. *Bosmina* and *Daphnia* were more widely distributed in respect to depth; of the two, *Bosmina* was the most abundant in the deepest water. The cladocerans were generally most abundant in the surface waters, as was the case with the copepods.

The comparison of the abundance of the cladocerans of these lakes with lakes of other regions in Maine was similar to the preceding comparison given for the copepods, namely; a greater abundance than in the Rangeley Lakes, and an equal abundance as in the lakes and ponds of the upper Saco River and Sebago Lake drainage systems.

Rotifera. These characteristically fresh-water animals are small but highly organized. They are readily identified by the corona which is one or more ciliated pads near the anterior end used to direct food-bearing water into the digestive cavity. Every lake or pond was abundantly supplied with one or more representatives of the group. The genera most common in the samples were *Anuraea, Polyarthra, Conochilus* which is a colonial form, and *Notholca. Rattulus* and *Anapus* were rare. The rotifers were found to be most common in the upper levels of water.

Protozoa. This is another group which has some very common representatives in lake plankton. The common genera encountered were *Dinobryon, Ceratium,* and *Actinophrys. Mallamonas, Epistilis,* and *Synura* were found occasionally. In one instance (Flying Pond) the genus *Synura* was found to be so abundant at the surface that it gave the entire lake a turbid appearance, and caused the water to feel greasy when rubbed between the hands.

Zoophyta. Forms which are usually claimed by both Botanists and Zoologists have been placed in the group Zoophyta. These forms were not present in sufficient numbers to be of much importance to the fertility of the lakes; in fact the Zoophyta were the least abundant of the nine major groups of plankters. The two genera present in the samples were *Volvox* and *Eudorina.*

Desmidiaceae. This group is a family of unicellular plants belonging to the green algae (Chlorophyceae). In general, they were not abundantly represented in the plankton samples. The genera present were *Staurastrum, Closterium, Cosmarium,* and *Xanthidium. Staurastrum* was more or less common, but the other genera were rare.

Chlorophyceae. All of the green algae, with the exception of the desmids, were placed in this group. They are called green algae because of the presence of plastids which contain chlorophyll and give them a grass-green color. This group provides a variety of forms and a wealth of individuals to fresh-water plantkon. The common genera of this group were *Micractinium, Ulothrix, Dictyosphaerium,* and *Scenedesmus.*

Bacillarieae. Members of this group, commonly called diatoms, are found widely distributed in fresh water. Two genera of diatoms were the most abundant and the most widely distributed of all plankters in the samples; these were *Asterionella* and *Tabellaria. Fragilaria* was common and *Sphaerozosma* was occasionally present in the samples.

Myxophyceae. One or more forms of the blue-green algae are usually found in samples of fresh-water plankton. Occasionally a member of this group may become so profuse as to cause a "bloom." Common genera encountered were *Anabaena* and *Microcystis; Aphanizomenon, Nostoc,* and *Spirulina* were occasional; and *Coelosphaerium* and *Merismopedia* were rare.

All Plankton. The frequency of the occurrence of different genera in the samples, and the records of occurrence of genera in the different lakes, were dependent upon the numerical abundance of the individuals of different genera, and may therefore be used as an index of their general abundance in the lakes as a whole. The records of occurrence in different lakes may not be so reliable an index of general abundance as the records of occurrence in different samples; because more samples were taken on some lakes than on others, and it was found that the greater the number of samples examined from any given lake, the greater was the number of genera recorded from that lake. Since more intensive sampling on some lakes gave records of a greater number of genera, it follows that our sampling was not adequate to indicate the complete distribution of any given genus among the lakes as a whole. In fact, it might be expected that most of the genera occurred in most of the 53 lakes and ponds. The figures on frequency of occurrence of different genera among the 182 separate plankton samples, and among the 53 lakes and ponds as recorded from these samples, are given in the following, in which the genera are listed within the different groups approximately in order of the numerical abundance of individuals in the samples as a whole:

	Number of samples	Number of lakes
Copepoda		
Cyclops	132	45
Diaptomus	121	40
Ergasilus	1	1
Cladocera		
Bosmina	134	46
Daphnia	131	43
Diaphanosoma	68	36
Holopedium	38	24
Leptodora	15	14
Polyphemus	7	6
Camptocercus	1	1
Leydigia	1	1
Rotifera		
Anuraea	41	28
Polyarthra	38	26
Conochilus	22	17
Notholca	20	13
Rattulus	1	1
Anapus	1	1
Protozoa		
Dinobryon	77	40
Ceratium	57	33
Actinophrys	12	11
Mallamonas	6	6
Epistilis	5	5
Synura	4	4

	Number of samples	Number of lakes
Zoophyta		
Volvox	3	2
Eudorina	1	1
Desmidiaceae		
Staurastrum	43	25
Closterium	2	1
Cosmarium	1	1
Xanthidium	1	1
Chlorophyceae		
Micractinium	46	25
Ulothrix	16	14
Dictyosphaerium	15	13
Scenedesmus	15	11
Bacillarieae		
Asterionella	133	46
Tabellaria	117	39
Fragilaria	40	19
Sphaerozosma	3	2
Myxophyceae		
Anabaena	35	30
Microcystis	8	5
Alphanizomenon	2	2
Nostoc	2	2
Spirulina	2	2
Coelosphaerium	1	1
Merismopedia	1	1

From eight lakes that were chosen as representing different types with respect to size and depth, samples were taken at three separate dates during the summer: early, middle, and late. Samples from the other lakes were all taken during late summer. The eight lakes, from which a series of samples was taken, all showed a gradual decline in plankton population during the summer. It is concluded, therefore, that the samples taken during August from the remaining lakes did not measure the maximum plankton abundance.

In comparing both total volume and numerical abundance of plankton, and taking into consideration seasonal and depth variations these lakes of the lower Androscoggin and Kennebec river drainages

rank high in basic fertility from the standpoint of plankton abundance in comparison to the Rangeley Lakes, and have about the same plankton fertility as the lakes of the Sebago Lake and Saco River drainages.

TABLE V. The average numbers of different types of plankters, and the average volumes of all plankton, per cubic foot of lake water within different depth strata of the 53 lakes combined, during the summer of 1940

Figures given in this table are averages of all data given in Table IV

Depth range in feet	Average volume of plankton per cu. ft. of lake water, in c.c.	Average number of plankton organisms per cu. ft. of lake water									
				In thousands, add ,000							
		Copepoda (water fleas)	Cladocera (water fleas)	Rotifera	Protozoa	Zoophyta	Desmidiaceae (desmids)	Chlorophyceae (other green algae)	Bacillarieae (diatoms)	Myxophyceae (blue-green algae)	All plankters
15 to 0	0.73	613	271	7	50	..	3	27	128	4	221
35 to 15	0.19	231	83	3	9	..	2	10	70	2	97
75 to 35	0.09	321	40	2	3	..	1	1	25	..	31
100 to 75	0.08	229	39	2	1	..	..	..	19	..	21

BOTTOM SOIL AND BOTTOM FAUNA OF THE LAKES AND PONDS

A total of 809 bottom samples was taken from 44 of the 53 lakes and ponds during the period from June 18 to September 11, 1940 (mostly during the months of July and August). All samples were taken in the daytime, mostly between 9:00 A.M. and 5:00 P.M. The samples were collected with Ekman dredges of a bottom area 9 inches by 9 inches square; photographs of this type of sampler are given on Plate VI of Survey Report No. 2 (Cooper, 1939b). The depth of water and type of bottom were noted for each sample. The entire samples were screened through brass sieves of two sizes of mesh, No. 20 and No. 40. Some samples were screened through the No. 40 mesh, while others were screened through only the No. 20 mesh sieves. The possible effect of the use of sieves of these two mesh sizes on the reliability of the results will be discussed later. All organisms in the samples were preserved in 70 per cent alcohol for later studies. Samples were taken at points distributed somewhat evenly over all parts of each lake or pond, with the realization that, by so doing, the samples would be distributed, according to depth, in proportion to the depth distribution of the bottom area of each lake. The samples, therefore, should represent, to the degree that the number of samples was adequate, a true picture of average conditions for each lake as a whole.

The bottom organisms were identified in the laboratory mostly to Orders and Families. The number of individuals of each type was counted. The volume of all organisms of each type was determined by water displacement: volumes of less than 1 c.c. were measured to the nearest 0.02 c.c.; volumes of less than 0.02 c.c. were estimated in some instances, or were determined by lumping several small organisms, measuring their total volume, and estimating the relative size of each type. Volumes of over 1 c.c. were measured to the nearest 0.1 c.c.

Bottom Soil. A variety of types, and combinations of these types, of bottom soil was encountered among the 809 bottom samples from these lakes and ponds. There were some differences in the occurrence of these types of bottom soil between the different lakes, and there was a considerable difference in most individual lakes in the distribution of bottom types according to depth of water. The predominant type of bottom soil was material classed as mud; this type was found in 507 samples. This "mud" included a variety of materials: some fine and light silt, some silt mixed with various amounts of partly decomposed organic material, and some fibrous or flocculent material.

Combinations of mud with wood debris, sand, or gravel were found in an additional 108 samples; thus, 615 of the 809 samples were either entirely or partly of mud. Sand was the next most prevalent of the bottom soil types; clear sand was found in 118 of the samples, and mixtures of sand with clay or gravel were found in an additional 16. Gravel was the third most abundant bottom soil type, occurring in 44 samples; and mixtures of gravel and sand occurred in 11 samples. Three samples contained entirely clay, and 13 samples contained entirely wood debris which was mostly sawdust. Most of the more shallow lakes and ponds had predominantly mud bottoms throughout, with the exception of a narrow strip along the shore shallows. In a majority of the ponds sand was found in some of the samples. Sand was more prevalent in some of the deeper lakes such as Auburn, Echo, and Maranacook lakes, and Embden Pond. A considerable amount of sawdust or other wood debris was encountered in a few ponds, one example being David Pond. Large gravel or bed rock was encountered in the deeper waters of a few of the lakes such as Thompson and Echo; on this type of bottom, no sampling with the Ekman Dredge was possible, and attempts at sampling on this type of bottom are not included among the 809 samples considered in the present discussion. Since only a few sampling attempts encountered large rock or bed rock, it is believed that the failure to obtain samples from this type of bottom does not invalidate any of the general conclusions which are given in this report.

The distribution of the different bottom soil types by depth for all of the lakes combined is indicated in Table VII. Among the samples taken in 3 to 10 feet of water, sand was the predominant type of bottom, mud was second in frequency of occurrence, then wood debris, then gravel. Among samples taken in 11 to 20 feet of water mud occurred in more samples than did all other types of bottom soil; sand was second in frequency; and gravel, third. Below a depth of 20 feet the frequency of sand and gravel dropped greatly and here the bottom soil was almost entirely mud. The uniformity of the mud bottom was still more extreme below a depth of 40 feet.

Bottom Fauna. All of the animals collected from the bottom samples were kept as a part of the samples, with the exception of a single eel (*Anguilla*) and frequent large bivalve mollusks. The organisms in the 809 samples from the 44 lakes were classified into 17 major groups of different taxonomic rank — classes, orders, families, or genera. All of these bottom organisms were invertebrates. They included two groups of annelid worms, namely, leeches and aquatic earthworms; small snails and clams among the mollusks; and, among the arthropods, a single water mite representing the arachnids, a single crayfish and numerous fresh-water shrimp representing the crustaceans, and representatives of 6 orders of aquatic insects. These

TABLE VI. Volumes and numbers of bottom organisms — Concluded

Name of lake or pond	Samples: Date: 1940	Range in depth of water in feet	Number of samples	Leeches (Hirudinea)	Aquatic earthworms (Oligochaeta)	Fresh-water shrimp (Amphipoda)	Crayfish (Decapoda)	Alderfly larvae (*Sialis*)	Mayfly nymphs (Ephemeridae)	Dragonfly nymphs (Anisoptera)	Damselfly nymphs (*Zygoptera*)	Beetle larvae (Coleoptera)	Caddisfly larvae (Trichoptera)	Midge larvae (Chironomidae)	Mosquito larvae (*Corethra*)	Water mites (Hydracarina)	Snails (Amnicolidae)	Other snails (Gastropoda)	Pill clams (Sphaeridae)	Other clams (Pelecypoda)	Unknown
Annabessacook	Aug. 6	5–41	20	0.01 (1)	....	0.001 (1)	....	.....	0.13 (5)	.....	.....	.....	0.05 (1)	0.441 (124)	0.25 (106)	.....	0.58 (56)	2.682 (43)	0.916 (249)	1.88 (18)	....
Cochnewagan	June 18–25	6–29	20	.....	0.095 (11)	0.136 (57)	....	.....	2.803 (54)	0.13 (4)	.....	.....	0.1 (7)	0.336 (200)	0.213 (71)	.....	1.544 (37)	1.17 (12)	0.081 (36)	0.85 (3)	....
Wilson (P.673)	July 30–31	5–40	16	.....	....	0.006 (4)	....	0.05 (6)	1.095 (36)	0.04 (3)	0.005 (1)	.....	0.005 (1)	0.207 (46)	0.043 (27)	.....	0.37 (23)	0.16 (4)	0.29 (26)	0.05 (1)	0.4 (3)
Dexter	Aug. 5	4–25	5	.....	....	0.071 (53)	....	.....	0.11 (1)	0.4 (2)	.....	.....	0.001 (1)	0.132 (20)	0.051 (16)	.....	......	.....	0.06 (18)	.....	....
Berry	Aug. 5	6–25	6	.....	....	0.004 (4)	....	.....	0.46 (3)	0.235 (9)	.....	.....	0.01 (1)	0.131 (13)	0.013 (7)	.....	0.02 (2)	.....	0.011 (4)	.....	....
Maranacook	Aug. 2	5–90	24	0.016 (3)	....	0.215 (106)	....	0.081 (7)	0.856 (72)	0.18 (2)	.....	0.01 (1)	0.185 (9)	0.139 (117)	0.023 (23)	.....	0.80 (72)	1.295 (36)	1.186 (120)	0.5 (1)	....
Torsey	July 31	3–30	22	.....	0.18 (3)	0.019 (19)	....	0.07 (4)	0.961 (27)	1.02 (13)	.....	.....	0.1 (6)	0.712 (104)	0.04 (51)	.....	0.33 (50)	2.79 (51)	0.722 (141)	.....	....
Narrows South Part	Aug. 13	4–100	8	.....	....	0.032 (27)	....	0.01 (1)	0.015 (2)	.....	.....	.....	0.01 (1)	0.2 (52)	0.005 (5)	.....	......	.....	0.013 (7)	.....	....
North Part	Aug. 13	12–54	9	.....	....	0.011 (11)	....	0.045 (8)	0.05 (7)	.....	.....	.....	0.05 (4)	0.451 (134)	0.266 (97)	.....	0.12 (9)	0.06 (5)	0.126 (14)	.....	....
Snow	July 1–2	7–113	17	.....	....	0.014 (14)	....	.....	0.075 (9)	0.35 (4)	.....	.....	0.001 (1)	0.982 (131)	0.476 (184)	0.001 (1)	0.223 (20)	3.533 (46)	0.631 (173)	0.5 (4)	....
Long of Belgrades South Part	June 21–22	6–51	12	.....	....	0.104 (29)	....	0.002 (1)	0.05 (6)	0.03 (1)	.....	.....	0.6 (10)	0.021 (22)	0.006 (6)	.....	0.306 (24)	0.26 (13)	0.281 (65)	.....	....
North Part	June 21	12–59	13	.....	....	0.075 (31)	....	.....	0.186 (4)	.....	.....	.....	0.005 (1)	0.265 (48)	0.002 (2)	.....	0.02 (7)	0.085 (9)	1.002 (160)	.....	....
Great of Belgrades	June 18–July 18	4–61	32	0.061 (4)	....	0.033 (33)	....	0.011 (2)	1.51 (46)	0.111 (2)	0.04 (1)	0.001 (1)	0.17 (8)	0.066 (61)	0.005 (5)	.....	0.892 (83)	1.196 (37)	0.987 (130)	0.27 (3)	....
North of Belgrades	July 9	7–20	23	0.08 (2)	....	0.006 (6)	....	0.1 (7)	1.58 (35)	0.22 (2)	0.01 (1)	.....	0.213 (11)	0.079 (58)	0.015 (15)	.....	0.156 (15)	2.541 (26)	0.051 (8)	1.43 (5)	0.11 (3)
East of Belgrades	July 11–12	8–27	23	0.13 (2)	....	0.016 (16)	....	0.2 (4)	3.125 (51)	0.21 (2)	.....	.....	0.01 (1)	0.091 (40)	0.042 (50)	.....	0.1 (19)	2.54 (28)	0.013 (5)	0.57 (4)	....
Salmon	July 25	7–36	12	0.01 (1)	....	0.028 (24)	....	0.16 (5)	0.5 (16)	.....	.....	.....	0.04 (3)	0.165 (52)	0.073 (33)	.....	0.41 (40)	1.01 (36)	0.113 (27)	0.04 (2)	....
McGrath	July 30	6–27	10	.....	....	0.017 (25)	....	0.06 (6)	0.591 (18)	.....	.....	0.06 (1)	0.05 (3)	0.172 (76)	0.016 (16)	.....	0.28 (26)	1.12 (37)	0.025 (10)	0.11 (2)	....
Sandy	July 28	4–34	10	0.01 (1)	....	0.099 (30)	....	.....	0.275 (7)	0.005 (1)	.....	.....	0.01 (1)	0.153 (27)	0.023 (16)	.....	0.11 (13)	0.11 (2)	0.021 (7)	.....	....
Embden	July 27	7–145	23	.....	....	0.023 (15)	....	0.052 (2)	0.09 (5)	.....	.....	.....	0.055 (2)	0.045 (42)	.....	.....	0.151 (20)	.....	0.203 (37)	.....	....
Totals (44 ponds)	June 12–Sept. 11	3–145	809	0.903 (36)	0.89 (62)	1.627 (1009)	0.25 (1)	2.554 (166)	27.628 (873)	9.001 (105)	0.186 (7)	0.115 (15)	2.351 (120)	25.791 (4529)	6.444 (2874)	0.001 (1)	13.913 (1339)	39.82 (728)	12.862 (2315)	12.65 (72)	0.53 (8)

TABLE VII. The average volumes in cubic centimeters and numbers (in parentheses) of bottom organisms per 9″ x 9″ sample for 44 lakes and ponds combined, and based on a total of 809 samples, arranged according to depth of water and type of bottom soil

Averages based on five or more samples are given in heavy type

Depth in feet	Type of bottom										
	Gravel	Gravel, sand	Sand	Sand, clay	Clay	Wood debris	Mud, gravel	Mud, sand	Mud, wood debris	Mud	All bottom types
3–10	**0.173 (9.1)**	0.037 (4.0)	**0.213 (18.4)**	....	....	**0.190 (11.1)**	0.717 (37.0)	**0.275 (35.6)**	**0.345 (14.3)**	**0.501 (21.9)**	**0.292 (19.4)**
11–20	**0.086 (7.1)**	**0.149 (9.7)**	**0.127 (11.7)**	....	0.062 (9.0)	0.714 (24.0)	0.080 (5.7)	**0.173 (9.6)**	**0.211 (11.0)**	**0.331 (15.4)**	**0.243 (12.9)**
21–30	**0.021 (4.2)**	0.010 (2.5)	**0.039 (7.6)**	0.132 (10.3)	....	....	0.161 (7.0)	**0.079 (11.3)**	**0.169 (31.1)**	**0.184 (19.7)**	**0.165 (18.5)**
31–40	**0.006 (1.8)**	....	**0.021 (6.7)**	0.027 (3.5)	0.010 (4.0)	....	0.067 (25.0)	0.002 (2.0)	0.085 (9.0)	**0.127 (26.0)**	**0.108 (22.2)**
41–50	0.020 (7.5)	....	0.002 (1.5)	....	....	....	....	....	0.127 (31.0)	**0.108 (20.4)**	**0.100 (19.4)**
51–60	....	....	0.017 (8.0)	....	0.001 (1.0)	....	....	....	0.200 (15.0)	**0.110 (24.8)**	**0.106 (23.1)**
61–70	....	....	....	....	....	....	0.002 (2.0)	....	....	**0.088 (18.3)**	**0.083 (17.3)**
71–80	....	....	....	....	....	....	....	....	....	**0.114 (17.5)**	**0.114 (17.5)**
81–90	....	....	....	....	....	....	....	....	0.650 (82.0)	**0.099 (23.2)**	**0.154 (29.1)**
91–100	....	....	....	....	....	....	....	....	....	0.066 (16.5)	0.066 (16.5)
101–110	0.0 (0)	....	....	....	....	....	....	....	....	0.053 (12.5)	0.035 (8.3)
111–120	....	....	....	....	....	....	....	....	....	0.086 (11.0)	0.086 (11.0)
121–130	....	....	....	....	....	....	....	....	....	....	....
131–140	....	....	....	....	....	....	....	....	....	....	....
141–145	....	....	....	....	....	....	....	....	....	0.002 (2.0)	0.002 (2.0)
All samples, all depths	**0.084 (6.4)**	**0.103 (7.4)**	**0.159 (14.4)**	**0.090 (7.6)**	0.024 (4.7)	**0.230 (12.1)**	**0.157 (14.1)**	**0.178 (17.5)**	**0.224 (17.1)**	**0.215 (20.0)**	**0.195 (17.6)**

aquatic insects included: alderfly larvae (Neuroptera), Mayfly nymphs (Ephemerida), dragonfly and damselfly nymphs (Odonata), beetle larvae (Coleoptera), caddisfly larvae (Trichoptera), and midge and mosquito larvae (Diptera). The volumes and numbers of each type of bottom organism in all samples from each lake, together with the number and range in depth of these bottom samples, are given for each lake in Table VI.

The validity of much of the following discussion on the kinds, numbers, and volumes of different types of bottom organisms in each lake, and the validity of the comparisons of different lakes on the basis of bottom food, depend on whether or not the methods of sampling and analysis were uniform. All sampling methods were essentially uniform except for the use of two sizes of sieves employed in screening the bottom samples. On about one-half of the ponds, only the No. 20 sieve was used; on the other half, only the No. 40 sieve was used. On four of the ponds included in the present report (Lower Range, Allen, Taylor, and Pleasant), and on one lake (Sabbathday) which is not discussed in the present report, samples were taken in order to determine whether or not the use of the No. 20 sieve gave results different from those obtained by the use of the No. 40 sieve. Since the No. 20 sieve has a larger mesh and therefore has larger openings, it might be supposed that more of the smaller organisms would escape through this size of mesh than through the No. 40 mesh, while the sample was being screened; and that, consequently, the samples obtained by the use of the No. 20 sieve would contain fewer organisms because of this source of error. Eighty-five bottom samples were taken from these five ponds, and these samples were distributed over the different ponds in the usual way. The samples were treated in the usual way with the exception that all odd-numbered samples (Nos. 1, 3, 5, . . . 85) were screened through a No. 40 sieve and all even-numbered samples were screened through a No. 20 sieve. There were, of course, the same number of even- and odd-numbered samples from each lake, with a maximum variation of one. These samples were taken at different depths and on different types of bottom, just the same as the other samples were distributed over any given lake; but, since these 85 samples were screened alternately through the two types of sieves, any differences due to depth, type of bottom, or variation of bottom organisms between different lakes, should have been compensated for by this method of selection. A comparison is here made of the volumes and numbers of organisms taken by these 85 samples, according to type of screen. Since the numbers and volumes of organisms were so variable from one sample to another, the data have been analyzed by standard statistical methods.[6] The average number of all organisms per sample in the 43 samples screened through the No. 20 sieve was 20.9±2.12; the standard deviation was 20.6. The average number of all organisms per sample in the 42 samples screened through the No. 40 sieve was 22.7±2.02; the standard deviation was 19.4. The difference between the two means is 1.8; or the samples with the No. 40 sieve contained an average of 1.8 more organisms than the samples with the No. 20 sieve. This difference of 1.8 organisms is only 0.6 of its probable error which is 2.93. The slightly greater number of organisms with the No. 40 sieve, therefore, is of practically no statistical significance. These figures for number of organisms, and similar figures on average volumes in cubic centimeters of organisms per sample, in samples screened through the two types of sieves, are as follows:

Sieve	Number of samples	Average number of organisms	σ=S.D.	$P.E._{Mean}$	Diff. Means	$P.E._{Diff.}$	$\frac{\text{Diff. Means}}{P.E._{Diff.}}$
No. 40 sieve	42	22.7	19.4	2.02	1.8	2.93	0.6
No. 20 sieve	43	20.9	20.6	2.12			
		Average volume of organisms					
No. 40 sieve	42	0.129	0.179	0.019	0.050	0.031	1.6
No. 20 sieve	43	0.179	0.229	0.024			

[6] Standard deviation $=\sigma=\sqrt{\frac{\Sigma D^2}{n}}=\sqrt{\frac{\Sigma X^2-M^2}{n}}=\frac{1}{n}\sqrt{n\Sigma X^2-(\Sigma X)^2}$

Where Σ = sum; D=deviation of an individual variant from the mean; n=the number of samples; X=the number or volume of all organisms in an individual sample; and M=the mean.

Probable error of mean = P.E. $=\frac{0.6745\sigma}{\sqrt{n}}$

Probable error of difference of two means = $P.E._{Diff.}$ = $\sqrt{(P.E._1)^2+(P.E._2)^2}$

These figures reveal a somewhat greater average volume of organisms in samples with the No. 20 sieve. The difference in volume of organisms, between samples with No. 20 and 40 sieves, of 0.050 c.c. is only 1.6 times its probable error of 0.031 c.c. The mathematical chances are thus about 2.6 to 1 that this greater volume of organisms in the No. 20 screen samples is of any significance; it is not sufficient to be conclusive. It is, also, the reverse in trend of what might logically be expected, for the finer screen should yield more organisms, of a greater total volume, if more were escaping through the No. 20 mesh. The reason for the lack of any significant difference in results of the use of these two types of sieves seems to be that only the macro-benthic forms are usually picked out of the samples, and these organisms are all within a size range of which individuals do not readily escape from the coarser sieve in the usual method of screening; and therefore nothing is gained by using the finer-meshed sieves. The analysis has shown that the variation in use of No. 20 and No. 40 sieves, for bottom samples from different lakes and ponds, has had very little if any effect on the results of the sampling, and does not necessitate qualifications of the present presentation of the data on this account.

The different types of bottom organisms occurred in the bottom samples in different degrees of abundance. Some idea of the relative importance of these types of bottom food may be obtained from a summary of their frequency of occurrence in the different lakes; of all bottom organisms from the 44 lakes:

Midge larvae and Mayfly nymphs were taken from	44 lakes
Corethra larvae and pill clams (Sphaeridae) from	43 "
Fresh-water shrimp from	41 "
Snails of the Family Amnicolidae from	37 "
Caddisfly larvae, and snails other than Amnicolidae, from	35 "
Alderfly larvae from	30 "
Small clams other than Sphaeridae from	25 "
Dragonfly nymphs from	24 "
Leeches from	16 "
Aquatic earthworms from	9 "
Beetle larvae from	7 "
Damselfly nymphs from	6 "
A single crayfish from	1 "
A single water mite from	1 "

A further idea of the relative importance of these different types of bottom organisms in these lakes and ponds may be obtained from the total volume and number of each type of organism in the 809 samples (see bottom of Table VI). These 809 samples contained

TABLE VIII. The total and average volumes and numbers of organisms in bottom samples, and the calculated average volumes and numbers of organisms per square foot of lake bottom, for the 44 lakes and ponds

Name of pond	Pond number	Number of samples	Totals of organisms in all samples: Volume in c.c.	Totals of organisms in all samples: Number	Average volume and number of organisms per sample: Volume: Mean	Average volume and number of organisms per sample: Volume: σ=S.D.	Average volume and number of organisms per sample: Number: Mean	Average volume and number of organisms per sample: Number: σ=S.D.	Organisms per square foot (calculated): Volume in c.c.	Organisms per square foot (calculated): Number
Sabattus Pond	389	20	9.748	233	0.49	0.60	11.65	6.7	0.87	20.7
Taylor Pond	392	20	2.781	365	0.14	0.23	18.25	25.4	0.25	32.4
Lower Range Pond	398	15	1.743	255	0.12	0.12	17.00	11.3	0.21	30.2
Middle Range Pond	400	20	2.308	196	0.12	0.15	9.80	7.9	0.21	17.4
Upper Range Pond	401	14	2.315	243	0.17	0.16	17.36	7.7	0.30	30.9
Hogan Pond	403	10	1.269	145	0.13	0.12	14.50	12.0	0.23	25.8
Whitney Pond	404	10	1.760	123	0.18	0.15	12.30	8.1	0.32	21.9
Tripp Pond	408	19	0.834	130	0.04	0.03	6.84	5.1	0.07	12.2
Thompson Lake	409	22	1.097	271	0.05	0.03	12.32	8.4	0.09	21.9
Pennesseewassee Lake	416	24	4.320	387	0.18	0.17	16.13	14.1	0.32	28.7
Auburn Lake	428	31	2.542	345	0.08	0.06	11.13	7.5	0.14	19.8
Allen Pond	437	13	3.081	255	0.24	0.34	19.62	16.1	0.43	34.9
Pleasant Pond	443	20	4.926	680	0.25	0.13	34.00	21.7	0.44	60.4
Androscoggin Lake	464	29	3.799	439	0.13	0.09	15.14	14.9	0.23	26.9
Pocasset Lake	466	16	2.742	122	0.17	0.19	7.63	3.3	0.30	13.6
Lovejoy Pond	470	19	2.903	154	0.15	0.18	8.11	4.8	0.27	14.4
Echo Lake	472	22	2.660	169	0.12	0.32	7.68	11.8	0.21	13.7
Parker Pond	474	29	3.043	322	0.10	0.13	11.10	9.7	0.18	19.7
David Pond	476	21	12.770	1,109	0.61	0.43	52.81	39.3	1.08	93.9
Flying Pond	481	20	1.316	159	0.07	0.08	7.95	5.0	0.12	14.1
Webb Lake	503	27	5.831	869	0.22	0.21	32.19	24.9	0.39	57.2
South Pond	522	14	2.419	212	0.17	0.30	15.14	17.4	0.30	26.9
Purgatory Pond	659	20	6.972	441	0.35	0.45	22.05	12.5	0.62	39.2
Sand Pond	660	14	0.787	234	0.06	0.06	16.71	12.3	0.11	29.7
Cobbosseecontee Lake	668	35	5.266	1,004	0.15	0.16	28.69	17.9	0.27	51.0
Annabessacook Lake	671	20	6.940	604	0.35	0.39	30.20	45.1	0.62	53.7
Cochnewagan Pond	672	20	7.458	492	0.37	0.41	24.60	20.6	0.66	43.7
Wilson Pond	673	16	2.721	181	0.17	0.13	11.31	3.3	0.30	20.1
Dexter Pond	674	5	0.825	111	0.17	0.22	22.20	16.3	0.30	39.5
Berry Pond	675	6	0.884	43	0.15	0.16	7.17	3.7	0.27	12.7
Maranacook Lake	676	24	5.486	569	0.23	0.23	23.71	16.6	0.41	42.2
Torsey Pond	678	22	6.944	469	0.32	0.36	21.32	18.8	0.57	37.9
Narrows Pond (South)	681	8	0.285	95	0.04	0.04	11.88	8.2	0.07	21.1
Narrows Pond (North)	682	9	1.179	289	0.13	0.10	32.11	17.9	0.23	57.1
Snow Pond	698	17	6.786	587	0.40	0.68	34.53	28.1	0.71	61.4
Long of Belgrades (South)	712	12	1.660	177	0.14	0.25	14.75	17.0	0.25	26.2
Long of Belgrades (North)	713	13	1.640	262	0.13	0.09	20.15	14.2	0.23	35.8
Great Pond of Belgrades	719	32	5.353	416	0.17	0.17	13.00	9.2	0.30	23.1
North Pond of Belgrades	720	23	6.591	194	0.29	0.28	8.43	4.5	0.52	15.0
East Pond of Belgrades	724	23	7.047	222	0.31	0.38	9.65	7.6	0.55	17.2
Salmon Lake	725	12	2.549	239	0.21	0.15	19.92	9.9	0.37	35.4
McGrath Pond	726	10	2.501	220	0.25	0.20	22.00	10.3	0.44	39.1
Sandy Pond	883	10	0.816	105	0.08	0.09	10.50	5.2	0.14	18.7
Embden Pond	887	23	0.619	123	0.03	0.02	5.35	3.7	0.05	9.5
Totals	44	809	157.516	14,260	......	....	....	....	....	......
Averages for lakes	.....	....	....	....	0.19	....	17.47	....	0.34	31.1

14,260 individual organisms of a total volume of 157.516 c.c. of which:

4,529 midge larvae made up .... 25.791 c.c.
873 Mayfly nymphs made up .... 27.628 c.c.
1,339 snails of the Family Amnicolidae made up .... 13.913 c.c.
728 other snails made up .... 39.82 c.c.
2,315 pill clams made up .... 12.862 c.c.
72 other clams made up .... 12.65 c.c.
2,874 *Corethra* larvae made up .... 6.444 c.c.
105 dragonfly nymphs made up .... 9.001 c.c.
1,009 fresh-water shrimp made up .... 1.627 c.c.
166 *Sialis* larvae made up .... 2.554 c.c.
120 caddisfly larvae made up .... 2.351 c.c.

Differences in average size of different types of organisms are obvious from the above figures. For example, Mayfly nymphs had an average size of about five times that of the midge larvae. Clams, other than Sphaeridae, were of the largest average size of all types of organisms; these clams were mostly the young stages of large species. Practically all of the smaller snails were of the Family Amnicolidae. Among the insects, the Mayfly nymphs, dragonfly nymphs, *Sialis* larvae, and caddisfly larvae were of relatively large average size as compared to the small size of midge and *Corethra* larvae. Fresh-water shrimp were among the smallest of all bottom types recovered from the samples.

The character of the bottom fauna varied some with the depth of the water; part of the data on distribution of organisms by depth is given in Table VII. The shallower water for all of the lakes in general had a greater variety of bottom forms and also had the larger organisms; the individual organisms from the upper 20 feet of depth averaged from two to four times the volume of the organisms from deeper water, due mostly to differences in kinds of species present. The total volume of all organisms per square foot was somewhat greater in the upper 20 feet than in deeper water. The number of all organisms per square foot varied somewhat throughout depths of 3 to 120 feet; however, the data showed no definite trend in change of average number of organisms with change in depth (Table VII). The type of bottom soil obviously had an effect on the volume and number of organisms present. Gravel, sand, clay, and mixtures of these types, mostly contained fewer organisms and a smaller volume of organisms than were contained on mud bottom or on mixtures of mud with other soil types.

The data obtained from these bottom samples offer an opportunity to compare the abundance of bottom food (i.e., food for fishes) in different types of lakes. Available figures for such comparisons are the average volumes and average numbers of organisms per square foot of lake bottom. Since the locations of sampling were scattered fairly uniformly over the surface of each lake, the averages of the samples presumably represent the average conditions for the entire bottom area of each lake. The number of bottom samples, the total volume and number of all organisms in all samples from each lake,

the average volume and number of organisms per sample, and the calculated volume and number per square foot of lake bottom, are given for each lake and for all lakes combined in Table VIII. The considerable variability in quantity of organisms in the individual samples is indicated by the standard deviations (σ=S.D.) of numbers and volumes of organisms, which are also given in this Table for each lake. The average for the 809 samples was 17.47 organisms, of 0.19 c.c. in volume, per sample; or a calculated 31.1 organisms, of 0.34 c.c. in volume, per square foot of lake bottom. The averages for the individual lakes varied from a low of 9.5 organisms of 0.05 c.c. per square foot in Embden Pond, to a maximum of 93.9 organisms of 1.08 c.c. per square foot in David Pond. All lakes except David had less than 1 c.c. per square foot. The variations in average volumes of organisms per sample for these lakes may be attributed mostly to differences in basic fertility, and not to the variable factor of date at which the samples were taken; for if the lakes are divided into several groups on the basis of average volume of bottom organisms per sample, and compared to the dates of sampling (See Table VI), there is no indication of a gradual change in volume of organisms over the three-months period during which most of the samples were taken.

A division of the lakes and ponds into different types on the basis of depth and chemistry of the water offers one basis for a comparison of abundance of bottom fauna in different types of lakes. Such a comparison has considerable significance, since depth and chemistry of the water are among the most important factors which determine the types of fishes to which the lake is best suited. A division of the 53 lakes, which were studied by the survey during 1940, into different types on the basis of depth, temperature, and dissolved oxygen content of the water has been given previously (see page 66). The 44 lakes from which bottom samples were taken may be divided on the same basis into the following three types:

Deep lakes and ponds, thermocline present, high oxygen below thermocline, good trout or salmon water [Includes: Middle Range, Upper Range, Thompson, Auburn, Allen, Pleasant, Echo, Flying, South, Sand, Maranacook, Narrows (both parts), Long (south part), and Embden] .... 15 lakes and ponds

Deep lakes and ponds, thermocline present, low oxygen below thermocline, poor or fair trout or salmon water [Includes: Taylor, Lower Range, Hogan, Whitney, Tripp, Pennesseewassee, Parker, David, Webb, Purgatory, Cobbosseecontee, Annabessacook, Wilson in Monmouth, Dexter, Berry, Torsey, Snow, Long (north part), Great, Salmon, and Sandy] .... 21 lakes and ponds

Shallow lakes and ponds, no thermocline, i.e., warm water to bottom, poor trout and salmon water [Includes: Sabattus, Androscoggin, Pocasset, Lovejoy, Cochnewagan, North Pond of Belgrades, East, and McGrath] .... 8 lakes and ponds

It should be noted that this classification differs somewhat from the one given on page 66 in the discussion of the suitability of water for trout and salmon, since this previous classification was intended to be more detailed. This second division of the lakes into three types recognizes two categories on the basis of the suitability of the water for trout or salmon: either good or poor. The poor trout and salmon waters are of two types: either shallow and warm to the bottom, or deep but with oxygen deficiency in the deeper water. These same factors of depth, temperature, and oxygen deficiency presumably affect the composition of the bottom fauna as well as the composition of the fish fauna. The following comparison of the abundance of the bottom fauna in these three types of lakes is made by lumping all samples for lakes of one type. The 266 bottom samples from the 15 good trout or salmon lakes, when considered as a unit, contained an average of 15.1 organisms of 0.123 c.c. volume per sample; and the 383 samples from the 21 deep lakes with oxygen deficiency contained an average of 21.3 organisms of 0.214 c.c. volume per sample. When the above averages for volume are compared statistically: the first volume is 0.123±0.008; the second is 0.214±0.010; and the difference between the two volumes is 0.091±0.013, or the difference is seven times the probable error. The statistical odds are about 400,000 to one on the basis of this analysis that the deep lakes with oxygen deficiency had a greater volume of bottom organisms than the good trout or salmon lakes. The data for this and other comparisons of bottom organisms in these three types of lakes are as follows:

Type of lake or pond	No. of ponds	No. of samples	Volumes of organisms in c.c.			Numbers of organisms		
			Mean	σ=S.D	$P.E._{Mean}$	Mean	σ=S.D.	$P.E._{Mean}$
(A) Deep; high oxygen below thermocline; good for trout or salmon.	15	266	0.123	0.193	0.008	15.1	15.0	0.62
(B) Deep; low oxygen below thermocline; poor for trout or salmon	21	383	0.214	0.304	0.010	21.3	23.1	0.80
(C) Shallow; no thermocline; poor for trout or salmon	8	160	0.267	0.351	0.019	13.0	12.4	0.66

from which, statistical comparisons of volumes and numbers of bottom organisms in these three types (note A, B, & C) of lakes are as follows:

Comparing type:	Volumes in c.c.			Numbers of organisms		
	Difference of means	$P.E._{Diff.}$	$\frac{Diff.}{P.E.}$	Difference of means	$P.E._{Diff.}$	$\frac{Diff.}{P.E.}$
A and B	0.091	0.013	7.0	6.2	1.01	6.1
A and C	0.144	0.021	6.9	2.1	0.91	2.3
B and C	0.053	0.021	2.5	8.3	1.04	8.0

Certain generalizations on abundance of bottom fauna in these three types of lakes may be made from the above comparisons. The deep lakes with oxygen deficiency had a much greater number and a much greater volume of organisms per unit of area than did the trout and salmon lakes. The organisms in these two types of lakes were of about the same average size. The shallow lakes had a much greater volume of organisms but somewhat fewer numbers than the good trout and salmon lakes. The organisms in the shallow lakes were much larger than in either of the other two types of lakes; this difference in size of organisms was attributable to the abundance of large forms such as dragonfly nymphs, Mayflies, etc., in the shallower water as compared to the predominance of small midge and *Corethra* larvae in the deeper water. The shallow lakes had a greater volume of bottom organisms than the deeper, oxygen-deficient lakes, even though the number of organisms was fewer. The significance of these differences from the standpoint of game fishes may be inferred. Those lakes and ponds which have the best water for trout and salmon have the least volume of bottom food per unit area; and conversely, those waters which are best adapted for warm-water game fishes have the greatest volume of bottom food. Of the two types of ponds primarily suited to the warm-water species, the shallower ones have by far the largest food organisms. Among those deep lakes with partial oxygen deficiency and thus with fair trout water, there is a comparatively large volume of bottom food organisms, but the organisms themselves are mostly small forms. These facts, if applicable to waters in general, have considerable significance in relation to the introduction of warm-water game fishes in the better trout and salmon lakes. In this type of lake with the bottom food supply at a minimum, competition for this food is presumably more severe, and this competition might be still more extreme if species of warm-water game fishes are introduced. At least this type of lake cannot support so many individuals of competing bottom-feeding species, and this relative scarcity of bottom food might be the reason that the introduction of warm-water game species reduces or practically eliminates trout and salmon from the better trout and salmon lakes.

The two principal sources of fish food in lakes and ponds are the bottom fauna and the plankton. The two together, therefore, are the principal measures of basic fertility. Some data are here available for making a general comparison of the abundance of bottom fauna and of plankton in most of the lakes studied by the survey. The comparison (to follow) is between the numbers and volumes of bottom organisms collected during the period from June 18 to September 11, and the volume of plankton collected during the month of August for all lakes except one from which the samples were taken in early September. (Sabattus Pond is eliminated from the comparison because the plankton samples from this pond were collected in June.) This leaves 43 ponds for which suitable data are available. The figures used in this comparison are the average number and volume of bottom organisms per 9-inch by 9-inch sample for each lake, and the volume in c.c., as determined by settling (see page 69), of all plankton taken by two 15-foot-to-surface hauls with a Birge closing net. The most reliable comparison of the available data on bottom fauna and plankton is probably the coefficient of correlation (r_{xy})[7] between the average numbers or average volumes of bottom fauna and the volumes of plankton, as obtained from the individual lakes. The coefficient of correlation between these available figures on volume of bottom fauna and volume of plankton was +0.02; the coefficient of correlation between the figures on number of bottom organisms and the volume of plankton was +0.06. In other words, there was practically no correlation between the average numbers or volumes of bottom organisms and the volume of plankton in the surface waters, as indicated by our survey data for these 43 lakes and ponds.

Another attempt to correlate bottom fauna and plankton in these lakes and ponds, from our survey data, is here made by arranging the lakes on the basis of volume of plankton into five groups, and comparing the average numbers and volumes of bottom organisms for lakes in these different groups. The 43 lakes and ponds may be

7 $$r_{xy} = \frac{a}{\sqrt{b \times c}} \quad \text{where: } \begin{aligned} a &= n\Sigma xy - \Sigma x \Sigma y \\ b &= n\Sigma x^2 - (\Sigma x)^2 \\ c &= n\Sigma y^2 - (\Sigma y)^2 \end{aligned}$$

in which: x = either the number or volume of bottom organisms.
y = the volume of plankton.
n = the number of lakes or ponds.
Σ = the sum of.

divided on the basis of total volume of plankton taken in two 15-foot-to-surface hauls mostly in August, as follows:

0.0 to 0.6 c.c. of plankton: Hogan, Pennesseewassee, Auburn, Pleasant, Androscoggin, Pocasset, Lovejoy, Webb, South, Dexter, and Berry.

0.7 to 1.2 c.c. of plankton: Taylor, Lower Range, Whitney, Tripp, Echo, Purgatory, Cobbosseecontee, Cochnewagan, Wilson in Monmouth, Narrows (south part), Snow, Long (south part), Great, North in Smithfield, East, Salmon, and McGrath.

1.3 to 2.4 c.c. of plankton: Middle Range, Parker, Sand, Annabessacook, Narrows (north part), Long (north part), and Embden.

2.5 to 3.6 c.c. of plankton: Thompson, Allen, David, Maranacook, Torsey, and Sandy.

5.0 to 7.0 c.c. of plankton: Upper Range and Flying.

When the figures on average number and average volume of all bottom organisms per sample for each lake were treated as variants, and grouped according to the above classification on the abundance of plankton by volume, the following comparative figures were obtained:

Plankton: volume in c.c.	Number of lakes	Bottom fauna: Average volumes in c.c.			Bottom fauna: Average numbers		
		Mean	σ = S.D.	$P.E._{Mean}$	Mean	σ = S.D.	$P.E._{Mean}$
0.0–0.6	11	0.16	0.04	0.008	16.67	8.83	1.80
0.7–1.2	17	0.20	0.11	0.018	16.64	7.59	1.24
1.3–2.4	7	0.13	0.10	0.025	17.92	9.48	2.42
2.5–3.6	6	0.26	0.18	0.050	23.38	13.98	3.85
5.0–7.0	2	0.12	0.05	0.024	12.66	4.71	2.25

This comparison does not indicate any close correlation between plankton in the upper waters and either the average volumes or average numbers of bottom organisms. It is true that the averages of volumes and numbers of bottom organisms are quite variable between the different groups; but, in general, the differences between any two means are so small in comparison to the probable errors (not given, but may be readily computed from the above figures) of these differences, that the differences themselves have relatively little significance. Also the two lakes which yielded the most plankton, and the 11 which yielded the least, had volumes and numbers of bottom organisms between which the differences are of almost no significance. Actually, the two lakes richest in plankton had the fewest and smallest volume of organisms of any of the groups. The group second richest in plankton, however, had the greatest volume of bottom organisms; and this is the only indication among the data that those lakes which were richer in plankton were also richer in bottom fauna.

On the basis of both of the above comparisons it does not appear from our data that there was any marked correlation between the productivity of bottom fauna, and the productivity of plankton in the upper layers of water. It is recognized that the data available might be inadequate for such a comparison, and that a more detailed study of a few individual lakes, involving more thorough sampling at all seasons over a period of years, might give somewhat different results. However, the facts that the above comparison involves samples bunched during a short period, and involves a considerable number of lakes and ponds, tends, in the writer's opinion, to validate the results of the comparison to a considerable degree.

The extent to which the bottom fauna is utilized as food by fishes in these lakes is discussed in a later section of this report (see page 125). A practical application of these data on bottom organisms is made in connection with the formulation of a stocking policy for these lakes and ponds (see page 218).

FISHES OF THE LAKES AND PONDS

This account of the fish fauna of the present group of lakes has been based on collections made with gill nets and seines, and to some extent on the occurrence of small fishes in the stomachs of game species, and supplemented by information obtained from local Fish and Game Wardens.

Fishes were collected by two gill nets each of the same type, each 375 feet by 6 feet with five 75-foot sections of the following mesh sizes: 4, 2, 6, 3, and 5 inches stretched measure, or 2, 1, 3, 1½, and 2½ inches bar measure, and with the five units tied together in that order. These nets were set in 40 of the 53 lakes and ponds for a total of 86 individual sets representing 1,869¾ hours of netting effort. The number of net sets in individual lakes was somewhat in proportion to the size of the lakes. Only one set was made in the small ponds, while from two to four sets were made in the larger ponds, and 12 sets were made in Great Pond of the Belgrades. These net sets were made from June 15 to September 11. All but three of the 86 sets were made over night. Most sets were for from 19 to 24 hours,

the average for the 86 sets being 21.7 hours. Usually the nets were set in the morning, they were examined and the fish removed that evening, and the net was lifted and fish removed the following morning. (It has been our experience, during the past four summers of lake surveys in Maine, that these experimental gill nets catch many more fish during the night than they do during the daytime.) Most sets were at depths within the limits of 10 to 50 feet. In 56 of the 86 net sets the nets were set with at least part or all of the net deep enough (that is, below the thermocline) to catch cold-water fishes, or else were in the deepest part of the shallower ponds.

Seine collections were made with a variety of seines, varying from 10 to 50 feet in length and with mesh varying from Common Sense to one-fourth inch. Seine collections were made from 37 of the lakes and ponds and were confined almost entirely to pond waters and not to tributary streams. Seining was done entirely in the shallow water, from the shore out to a depth of four feet; and was done entirely during the daytime, and between the dates of June 20 and September 11. A total of 45 seine collections was made, representing a total of 25 hours of actual seining effort. The records of our seining collections do not include all individuals of some of the species which were collected; but the numbers recorded represent approximately the relative abundance of the different species.

Information on the distribution and abundance of game fishes was obtained from local Fish and Game Wardens, by distributing a general questionnaire to each warden who gave his opinion of the abundance of each species in each lake.

The fish fauna of these 53 lakes and ponds includes possibly 27 species representing 14 families. Of these 27 species, 22 were collected by gill nets or seines, and one (the fresh-water sculpin) was recovered only from the stomach of a White Perch; the four others included the Eel, Brown Trout, and Rainbow Trout which were reported by Wardens to be present, and the Chum Salmon which was planted recently in two of the lakes and probably is still present. The distribution of the 22 species taken by nets, and the type of net by which they were taken, are given in Table IX. Estimates of abundance of the different species, as based on survey collections, and the warden's estimates of abundance of different species, are given by lake in Table X.

The records of occurrence of fishes in the stomachs of game fishes are summarized in a later section of this report, but are listed here because they represent records of fish distribution. The species of fish containing other fish in their stomachs, and the kind and number of fish in these stomach contents, for each lake or pond, were as follows:

Stomachs of:	Fish in stomachs	Lake or pond; and number, in ( ), of fish in stomachs
White Perch	Smelt	Pocasset (1), Echo (62), Sand (1), Annabessacook (17), Maranacook (668), Long of Belgrades (3), and Great Pond (36).
" "	Fallfish	East of Belgrades (1).
" "	White Perch	Great (2), and Sandy (2).
" "	Yellow Perch	Androscoggin (1), Pocasset (6), Lovejoy (2), Torsey (46), Great (1), and East of Belgrades (3).
" "	Fresh-water Sculpin	Maranacook (1).
Yellow Perch	Smelt	Auburn (4).
" "	Common Sucker	Sabattus (1).
" "	Red-bellied Sunfish	Long of Belgrades (1).
" "	White Perch	Auburn (7), Snow (1), and Great (1).
" "	Yellow Perch	Auburn (1), Torsey (64), Great (1), and East of Belgrades (2).
Small-mouthed Bass	White Perch	Thompson (2), Wilson in Monmouth (2), Snow (5), Great (3), and North of Belgrades (1).
" "	Yellow Perch	Tripp (1), and North in Woodstock (4).
" "	Common Sunfish	Parker (1).
Common Pickerel	Smelt	Allen (2).
" "	Golden Shiner	Torsey (1), and Snow (1).
" "	White Perch	Sabattus (1), Taylor (1), Tripp (1), Webb (1), Snow (6), Great (8), and East of Belgrades (1).
" "	Yellow Perch	Taylor (1), Androscoggin (1), and Torsey (11).
Pike Perch	Smelt	Great (12).
" "	White Perch	Great (2).
Brook Trout	Smelt	Pleasant (38), and Great (1).
Togue or Lake Trout	Smelt	South (1), and Embden (3).
Land-locked Salmon	Smelt	Auburn (1), Great (21), and Embden (2).
" "	Yellow Perch	Auburn (1).
Chinook Salmon	Smelt	Great (9).

The fish fauna of this group of lakes as a whole is predominantly a game-fish, food-fish, predatory population, with 6 to 7 species of salmonids, 3 perches, 2 basses, and the pickerel, cusk, smelt, horned pout, and eel. The whitefish might also be included as a food fish, and the two sunfishes might be included as being predators to some extent. The fishes, whose principal value is as forage for the food and game species, include the Smelt and six other species of which only the Common Sucker, Golden Shiner, and Fallfish are very widespread and abundant. Of the food and game species, the White Perch, Yellow Perch, Small-mouthed Bass, and Pickerel greatly predominate in this group of lakes. These four "warm-water species" definitely predominate over the salmonids as indicated by our collections, in spite of continual past stockings of the latter. The Common Sunfish and Common Sucker are generally very widespread and abundant. The Horned Pout and Red-bellied Sunfish are fairly abundant, as also are the Golden Shiner and Fallfish among the minnows. The composition of the fish fauna of this group of lakes as a whole may be judged from a summary of the results of survey gill net and seine collections; the total number of each species of fish taken by the 86 individual gill net sets in 40 of the lakes, the number of each species from 37 lakes and ponds in 45 seine collections, and the number of individual lakes from which each species was recorded by these collections (includes records of a few fish picked up dead), were:

Kind of fish	Total number taken by gill nets	Total number in seine collections	Number of lakes: fish taken by gill net or seine*
Land-locked Salmon	7	1	5
Chinook Salmon	4	..	3
Brook Trout	13	..	4
Togue	10	..	3
White Perch	1,627	281	29
Yellow Perch	226	1,181	31
Small-mouthed Bass	66	82	31
Large-mouthed Bass	1	14	5
Common Pickerel	78	79	32
Pike Perch or Walleyed Pike	8	..	1
Whitefish	1	..	1
Cusk	6	..	3
Smelt	2	..	2
Horned Pout	95	198	19
Pumpkinseed or Common Sunfish	117	414	33
Red-bellied Sunfish	19	177	18
Sunfish hybrid *Lepomis gibbosus X L. auritus*	..	13	6
Common Sucker	388	694	32
Golden Shiner	73	799	21
Fallfish	7	344	14
Common Shiner	..	203	4
Black-nosed Dace	..	3	1
Banded Killfish	..	65	5

*Includes records of a few fish picked up dead.

The trouts and salmons were not encountered, in the 86 gill net sets, from so many separate lakes and ponds as might have been expected judging from the extensive recent plantings of these species. Plantings of salmonids had been made in 42 of the 53 lakes and ponds during the 7 years preceding the survey. Of these 42 lakes which had been stocked, gill nets were fished in 35; there were 79 individual net sets made during which the nets fished for a total of 1,738¾ hours; yet salmonids were collected from only 12 of these lakes and ponds. Also, the number of individual trout and salmon encountered in the net sets was not so great as might have been expected to result from the plantings, as only 34 salmonids were taken by the 1,738¾ hours of gill netting. The average annual stocking of salmonids in this group of lakes over the preceding 7 years was 640,000 fish; the total area of the lakes stocked is about 59,000 acres. The results obtained by gill net sets in the six Rangeley lakes during the summer of 1939 (Cooper, 1940) might be cited for comparison. These Rangeley lakes and their tributaries had been stocked during the preceding 6 years with an annual average of 720,000 salmonids; the total area of these lakes is about 38,000 acres. A similar type of gill net fished for a total of 1,145¾ hours took 280 salmonids; i.e., in the Rangeleys, the nets caught more than 10 times as many salmonids in a similar amount of fishing effort. From this comparison, it is concluded that the lakes and ponds studied by the present survey do not support nearly so large salmonid populations as do the Rangeleys, even though the two lake areas have been stocked at somewhat the same rate in proportion to their acreage.

The number of salmonids taken by gill nets during the 1940 survey was, in fact, so few as to make difficult any attempt to evaluate the stockings in the different lakes. Most of the salmonids (25 out of 34) which were collected were from lakes which, on the basis of suitability of the water (see page 66), are excellent trout and salmon lakes. Exceptions might be noted in the case of survey records of salmon and trout from Great Pond of the Belgrades, salmon from Webb and Cobbosseecontee, and trout from Snow Pond. Even in the better trout and salmon lakes, the net catches indicated small salmonid populations resulting from the extensive stocking — records for the 18 lakes and ponds found to have "excellent" or "good" water for trout and salmon (see page 66) might be cited. All of these 18 lakes had been stocked previously with salmonids; gill net sets were made in 15 of them — a total of 24 sets covering 520 hours of fishing; and these 520 hours of fishing yielded 25 salmonids, or only about one-fifth as many per comparable netting effort as were caught in the Rangeleys. Since so few salmonids were taken by the nets, the records do not offer a basis for a detailed comparison of the success of plantings of the different species. No Brown Trout or Rainbow Trout were obtained from the numerous lakes in which they had been

stocked, and no Chum Salmon were collected from the two lakes (Cobbosseecontee and Great Pond) where they were planted in 1938. Chinook Salmon were obtained from three of the 12 lakes in which they had been planted; the net records for Brook Trout, Togue, and Land-locked Salmon were similar. The records of plantings of the different species of salmonids in the lakes and ponds of the 1940 survey, and the survey net sets and catches of salmonids, are summarized, as follows:

Species	Number lakes planted*	Number lakes netted	Number individual net sets	Total hours of netting	Number lakes, fish caught	Total number fish
Brook Trout	29	23	55	1,219¾	4	13
Brown Trout	12	11	17	379	0	0
Rainbow Trout	10	9	15	343½	0	0
Togue	12	10	30	667¼	3	10
Land-locked Salmon	16	12	39	882	5	7
Chinook Salmon	12	11	34	757¼	3	4
Chum Salmon	2	2	15	352½	0	0
Some type of salmonid	42	35	79	1,738¾	12	34

*Includes tributaries for togue and the three salmons.

The species of fishes, and their numbers, taken by seines, and as listed previously, represent the fish fauna of the shore shallows. This fauna included the young of the warm-water game species, plus horned pout, sunfishes, suckers, and several species of minnows. The absence of young salmonids in our seining collections indicates their general absence in lake shallows, and emphasizes the importance of planting fry and fingerling trouts and salmons (except togue) in the tributary streams — the single fingerling salmon taken by seine was from the mouth of a tributary of Webb Lake. Since many of the present series of lakes and ponds are best adapted for production of the warm-water game fishes, and since the Small-mouthed Bass is one of the most important of these warm-water species in southern Maine, the success of natural reproduction of the Small-mouth is of considerable importance to fishing. The number of young bass encountered by our seining in the lake shallows was small. From survey collections and reports by local wardens, it is known that the Small-mouthed Bass occurs in 48 of the 53 lakes and ponds. Of these 48 lakes, seining collections were made in 35, for a total of 23¾ hours of actual seining effort. This seining took 82 Small-mouthed Bass which were mostly fry and fingerlings, or 3.5 bass per hour of seining effort. This indicated an even smaller population of young bass in these lakes of the Androscoggin and Kennebec drainages than was found in lakes and ponds of the Saco River and Sebago Lake drainages in 1938 (Cooper, 1939b), where comparable seining took 7 bass

TABLE IX. The distribution of fishes in the lakes and ponds as determined by survey collections with gill nets (G), seines (S), or both gill nets and seines (GS)

Name of pond	Pond number*	Type of gear**	Land-locked Salmon *Salmo sebago*	Chinook Salmon *Oncorhynchus tshawytscha*	Brook Trout *Salvelinus f. fontinalis*	Togue *Cristivomer namaycush*	White Perch *Morone americana*	Yellow Perch *Perca flavescens*	Pike Perch *Stizostedion vitreum*	Small-mouthed Bass *Micropterus dolomieu*	Large-mouthed Bass *Huro salmoides*	Common Pickerel *Esox niger*	Whitefish *Coregonus clupeaformis*	Cusk *Lota maculosa*	Smelt *Osmerus mordax*	Horned Pout *Ameiurus n. nebulosus*	Pumpkinseed Sunfish *Lepomis gibbosus*	Red-bellied Sunfish *Lepomis auritus*	Hybrid sunfish *L. gibbosus X L. auritus*	Common Sucker *Catostomus c. commersonnii*	Golden Shiner *Notemigonus c. crysoleucas*	Fallfish *Leucosomus corporalis*	Black-nosed Dace *Rhinichthys a. atratulus*	Common Shiner *Notropis c. cornutus*	Banded Killifish *Fundulus d. diaphanus*
Sabattus Pond	389	GS	..	..	..	..	GS	G	..	G	..	GS	..	..	..	GS	..	..	..	G	..	S	..	..	..
Taylor Pond	392	G	..	..	..	..	G	..	..	..	..	G	..	..	..	..	..	..	..	G	G	..	..	..	..
Lower Range Pond	398	S	..	..	..	..	S	..	..	..	..	S	..	..	..	..	S	..	..	..	S	..	..	..	..
Middle Range Pond	400	GS	..	..	..	..	..	..	..	S	..	S	..	..	..	..	..	S	..	..	..	..	..	..	..
Upper Range Pond	401	GS	..	..	..	..	..	..	..	S	..	S	..	..	..	..	S	..	S	G	S	..	..	..	..
Hogan Pond	403	S	..	..	..	..	..	S	..	..	..	..	..	..	..	..	..	..	..	S	..	S	..	..	..
Whitney Pond	404	GS	..	..	..	..	GS	S	..	..	..	..	..	..	..	..	S	..	..	G	..	..	..	..	..
Tripp Pond	408	GS	..	..	..	..	GS	S	..	G	..	GS	..	..	..	S	S	S	..	G	S	G	..	..	..
Thompson Lake	409	GS	..	..	..	..	..	GS	..	G	..	S	..	G	..	..	S	..	..	GS	..	S	..	..	..
Pennesseewassee Lake	416	G	..	..	..	..	G	G	..	G	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Twitchell Pond	425	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bryant Pond	427	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Auburn Lake	428	GS	G	..	..	..	GS	GS	..	..	..	S	..	..	..	..	S	S	..	G	S	..	..	..	S
Allen Pond	437	GS	..	..	..	..	..	G	..	S	..	GS	..	..	..	..	S	S	..	..	S	..	..	..	..
Pleasant Pond	443	GS	..	..	G	..	..	S	..	GS	..	S	..	..	..	..	S	S	S	..	S	..	..	..	..
Androscoggin Lake	464	G	..	..	..	..	G	G	..	..	..	G	..	..	..	G	G	..	..	G	G	..	..	..	..
Pocasset Lake	466	GS	..	..	..	..	G	GS	..	G	S	GS	..	..	..	G	G	..	..	G	S	S	..	..	..
Lovejoy Pond	470	GS	..	..	..	..	G	..	..	..	S	..	..	..	..	..	..	..	..	G	..	S	..	..	..
Echo Lake	472	GS	..	..	..	..	GS	S	..	S	S	S	..	..	..	..	S	..	S	GS	S	S	..	S	..
Parker Pond	474	GS	..	..	..	..	..	S	..	GS	..	..	..	G	..	..	S	..	S	G	..	..	..	..	..
David Pond	476	GS	..	..	..	..	..	S	..	GS	GS	G	..	..	..	..	GS	GS	..	G	..	..	..	..	..
Tilton Pond	478	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Flying Pond	481	GS	..	..	..	..	..	GS	..	G	..	S	..	G	..	GS	S	S	..	G	S	GS	..	S	..
Worthley Pond	499	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Webb Lake	503	GS	GS	..	..	..	G	..	..	G	..	GS	..	..	..	S	..	G	..	GS	S	S	..	S	..
Silver Lake	515	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Garland Pond	516	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
North Pond	521	G	..	..	..	..	..	G	..	G	..	G	..	..	..	..	..	..	..	..	..	..	..	..	..
South Pond	522	G	..	..	..	G	G	..	..	G	..	..	G	..	..	G	G	G	..	G	..	..	..	..	..
Purgatory Pond	659	GS	..	..	..	..	G	S	..	..	..	S	..	..	..	GS	S	S	..	..	S	..	..	..	..
Sand Pond	660	GS	G	..	..	..	G	S	..	GS	..	S	..	..	..	S	S	S	..	G	..	..	..	..	..
Cobbosseecontee Lake	668	GS	..	G	..	..	G	GS	..	GS	..	GS	..	..	..	GS	GS	GS	S	G	S	..	..	..	S
Annabessacook Lake	671	GS	..	..	..	..	G	S	..	S	..	S	..	..	..	G	S	S	..	G	..	..	..	..	..
Cochnewagan Pond	672	GS	..	..	..	..	GS	GS	..	S	..	..	..	..	..	G	S	S	S	G	..	..	..	..	..
Wilson Pond	673	GS	..	..	..	..	GS	GS	..	GS	..	G	..	..	..	..	S	S	..	G	S	..	..	..	..
Dexter Pond	674	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Berry Pond	675	S	..	..	..	..	S	S	..	..	..	S	..	..	..	..	S	..	..	..	..	..	..	..	..
Maranacook Lake	676	GS	..	..	..	..	G	G	..	GS	..	GS	..	..	..	G	GS	GS	..	G	G	..	..	..	S
Torsey Pond	678	GS	..	..	..	..	G	GS	..	..	..	GS	..	..	..	GS	GS	S	..	G	GS	..	..	..	..
Narrows Pond South Part	681	GS	..	..	..	G	..	..	..	S	..	..	..	..	..	..	S	S	..	..	..	S	..	..	..
North Part	682	GS	..	G	..	..	..	S	..	S	..	..	..	..	..	..	S	..	..	..	S	..	..	..	S
Snow Pond	698	GS	..	..	G	..	GS	G	..	GS	..	G	..	..	G	G	GS	..	..	G	G	S	..	..	..

TABLE IX. The distribution of fishes in the lakes and ponds — Concluded

Name of pond	Pond number*	Type of gear**	Land-locked Salmon *Salmo sebago*	Chinook Salmon *Oncorhynchus tshawytscha*	Brook Trout *Salvelinus f. fontinalis*	Togue *Cristivomer namaycush*	White Perch *Morone americana*	Yellow Perch *Perca flavescens*	Pike Perch *Stizostedion vitreum*	Small-mouthed Bass *Micropterus dolomieu*	Large-mouthed Bass *Huro salmoides*	Common Pickerel *Esox niger*	Whitefish *Coregonus clupeaformis*	Cusk *Lota maculosa*	Smelt *Osmerus mordax*	Horned Pout *Ameiurus n. nebulosus*	Pumpkinseed Sunfish *Lepomis gibbosus*	Red-bellied Sunfish *Lepomis auritus*	Hybrid sunfish *L. gibbosus X L. auritus*	Common Sucker *Catostomus c. commersonnii*	Golden Shiner *Notemigonus c. crysoleucas*	Fallfish *Leucosomus corporalis*	Black-nosed Dace *Rhinichthys a. atratulus*	Common Shiner *Notropis c. cornutus*	Banded Killifish *Fundulus d. diaphanus*
Long of Belgrades South Part	712	GS	..	..	..	..	G	..	..	S	S	G	..	..	G	G	S	..	..	G	..	..	..	..	..
North Part	713	GS	..	..	G	..	G	G	..	..	..	G	..	..	..	G	GS	..	..	G	..	..	..	..	..
Great Pond of Belgrades	719	GS	G	G	G	..	GS	GS	G	G	..	G	..	..	..	GS	GS	..	..	GS	GS	GS	..	..	..
North Pond of Belgrades	720	GS	..	..	..	..	GS	GS	..	GS	..	G	..	..	..	..	GS	..	..	GS	S	GS	..	..	S
East Pond of Belgrades	724	G	..	..	..	..	G	G	..	G	..	G	..	..	..	G	G	..	..	G	..	..	..	..	..
Salmon Lake	725	GS	..	..	..	..	..	..	..	S	..	..	..	..	..	..	S	..	..	G	..	..	..	..	..
McGrath Pond	726	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Clearwater Pond	815	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wilson Pond	833	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Sandy Pond	883	GS	..	..	..	..	G	..	..	..	..	S	..	..	..	..	..	..	..	..	..	..	..	..	..
Embden Pond	887	GS	G	..	..	G	..	..	..	GS	..	..	..	..	..	..	..	..	..	GS	..	S	S	S	..

*Ponds numbered 389 to 522 are in the Androscoggin River Drainage; ponds 659 to 887 are in the Kennebec
**G indicates gill net; S indicates seines; GS, both gill net and seines.
These symbols under each species indicate that the species was collected by that type of gear.

fry and fingerlings per hour of seining effort. We found adult Small-mouthed Bass heavily parasitized with the bass tapeworm in 8 lakes (see Table XVI); seining in 7 of these 8 lakes produced about as many (3.3) young bass per hour as did seining in lakes where we found no bass tapeworms. However, our data are inadequate to indicate a possible relationship between extent of this parasitism and the abundance of young bass, for too few young bass were collected.

Further notes on the distribution and abundance of the fishes known to occur in the lakes and ponds of the present survey are given in the following annotated list:

Family **Osmeridae,** Smelts

Smelt (*Osmerus mordax*). Smelts were taken by our gill nets from only two ponds, i.e., Snow and Long. None were taken by seining. Several dead smelts were picked up on the east shore of Great Pond, and specimens of smelts from Wilson Pond in Monmouth and South Pond in Greenwood were obtained from local fishermen. Our failure to take smelts by either gill net or seine should not be construed to indicate an absence of this fish, for smelts are mostly too small to be taken by the gill net which was used, and they apparently do not frequent the shallow shore waters of lakes and ponds in the summer time to any great extent. Our best source of records of the occurrence of smelts was from the stomach contents of game fishes. Smelts were so taken from Brook Trout, Togue, Land-locked Salmon, Chinook Salmon, Common Pickerel, White Perch, Yellow Perch, and Walleyed Pike. Records of occurrence of smelt in these fish were from the following lakes and ponds: Auburn, Allen, Pleasant, Pocasset, Echo, South in Greenwood, Sand, Annabessacook, Maranacook, Long of Belgrades, Great, and Embden. Most smelts so obtained were from Maranacook, Great, Echo, Annabessacook, Auburn, and Pleasant; a very few were from Allen, Pocasset, and Sand. The record for Sand Pond suggests that the species is at least still present even though believed by local wardens (Table X) to be absent. Reports by the local Fish and Game Wardens indicated that smelts are present in the majority of the lakes and ponds of the area.

The lakes of the present survey are the center of considerable interest in connection with different types of smelts. There are distinct populations of at least two sizes of smelts: a large race and a small race. In addition, two distinct forms of smelts have been described from lakes of the area. The native smelt of Wilton Pond (or Wilson Pond) in Wilton was described as *Osmerus spectrum*, a species different from our common form, by Cope in 1870. A second distinct type of smelt, *Osmerus abbotti*, was also described by Cope in 1870 from Cobessicontic Lake (Cobbosseecontee Lake). Kendall (1914) lists several localities of *O. abbotti* in addition to Cobbosseecontee Lake, namely: ponds in Monmouth, Cochnewagan Pond, Sabattus Pond, Winthrop (Pond?), and Moose Pond and the Sebasticook River (its outlet). These two supposedly different types of Maine smelts, *spectrum* and *abbotti*, are listed by Jordan, Evermann, and Clark (1930) as subspecies of the typical and widespread (in Maine) *Osmerus mordax*.

Family **Coregonidae**, Whitefishes

Whitefish (*Coregonus clupeaformis*). Our only record of Whitefish was a single fish (see Plate I-B) taken from South Pond in Greenwood by gill net on September 5, 1940. Local residents reported that the species is common in this pond. A warden report indicates that the species might also be present in Thompson Lake.

Family **Salmonidae**, Trouts and salmons

Chum or Dog Salmon (*Oncorhynchus keta*). According to the Fish and Game Department's records, 119,000 fingerling Chum Salmon were planted in Cobbosseecontee Lake in August, 1938; and 31,000 fingerlings were planted in tributaries of this lake during June and July, 1938. Also, 16,000 were planted in a tributary of Great Pond of Belgrades in July, 1938. By the summer of 1940 these fish should have reached a size sufficient to be caught by gill nets, but none were so taken. Presumably the plantings in Cobbosseecontee were on a large enough scale to give successful results, if the species were well adapted to the lake.

Chinook or King Salmon (*Oncorhynchus tshawytscha*). Chinook Salmon have been planted in many lakes in southern Maine during the past 10 years. During the past seven years they have been planted in 12 of the 53 lakes and ponds studied by the survey, mostly in the larger waters. Such plantings have been made most heavily in Cobbosseecontee Lake and Great Pond, both of which have produced some Chinook Salmon fishing. In some, if not all, of these lakes where the species has been planted, the Chinook Salmon is reaching maturity while being confined entirely to fresh water. Most of these lakes have screens at their outlets, or else there are impassable dams between the lakes and the ocean; thus, while the salmon smolts might be able to reach the ocean, in most instances the adult salmon could not get back into these lakes. Fully adult Chinook Salmon were taken by our nets, and have been commonly taken by fishermen from many lakes in Maine. These salmon are not only growing to maturity in our fresh-water lakes, but are attempting, in some instances at least, to spawn in tributaries or the outlets of some of the lakes. In the fall of 1937, for example, a spawning run of adult Chinooks from Cobbosseecontee Lake appeared in the outlet, in the

first one-fourth mile of the stream down to a permanent fish screen. The writer visited this section of the stream on October 15, 1937, and collected 18 dead adult Chinook Salmon (10 males and 8 females) which were spent fish, and also one immature Chinook which was found dead. There were about 8 live adults still in the stream, some of which were females still digging their redds. Local residents reported that these Chinooks came into the outlet several weeks before they commenced to die, and that about 60 of these fish had died during the first two weeks of October. All available evidence indicated that attempts of the fish to spawn had been successful. There were several mounds of freshly washed gravel in the stream, which appeared to be salmon redds; the eight adult females found on October 15 were all spent, but each contained a few ripe eggs which had not been spawned but which indicated maturity; and these same eight females all showed evidence of having dug their nests in that the tail fin and the skin and scales from the under side of the tail end of the body were badly worn. The success of this natural reproduction is not known. In the writer's opinion, the Chinook spawning in this section of the outlet was not a fair test of the possibility of success of natural reproduction of the species in Maine waters. There was only a very limited spawning area available; and it appeared probable that the nests of most of the early spawners had been dug up by the late spawners, for approximately 30 females had spawned in a region where spawning grounds were available for less than 10 fish. Examination of the scales of the 19 Chinooks, which were found dead on October 15, showed that all of the spawning males were five years old, and that most of the spawning females were four years old. The 18 adult fish were from young of 1933 and 1934, during which years plantings of Chinooks in Cobbosseecontee Lake were 76,000 and 80,000 fingerlings, respectively, and in tributaries of the lake, 56,000 fingerlings and 100,000 fry, respectively. The scales further revealed that rapid growth, presumably in the lake, started the second year, and that the rate of growth increased with age. The individual lengths and ages of these 18 adult, and one immature, chinooks from Cobbossee Stream on October 15, 1937, were as follows:

Sex	Body length: inches	Total* length: inches	Age: completed summers	Young of year:
Female	19	?	IV	1934
"	19¾	?	"	"
"	20½	?	"	"
"	21¼	?	"	"
"	21½	?	"	"
"	21¾	?	"	"
"	21¼	?	V	1933
"	23	?	"	"
Male	20¾	23¾	V	1933
"	21½	24½	"	"
"	21½	25	"	"
"	22	25	"	"
"	22	25	"	"
"	22¼	25½	"	"
"	22¼	25½	"	"
"	22½	25¾	"	"
"	22½	25¾	"	"
"	23	26½	"	"
Sex?	9¼	?	II	1936

*Total lengths of females were not taken, because the tails were partly worn away.

Land-locked Salmon (*Salmo sebago*). The Land-locked Salmon was not native to any of the present group of lakes and ponds of the Androscoggin and Kennebec river drainages. For many years, however, the species has been widely distributed, by fish cultural operations, in lakes of southern Maine and including the present group of lakes. The State Fish and Game Department has planted the species, during the past seven years, in 16 of these lakes and ponds, mostly in the larger and deeper ones. Land-locked Salmon were taken by gill nets from Auburn, Webb, Sand, Great, and Embden ponds, and reports by local wardens indicated that the species occurs in several other lakes of the area.

Brown Trout (*Salmo trutta*). The Brown Trout has been planted in 12 of the lakes and ponds and in many tributary streams in the area during the past seven years. These plantings have been mostly in the lakes of the Androscoggin Watershed, and the heaviest plantings have been made in Androscoggin and Cobbosseecontee lakes, and Taylor, Flying, and Cochnewagan ponds. No Brown Trout were taken by the several gill net sets in these lakes.

Rainbow Trout (*Salmo gairdnerii irideus*). The Rainbow Trout has been planted in 10 of the present group of lakes and ponds, most heavily in Cobbosseecontee Lake and in North and East ponds of the Belgrade chain. None were taken by our nets.

Togue or Lake Trout (*Cristivomer n. namaycush*). The Togue or Lake Trout had been planted in 12 of these lakes and ponds. Our soundings and water analyses revealed that almost all of these waters in which Togue had been planted are excellent Togue lakes. Our gill nets took Togue from South, Narrows, and Embden ponds, and several other lakes in the area are known to be good Togue waters.

Brook Trout or "Square-tail" (*Salvelinus f. fontinalis*). Of all of the salmonids, the Brook Trout has been planted in the greatest numbers and among the greatest number of ponds of the area. During the preceding seven years the species had been planted in 29 of the lakes, and extensively in the streams of this area. We obtained trout by gill net from Pleasant, Snow, Long, and Great ponds.

Family **Catostomidae,** Suckers

Common Sucker (*Catostomus c. commersonnii*). The Common Sucker is one of the most abundant and widely distributed fish in the area. It was taken by nets in 32 lakes, and wardens reported it to be present in all of the waters with the possible exception of Berry, Sandy, and Embden ponds. The species was taken by net from Embden Pond, and it seems probable that it is present in all of these lakes. The Common Sucker is apparently even more widespread in its distribution in this area than is the White Perch; and it is second in abundance only to the White Perch. Suckers from one to two pounds in weight, and sometimes more, were taken from most of the lakes.

Family **Cyprinidae,** Minnows

Black-nosed Dace (*Rhinichthys a. atratulus*). This is typically a stream fish. It was taken only from Embden Pond by seine. It is possibly more widespread in the streams of the area.

Fallfish (*Leucosomus corporalis*). The Fallfish was taken commonly by seines and occasionally by gill nets from 14 of the lakes and ponds. Several of those taken by gill nets were from one to two pounds in weight. According to our records, it is the second most abundant species of minnow in the lakes of this area.

Common Shiner (*Notropis c. cornutus*). This species is usually more abundant in streams than in lakes. It was taken by seines from four lakes.

Golden Shiner (*Notemigonus c. crysoleucas*). The Golden Shiner was found to be the most abundant and widespread species of minnow in lakes of this area. It is more typically a lake or pond fish. Individuals up to 10 inches long were taken by gill nets from six of the lakes.

TABLE X. The distribution and abundance of fishes in the lakes and ponds as reported by local State Fish and Game Wardens,* and as estimated from survey collections

The wardens reported the separate species as: abundant (AB), common (C), rare (R), or known to be absent (.). A ? indicates that the warden was not certain whether or not the species was present; a ? following an estimate of abundance indicates that the warden was in doubt concerning that estimate of abundance. An indication that a species was absent, as based on the survey collections (Sur), means only that the species was not taken by our collecting with gill nets and seines. For pond numbers, see Table I

Name of lake or pond	Reported by*	Land-locked Salmon	Chinook Salmon	Chum Salmon	Brook Trout	Brown Trout	Rainbow Trout	Togue (Lake Trout)	White Perch	Yellow Perch	Pike Perch	Small-mouthed Bass	Large-mouthed Bass	Common Pickerel	Whitefish	Cusk	Smelt	Horned Pout	Eel	Sunfish	Sucker	Minnows (several species)
Sabattus	K	.	.	.	R	.	.	.	AB	AB	.	AB	.	C	.	.	C	AB	AB	AB	AB	AB
	P	R	.	.	.	.	.	.	AB	AB	.	AB	.	R	.	.	C	AB	C	AB	C	AB
	Sur	.	.	.	.	.	.	.	AB	C	.	R	.	C	.	.	.	C	.	.	.	R
Taylor	K	.	.	.	R	R	.	.	AB	AB	.	R	.	C	.	.	.?	AB	C	AB	AB	AB
	P	.	.	.	.	R	.	.	AB	AB	.	.	.	C	.	.	R	C	.	AB	C	C
	Sur	.	.	.	.	.	.	.	R	.	.	.	.	AB	.	.	.	.	.	.	AB	R
Lower Range	P	R	.	.	R	R	.	R	AB	AB	.	C	.	R	.	.	.	AB	C	AB	C	C
	Sur	.	.	.	.	.	.	.	R	.	.	.	.	R	.	.	.	.	.	C	.	C
Middle Range	W	R	.	.	.	.	.	C	AB	AB	.	C	.	C	.	.	C	AB	C	AB	AB	C
	Sur	.	.	.	.	.	.	.	.	.	.	R	.	R	.	.	.	.	.	C	.	.
Upper Range	Kw	.	.	.	R	.	.	R	AB	AB	.	C	.	C	.	.	C	C	C	AB	AB	AB
	W	.	.	.	.?	.	.	.	AB	AB	.	C	.	C	.	.	C	AB	C	AB	AB	C
	Sur	.	.	.	.	.	.	.	.	.	.	C	.	R	.	.	.	.	.	AB	C	AB
Hogan	W	.	.	.	.	.	.	.	AB	AB	.	C	.	C	.	.	.	AB	C	AB	AB	C
	B	.	.	.	R	.	.	.	R	C	.	C	.	C	.	.	.	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	AB	C
Whitney	W	.	.	.	.	.	.	.	AB	AB	.	C	.	C	.	.	R	AB	C	AB	AB	C
	B	.	.	.	R	C?	.	.	R	C	.	C	.	C	.	.	R	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	C	R	.	.	.	.	.	.	.	.	.	R	C	.
Tripp	W	.	.	.	.	.	.	.	AB	AB	.	C	.	C	.	C	C	AB	C	AB	AB	C
	B	.	.	.	R	.	.	.	AB	C	.	C	.	C	.	.	C	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	C	.	.	R	.	C	.	.	.	.	.	C	C	R
Thompson	W	C	.	.	.	.	.	AB	.	AB	.	C	.	C	.	C	C	AB	C	AB	AB'	C
	B	C	.	.	R	.	.	C	R	R	.	C	.	C	R	C	C	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	.	AB	.	C	.	C	.	C	.	.	.	C	AB	C
Pennesseewassee	W	.	R	.	R	.	.	.	AB	AB	.	AB	.	C	.	.	C	AB	C	AB	AB	C
	B	R	C?	.	C?	R	.	.	C	C	.	C	.	C	.	R	R	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	R	C	.	C	.	.	.	.	.	.	.	.	.	.
Twitchell	F	R	R	.	R	.	.	.	.	C	.	AB	.	R	.	.	C	C	C	C	C	R
	B	C?	C?	.	C?	.	.	.	.	C	.	C	.	C	.	.	R	C	C	C	C	C
	W	.	R	.	.	R	.	.	C	AB	.	C	.	C	.	.	R	AB	C	AB	AB	R
Bryant	F	R	.	.	C	R	.	.	.	R	.	C	.	C	.	.	C	C	C	C	.	R
	B	.	.	.	C	C?	.	.	.	R	.	R	.	C	.	.	AB	C	C	C	C	C
	W	.	.	.	C	.	.	.	C	.	.	C	.	R	.	.	C	C	C	.?	AB	R
Auburn	K	R	C	.	R	R	.	.	AB	AB	.	R	.	C	.	.	AB	AB	AB	AB	AB	AB
	P	C	C	.	R	R	R	.	AB	AB	.	.	.	R	.	.	C	C	C	AB	C	AB
	Sur	C	.	.	.	.	.	.	AB	AB	.	.	.	R	.	.	.	.	.	C	C	AB
Allen	K	R	.	.	R	.	.	.	R	AB	.	AB	.	C	.	.	.?	AB	AB	AB	AB	AB
	P	.	.	.	R	.	.	.	.	R	.	C	.	R	.	.	.	C	R	C	C	C
	Sur	.	.	.	.	.	.	.	.	C	.	C	.	C	.	.	.	.	.	C	.	C
Pleasant	P	.	R	.	AB	.	.	.	.?	.	.	C	.	R	.	.	R	.	C?	C	C	C
	Sur	.	.	.	AB	.	.	.	.	C	.	C	.	R	.	.	.	.	.	C	.	C
Androscoggin	P	R	R	.	C	C	R	.	AB	AB	.	C	.	C	.	C	C	AB	C	AB	AB	AB
	Sur	.	.	.	.	.	.	.	AB	R	.	.	.	C	.	.	.	AB	.	C	AB	C
Pocasset	P	.	.	.	C	R?	R?	.	AB	AB	.	C	C	R	.	.	.	C	C	AB	C	C
	Sur	.	.	.	.	.	.	.	AB	C	.	R	C	C	.	.	.	R	.	C	C	C
Lovejoy	P	.	.	.	.	.	.	.	AB	AB	.	C	C	R	.	.	.	AB	AB	AB	AB	AB
	Sur	.	.	.	.	.	.	.	AB	.	.	.	R	.	.	.	.	.	.	.	AB	AB
Echo	L	R	.	.	R	R	R	C	C	AB	.	C	C	C	.	C	C	.?	C	C	C	AB
	P	.	.	.	R	.	.	C	AB	AB	.	C	C	R	.	C	R	AB	C	C	C	C
	Sur	.	.	.	.	.	.	.	AB	C	.	C	C	R	.	.	.	.	.	C	AB	AB
Parker	L	R	.	.	.	.	.	.	.	R	.	AB	R	C	.	C	AB	C	.?	C	C	C
	P	R	.	.	.	.	.	.	.	R	.	AB	C	R	.	R	C	R	.?	R	C	R
	Sur	.	.	.	.	.	.	.	.	C	.	C	.	.	.	R	.	.	.	C	C	.
David	L	.	.	.	.	.	.	.	.	C	.	C	C	C	.	.?	.	C	.?	C	C	C
	P	.	.	.	.	.	.	.	.	R	.	AB	C	R	.	R	C	R	.?	R	C	R
	Sur	.	.	.	.	.	.	.	.	R	.	C	C	AB	.	.	.	.	.	AB	C	.
Tilton	L	.	.	.	.	.	.	.	.	.	.	R?	.	C	.	.	.	C	R	C	C	R
	P	.	.	.	.	.	.	.	.	R	.	.	.	R	.	.	.	C	C	R	.?	R
Flying	L	R	.	.	R	R	R	C	.	R	.	C	.?	C	.	C	AB	C	R	R	AB	AB
	P	.	.	.	R	.?	.?	C	.	R	.	C	.	R	.	C	C	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	.	C	.	C	.	C	.	R	.	C	.	AB	AB	AB
Worthley	C	R	.	.	R	R	.	R	.	C	.	C	.	R	.	.	C	C	.	.	C	C

TABLE X. The distribution and abundance of fishes in the lakes and ponds — Continued

Name of lake or pond	Reported by*	Land-locked Salmon	Chinook Salmon	Chum Salmon	Brook Trout	Brown Trout	Rainbow Trout	Togue (Lake Trout)	White Perch	Yellow Perch	Pike Perch	Small-mouthed Bass	Large-mouthed Bass	Common Pickerel	Whitefish	Cusk	Smelt	Horned Pout	Eel	Sunfish	Sucker	Minnows (several species)
Webb	Co	C	R	.	R	.	.	.	AB	.	.	AB	.	AB	.	.	R	C	R	AB	AB	R
	Sur	R	.	.	.	.	.	.	AB	.	.	AB	.	AB	.	.	.	R	.	R	AB	C
Silver	Co	.	.	.	.	.	.	.	AB	AB	.	AB	.	AB	.	.	.	C	.	AB	AB	.
Garland	Co	.	.	.	AB	.	.	.	.	.	.	.	.	.	.	.	AB	.	.	R	C	C
North (P. 521)	W	.	.	.	.	.	.	.	R	AB	.	C	.	C	.	.	.	AB	C	AB	AB	C
	B	.	.	.	C?	.	.	.	R	C	.	R	.	C	.	.	C	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	.	AB	.	C	.	R	.	.	.	.	.	.	.	.
South	F	.	.	.	.	.	.	C	.	C	.	C	.	C	C	.	C	C	C	C	C	R
	B	C?	.	.	R	.	.	C	.	C	.	R	.	C	R	R	C	C	C	C	C	C
	W	?	.	.	.	.	.	C	R	C	.	C	.	R	C	.	R	C	C	AB	AB	R
	Sur	.	.	.	.	.	.	C	R	.	.	R	.	.	R	.	.	C	.	C	C	.
Purgatory	K	.	.	.	R	C	R	.	AB	AB	.	AB	.	AB	.	.	.	C	AB	AB	AB	AB
	P	.	.	.	R	R	R	.	AB	AB	.	C	.	C	.	.	.	C	AB	AB	AB	AB
	Sur	.	.	.	.	.	.	.	R	C	.	.	.	C	.	.	.	C	.	AB	.	AB
Sand	K	.	.	.	R	C	R	.	AB	AB	.	AB	.	AB	.	.	.	C	AB	AB	AB	AB
	P	.	.	.	R	R	R	.	AB	AB	.	C	.	C	.	.	.	C	AB	AB	AB	AB
	Sur	R	.	.	.	.	.	.	R	C	.	C	.	C	.	.	.	R	.	AB	C	.
Cobbosseecontee	H	R	R	.	.	.	R	?	AB	AB	.	C	?	C	.	.	R	AB	C	AB	AB	C
	P	C	C	.	R	.	.	.	AB	AB	.	C	.	C	.	.	R	C	C	AB	AB	AB
	Sur	.	R	.	.	.	.	.	C	C	.	C	.	C	.	.	.	AB	.	AB	AB	C
Annabessacook	H	.	.	.	R	.	.	.	AB	C	.	C	?	C	.	.	?	C	R	C	C	C
	P	.	.	.	R	R	R	.	AB	AB	.	C	.	C	.	.	R	C	C	AB	AB	AB
	Sur	.	.	.	.	.	.	.	AB	R	.	R	.	R	.	.	.	R	.	AB	AB	.
Cochnewagan	K	.	.	.	R	R	.	.	AB	AB	.	AB	?	C	.	.	AB	AB	AB	AB	AB	AB
	P	.	.	.	R	.	.	.	AB	AB	.	C	.	C	.	R?	C	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	AB	C	.	C	.	.	.	.	.	R	.	AB	C	.
Wilson (P.673)	P	.	.	.	.	.	.	.	AB	AB	.	C	.	R	.	.	.	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	AB	C	.	C	.	R	.	.	.	.	.	C	C	C
Dexter	P	.	.	.	.	.	.	.	AB	AB	.	C	.	R	.	.	.	C	C	C	C	C
Berry	P	?	?	.	?	.	.	.	?	?	.	?	?	?	?	?	?	?	?	?	?	?
	Sur	.	.	.	.	.	.	.	R	R	.	.	.	R	.	.	.	.	.	C	.	.
Maranacook	H	.	.	.	AB	.	.	.	AB	C	.	C	.	C	.	.	C	AB	?	AB	C	C
	P	R	.	.	AB	.	.	.	AB	AB	.	C	R	C	.	R	R	AB	C	C	C	C
	Sur	.	.	.	.	.	.	.	AB	C	.	C	.	C	.	.	.	AB	.	AB	C	C
Torsey	L	.	.	.	?	.	.	.	R	AB	.	AB	.	AB	.	.	.	AB	C	AB	C	AB
	P	.	.	.	.	.	.	.	R	AB	.	C	R	C	.	.	.	AB	C	AB	C	C
	Sur	.	.	.	.	.	.	.	R	AB	.	.	.	AB	.	.	.	AB	.	AB	C	AB
Narrows South Part	H	R	R	.	R	.	.	C	C	R	.	C	.	R	.	.	AB	R?	R?	C	R?	C
	P	.	.	.	.	.	.	C	?	C	.	C	?	C	.	C	.	C	C	C	C	C
	Sur	.	.	.	.	.	.	C	.	.	.	R	.	.	.	.	.	.	.	AB	.	C
North Part	H	R	R	.	R	.	.	C	C	R	.	R	.	R	.	.	AB	R?	R?	C	R?	C
	P	.	.	.	.	.	.	C	?	C	.	C	?	C	.	C	.	C	C	C	C	C
	Sur	.	R	.	.	.	.	.	.	R	.	R	.	.	.	.	.	.	.	AB	.	C
Snow	L	C	C	.	C	R	.	.	AB	AB	?	AB	AB	AB	.	R	C	C	?	AB	AB	C
	P	R?	R	.	C	.	.	.	AB	AB	.	AB	AB	C	.	R	C	AB	C	C	C	C
	Sur	.	.	.	R	.	.	.	AB	AB	.	AB	.	AB	.	.	R	R	.	C	C	C
Long of Belgrades South Part	L	R	R	.	C	?	?	.	AB	AB	R?	AB	C	C	.	?	R	R	?	C	C	R
	P	C	C	.	C	?	?	.	C	AB	?	C	C?	C	.	?	R	.	C	C	C	C
	Sur	.	.	.	.	.	.	.	C	AB	.	C	R	C	.	.	R	R	.	R	R	.
North Part	L	R	R	.	C	?	?	.	AB	AB	R?	AB	C	C	.	?	R	R	?	C	C	R
	P	C	C	.	C	?	?	.	C	AB	.	C	C?	C	.	.	R	.	C	C	C	C
	Sur	.	.	.	R	.	.	.	C	AB	.	.	.	R	.	.	.	R	.	C	R	.
Great of Belgrades	L	R	R	.	R	.	.	.	AB	AB	C	C	.	R	.	.	R	R	C	R	C	R
	J	R	R	.	R	.	.	.	AB	AB	C	C	R	C	.	.	R	C	R	C	C	R
	Sur	R	R	.	R	.	.	.	AB	C	C	AB	.	AB	.	.	.	C	.	C	C	C
North of Belgrades	J	R	R	.	R	.	.	.	AB	AB	.	R	R	C	.	.	.	R	R	C	R	C
	P	.	.	.	.	.	.	.	AB	AB	.	?	?	C	.	.	.	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	AB	AB	.	R	.	C	.	.	.	.	.	C	AB	C
East of Belgrades	J	.	.	.	R	.	.	.	AB	AB	.	C	R	C	.	.	.	R	R	C	R	R
	P	.	.	.	.	.	.	.	AB	AB	.	?	?	C	.	.	.	C	C	C	C	C
	Sur	.	.	.	.	.	.	.	AB	AB	.	C	.	C	.	.	.	C	.	C	AB	.

TABLE X. The distribution and abundance of fishes in the lakes and ponds — Concluded

Name of lake or pond	Reported by*	Land-locked Salmon	Chinook Salmon	Chum Salmon	Brook Trout	Brown Trout	Rainbow Trout	Togue (Lake Trout)	White Perch	Yellow Perch	Pike Perch	Small-mouthed Bass	Large-mouthed Bass	Common Pickerel	Whitefish	Cusk	Smelt	Horned Pout	Eel	Sunfish	Sucker	Minnows (several species)
Salmon	J Sur	R .	R .	. .	R .	. .	. .	. .	AB .	AB .	. .	R C	R .	C .	. .	. .	.? .	R .	R .	AB AB	R C	R .
McGrath	J	R	R	.	R	.	.	.	AB	AB	.	R	R	C	.	.	R?	R	R	C	R	R
Clearwater	Pe	R	.	.	R	.	.	AB	.	.	.	AB	.	.	.	C	C	C	C	C	C	AB
Wilson (P.833)	Co	C	.?	.	R	.	.	C	C	.	.	C	.	C	.	.	C	C	.?	C	AB	C
Sandy	S Sur	. .	. .	. .	. .	. .	. .	. .	AB C	R? .	. .	. .	. .	C C	. .	. .	. .	.? .	C .	R .	.? .	C .
Embden	S Sur	AB R	AB .	. .	R .	. .	. .	AB C	R? .	R? .	. .	R C	. .	C .	. .	R .	AB .	.? .	R .	.? .	.? AB	R C

*Reports were made by the following wardens: (B) Chief Warden Verne M. Black, (P) Chief Warden Adelbert F. Piper, (K) Deputy Warden Earle F. Kellar, (C) Deputy Warden Guy Caldwell, (H) Deputy Warden Walter G. Harris, (Kw) Deputy Warden Albert Kweder, (L) Deputy Warden Wayne Lindsay, (Co) Deputy Warden Oscar M. Conant, (Pe) Deputy Warden Edwin R. Pearson. (J) Deputy Warden Lewis Johnson, and (S) Deputy Warden Randall Shelley. Reports from survey collections are indicated by (Sur).

Family **Ameiuridae,** Bullheads

Horned Pout or Brown Bullhead (*Ameiurus n. nebulosus*). The Horned Pout or Bullhead was found to be widespread in the area, particularly in lakes of the Kennebec River drainage where it is fairly abundant in some lakes. It reaches a length in these waters of about one foot.

Family **Esocidae,** Pickerel

Common Pickerel or Chain Pickerel (*Esox niger*). This is one of the four abundant species of warm-water game fishes in the State. It was found to be one of the most widespread in its distribution in lakes of the present survey, having been taken from 32 lakes and ponds. Most individuals taken by gill net were about two pounds in weight, while a few were as large as three and one-half pounds.

Family **Anguillidae,** Eel

Eel (*Anguilla bostoniensis*). No eels were collected by our nets; however, the species has access from the sea to most of these lakes and ponds, and is undoubtedly present in most of them as indicated by the wardens' reports.

Family **Cyprinodontidae,** Killifishes

Banded Killifish (*Fundulus d. diaphanus*). This fish is sometimes referred to by fishermen as a "minnow," but it belongs to a different family. It has a maximum length of about three inches. It is typically a lake fish, being found mostly on extensive lake shallows. It was taken by seine from five lakes, one in the Androscoggin River drainage and four in the Kennebec. These were mostly large lakes with extensive wave-swept shallows.

Family **Moronidae,** River basses

White Perch (*Morone americana*). The White Perch is one of the most widespread of the four species of warm-water game fishes of the area. Judging from our gill net collections, it is the most abundant of all of the larger fish; the 86 gill net sets in 40 lakes took 2,748 fish, mostly over 7 inches long, of which more than one-half (1,627) were White Perch. Young White Perch were one of the three species most commonly found in the stomachs of the game fishes, the other two being the Smelt and Yellow Perch.

Family **Percidae,** Perches

Yellow Perch (*Perca flavescens*). The Yellow Perch is one of the most widespread and abundant of the four warm-water game species of the area. Although it is here referred to as a game species, it is actually of little interest to Maine fishermen, either for food or for sport. The minor interest on the part of fishermen in the Yellow Perch is probably due to the facts that it is usually smaller than the White Perch and it tends to be commonly infested with grubs (larval flukes). Young Yellow Perch were found to be a very important food item in the diet of the larger game fishes.

Pike Perch or Walleyed Pike (*Stizostedion vitreum*). The Pike Perch was introduced into Great Pond of the Belgrade Lakes about twenty-five years ago, according to local reports. The species is well established in this lake at the present time. Our gill nets took eight adult Pike Perch from deep water in Great Pond; these fish weighed from three and one-half to seven pounds each. Warden reports indicated that the species has spread down stream to Long Pond and Snow Pond, but it is not so abundant in these two lakes as it is in Great Pond. The Pike Perch in Great Pond affords considerable fishing by night spearing on the spawning grounds in the spring (see Plates XXIV and XXV). The principal spawning grounds known to fishermen and from which this fish is speared are on the shallows off the mouth of Salmon Stream or Hatchery Brook near North Belgrade, around Pine Island, around Foster's or Pinkham's Point, over the shallows which extend from Pine Island to Horse Point, and off Snake Point in the northeast arm of the lake (see map, Figure 44). The most fish are speared off the mouth of Hatchery Brook. The fish are to be found on their spawning grounds as soon as the surface of the water is free of ice. The State Fish and Game Department has had no restrictions on spearing Pike Perch in Great Pond for the past eight years. During the first season, spearing was confined to the mouth of Hatchery Brook; and, according to Warden Arthur Rogers, 1,700 Pike Perch were so taken. According to Rogers, the average annual catch by spearing during the past few years has been several hundred fish.

Family **Centrarchidae,** Basses and sunfishes

Small-mouthed Black Bass (*Micropterus dolomieu*). The Small-mouthed Bass was not native to Maine, but was introduced here many years ago. It is now so widespread in southern Maine as to be more important than some of our native species. It is known to occur in at least 48, if not all, of the 53 lakes studied by the survey. The gill nets took fewer large bass than they took White Perch, Yellow Perch, or Pickerel. In the writer's opinion, this does not necessarily indicate a smaller population of bass than of these other species, for bass appear to avoid gill nets; thus the comparative numbers of these species taken by our gill nets (see page 103) may not be significant in relation to relative abundance of bass. Bass were taken in 31 lakes and ponds in the area.

The bass tapeworm was found to be present in three different "lake-units" in the area: Pocasset, Parker, and Flying ponds of the Androscoggin River drainage; Cobbosseecontee Lake; and Snow, Great, North, and East ponds of the Belgrades. The bass which were obtained from these lakes were mostly heavily infested with this parasite (see Table XVI).

Large-mouthed Black Bass (*Huro salmoides*). The Large-mouthed Bass is not native to Maine. It has been introduced into several lakes in the southern part of the State, but is not nearly so widespread as the Small-mouthed. It was found to be present in two "lake-units" of the area: in Pocasset, Lovejoy, David, and Echo ponds, and in the Belgrade chain. The species was collected from only one pond of the Belgrades (Long Pond), but was reported by Wardens to be present in other lakes of this chain.

Red-bellied Sunfish (*Lepomis auritus*). This is one of the two species of sunfishes which are widely distributed in Maine. In lakes of the present area it is less abundant and less widespread than the Common or Pumpkinseed Sunfish. It is present in both the Androscoggin and Kennebec river drainages. It was not found to be abundant in the Belgrade Chain, for our only record for the species there was a single fish from the stomach of a Yellow Perch from Long Pond.

Pumpkinseed Sunfish or Common Sunfish (*Lepomis gibbosus*). The Pumpkinseed or Common Sunfish is the most abundant of the two species of sunfishes in the present group of lakes. Our nets took this species from 33 lakes and ponds, or from more waters than any other single species of fish. Fish up to 8 to 10 inches long were commonly taken in gill nets from many of the lakes.

Hybrid sunfish (*Lepomis auritus X Lepomis gibbosus*). Thirteen individuals of hybrids between the two species of Maine sunfishes were taken from six lakes in all of which either one or both of the parent species were also collected.

Family **Cottidae,** Sculpins

Fresh-water Sculpin (*Cottus cognatus*). Our only record of this fish was a single individual from the stomach of a White Perch from Maranacook Lake.

Family **Gadidae,** Codfishes

Cusk (*Lota maculosa*). The Cusk was taken by gill net from Thompson Lake, and Parker and Flying ponds. The Wardens reported Cusk to be present in several others of the deeper lakes of the area.

FOOD HABITS AND AGE AND GROWTH OF THE WHITE PERCH (*Morone americana*)

The White Perch (*Morone americana*) is one of the most abundant species of fishes in lakes of the southern part of Maine, and it is one of the most important species to the fishermen. The White Perch is apparently involved in several important fish-management problems. It tends to become very abundant and dwarfed in many lakes, which dwarfing may be due to limitations of the food supply. In its feeding it is more or less competitive with most of the other game fishes in the state, and there is considerable evidence that its abundance in certain lakes is deleterious to trout or salmon populations. On the other hand, young perch are an important item in the diet of bass, pickerel, and other game species. Since the perch is such an important fish to the fisherman, and since it apparently has important relationships to our other game species, it is of utmost importance that an understanding of these problems involving the White Perch be obtained, so that proper and effective methods might be developed for the management of perch populations.

During the 1940 survey of lakes and ponds of the Androscoggin and Kennebec river drainages, and during the 1938 survey of lakes and ponds of the Saco and Presumpscot river drainages, a considerable number of White Perch was obtained; and these fish, together with collections from a few other localities, are the subject of the present discussion of food habits and age and growth of this species. This account is based on 2,056 fish from 45 lakes and ponds, of which food habits studies are based on the examination of stomachs of 1,757 perch from 42 lakes and ponds, and studies on age and growth are based on the examination of scales of 1,827 fish from 43 lakes and ponds. (The numbers of fish from each lake are given in Tables XI, XII, and XIV.) Most of these collections of perch were taken with experimental gill nets of the type described on page 100, or of a similar type with meshes of various sizes and designed to take fish of various sizes. Exceptions are the collections of perch from Graham Lake which were taken by hook and line; and the February 3, 1940 collection of fish from Great Pond which were collected from the screen in the outlet of this pond, where these migrating fish had been forced against the screen by the water current. These perch represent catches by only one gill net set for some lakes, and from two to twelve net sets in different parts of the lake in the case of other lakes. The net sets were made at various depth-ranges, more in shallow water than in deep, and were distributed according to depth approximately in proportion to the distribution of lake area with respect to depth. Also the amount of time that the nets were fished in each lake was

roughly in proportion to the size of each lake. It is the writer's opinion, therefore, that the samples of perch taken by this netting were representative of the perch populations which were present, to the degree that the number of net sets was adequate, and to the degree that the nets were capable of catching fish of different sizes. Of the 2,056 perch from the 45 lakes, 1,822 fish were taken from 44 of the lakes by a total of 80 individual gill net sets, each net set being at a different locality within a given lake. Approximately half as many additional net sets were made in these same lakes, mostly at greater depths, without catching any perch. This amount of sampling by nets was presumably sufficient to give an accurate picture of the perch population of this group of lakes as a whole. The ability of the gill nets to catch perch of various sizes is readily indicated by the length frequency distribution of the fish. Of the 1,827 White Perch from 43 lakes and ponds, which were used for the present studies on age and growth (see Table XIV), 1,593 fish were collected from 42 lakes by experimental gill nets. The length frequency distributions of body or standard lengths in millimeters, by frequency classes, of these 1,593 White Perch, for groups of lakes and some individual lakes (A to G — see below), were as follows:

	111 to 120	121 to 130	131 to 140	141 to 150	151 to 160	161 to 170	171 to 180	181 to 190	191 to 200	201 to 210	211 to 220	221 to 230	231 to 240	241 to 250	251 to 260	261 to 270	271 to 280	281 to 290	291 to 300	301 to 310	Total
A	.	.	10	23	17	14	5	8	10	19	13	19	25	28	29	10	2	2	3	1	238
B	2	47	124	51	47	43	19	35	40	21	24	14	13	8	12	4	5	.	.	.	509
C	.	14	34	6	4	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	61
D	.	22	43	11	14	25	16	8	3	1	.	.	.	1	1	.	.	.	.	.	145
E	.	.	.	.	.	.	.	.	26	63	13	1	.	.	.	.	.	.	.	.	103
F	.	2	12	4	5	11	15	43	21	26	4	1	3	2	.	.	.	1	.	.	157
G	.	23	76	72	30	10	13	11	46	36	24	13	13	5	7	6	2	.	.	.	380
Total	2	108	299	167	117	103	69	105	147	167	78	48	54	44	49	20	9	3	3	1	1,593

in which the White Perch from different lakes were grouped as follows:

A = All collections made in 1938 (from 15 lakes).
B = All collections from the Belgrade Chain of lakes (Snow, Long, Great, North, and East), except the February 3, 1940 collection from Great Pond.
C = Collections from Sabattus Pond.
D = Collections from Webb Lake.
E = Collection from Cochnewagan Pond.
F = Collections from Pushaw Pond.
G = All other collections made in 1940 (from 17 lakes).

The gill net used for the 1938 collections was 475 feet long by 6 feet deep, and was made up of five 75-foot sections with mesh of 4, 2, 6, 3, and 5 inches stretched measure, plus a 70-foot section of net with 2 3/8-inch mesh and a 30-foot section with 2¾-inch mesh. All other collections were made with 375-foot nets of five 75-foot sections of 4-, 2-, 6-, 3-, and 5-inch mesh. Judging from the length frequencies of the 1,593 fish, these nets were incapable of catching White Perch of a body length of less than about 120 millimeters or a total length of about 6 inches. Of perch above a length of 120 millimeters the nets took large and fairly uniform numbers of fish of each size-group, with gradually decreasing numbers of fish in the size-groups above 210 millimeters. This decrease in numbers among size-groups of over 210 millimeters in body length, or about 10 inches in total length, was to be expected judging from the usual maximum size of the species in the different lakes as known from returns of fishing. Within the above length-frequency distribution of all perch, the high number of fish in the 131–140 class, and the relatively low number in the 171–180 class, may warrant further comment. The 131- to 140-millimeter fish were caught mostly in the 2-inch mesh, and fish of this size might have been captured more readily than slightly larger or smaller fish by this size of netting. The low number of 171- to 180-millimeter fish, as compared to the high numbers of fish from 181 to 210 millimeters, may have been due to net selectivity to some extent but was obviously due more to other factors, including schooling of the fish in size groups or other peculiarities of size distribution of perch in the individual lakes. The relatively high numbers of perch from 191 to 210 millimeters in length, for example, were attributable mostly to the single gill net collection of 103 fish from Cochnewagan Pond; this collection obviously represented a school of uniformly large fish. The fish, smaller than 120 millimeters, which the net failed to catch were naturally the younger fish. No first- or second-year fish were included in the collections, and only 9 fish in their third summer of life were present. The 1,593 White Perch were distributed according to age (includes the calendar year in which they were collected) as follows:

Summer of life:	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
Number of fish:	9	236	123	220	227	211	211	156	115	42	22	14	5	1	1

The fish from Graham Lake and the fish in the February 3, 1940 collection from Great Pond also were all at least 4 summers old. Food habits studies were made on some White Perch of which the ages were not determined; however, these fish were of the same general size range, and presumable age composition, as were the 1,593 fish cited above. The present studies on food habits and age and growth, therefore, deal with samples of fish mostly above 6 inches in total length and at least 4 summers old; and these fish were distributed fairly uniformly throughout the size and age distribution above these limits in proportion to an expected normal life cycle.

Stomachs of the perch were preserved in 10 per cent formalin. The food items in each stomach were counted. The total volume of food in each stomach, and the volumes of each type, were measured by water displacement; the smallest volumes were estimated as parts

of a measured total volume of the contents of an individual stomach. Lengths and weights were taken from the fish in a fresh condition. The perch were measured mostly to the nearest millimeter; in some instances to the nearest 0.5 centimeter or to 1/16 inch. All lengths are here given to the nearest 0.1 inch. Weights were taken to the nearest gram, and are here given to the nearest 0.1 ounce. Age determinations were made from the scales, mostly from plastacele impressions.

Food habits of the White Perch. The 1,757 White Perch, on which this account is based, were from 42 lakes and ponds. They were collected mostly during the summer (June 15 to September 15), the exceptions being fish from Graham Lake, Pushaw Pond, and the 1936 collection from Long Pond of the Belgrades. They were collected mostly by gill nets, and more by over-night sets than by daytime sets, but in considerable numbers by the latter. They were collected from a wide range in depth of water. The present results, therefore, represent average feeding habits of perch, over 6 inches in length, during the summer months. The number and size range of White Perch from each lake, the dates of collection, the total stomach contents, and the volumes and numbers of different types of food organisms in the stomachs, are given for the 1940 survey collections in Table XI and for other collections and other lakes in Table XII.

The summer diet of the White Perch was almost exclusively of arthropods and fish, with the arthropods the much more important of the two. Almost no vegetable material was found in the stomachs. Of the arthropods, the aquatic insects were most important, water fleas and fresh-water shrimp were of some importance, and terrestrial insects were of almost no importance. Mayfly nymphs made up about half of the total volume of food from all perch. Next in importance among the aquatic insects were caddisfly larvae, dragonfly nymphs, and midge larvae. Alderfly larvae, mosquito larvae, and other aquatic insects were of less importance. Among the fishes, so far as they could be identified, the most important items in the perch diet were the Smelt, Yellow Perch, and White Perch. Leeches, aquatic earthworms, small clams, and snails were of little importance. The water fleas taken from all perch represented only about 5 per cent of the total volume of food; on the other hand, the total number (over 100,000) of water fleas was much greater than of any other type of food, and their occurrence in the perch stomachs was quite general. The total volume of stomach contents of the 1,252 perch taken by the 1940 survey was 653 c.c. (Table XI), of which the percentages made up by different types of food organisms were as follows:

Leeches	0.00+	Ants	0.86
Aquatic earthworms	0.08	Insect remains	0.08
Water fleas	5.75	**All aqautic insects**	**60.29**
Fresh-water shrimp	2.22	Water mites	0.00+
Crayfish	4.03	Snails	0.02
All Crustaceans	**12.00**	Pill clams	0.01
Alderfly larvae	1.68	Smelt	9.09
Mayfly nymphs	44.21	Fallfish	0.91
Dragonfly nymphs	5.59	Yellow Perch	10.08
Damselfly nymphs	0.28	White Perch	3.79
Back swimmers	0.00+	Fresh-water Sculpin	0.01
Beetle larvae	0.03	Fish remains	2.39
Caddisfly larvae	3.27	**All fish**	**26.27**
Cranefly larvae	0.00+	Vegetation	0.09
Midge larvae	3.18	Unknown	0.38
Mosquito larvae	1.97		
		Total	100.00

The 505 perch from collections from other than the 1940 summer survey contained mostly these same food types in about the same proportions, notable differences being greater percentages of dragonfly nymphs and caddisfly larvae (Table XII).

The present study on food habits of the White Perch, together with the data obtained on amounts of different kinds of bottom food organisms present in many of the same lakes from which the perch were collected, offers an opportunity to examine the degree of selectivity exhibited by this fish in its feeding habits. This present comparison deals only with the organisms of the bottom fauna and the bottom organisms found in the perch stomachs; thus it deals with the degree of selectivity of the perch as it feeds on the bottom fauna. The data here used are for stomachs of perch collected during the summer of 1940 and for bottom samples collected from the same lakes during the same period. The data used to represent the bottom fauna (from Table VII) are the average amounts of different types of organisms in all bottom samples from each lake; they presumably represent, therefore, the bottom fauna for each lake as a whole. The perch were collected by gill nets from different depth ranges in the different lakes; but were collected more in shallow water than in deep, as were also the bottom samples. Data were available for 23 lakes of the 1940 survey, on both bottom fauna (490 bottom samples) and stomach contents of White Perch (1,249 fish). Comparative figures on volumes and numbers of each type of bottom organism in the bottom fauna and in the perch stomachs are given for each lake, and for all lakes combined, in Table XIII. The figures for perch stomachs are the percentages of the volume and number of each type of bottom organism to the total volume and number of all bottom organisms (not including other types of food) in the perch stomachs; the figures for the bottom fauna are the percentages of

the volume and number of each type of organism in the bottom fauna. The totals, given at the end of Table XIII, represent the 1,249 perch stomachs and the 490 bottom samples as a whole; these data for all perch and all bottom samples are represented graphically in Figure 4. The more obvious conclusions to be drawn from this comparison relate to the role of the molluscs, Mayflies, and midges in the diet of the White Perch, and to the differences involved in using either volumes or numbers as the basis for the comparison. It has been shown previously (page 125) that, among 1,757 perch from 42 lakes, snails and clams were fed upon only to a very small extent. Among the perch referred to in the present comparison of food with the bottom fauna, practically no molluscs were present in the stomachs, even though they were relatively abundant in the bottom fauna. The obvious conclusion is that these White Perch were almost completely avoiding snails and clams in their feeding. This avoidance of the molluscs could not be attributed to their large size, for the snails of the family Amnicolidae, the pill clams, and most of the other molluscs, were small enough to be eaten readily. These 1,249 fish from the 23 lakes had fed mostly on aquatic insects and fresh-water shrimp of the bottom fauna. The question of the use of volumes of organisms as a measure of selective feeding, as opposed to the use of numbers, must be considered in evaluating the results of this comparison. The number of food organisms is presumably the better index of the amount of effort on the part of the fish in seeking and capturing its food; while volume of food is presumably the better index of the amount of benefit which the fish obtains from it. A comparison of numbers with volumes gives an index of the degree to which the fish selects the larger or smaller organisms of a given type. From the standpoint of numbers of organisms, these perch had fed mostly on the four most abundant types (except molluscs) of food, i.e., midge larvae, fresh-water shrimp, mosquito larvae, and Mayfly nymphs. Nearly half (49%) of the bottom organisms which they contained were midges; and the midges apparently were being selected to a considerable extent, since they made up only 29 per cent of the bottom fauna. A still greater degree of selectivity was indicated for fresh-water shrimp which made up 22 per cent of all bottom organisms in the perch but made up only 5 per cent of the bottom fauna. Some numerical selectivity was also shown for Mayflies and caddisflies. The numerical selectivity for these types of insects was mostly the result of the fact that molluscs were avoided. Mosquito larvae were relatively somewhat more abundant in the bottom fauna than in the perch stomachs. From the standpoint of volume of food organisms, these perch had fed mostly on Mayfly nymphs (66%), and only to a slight extent on dragonflies, caddisflies, midges, crayfish, fresh-water shrimp, and mosquitoes. Thus while Mayflies were a minor item numerically, they were by far the most important from

TABLE XI. Volumes in cubic centimeters and numbers (in parentheses) of food organisms in stomachs of 1,252 White Perch (*Morone americana*) from 25 lakes and ponds of the 1940 lake survey

(For pond numbers, see Table I)

Name of lake or pond	Date of collection: 1940	Fish examined			Water fleas (Cladocera)	Fresh-water shrimp (Amphipoda)	Crayfish (Decapoda)	Alderfly larvae (*Sialis*)	Mayfly nymphs (Ephemeridae)	Dragonfly nymphs (Anisoptera)	Caddisfly larvae (Trichoptera)	Midge larvae (Chironomidae)	Mosquito larvae (*Corethra*)	Ants (Formicidae)	Miscellaneous aquatic invertebrates*	Smelt (*Osmerus*)	Yellow Perch (*Perca*)	White Perch (*Morone*)	Other fish**	Vegetation and unknown
		Number of fish; and number of fish, in ( ), containing food	Range in total length in inches	Total stomach contents																
Sabattus	June 19–20	57(49)	5.8–9.9	9.045 (3877)	......	.....	....	0.3 (15)	1.044 (16)	....	0.1 (5)	7.226 (3806)	.....	0.37 (34)	0.005 (1)	....	....	....	....	...
Taylor	Aug. 14	4(3)	7.1–9.1	0.9 (144)	......	.....	....	0.1 (2)	0.08 (2)	0.01 (1)	0.19 (1)	0.22 (36)	0.3 (102)	....	...	....	....	....	....	...
Tripp	Aug. 10	13(7)	6.4–10.8	4.35 (28)	......	.....	2.8 (1)	....	1.55 (27)	....	.....	......	.....	....	...	....	....	....	....	...
Auburn	June 27–29	14(9)	6.3–8.5	0.321 (636)	0.316 (635)	.....	....	....	.....	....	0.005 (1)	......	.....	....	...	....	....	....	....	...
Androscoggin	June 25–26	31(28)	5.9–12.4	108.66 (839)	0.027 (300)	0.002 (2)	....	0.09 (5)	97.772 (393)	4.6 (5)	.....	0.569 (133)	.....	....	...	....	5.0 (1)	....	....	0.6
Pocasset	Aug. 2–3	77(65)	6.3–12.9	32.35 (421)	......	0.126 (121)	....	0.41 (14)	10.283 (118)	5.817 (51)	0.93 (49)	0.084 (37)	0.015 (14)	....	0.1 (5)	0.2 (1)	11.935 (6)	....	2.25 (5)	0.2
Lovejoy	Aug. 6	15(9)	6.2–12.9	10.61 (585)	0.06 (100)	.....	....	....	0.53 (11)	0.4 (2)	.....	0.02 (20)	.....	0.8 (450)	...	....	8.8 (2)	....	....	...
Echo	July 20	20(19)	6.7–13.5	27.2 (1948)	1.1 (Remains)	0.101 (39)	....	....	0.6 (5)	0.2 (1)	0.888 (29)	0.352 (2)	5.69 (1808)	0.5 (Remains)	0.8 (2)	15.269 (62)	....	....	....	1.7
Webb	Sept. 9–11	144(125)	6.1–12.3	33.635 (27,065)	22.239 (26,230)	0.191 (236)	....	0.995 (15)	2.298 (76)	1.18 (6)	0.05 (2)	0.249 (49)	.....	3.409 (444)	0.574 (4)	....	....	....	2.45 (3)	...
[illegible]th	Sept. 5	1(1)	8.7	0.1 (300)	0.1 (300)	.....	....	....	.....	....	.....	......	.....	....	...	....	....	....	....	...
Purgatory	Aug. 15	2(2)	6.8–11.0	2.45 (76)	......	.....	....	1.1 (21)	1.1 (20)	....	0.05 (10)	......	0.15 (20)	....	0.05 (5)	....	....	....	....	...
[illegible]nd	Aug. 16	2(2)	9.7–11.4	0.7 (503)	0.3 (500)	.....	....	....	.....	....	.....	......	.....	....	...	0.1 (1)	....	....	0.3 (2)	...
Cobbosseecontee	Aug. 7–10	37(30)	6.1–10.0	7.999 (5790)	......	0.389 (92)	0.05 (1)	0.248 (5)	1.689 (53)	1.64 (3)	1.394 (60)	1.803 (5487)	0.096 (85)	0.073 (Remains)	...	....	....	....	0.617 (4)	...
Annabessacook	Aug. 5–7	31(25)	6.3–9.7	8.21 (1307)	0.47 (900)	0.015 (15)	0.2 (1)	0.055 (2)	0.335 (7)	1.049 (6)	0.052 (4)	1.102 (314)	0.067 (35)	0.45 (Remains)	0.055 (5)	3.86 (17)	....	....	0.5 (1)	...
Cochnewagan	June 18–19	102(87)	9.1–10.4	26.065 (6244)	1.285 (2960)	4.354 (2047)	....	0.06 (2)	9.177 (107)	2.02 (15)	8.044 (793)	0.736 (314)	0.004 (4)	....	0.075 (2)	....	....	....	....	0.31
Wilson (P.673)	July 30–Aug. 1	33(23)	6.4–10.9	10.921 (323)	0.01 (Remains)	.....	....	1.535 (79)	5.065 (180)	4.0 (42)	.....	0.1 (10)	0.011 (11)	....	...	....	....	....	0.2 (1)	...
Maranacook	Aug. 1–4	89(82)	6.1–12.4	87.66 (6961)	2.921 (2925)	2.451 (991)	....	0.42 (24)	37.677 (1036)	5.595 (38)	1.18 (30)	0.879 (139)	4.657 (1100)	....	0.022 (7)	30.075 (668)	....	....	1.683 (3)	0.1
Torsey	July 31	1(1)	11.0	5.0 (50)	......	.....	....	....	0.4 (4)	....	.....	......	.....	....	...	....	4.6 (46)	....	....	...
Snow	June 27–July 3	82(55)	5.9–11.3	15.351 (2031)	0.045 (430)	0.567 (414)	....	0.35 (14)	7.014 (65)	2.52 (70)	3.369 (197)	0.62 (511)	0.565 (329)	....	0.301 (1)	....	....	....	....	...
Long of Belgrades South Part	June 26–27	25(19)	10.0–12.3	14.16 (3556)	0.617 (2700)	1.246 (494)	....	0.03 (1)	9.027 (96)	0.999 (7)	0.09 (1)	0.053 (46)	0.601 (201)	....	0.5 (7)	....	....	....	0.85 (3)	0.147
North Part	June 21–25	29(25)	6.2–13.3	18.215 (1083)	0.405 (60)	2.58 (835)	7.0 (6)	1.194 (56)	4.115 (52)	0.68 (5)	0.005 (1)	0.052 (46)	.....	....	0.584 (16)	1.1 (3)	....	....	0.5 (3)	...
Great of Belgrades	June 17–Sept. 8	315(251)	5.9–12.8	124.186 (18,280)	4.676 (11,575)	2.08 (1270)	13.823 (34)	4.008 (184)	48.911 (423)	1.514 (4)	4.804 (243)	6.586 (4348)	0.151 (139)	....	0.171 (6)	8.776 (36)	0.7 (1)	22.5 (2)	5.481 (15)	0.005
North of Belgrades	July 9–11	35(30)	6.2–13.2	15.08 (233)	......	0.025 (22)	2.46 (3)	....	10.926 (125)	1.17 (5)	0.025 (5)	0.069 (71)	.....	....	0.06 (1)	....	....	....	0.295 (1)	0.05
East of Belgrades	July 11–13	81(78)	6.1–13.1	80.28 (11,018)	2.768 (10,650)	0.03 (29)	....	0.06 (1)	35.554 (278)	0.4 (4)	0.185 (3)	0.016 (17)	0.037 (28)	....	...	....	34.8 (3)	....	6.43 (5)	...
Sandy	July 28	12(12)	9.8–12.4	9.85 (803)	0.197 (200)	0.337 (274)	....	....	3.67 (19)	2.7 (31)	.....	0.059 (66)	0.513 (210)	....	...	....	....	2.274 (2)	0.1 (1)	...
Totals	June 17–Sept. 11	1252(1037)	5.9–13.5	653.298 (94,101)	37.536 (60,465)	14.494 (6,881)	26.333 (46)	10.955 (440)	288.817 (3,113)	36.494 (296)	21.361 (1,434)	20.795 (15,452)	12.857 (4,086)	5.602 (928)	3.297 (62)	59.380 (788)	65.835 (59)	24.774 (4)	21.656 (47)	3.112

*Includes: Leeches, aquatic earthworms, damselfly nymphs, back swimmers, beetle larvae, cranefly larvae, insect remains, water mites, snails, and pill clams.
**Includes: Fallfish, fresh-water sculpin, and fish remains.

TABLE XII. Volumes in cubic centimeters and numbers (in parentheses) of food organisms in stomachs of 505 White Perch (*Morone americana*) from 19 lakes and ponds

Data are in addition to those given in Table XI

Name of pond	Pond number	Date of collection	Fish Examined: Number of fish; and number of fish, in ( ), containing food	Fish Examined: Range in total length in inches	Fish Examined: Total stomach contents	Water fleas (Cladocera)	Fresh-water shrimp (Amphipoda)	Crayfish (Decapoda)	Alderfly larvae (*Sialis*)	Mayfly nymphs (Ephemeridae)	Dragonfly nymphs (Anisoptera)	Caddisfly larvae (Zygoptera)	Midge larvae (Chironomidae)	Mosquito larvae (*Corethra*)	Terrestrial beetles	Miscellaneous aquatic invertebrates*	Smelt (*Osmerus*)	Golden Shiner (*Notemigonus*)	Common Sunfish (*Lepomis gibbosus*)	Yellow Perch (*Perca*)	White Perch (*Morone*)	Other fish and fish remains	Vegetation and unknown
Long of Belgrades (North)	713	Nov. 6–7, 1936	30(19)	8.1–10.8	9.67 (560)	......	0.23 (255)	0.3 (1)	0.812 (35)	2.14 (226)	0.75 (4)	0.18 (1)	0.028 (32)	...	..	.....	1.2 (1)	..	...	1.98 (1)	..	2.05 (4)	...
Great of Belgrades	719	June 23–26, 1937	81(71)	7.8–10.2	76.32 (13,097)	0.93 (5300)	0.202 (199)	0.5 (1)	0.426 (13)	8.953 (172)	0.96 (12)	51.99 (4864)	0.069 (26)	...	..	5.05 (2000)	4.9 (6)	..	...	...	..	1.84 (504)	0.5
Mousam Pond	63	July 28–30, 1937	5(2)	7.0–10.8	0.35 (804)	......	0.003 (3)	..	...	0.047 (1)	....	.....	0.3 (800)	...	..	.....	...	..	...	...	..	.....	...
Moose Pond	182	July 17–18, 1938	27(26)	6.5–11.7	10.96 (1915)	0.05 (500)	0.823 (603)	..	0.001 (1)	3.449 (23)	4.64 (35)	.....	0.163 (218)	0.966 (505)	..	0.708 (29)	...	..	...	...	..	0.16 (1)	...
Beaver Pond	183	July 21–22, 1938	11(11)	9.8–14.0	27.6 (248)	......	.....	..	0.05 (3)	21.44 (215)	0.31 (2)	.....	0.003 (3)	0.01 (17)	..	.....	...	..	...	...	2.3 (2)	1.487 (6)	2.0
Kezar Lake	238	July 20–21, 1938	4(2)	9.8–12.0	0.19 (1)	......	.....	..	...	.....	....	.....	.....	...	..	0.1 (?)	...	..	...	...	..	0.09 (1)	...
Sebago Lake	291	Aug. 4–5, 1938	12(9)	10.4–14.4	9.75 (74)	......	.....	..	...	0.11 (2)	0.5 (1)	.....	.....	...	..	.....	8.64 (68)	..	...	...	..	0.5 (3)	...
Adams Pond	307	July 1–2, 1938	4(4)	8.7–9.5	5.0 (311)	......	.....	..	0.01 (1)	2.89 (97)	0.4 (1)	0.1 (2)	1.4 (206)	...	..	0.2 (4)	...	..	...	...	..	.....	...
Long Lake	309	July 7–8, 1938	11(8)	6.4–7.8	0.932 (729)	......	0.006 (6)	..	...	0.314 (13)	....	.....	0.012 (10)	...	..	.....	...	..	...	...	..	.....	0.6 (700)
Highland Lake	314	June 29–30, 1938	10(10)	10.0–12.7	6.25 (801)	0.5 (700)	1.127 (34)	..	0.1 (4)	1.739 (30)	0.7 (4)	.....	0.004 (4)	0.002 (2)	..	0.3 (9)	...	..	...	...	..	1.778 (14)	...
earns Pond	315	July 25–26, 1938	1(1)	12.7	3.1 (8)	......	.....	..	...	.....	....	.....	.....	...	..	.....	...	..	...	...	..	3.1 (8)	...
ear Pond	321	July 28–29, 1938	2(2)	7.5–14.4	5.7 (18)	......	.....	..	...	0.2 (6)	0.5 (1)	.....	.....	...	..	0.05 (2)	...	..	...	4.1 (4)	..	0.85 (5)	...
rystal Lake	324	July 27–28, 1938	4(3)	9.1–9.3	1.3 (7500)	1.3 (7500)	.....	..	...	.....	....	.....	.....	...	..	.....	...	..	...	...	..	.....	...
leasant Lake	327	Aug. 11–12, 1938	3(2)	7.7–12.6	1.01 (11)	......	.....	..	...	.....	....	.....	0.01 (7)	...	..	.....	...	..	...	...	..	1.0 (4)	...
homas Pond	356	Aug. 17–19, 1938	94(91)	6.5–12.4	57.431 (2973)	......	0.168 (23)	..	0.168 (8)	13.256 (249)	17.755 (103)	0.03 (1)	3.772 (2548)	...	0.01 (2)	0.06 (1)	4.75 (10)	..	4.263 (5)	1.1 (1)	6.27 (8)	5.819 (14)	0.01
attlesnake Pond	359	Aug. 22–23, 1938	47(32)	6.6–13.0	10.512 (198)	......	0.137 (42)	..	0.45 (11)	1.48 (38)	0.4 (1)	0.11 (2)	0.215 (82)	...	..	.....	...	..	1.1 (1)	1.3 (1)	..	5.25 (20)	0.07
abbathday Lake	372	Aug. 13–14, 1937	11(4)	8.5–9.4	2.11 (7)	......	.....	..	...	0.01 (1)	0.02 (1)	.....	.....	...	..	.....	...	..	...	...	..	2.08 (5)	...
raham Lake**		Jan. 29–Feb. 12, 1939	30(3)	9.5–13.6	1.12 (3)	......	.....	..	...	.....	....	.....	.....	...	..	.....	...	0.7 (1)	...	...	..	0.42 (2)	...
ushaw Pond		Oct. 14–16, 1940	118(88)	5.2–10.9	31.31 (31,211)	2.829 (28,730)	4.758 (2,222)	..	...	1.199 (72)	4.779 (46)	0.731 (76)	0.023 (22)	...	..	1.341 (29)	...	10.5 (2)	...	2.4 (7)	..	1.04 (5)	1.71
Totals		Nov., 1936–Aug., 1940	505(388)	5.2–14.4	260.615 (60,469)	5.609 (42,730)	7.454 (3,387)	0.8 (2)	2.017 (76)	57.227 (1,145)	31.714 (211)	53.141 (4,946)	5.999 (3,958)	0.978 (524)	0.01 (2)	7.809 (2,074)	19.49 (85)	11.2 (3)	5.363 (6)	10.88 (14)	8.57 (10)	27.464 (596)	4.89 (700)

*"Miscellaneous aquatic invertebrates" includes: Insect remains, leeches, aquatic earthworms, damselfly nymphs, and beetle larvae

**Fish from Graham Lake were taken through the ice with hook and line.

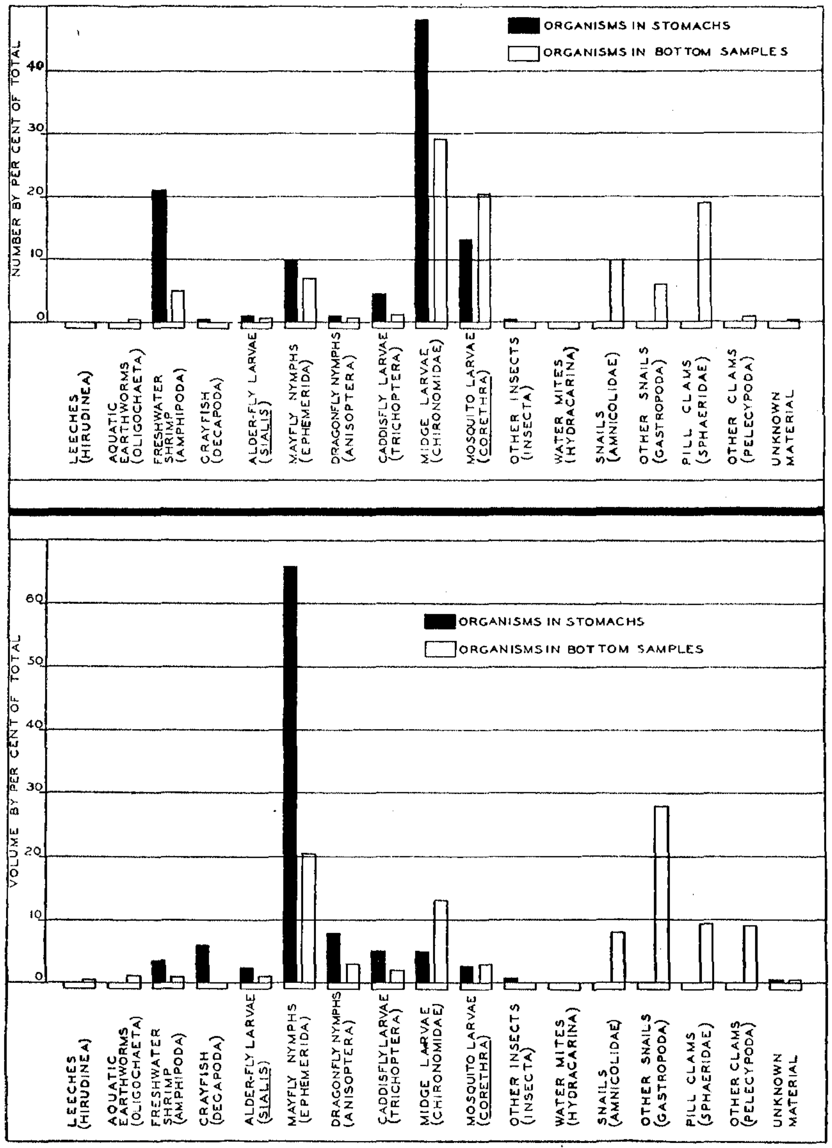


Figure 4. Percentages of volumes and numbers of different types of organisms in the bottom faunas, and percentages of volumes and numbers of each type of bottom organism to all bottom organisms in stomachs of White Perch. Based on 490 bottom samples and 1,249 perch stomachs from 23 lakes and ponds. Data are from Table XIII.

TABLE XIII. Percentages of volumes and numbers of different

This table is base

Name of lake or pond	Bottom organisms from	Leeches (Hirudinea)		Aquatic earthworms (Oligochaeta)		Fresh-water shrimp
		Vol.	No.	Vol.	No.	Vol.
Sabattus	Perch Stomachs	.....	.....	.....	.....	.....
	Bottom Samples	.....	.....	.....	.....	.....
Taylor	Perch Stomachs	.....	.....	.....	.....	.....
	Bottom Samples	2.2	0.8	0.4	0.3	.....
Tripp	Perch Stomachs	.....	.....	.....	.....	.....
	Bottom Samples	.....	.....	.....	.....	0.4
Auburn	Perch Stomachs	.....	.....	.....	.....	.....
	Bottom Samples	0.8	0.3	9.4	7.8	0.4
Androscoggin	Perch Stomachs	.....	.....	.....	.....	0.1
	Bottom Samples	.....	.....	.....	....	0.8
Pocasset	Perch Stomachs	.....	.....	.....	.....	0.7
	Bottom Samples	.....	.....	0.4	0.8	0.1
Lovejoy	Perch Stomachs	.....	.....	.....	.....	.....
	Bottom Samples	.....	.....	.....	.....	1.5
Echo	Perch Stomachs	.....	.....	....	.....	1.0
	Bottom Samples	0.4	0.6	.....	.....	0.1
Webb	Perch Stomachs	0.2	0.3	10.0	0.5	3.4
	Bottom Samples	.....	.....	1.0	0.8	0.1
Purgatory	Perch Stomachs	.....	.....	.....	.....	.....
	Bottom Samples	0.2	0.4	2.0	0.7	0.2
Cobbosseecontee	Perch Stomachs	.....	.....	.....	.....	5.3
	Bottom Samples	.....	.....	.....	.....	0.5
Annabessacook	Perch Stomachs	.....	.....	.....	.....	0.5
	Bottom Samples	0.1	0.2	.....	.....	0.1
Cochnewagan	Perch Stomachs	.....	.....	.....	.....	17.8
	Bottom Samples	.....	.....	1.3	2.2	1.8
Wilson (P. 673)	Perch Stomachs	.....	.....	.....	.....	.....
	Bottom Samples	.....	.....	.....	.....	0.2
Maranacook	Perch Stomachs	.....	.....	.....	.....	4.6
	Bottom Samples	0.3	0.5	.....	.....	3.9
Torsey	Perch Stomachs	.....	.....	.....	.....	.....
	Bottom Samples	.....	.....	2.6	0.6	0.3
Snow	Perch Stomachs	.....	.....	.....	.....	3.7
	Bottom Samples	.....	.....	.....	.....	0.2
Long of Belgrades South Part	Perch Stomachs	.....	.....	.....	.....	9.8
	Bottom Samples	.....	.....	.....	.....	6.3
North Part	Perch Stomachs	.....	.....	.....	.....	15.9
	Bottom Samples	.....	.....	.....	.....	4.6
Great of Belgrades	Perch Stomachs	.....	.....	.....	.....	2.5
	Bottom Samples	1.2	1.0	.....	.....	0.6
North of Belgrades	Perch Stomachs	.....	.....	.....	.....	0.2
	Bottom Samples	1.2	1.0	.....	.....	0.1
East of Belgrades	Perch Stomachs	.....	.....	.....	.....	0.1
	Bottom Samples	1.9	0.9	.....	.....	0.2
Sandy	Perch Stomachs	.....	.....	.....	.....	4.6
	Bottom Samples	1.2	1.0	.....	.....	12.1
Total for all	Perch Stomachs	0.002	0.003	0.13	0.006	3.31
Total for all	Bottom Samples	0.39	0.23	0.70	0.62	0.82

*Includes damselfly nymphs, back swimmers, beetle larvae, cranefly larvae, e

TABLE XIII

of bottom organisms in the bottom faunas, and percentages of volumes and numbers of each type of bottom organism to all bottom organisms in stomachs of White Perch

al of 490 bottom samples and 1,249 perch stomachs from 23 lakes and ponds. For numbers of bottom samples and perch stomachs from each pond, see Tables VI and XI

Crayfish (Decapoda)		Alderfly larvae (*Sialis*)		Mayfly nymphs (Ephemerida)		Dragonfly nymphs (Anisoptera)		Caddisfly larvae (Trichoptera)		Midge larvae (Chironomidae)		Mosquito larvae (*Corethra*)		Other aquatic insects* (Insecta)		Water mites (Hydracarina)		Snails (Amnicolidae)		Other snails (Gastropoda)		Pill clams (Sphaeridae)		Larger clams (Pelecypoda)		Unknown materials	
ol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.	Vol.	No.
...	.....	3.5	0.4	12.0	0.4	......	......	1.1	0.1	83.3	99.0	....	.....	....	....	.....	.....	.....	.....	.....	.....	0.1	0.1	.....	....		...
...	.....	.....	.....	39.9	18.0	......	......	......	......	47.3	73.8	0.1	3.4	....	....	.....	.....	.....	.....	2.1	2.6	0.3	1.3	10.3	0.9		...
...	.....	11.1	1.4	8.9	1.4	1.1	0.7	21.1	0.7	24.5	25.0	33.3	70.8	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....		
...	.....	.....	.....	0.4	1.4	......	......	0.4	0.3	8.6	16.1	5.1	17.8	....	....	.....	.....	65.8	59.2	6.33	1.1	1.5	2.5	9.3	0.5		
1.4	3.6	.....	.....	35.6	96.4	......	......	......	......	.....	.....	....	.....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....		
...	.....	16.8	3.8	31.2	10.8	......	......	3.0	2.3	14.6	20.0	20.5	55.4	....	....	.....	.....	.....	.....	.....	.....	1.5	5.4	12.0	0.8		
...	.....	.....	.....	......	......	......	......	100.0	100.0	.....	.....	....	.....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....		
...	.....	.....	.....	0.8	0.3	1.2	0.3	......	......	30.1	44.4	8.7	21.7	....	....	.....	.....	22.3	14.5	21.2	7.5	.....	.....	5.1	0.3		
...	.....	0.1	0.9	94.3	73.1	4.4	0.9	......	......	0.5	24.7	....	.....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	0.0	
...	.....	4.1	1,6	45.5	8.4	3.2	0.2	3.7	2.1	3.0	13.2	15.7	61.3	....	....	.....	.....	2.5	3.2	14.8	2.7	1.4	1.6	5.3	0.2		
...	.....	2.3	3.4	57.9	28.9	32.7	12.5	5.2	12.0	0.5	9.0	0.1	3.4	0.6	1.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	....		
...	.....	0.4	0.8	15.3	12.3	9.1	0.8	8.7	7.4	1.9	24.6	0.6	14.0	....	....	.....	.....	10.9	17.2	15.7	11.5	1.5	4.9	35.0	4.1	0.1	0.8
...	.....	.....	.....	55.8	33.3	42.1	6.1	......	......	2.1	60.6	....	.....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....		
...	.....	2.4	2.0	28.3	18.2	0.3	0.6	2.8	1.3	4.1	25.3	1.4	23.4	....	....	.....	.....	6.2	11.7	30.0	5.2	0.3	4.5	22.7	2.0		
...	.....	.....	.....	5.8	0.3	1.9	0.1	8.6	1.5	3.4	0.1	55.1	95.9	7.7	0.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	10.0	
...	.....	.....	.....	5.6	7.0	......	......	0.7	0.6	5.6	41.4	1.3	21.3	....	....	.....	.....	3.4	5.3	75.6	3.6	3.5	17.8	3.8	0.6		
...	.....	18.0	3.9	41.5	19.6	21.3	1.5	0.9	0.5	4.5	12.6	....	.....	....	....	.....	.....	.....	.....	0.2	0.3	.....	.....	.....	....		
...	.....	0.3	0.4	5.2	1.5	0.2	0.1	0.2	0.1	11.3	18.0	15.1	49.7	....	....	.....	.....	2.7	1.6	48.2	3.1	15.7	24.5	.....	....		
...	.....	44.9	27.6	44.9	26.3	......	......	2.0	13.2	.....	.....	6.2	26.3	....	....	.....	.....	.....	.....	.....	.....	2.0	6.6	.....	....		
...	.....	0.1	0.2	14.9	5.0	2.9	0.4	0.3	0.7	16.4	36.7	0.8	11.6	....	....	.....	.....	5.9	10.2	25.8	10.2	26.2	20.9	4.3	0.7		
0.7	0.1	3.4	0.1	23.1	0.9	22.4	0.1	19.1	1.0	24.7	94.8	1.3	1.5	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....		
...	.....	1.5	0.5	7.3	1.8	......	......	0.2	0.2	38.5	69.0	2.9	12.3	....	....	.....	.....	5.3	3.8	25.7	4.3	16.4	15.0	1.7	0.1		
5.8	0.3	1.9	0.5	11.4	1.8	35.8	1.5	1.8	1.0	37.6	80.7	2.3	9.0	1.9	1.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	....		
...	.....	.....	.....	1.8	0.8	......	......	0.7	0.2	6.3	20.5	3.6	17.5	....	....	.....	.....	8.4	9.3	38.7	7.1	13.2	41.2	27.1	3.0		
...	.....	0.2	0.1	37.5	3.2	8.2	0.4	32.8	24.1	3.0	9.6	0.1	0.1	0.3	0.1	.....	.....	.....	.....	.....	.....	0.1	0.1	.....	....		
...	.....	.....	.....	37.6	11.0	1.7	0.8	1.3	1.4	4.5	40.7	2.9	14.4	....	....	.....	.....	20.7	7.5	15.7	2.5	1.1	7.3	11.4	0.6		
...	.....	14.4	24.5	47.3	55.9	37.3	13.1	......	......	0.9	3.1	0.1	3.4	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....		
...	.....	1.8	3.3	40.2	19.9	1.4	1.6	0.2	0.6	7.6	25.4	1.5	14.9	0.2	0.5	.....	.....	14.0	12.7	5.8	2.2	10.6	14.4	1.8	0.6	11.7	1.7
....	.....	0.8	0.7	71.2	30.8	10.6	1.1	2.2	0.9	1.6	4.1	8.8	32.7	0.11	0.1	0.09	0.1	.....	.....	.....	.....	.....	.....	.....	....		
....	.....	1.5	1.2	15.6	12.7	3.3	0.4	3.4	1.6	2.5	20.6	0.4	4.0	0.2	0.2	.....	.....	14.6	12.6	23.6	6.3	21.6	21.1	9.1	0.2		
....	.....	.....	.....	100.0	100.00	......	......	......	......	.....	.....	....	.....	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....		
....	.....	1.0	0.8	13.8	5.7	14.7	2.7	1.4	1.3	10.2	22.2	0.6	10.9	....	....	.....	.....	4.8	10.9	40.2	10.9	10.4	30.0	.....	....		
....	.....	2.3	0.9	45.8	4.0	16.5	4.4	22.0	12.3	4.0	31.9	3.7	20.5	2.0	0.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	....
....	.....	.....	.....	1.1	1.5	5.2	0.7	0.1	0.2	14.4	22.3	7.0	31.3	....	....	0.1	0.2	3.2	3.4	52.0	7.8	9.3	29.5	7.4	0.7	....	....
....	.....	0.3	0.1	71.1	11.3	7.8	0.8	0.7	0.1	0.4	5.4	4.7	23.6	4.0	0.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	1.2	....
....	.....	0.1	0.6	3.0	3.4	1.8	0.6	36.1	5.6	1.3	12.4	0.4	3.4	....	....	.....	.....	18.4	13.6	15.7	7.3	16.9	36.7	.....	....	....	....
3.2	0.6	7.3	5.5	25.4	5.1	4.2	0.5	0.1	0.1	0.3	4.5	....	.....	3.0	1.4	.....	.....	.....	.....	0.6	0.2	.....	.....	.....	....	....	....
....	.....	.....	.....	11.3	1.5	......	......	0.3	0.4	16.2	18.3	0.1	0.8	....	....	.....	.....	1.2	2.7	5.2	3.4	61.1	61.1	.....	....	....	....
6.8	0.5	5.0	2.8	59.6	6.3	1.8	0.1	5.8	3.6	8.0	65.3	0.2	2.1	0.2	0.1	.....	.....	.....	.....	0.08	0.1	.....	.....	.....	....	0.02	....
....	.....	0.2	0.5	28.2	11.1	2.1	0.5	3.2	1.9	1.2	14.6	0.1	1.2	0.8	0.5	.....	.....	16.7	20.0	22.3	8.9	18.4	31.2	5.0	0.7	....	....
6.6	1.3	.....	.....	73.9	53.9	7.9	2.2	0.2	2.2	0.5	30.6	....	.....	0.4	0.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	0.3	....
....	.....	1.5	3.6	24.0	18.1	3.3	1.0	3.2	5.7	1.2	29.9	0.2	7.7	0.2	0.5	.....	.....	2.4	7.7	38.5	13.4	0.8	4.1	21.7	2.6	1.7	1.6
....	.....	0.1	0.3	98.0	77.2	1.1	1.1	0.5	0.8	0.1	4.7	0.1	7.8	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	....
....	.....	2.8	1.8	44.4	23.0	3.0	0.9	0.1	0.5	1.3	18.0	0.6	22.5	....	....	.....	.....	1.4	8.6	36.0	12.6	0.2	2.2	8.1	1.8	....	....
....	.....	.....	.....	50.4	3.1	37.1	5.1	......	......	0.8	11.0	7.1	35.0	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	....
....	.....	.....	.....	33.7	6.6	0.6	1.0	1.2	1.0	18.8	25.7	2.8	15.2	....	....	.....	.....	13.5	12.4	13.5	1.9	2.6	6.6	.....	....	....	....
6.03	0.14	2.50	1.38	65.94	9.79	8.33	0.93	4.87	4.51	4.75	48.58	2.94	12.85	0.58	0.13	0.001	0.015	.....	.....	0.03	0.015	0.017	0.021	.....	....	0.57	....
....	.....	0.95	0.00	20.539	6.55	2.76	0.48	1.90	1.03	12.79	29.30	3.28	20.35	0.06	0.06	0.001	0.01	8.85	9.87	27.60	5.83	9.54	19.24	9.33	0.69	0.49	0.08

the standpoint of volume; in comparison, the midges, shrimp, and mosquitoes were of greater numerical importance but of minor importance from the standpoint of volume. The perch were selecting more volume of Mayflies, in proportion to what was available, than of any other food type, but were also selecting more volume of most other insects; this selectivity for quantity of insects was the result of an avoidance of the molluscs which made up a larger proportion of the bottom fauna volumetrically than numerically. The fact that the numerical occurrence of Mayflies was relatively small, while their occurrence by volume was great, indicates that the perch were selecting by far the larger Mayflies and avoiding the smaller ones. On the other hand, the data for the midge larvae would indicate just the reverse in selectivity, i.e., that the perch were selecting the smaller midges and avoiding the larger ones; such a habit, in the writer's opinion, is difficult to ascribe to the White Perch with its large mouth and voracious feeding habits, unless it is due more to necessity than willful selectivity. In fact, it is quite possible that most or all of the tendencies toward selectivity in the feeding habits of the White Perch, as indicated from these data, may have been more the result of variations in availability of different types or sizes of food organisms, either as these organisms were distributed over different depths of the lakes or as they were buried to different depths in the bottom soil, than to willful selectivity by the fish. In either event, the results indicate the amount of each type of bottom food which was eaten by the fish as compared to the amount of each type present in the bottom fauna.

Age and growth of the White Perch. This account of the age, growth, and related phenomena in the life history of the White Perch has been based on a study of the scales (mostly plastacele impressions) of 1,827 fish from 43 lakes. The names of the lakes, the number of fish from each, and the dates of collection are given in Table XIV. Practically all of these fish were over 6 inches in total length, but above this length the size-frequency distribution of the fish was fairly uniform but with gradually decreasing numbers of larger fish. As has already been pointed out (page 124), the omission of fish less than 6 inches long has resulted in the omission of almost all fish less than 4 summers old. The study therefore deals with fish mostly at least 4 summers old and mostly over 6 inches in length (the legal length limit for this species in Maine). The present account involves the length, weight, and age of fish at the time they were collected; computed lengths for fish at the end of previous growing seasons are not involved.

Structure of scales. The structure of the scales of the White Perch, and the characteristics of the annulus or "winter mark," are described here very briefly. Several photographs of plastacele impressions of perch scales are reproduced on Plates IV to XXIII. The White Perch scale is very similar to the scales of centrarchid fishes, of which a detailed description has been given by Creaser (1926). The scales of the White Perch (and of other bony fishes) are flat or slightly rounded plates, made up of two layers. The outer or hyalodentine layer is a deposit of mineral salts. On the surface of this outer layer are numerous ridges or circuli, composed also of hardened deposits of mineral salts and arranged semiconcentrically around the anterior (or upper, on Plates IV to XXIII) part of the scale. During growth of the fish the scale is enlarged by the addition of scale material around its margin, and the ridges or circuli are added near the expanding margin. Usually, many ridges are formed during each growing season, and their shape and arrangement vary with the different parts of a growing season. The annulus, or "year mark," or "winter mark," is a line of demarcation of the interruption of the circuli formation in the fall as it is followed by a different formation of the circuli of the following spring or summer. The chief characteristics of the annulus of the White Perch scale, as evident in the accompanying scale photographs, are as follows:

(1) The circuli of late fall growth are left incomplete along the lateral margins of the scale by a cessation of growth during the winter. When scale growth is resumed the following spring, these incomplete circuli or ridges are not extended but are left incomplete; rather, the first circulus formed in the spring completely encircles most of the scale, "cutting across" the ends of the incomplete circuli of the preceding fall. (See especially Plate IX.)

(2) The first circulus forming in the spring, after the 3rd or 4th "winter mark," curves uniformly around the posterolateral field of the scale. Successive circuli or ridges passing across this field tend to flare outward more and more as the scale grows during that season. This flaring is then interrupted by the first circulus of the following spring. (See Plate IX.)

(3) In the anterior field of the scale, between radii, sections of those circuli which are formed during normal growth tend to curve toward the focus of the scale. With resumption of growth in the spring, the segments of the first circulus between the radii in this anterior field tend to be straight. These straight segments of this first spring circulus tend to form a straight line across this field, in contrast to the curved segments of the preceding and following circuli. (See Plates XI and XIX.)

The ages of the perch here discussed were determined by the number of the annuli as shown on the scales.

Size, age, and mortality. The age of each of the 1,827 White Perch was determined, and these fish have been combined by age groups for each lake. The number of fish, and their average lengths and weight and ranges in lengths and weight are given for each age group for each lake in Table XIV. Ages include the calendar year in which the fish were collected, with the exceptions of fish from Graham Lake and fish in the February 3, 1940 collection from Great Pond; for example, a V-fish collected in the summer of 1940 was a young of the year 1936.

The smallest fish taken from most of the lakes were about 6 to 6½ inches in total length, and were of about 1½ ounces in weight, but these minimum lengths and weights are of little special interest except that they indicate the lower size limit of fish taken by the nets. The maximum size is of more interest, since our collections were presumably representative samples of the larger fish. Perch over 10 inches in length were taken from most of the lakes; fish over 12 inches in length were taken from more than half of the lakes; and perch at least 14 inches long were taken from 4 lakes. The two largest fish were 14.4 inches long and were from Sebago Lake and Bear Pond. These larger fish were mostly over a pound in weight (fish from 15 lakes); fish of over 20 ounces in weight were obtained from 6 lakes; and the heaviest fish of 27.2 ounces was the 14.4-inch fish from Bear Pond. There were relatively few fish above 12 inches long (see frequency distribution of body lengths, on page 123); and there was a decided drop in numbers of fish in our samples above a length of about 10 inches, indicating a considerable mortality among perch after this size is reached.

The age distribution of those fish taken by gill net has been cited previously (page 124). If to this frequency are added the perch taken by other means (ages as given in Table XIV), the following age frequency for all fish is obtained:

Summer of life:	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
Number of fish:	10	236	146	326	276	254	218	161	115	42	22	14	5	1	1

The oldest fish, in its 17th summer of life (see Plates XXII and XXIII), was from Webb Lake in Weld. It was 12.3 inches long and weighed 14.6 ounces; it was, therefore, far from being the largest perch. The second oldest fish, in its 16th summer, was also from Webb Lake; it was only 11.9 inches long and weighed only 11.0 ounces. One of the five 15-year fish was also from Webb Lake, and weighed only 7.1 ounces. The remaining four 15-year fish were from Andro-scoggin Lake, Great Pond, and Pushaw Pond. Fish from 12 to s, years old were taken from many lakes, and fish at least 10 years ose were found in practically all of those lakes from which relat t be large collections of perch were obtained. The inference from these figures on age distribution is that, of those perch which reach a length of at least 6 inches, a considerable per cent live to be at least 8 to 10 years old, after which the rate of mortality increases greatly. The above figures on number of perch in the III-class to V-class deserve further comment. As already mentioned, the almost complete absence of III-fish was obviously due to failure of the net to catch these small fish. There is evidence that the low numbers of IV- and V-fish, as compared to VI-fish, were also due to failure of the nets to catch representative samples of these age groups. As will be discussed later, in many lakes the perch were growing so slowly that few individuals reached a length of 6 inches before they were 4 to 6 years old, and presumably the selecting gill net caught only the largest individuals, and relatively small numbers of fish, of these younger age groups.

Rate of growth. The rate of growth of the White Perch in the present group of lakes and ponds may be summarized from the data given in Table XIV. The numbers of fish, representing certain age groups and certain lakes, are obviously not adequate to show average growth for these individual age groups and lakes. However, among those lakes from which from 25 to over 300 perch are represented, the trend in growth among consecutive age groups is sufficiently orderly to indicate that the age groups were fairly well represented; the same is true for the number of fish in different age groups for all lakes combined. The rate of growth of the perch in this group of lakes as a whole may be represented by the unweighted averages of average lengths and weights for those age groups represented from the different lakes; these averages for body length in inches and weight in ounces, for the age groups as given in Table XIV, are as follows:

Age group:	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
Body length, inches:	5.7	5.5	6.5	6.7	7.1	7.6	8.0	8.3	8.7	9.5	9.8	10.0	9.8	9.6	10.0
Weight, ounces:	3.0	2.4	4.3	4.7	6.0	7.3	7.6	8.5	9.6	12.9	13.8	13.6	14.5	11.0	14.6

These average lengths and weights are indicated as an age-length curve by the heavy line in Figure 5 and an age-weight curve by the heavy line in Figure 6. These average lengths and weights should be interpreted with the knowledge of the failure of the net to catch the smaller fish. The age-length curves for the individual lakes (Figure 5), and the age-weight curves for some individual lakes (Figure 6), reflect the fact that the nets caught only the larger individuals of the younger age groups, especially from those lakes where the fish were growing more slowly; for some of these growth curves do not tend to swing sharply upward until the 6th, 7th, or even older age groups

are reached. The above average length and weight for III-fish are, presumably, much too large; and the figures for IV-fish to VI-fish are, to a decreasing degree, also somewhat too high. Judging from scale diameters (not measured), the true average lengths of III-, IV-, and V-fish from these lakes as a whole might be set at approximately 4, 5, and 6 inches, and their weights adjusted accordingly. A fairly accurate picture of average growth is presumably indicated by the above figures starting with the VI-fish. The average growth of the White Perch in these lakes is obviously very slow, as compared to the growth of such fresh-water game fishes in Maine as the bass, pickerel, trout, and salmon (judging from rather limited studies of these other species in Maine). It requires more than three years for the White Perch to reach the legal limit of 6 inches, and such small fish are still of little interest or are little prized by fishermen; the more desirable size of 10 inches (total length) or ½ pound requires about 10 years of growth; and the especially prized fish of over a pound in weight, in most lakes, take from 12 to 15 years to reach this size. It should be noted, among the preceding figures on average growth, that length and weight increased steadily up to an age of about 13 to 14 years, after which the trend was erratic, and some of the older fish were not so large as some of the younger ones. The explanation may be seen in Figures 5 and 6, namely, that in those lakes in general where the fish grew more rapidly, they did not live to so great an age as they did in lakes where they grew more slowly. In other words, White Perch live longer in waters where they grow more slowly — a phenomenon which has been recognized to apply to many species of fishes. This tendency for a greater age in those lakes where growth was slower may be affirmed by a numerical comparison: Of the 29 lakes from which at least 10 perch were obtained, the average growth of the White Perch from 17 lakes was below the average, as compared to all perch, while the growth of perch from 12 lakes was above the average (see page 151); the average age of the 1,323 perch representing 15 age groups from those lakes where growth was slow was 7.6 years, while the average age of the 469 perch representing 12 age groups from those lakes where growth was more rapid was 6.9 years (selectivity of the gill net might account for part of this difference, but not for all of it — see page 123).

The variation, between the different lakes, in average lengths of fish of given ages may be seen in Table XIV and Figure 5; in this figure the individual lakes are not identified. This degree of variation in rate of growth may be expressed quantitatively, i.e., by the difference between the average growth of fish in any one lake and the average growth of fish in the lakes as a whole. Numerical values, representing this variation in growth, have been calculated for those lakes represented by at least ten fish. These values, which might be

TABLE XIV. Average lengths and weight, and range in lengths and weight, of different age groups of 1,827 White Perch (*Morone americana*) from 43 lakes and ponds

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
Sabattus Pond, P.389 June 19 to 20, 1940	VI	6	5.2 (4.9–5.8)	6.4 (5.8–7.0)	1.8 (1.5–2.5)
	VII	17	5.4 (5.0–5.9)	6.5 (6.1–7.0)	1.8 (1.4–2.3)
	VIII	23	5.3 (5.1–6.3)	6.4 (6.0–7.6)	1.7 (1.5–2.8)
	IX	8	5.6 (5.1–6.1)	6.7 (6.1–7.3)	2.0 (1.6–2.5)
	X	4	5.6 (5.1–6.1)	6.7 (6.1–7.4)	2.0 (1.5–2.6)
	XI	2	7.3 (6.7–7.9)	8.8 (8.1–9.5)	4.8 (3.1–6.5)
	XIII	1	8.0	9.9	7.4
Taylor Pond, P.392 Aug. 13 to 14, 1940	V	2	5.9 (5.9–5.9)	7.2 (7.1–7.3)	2.7 (2.6–2.9)
	VIII	1	6.5	8.0	4.0
	IX	1	7.5	9.1	5.3
Tripp Pond, P.408 Aug. 9 to 10, 1940	VII	3	5.4 (5.2–5.6)	6.7 (6.4–6.9)	2.1 (1.9–2.4)
	VIII	5	5.6 (5.5–5.9)	7.0 (6.9–7.2)	2.4 (2.3–2.5)
	X	1	7.0	8.3	4.3
	XI	2	7.2 (6.9–7.5)	8.7 (8.5–9.0)	5.0 (4.8–5.3)
	XII	1	7.8	9.5	5.7
	XIV	1	9.1	10.8	8.9
Pennesseewassee Lake, P.416 July 16 to 17, 1940	IX	2	7.6 (7.6–7.6)	9.2 (9.1–9.2)	5.6 (5.5–5.7)
Auburn Lake, P.428 June 27 to 29, 1940	V	3	5.4 (5.3–5.5)	6.4 (6.3–6.5)	1.6 (1.5–1.7)
	VI	3	5.4 (5.2–5.6)	6.5 (6.4–6.7)	1.7 (1.7–1.8)
	VII	6	5.6 (5.4–6.3)	6.8 (6.5–7.5)	1.8 (1.7–2.1)
	VIII	1	5.4	6.7	1.7
	IX	1	7.1	8.5	3.8

*Ages include the calendar year in which the fish were collected for all except the fish in the February 3, 1940 catch from Great Pond of the Belgrades and the fish from Graham Lake.

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
Androscoggin Lake, P.464 June 25 to 26, 1940	VII	6	5.5 (5.2–5.8)	6.7 (6.2–6.9)	2.1 (1.6–2.4)
	VIII	8	5.7 (5.0–6.2)	6.9 (5.9–7.4)	2.5 (2.0–3.1)
	IX	4	6.1 (5.4–7.2)	7.4 (6.7–8.7)	3.4 (2.2–5.7)
	X	5	6.5 (5.6–7.6)	7.8 (6.7–9.1)	3.8 (2.4–5.9)
	XI	4	6.5 (5.2–7.7)	7.9 (6.5–9.3)	4.0 (1.8–6.2)
	XII	2	7.9 (7.8–8.0)	9.6 (9.3–9.8)	6.6 (5.5–7.7)
	XIV	1	9.9	11.7	13.3
	XV	1	10.4	12.4	15.3
Pocasset Lake, P.466 Aug. 2 to 3, 1940	IV	15	5.3 (5.1–5.5)	6.7 (6.3–7.0)	1.9 (1.6–2.3)
	V	11	5.4 (5.1–5.9)	6.9 (6.6–7.2)	2.0 (1.7–2.2)
	VI	25	5.9 (5.4–6.5)	7.4 (6.7–8.0)	2.5 (1.9–3.3)
	VII	4	6.1 (5.7–6.9)	7.7 (7.2–8.6)	3.0 (2.3–4.5)
	VIII	5	7.6 (6.9–8.7)	9.4 (8.6–10.6)	5.7 (4.3–8.6)
	IX	5	8.1 (7.7–9.1)	10.0 (9.5–11.2)	7.2 (5.8–10.5)
	X	6	8.9 (7.7–10.2)	11.1 (9.6–12.8)	10.3 (6.6–15.9)
	XI	4	9.6 (8.5–10.4)	11.9 (10.6–12.9)	12.3 (8.5–15.3)
	XII	2	9.6 (8.7–10.4)	11.7 (10.6–12.8)	11.5 (8.7–14.4)
Lovejoy Pond, P.470 Aug. 5 to 6, 1940	IV	7	5.6 (5.2–6.0)	6.7 (6.2–7.1)	2.0 (1.7–2.7)
	V	5	5.9 (5.4–6.3)	7.1 (6.6–7.5)	2.3 (1.8–2.8)
	X	1	10.4	12.3	13.9
	XI	1	10.8	12.9	16.5
	XII	1	10.3	12.3	12.7
Echo Lake, P.472 July 19 to 20, 1940	IV	1	5.4	6.7	1.9
	V	1	6.5	8.1	3.8
	VI	1	7.5	9.2	6.1
	VIII	1	8.7	10.6	9.3
	IX	12	8.4 (8.0–8.9)	10.3 (9.6–11.0)	8.1 (7.0–9.7)
	X	2	8.9 (8.7–9.2)	10.9 (10.7–11.1)	9.2 (8.8–9.6)
	XI	1	10.0	12.5	15.4
	XIII	1	10.9	13.5	18.6

TABLE XIV. Age and growth of White Perch — Continued

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
Webb Lake, P.503 Sept. 9 to 11, 1940	IV	65	5.2 (4.9–5.6)	6.5 (6.1–6.8)	1.9 (1.4–2.3)
	V	12	5.8 (5.2–6.5)	7.1 (6.4–8.0)	2.6 (1.9–3.7)
	VI	13	6.3 (6.1–6.9)	7.8 (7.4–8.4)	4.0 (3.1–4.4)
	VII	9	6.3 (6.0–7.0)	7.8 (7.4–8.5)	3.7 (3.2–4.9)
	VIII	20	6.7 (6.4–7.8)	8.4 (7.9–9.6)	4.5 (3.8–6.5)
	IX	19	6.9 (6.4–7.4)	8.5 (8.0–9.3)	4.8 (4.1–5.7)
	X	3	7.4 (7.2–7.6)	9.2 (8.9–9.5)	5.8 (5.6–6.2)
	XIV	1	7.8	9.7	6.9
	XV	1	8.0	10.0	7.1
	XVI	1	9.6	11.9	11.0
	XVII	1	10.0	12.3	14.6
South Pond, P.522 Sept. 4 to 5, 1940	III	1	7.1	8.7	5.9
Purgatory Pond, P.659 Aug. 14 to 15, 1940	V	1	5.5	6.8	2.1
	XI	1	9.1	11.0	10.1
Sand Pond, P.660 Aug. 15 to 16, 1940	VIII	1	9.3	11.4	11.9
	X	1	8.0	9.7	6.8
Cobbosseecontee Lake, P.668 Aug. 7 to 10, 1940	IV	9	5.1 (4.9–5.3)	6.3 (6.1–6.5)	1.7 (1.6–1.9)
	V	10	5.7 (5.4–6.2)	7.2 (6.9–7.6)	2.5 (2.1–2.9)
	VI	7	5.8 (5.2–6.0)	6.9 (6.3–7.4)	2.5 (1.8–2.7)
	VII	2	6.7 (6.7–6.7)	8.2 (8.2–8.3)	3.9 (3.8–3.9)
	VIII	4	7.0 (6.6–7.5)	8.7 (8.1–9.2)	4.6 (3.9–5.5)
	IX	2	7.8 (7.8–7.9)	9.6 (9.6–9.6)	6.7 (6.7–6.8)
	X	3	8.2 (8.0–8.3)	9.8 (9.6–10.0)	6.3 (5.6–7.1)
Annabessacook Lake, P.671 Aug. 5 to 7, 1940	V	1	5.4	6.5	1.9
	VI	13	5.4 (5.1–5.8)	6.6 (6.3–7.0)	2.0 (1.7–2.5)
	VII	12	5.7 (5.1–6.2)	7.0 (6.3–7.5)	2.6 (1.7–3.5)
	VIII	3	6.7 (5.7–7.9)	8.2 (6.9–9.7)	4.1 (2.5–6.4)
	IX	1	7.7	9.5	6.1
	X	1	7.9	9.7	6.4
	XI	1	7.6	9.3	6.3

TABLE XIV. Age and growth of White Perch — Continued

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
Cochnewagan Pond, P.672 June 18 to 19, 1940	VI	3	7.6 (7.6–7.7)	9.3 (9.1–9.4)	5.8 (5.6–6.0)
	VII	3	8.0 (7.9–8.1)	9.6 (9.6–9.8)	6.2 (5.9–6.3)
	VIII	3	7.8 (7.7–8.0)	9.5 (9.3–9.6)	6.2 (5.7–6.5)
	IX	19	8.1 (7.7–8.5)	9.7 (9.2–10.4)	6.9 (6.0–9.0)
	X	24	7.9 (7.8–8.6)	9.8 (9.3–10.4)	6.9 (5.8–8.0)
	XI	39	8.1 (7.8–8.7)	9.7 (9.4–10.4)	6.9 (6.3–8.3)
	XII	8	8.2 (8.0–8.3)	9.9 (9.5–10.2)	7.3 (6.6–9.1)
	XIII	3	8.2 (8.1–8.3)	9.9 (9.8–10.1)	7.2 (6.9–7.4)
	XIV	1	8.7	10.4	8.4
Wilson Pond, P.673 July 30 to Aug. 1, 1940	V	2	5.3 (5.2–5.4)	6.7 (6.6–6.8)	1.9 (1.9–2.0)
	VI	13	5.5 (5.1–6.6)	6.8 (6.4–8.1)	2.1 (1.7–3.8)
	VII	10	6.7 (5.3–8.3)	8.1 (6.6–9.8)	3.9 (1.8–6.7)
	VIII	2	7.9 (7.3–8.4)	9.6 (8.9–10.2)	6.1 (4.9–7.4)
	IX	3	8.3 (7.9–8.7)	9.9 (9.3–10.5)	6.7 (5.4–8.1)
	X	3	8.7 (8.0–9.1)	10.5 (9.8–10.9)	8.3 (6.8–9.2)
	XI	1	8.5	10.0	7.4
Maranacook Lake, P.676 Aug. 1 to 4, 1940	III	1	5.0	6.1	1.6
	IV	17	5.8 (5.1–6.3)	7.0 (6.6–7.7)	2.7 (2.1–3.6)
	V	5	7.5 (7.3–7.7)	9.2 (9.1–9.5)	5.8 (5.6–6.2)
	VI	19	7.7 (6.8–8.3)	9.3 (8.3–10.2)	6.3 (4.3–8.5)
	VII	10	8.0 (7.6–8.7)	9.8 (9.4–10.6)	7.5 (6.1–10.1)
	VIII	7	8.0 (7.7–8.4)	9.8 (9.5–10.4)	7.5 (6.4–8.7)
	IX	17	8.3 (7.9–8.7)	10.1 (9.6–10.6)	8.4 (7.0–10.0)
	X	9	9.5 (9.1–10.0)	11.5 (11.2–12.4)	12.6 (10.9–14.8)
	XI	4	9.6 (8.9–10.0)	11.7 (10.8–12.2)	13.8 (13.0–15.7)
	XII	1	9.8	12.0	13.3
Torsey Pond, P.678 July 30 to 31, 1940	VIII	1	9.3	11.0	15.0

TABLE XIV. Age and growth of White Perch — Continued

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
Snow Pond, P.698 June 27 to July 3, 1940	V	1	5.3	6.5	1.6
	VI	6	5.2 (4.9–5.3)	6.3 (6.1–6.5)	1.7 (1.6–2.3)
	VII	29	5.3 (4.7–8.5)	6.5 (5.7–10.0)	2.0 (1.3–9.6)
	VIII	14	5.6 (4.9–6.1)	6.8 (6.1–7.5)	2.2 (1.6–3.0)
	IX	15	5.8 (4.9–7.6)	7.0 (6.1–9.3)	2.5 (1.6–6.2)
	X	4	6.4 (5.8–7.0)	7.6 (7.0–7.9)	3.2 (2.3–4.4)
	XI	2	7.4 (7.2–7.7)	9.3 (9.2–9.3)	5.9 (5.5–6.3)
	XII	9	8.3 (7.8–9.1)	10.1 (9.5–11.0)	7.8 (6.4–9.4)
	XIII	3	8.5 (7.7–9.3)	10.4 (9.3–11.3)	8.3 (5.9–9.8)
Long Pond of Belgrades (South Part), P.712 June 26 to 27, 1940	VIII	3	8.6 (8.5–8.7)	10.4 (10.0–10.6)	9.5 (9.2–9.9)
	IX	6	9.1 (8.5–9.8)	10.9 (9.8–11.4)	11.3 (8.7–13.3)
	X	9	9.5 (9.3–9.9)	11.6 (11.2–12.3)	12.8 (11.3–14.9)
	XI	4	9.1 (8.3–10.0)	11.1 (10.0–12.0)	10.7 (8.0–12.9)
	XIII	2	9.6 (9.1–10.2)	11.8 (11.2–12.4)	13.2 (10.9–15.4)
	XIV	1	10.8	12.8	17.1
Long Pond of Belgrades (North Part), P.713 June 21 to 25, 1940	IV	4	5.3 (5.1–5.4)	6.4 (6.2–6.5)	1.8 (1.5–1.9)
	VI	2	6.6 (5.6–7.6)	7.9 (6.6–9.2)	3.7 (2.3–5.1)
	VIII	3	7.1 (6.3–7.6)	8.5 (7.7–9.0)	4.9 (3.3–6.1)
	IX	4	8.0 (7.4–8.3)	9.7 (9.1–9.9)	6.7 (5.5–7.7)
	X	10	8.1 (7.7–8.9)	9.8 (9.5–10.6)	6.7 (5.8–8.8)
	XI	5	8.5 (7.7–10.0)	10.4 (9.3–12.0)	8.4 (5.8–12.8)
	XII	1	8.7	10.6	8.0
	XIV	1	10.6	13.3	15.4

TABLE XIV. Age and growth of White Perch — Continued

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
Great Pond of Belgrades, P.719 Feb. 3, 1940	III*	1	4.4	5.5	1.2
	V*	15	5.8 (4.7–6.4)	7.1 (5.6–7.8)	2.6 (1.4–3.4)
	VI*	86	6.3 (4.9–7.0)	7.5 (6.1–8.4)	3.1 (1.4–4.0)
	VII*	37	6.3 (5.9–6.9)	7.8 (7.0–8.5)	3.5 (2.7–4.3)
	VIII*	38	6.5 (6.1–7.2)	8.0 (7.4–8.7)	3.7 (3.0–4.9)
	IX*	5	7.0 (6.4–7.8)	8.6 (7.9–9.6)	4.8 (3.5–6.5)
	X*	4	7.1 (6.5–7.7)	8.8 (8.1–9.6)	5.0 (3.8–7.0)
Great Pond of Belgrades, P.719 June 17 to July 12, 1940	IV	3	5.0 (4.9–5.1)	6.0 (5.9–6.1)	1.6 (1.4–1.7)
	VI	17	5.7 (5.1–6.5)	7.0 (6.3–7.9)	2.4 (1.7–3.6)
	VII	24	6.1 (4.7–7.1)	7.4 (6.1–8.7)	3.0 (1.6–4.5)
	VIII	19	6.7 (5.8–7.6)	8.1 (6.9–9.3)	4.1 (2.2–6.2)
	IX	15	7.4 (6.5–7.9)	8.8 (7.9–9.5)	5.4 (3.4–6.5)
	X	11	7.9 (7.2–8.5)	9.6 (8.7–10.4)	6.9 (5.5–9.2)
	XI	14	8.8 (7.9–10.0)	10.6 (9.5–12.0)	9.3 (6.3–16.0)
	XII	5	8.9 (7.7–9.7)	10.7 (9.3–11.6)	9.3 (5.8–11.8)
	XIII	3	10.2 (9.6–10.7)	12.2 (11.4–12.8)	14.4 (12.7–16.1)
	XIV	4	10.2 (10.0–10.6)	12.2 (12.0–12.6)	15.6 (12.5–17.5)
	XV	1	10.3	12.8	15.8
Great Pond of Belgrades, P.719 Sept. 6 to 8, 1940	IV	45	5.3 (4.9–6.2)	6.7 (6.1–7.7)	2.0 (1.5–3.3)
	V	1	5.9	7.3	2.7
	VI	2	6.2 (6.1–6.3)	7.7 (7.6–7.8)	3.5 (3.5–3.6)
	VII	13	6.3 (5.7–7.0)	7.8 (7.0–8.6)	3.6 (2.4–5.1)
	VIII	12	6.9 (6.3–7.6)	8.6 (7.8–9.4)	4.9 (3.5–6.3)
	IX	8	7.2 (6.4–7.9)	8.8 (8.0–9.7)	5.6 (3.7–7.4)
	X	10	7.4 (6.1–8.3)	9.1 (7.6–10.2)	6.0 (3.2–8.0)
	XI	6	7.7 (6.9–8.2)	9.5 (8.6–10.1)	6.9 (5.1–8.7)

TABLE XIV. Age and growth of White Perch — Continued

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
North Pond of Belgrades, P.720 July 9 to 11, 1940	IV	2	5.1 (4.9–5.2)	6.3 (6.2–6.3)	1.8 (1.7–1.9)
	V	1	5.0	6.1	1.7
	VI	11	5.2 (5.0–5.5)	6.5 (6.1–6.7)	1.9 (1.6–2.1)
	VII	22	5.4 (5.0–5.9)	6.6 (6.1–7.0)	2.1 (1.7–2.5)
	VIII	16	5.7 (5.1–7.3)	7.1 (6.3–8.9)	2.7 (1.9–5.5)
	IX	9	6.4 (5.8–7.4)	7.8 (7.1–8.9)	3.6 (2.6–5.2)
	X	8	7.5 (6.3–8.3)	9.2 (7.7–10.2)	6.0 (3.5–8.1)
	XI	3	8.8 (8.5–9.1)	10.8 (10.6–11.0)	9.6 (8.7–11.2)
	XII	1	10.7	13.2	16.9
	XIII	2	10.2 (10.0–10.3)	12.4 (12.2–12.6)	14.3 (13.6–14.9)
	XIV	1	10.2	12.6	16.0
East Pond of Belgrades, P.724 July 11 to 13, 1940	IV	43	5.4 (5.0–5.8)	6.6 (6.1–7.2)	2.1 (1.7–2.7)
	V	2	6.3 (6.2–6.3)	7.6 (7.5–7.6)	3.4 (3.3–3.5)
	VI	6	6.5 (6.3–6.9)	7.9 (7.6–8.5)	3.9 (3.5–4.9)
	VII	16	6.8 (6.3–7.8)	8.2 (7.6–9.5)	4.3 (3.5–5.8)
	VIII	6	7.7 (7.2–7.9)	9.3 (8.9–9.6)	5.8 (5.4–6.3)
	IX	3	8.6 (8.0–9.3)	10.3 (9.4–11.1)	8.1 (6.1–10.1)
	X	3	9.2 (9.1–9.3)	11.1 (11.0–11.2)	9.6 (9.5–9.9)
	XI	1	10.0	12.3	14.8
	XII	2	10.8 (10.7–10.8)	13.0 (12.8–13.1)	16.8 (16.4–17.2)
Sandy Pond, P.883 July 27 to 28, 1940	VIII	6	8.3 (8.2–8.6)	10.0 (9.8–10.3)	7.6 (7.2–8.3)
	IX	2	9.5 (8.5–10.5)	11.3 (10.1–12.4)	11.2 (7.4–15.0)
	X	3	9.6 (9.2–10.2)	11.0 (10.8–12.1)	11.9 (10.3–14.3)
	XI	1	9.0	10.8	10.0

TABLE XIV. Age and growth of White Perch — Continued

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
Moose Pond, P.182 Bridgton Twp. July 17 to 18, 1938	IV	1	5.4	6.5	1.9
	V	7	5.8 (5.3–6.7)	7.1 (6.6–8.2)	2.4 (1.9–3.7)
	VI	6	6.4 (5.8–7.2)	7.9 (7.1–8.8)	3.4 (2.5–4.8)
	VII	7	6.5 (5.7–7.6)	8.0 (7.2–9.2)	3.7 (2.4–5.6)
	VIII	2	7.9 (7.6–8.2)	9.8 (9.6–10.0)	6.5 (6.2–6.8)
	IX	2	8.3 (8.2–8.3)	10.2 (10.2–10.3)	7.1 (6.4–7.9)
	X	2	9.2 (8.9–9.5)	11.4 (11.0–11.7)	10.1 (8.6–11.5)
Beaver Pond, P.183 Bridgton Twp. July 21 to 22, 1938	V	2	8.2 (8.0–8.4)	10.1 (9.8–10.4)	8.7 (8.3–9.0)
	VI	2	9.2 (9.2–9.3)	11.3 (11.2–11.3)	11.4 (11.0–11.9)
	VII	2	9.6 (9.3–9.8)	11.7 (11.2–12.0)	12.6 (11.3–13.9)
	VIII	3	9.7 (9.5–9.9)	11.9 (11.4–12.1)	13.5 (13.3–13.8)
	IX	2	11.0 (10.2–11.7)	13.2 (12.4–14.0)	18.0 (15.5–20.4)
Kezar Lake, P.238 Lovell Twp. July 20 to 21, 1938	IV	1	8.3	9.8	8.5
	V	1	9.4	11.4	12.7
	VII	2	9.9 (9.9–9.9)	12.0 (11.9–12.0)	15.5 (15.1–15.8)
Sebago Lake, P.291 Raymond Twp. Aug. 4 to 5, 1938	VII	1	8.9	10.7	10.8
	VIII	5	9.2 (8.6–10.0)	11.1 (10.4–12.0)	12.1 (9.4–15.1)
	IX	2	9.7 (9.5–9.9)	11.7 (11.5–12.0)	14.5 (13.9–15.1)
	XIII	3	11.1 (10.6–11.9)	13.4 (12.8–14.4)	21.4 (18.9–25.8)
	XIV	1	11.7	14.4	24.5
Adams Pond, P.307 Bridgton Twp. July 1 to 2, 1938	VII	4	8.2 (8.1–8.3)	10.0 (9.8–10.1)	8.1 (7.7–8.5)
Long Lake, P.309 Harrison Twp. July 7 to 8, 1938	VIII	8	5.8 (5.2–6.3)	7.2 (6.4–7.8)	2.4 (1.7–2.9)
	IX	3	5.9 (5.6–6.4)	7.3 (6.9–7.8)	2.5 (2.0–3.1)
Wood Pond, P.313 Bridgton Twp. June 22 to 24, 1938	VIII	2	9.3 (8.6–9.9)	11.2 (10.6–11.8)	11.4 (8.9–13.9)

TABLE XIV. Age and growth of White Perch — Continued

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
Highland Lake, P.314 Bridgton Twp. June 29 to 30, 1938	VI	1	8.3	10.0	8.1
	IX	1	9.7	11.7	9.1
	X	2	9.5 (9.0-9.9)	11.3 (10.7-11.9)	10.2 (9.4-10.9)
	XI	1	9.2	11.2	10.7
	XII	2	9.7 (9.7-9.7)	11.8 (11.8-11.8)	13.9 (13.7-14.0)
	XIII	2	10.0 (9.9-10.1)	11.9 (11.8-12.0)	14.3 (13.7-15.0)
	XIV	1	10.7	12.7	16.5
Stearns Pond, P.315 Sweden Twp. July 25 to 26, 1938	XII	1	10.3	12.7	17.9
Bear Pond, P.321 Waterford Twp. July 28 to 29, 1938	III	2	6.6 (6.1-7.0)	8.1 (7.5-8.6)	4.2 (3.3-5.0)
	V	1	9.0	10.9	11.3
	XII	1	11.7	14.4	27.2
Crystal Lake, P.324 Harrison Twp. July 27 to 28, 1938	VII	1	7.4	9.2	5.6
	VIII	3	7.5 (7.4-7.6)	9.2 (9.1-9.3)	5.9 (5.7-6.1)
Pleasant Lake, P.327 Casco Twp. Aug. 11 to 12, 1938	VI	1	6.3	7.7	2.8
	VIII	1	7.2	8.9	3.9
	XIV	1	10.2	12.6	7.2
Thomas Pond, P.356 Raymond Twp. Aug. 17 to 19, 1938	III	5	5.6 (5.5-5.7)	6.9 (6.7-7.1)	2.1 (2.0-2.3)
	V	32	8.1 (6.9-9.1)	9.9 (8.5-11.2)	7.7 (4.4-11.1)
	VI	35	9.3 (8.5-10.0)	11.3 (10.5-12.2)	12.4 (9.2-16.0)
	VII	21	10.0 (9.5-10.5)	12.1 (11.5-12.9)	15.2 (12.6-17.1)
	VIII	1	9.8	11.8	13.6
Rattlesnake Pond, P. 359 Casco Twp. Aug. 22 to 23, 1938	IV	6	5.7 (5.3-6.3)	7.0 (6.6-7.6)	2.3 (1.8-2.9)
	V	20	6.1 (5.5-6.6)	7.5 (6.7-8.1)	3.1 (2.1-3.8)
	VI	3	6.3 (6.2-6.3)	7.7 (7.6-7.8)	3.2 (3.1-3.4)
	VII	1	6.3	7.8	3.4
	VIII	4	9.3 (9.0-9.8)	11.3 (10.8-12.0)	11.8 (10.7-14.4)
	IX	9	9.9 (9.4-10.5)	12.0 (11.4-12.6)	14.2 (10.4-18.3)
	X	2	10.2 (10.0-10.3)	12.2 (12.2-12.3)	14.5 (14.2-14.9)
	XI	3	10.3 (10.2-10.6)	12.7 (12.5-13.0)	15.0 (13.6-16.1)
	XII	1	11.1	13.6	21.5
	XIII	1	11.1	13.5	20.0

TABLE XIV. Age and growth of White Perch — Concluded

Lake, and date of collection	Age in growing seasons*	Number of fish	Body length in inches	Total length in inches	Weight in ounces
South Branch Lake Seboeis Twp. June 2, 1938	V	1	8.7	10.6	8.5
Graham Lake Waltham Twp. Jan. 29 and Feb. 12, 1939	V*	8	8.3 (7.8-8.8)	10.2 (9.5-10.8)	8.5 (6.3-10.0)
	VI*	13	9.0 (8.5-9.7)	11.1 (10.4-12.0)	11.4 (8.0-15.8)
	VII*	5	9.9 (9.4-10.6)	12.2 (11.6-13.1)	16.5 (14.4-20.3)
	VIII*	1	10.8	13.1	23.4
	IX*	2	10.8 (10.1-11.4)	13.0 (12.3-13.6)	21.1 (17.8-24.4)
	X*	1	10.7	13.1	21.8
Graham Lake Waltham Twp. Jan. 30, 1941	VI*	7	8.7 (7.8-9.5)	10.1 (9.3-11.5)	9.1 (6.8-12.8)
	VII*	7	9.1 (8.6-9.8)	11.0 (10.5-11.6)	11.8 (10.5-14.0)
	VIII*	4	10.7 (9.9-11.4)	13.1 (12.1-13.9)	19.3 (15.7-23.5)
Pushaw Pond Hudson Twp. Oct. 14 to 16, 1940	IV	17	5.4 (5.0-6.3)	6.7 (6.1-7.7)	2.0 (1.5-3.1)
	V	1	6.4	8.0	3.3
	VI	25	6.7 (5.8-8.0)	8.4 (7.4-9.9)	4.3 (2.5-7.8)
	VII	2	7.8 (7.5-8.2)	9.6 (9.3-9.9)	6.7 (5.8-7.5)
	VIII	18	7.4 (6.8-8.2)	9.3 (8.5-10.1)	5.7 (4.6-7.1)
	IX	36	7.5 (7.0-8.7)	9.3 (8.6-10.6)	6.1 (4.8-10.0)
	X	29	7.9 (7.1-9.8)	9.8 (9.0-12.1)	7.2 (5.1-12.4)
	XI	15	7.8 (7.2-8.6)	9.7 (9.1-10.7)	6.8 (5.6-9.2)
	XII	4	8.5 (7.9-9.3)	10.5 (9.6-11.5)	9.6 (7.1-12.1)
	XIII	1	9.8	12.1	12.7
	XV	2	10.4 (9.5-11.4)	13.0 (11.7-14.2)	19.9 (13.7-26.2)

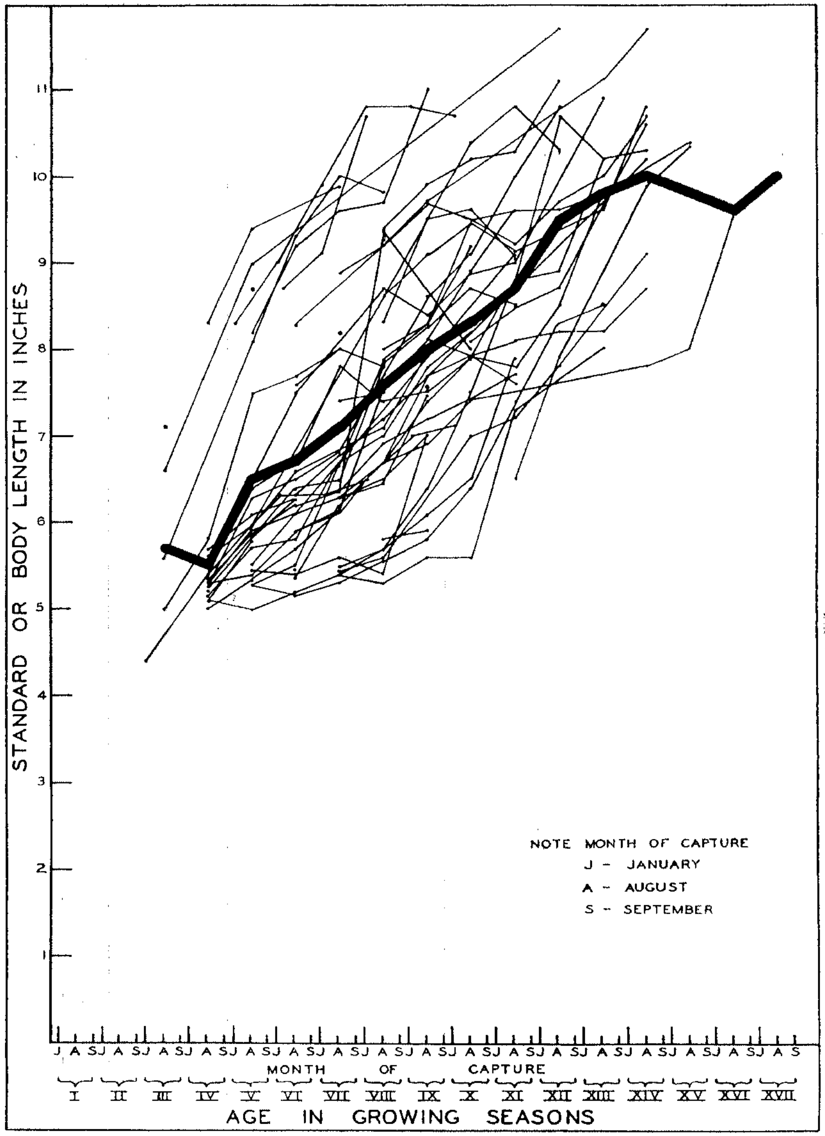


Figure 5. Age-length curves of body lengths (does not include tail fin) of White Perch for individual lakes (lakes not identified), and the average age-length curve for all lakes. Isolated dots represent single age groups for individual lakes. Data are from Table XIV.

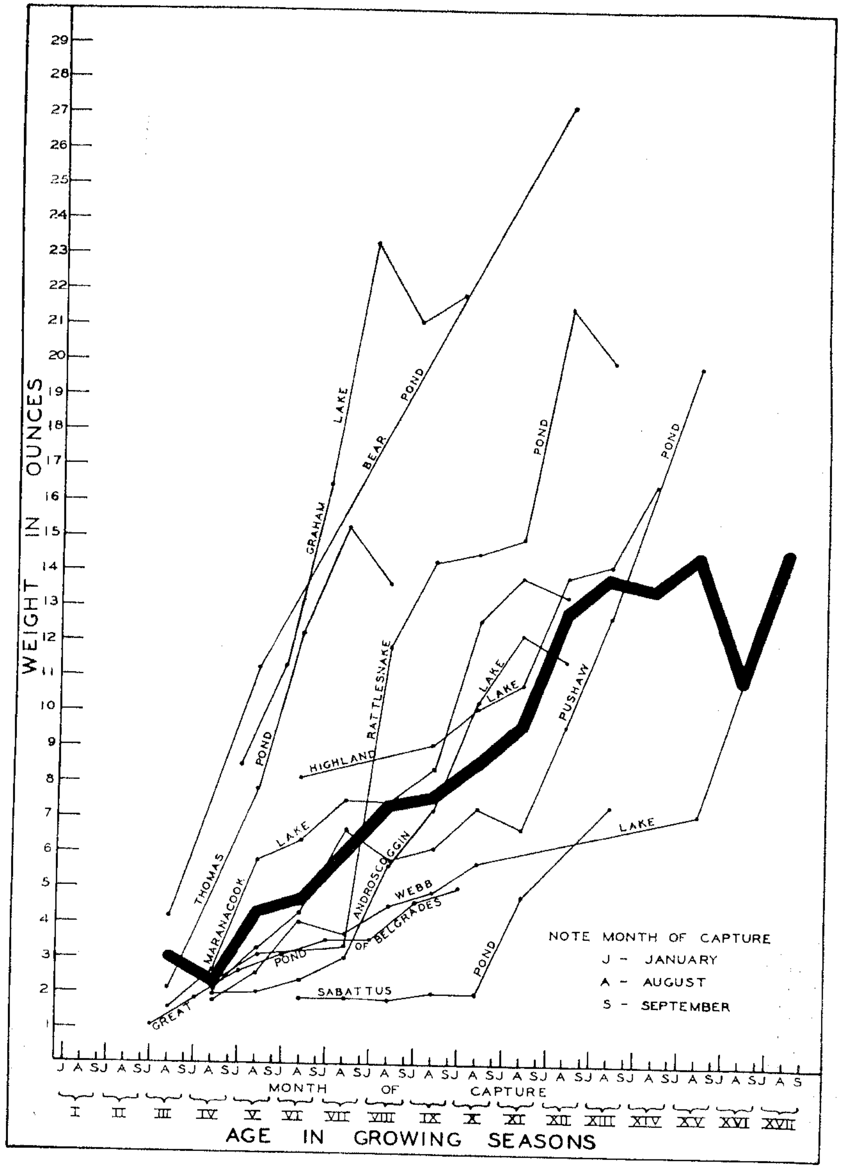


Figure 6. Age-weight curves for White Perch for selected individual lakes and the average age-weight curve for all lakes. Data are from Table XIV.

TABLE XV. The rate of growth of White Perch from 20 lakes, as compared to foo
and feeding habits, density of fish populations, and type of lake

Name of lake or pond	Growth index for White Perch*	Volume in c.c. of bottom fauna per square foot**	Percentage by volume of bottom food in diet of perch***	Percentage by volume of fish in diet of perch***	Percentage by volume of plankton crustacea in diet of perch***	Number of fish caught per 24 hours by 375-foot gill net****		Per cen of wate volume in trout or salmo zone****
						White Perch	White Perch plus other species	
Sandy	+1.0	0.14	74	24	2	16	16	20
Lovejoy	+0.9	0.27	9	83	1	18	41	0
Echo	+0.7	0.21	32	56	4	21	30	43
Long of Belgrades (South)	+0.7	0.25	89	6	4	13	16	30
Maranacook	+0.6	0.41	60	36	3	37	50	33
East of Belgrades	+0.4	0.55	45	51	3	80	117	0
Long of Belgrades (North)	—0.2	0.23	89	9	2	8	12	12
Pocasset	—0.2	0.30	55	44	0	45	63	0
Cochnewagan	—0.3	0.66	94	0	5	105	109	0
Wilson (P.673)	—0.3	0.30	97	2	0.1	18	25	0
Cobbosseecontee	—0.5	0.27	91	8	0	13	44	6
Great of Belgrades	—0.6	0.30	66	30	4	27	31	0
North of Belgrades	—0.7	0.52	98	2	0	62	76	0
Webb	—0.8	0.39	16	7	66	46	65	6
Annabessacook	—0.9	0.62	40	53	6	17	42	2
Androscoggin	—1.3	0.23	95	5	0.2	16	23	0
Auburn	—1.4	0.14	2	0	98	7	23	47
Tripp	—1.5	0.07	100	0	0	10	17	0
Snow	—1.6	0.71	100	0	0.3	18	27	0
Sabattus	—2.0	0.87	96	0	0	128	139	0

* Based on 1,379 perch from these 20 lakes as compared to the average growth of 1,827 perch from 43 lakes (see Table XIV).

** Data on bottom fauna in these 20 lakes based on 428 bottom samples. (From Table VIII).

*** Based on 1,242 perch stomachs which contained 644.148 c.c. of food of which 431.948 c.c. or 67% was from the bottom fauna, 166.645 c.c. or 26% was fish, and 37.136 c.c. or 6% was plankton crustacea. Data condensed from Table XI.

**** Represents a total of 54 individual over-night gill net sets, for a total of 1,226 hours of fishing, or an average of 22½ hours per set. The fish included are 1,610 White Perch, 283 Common Suckers, 165 Yellow Perch, 76 Horned Pout, and 76 Sunfish: a total of 2,210 fish. These were the most abundant species encountered in the net collections and known or believed to be primarily bottom feeders.

***** "Trout or salmon zone" refers to a stratum of deep water of a temperature of less than 70° F. and a dissolved oxygen content of more than 5 p.p.m. as maintained during late summer. Data are from Table III.

termed growth indices, were obtained by comparing average body lengths for individual age groups from each lake with the average lengths (given in the preceding paragraph) for corresponding age groups for all lakes combined; the sum of length differences by which growth was above the average, minus the sum of length differences by which growth was below the average, was divided by the number of age groups involved; and the resultant figure, or growth index, for each lake was thus the average amount by which the average lengths for individual age groups varied above or below the average lengths for the different age groups for all lakes combined. These average deviations of body length in inches, and the number of age groups involved, for White Perch for the lakes as given in Table XIV, were as follows:

Lake	Deviation in length from average	Number age groups
Sabattus	—2.0	7
Tripp	—1.5	6
Auburn	—1.4	5
Androscoggin	—1.3	8
Pocasset	—0.2	9
Lovejoy	+0.9	5
Echo	+0.7	8
Webb	—0.8	11
Cobbosseecontee	—0.5	7
Annabessacook	—0.9	7
Cochnewagan	—0.3	9
Wilson (P.673)	—0.3	7
Maranacook	+0.6	10
Snow	—1.6	9
Long of Belgrades (S)	+0.7	6
Long of Belgrades (N)	—0.2	8

Lake	Deviation in length from average	Number age groups
Great: Feb. 3	—0.9	7
Great: June to July	—0.3	11
Great: Sept.	—0.7	8
North of Belgrades	—0.7	11
East of Belgrades	+0.4	9
Sandy	+1.0	4
Moose	—0.03	7
Beaver	+2.4	5
Sebago	+1.6	5
Long Lake (P.309)	—1.9	2
Highland	+0.9	7
Thomas	+1.8	5
Rattlesnake	+0.9	10
Graham: 1939	+2.6	6
Graham: 1941	+2.4	3
Pushaw	—0.2	11

The most-rapidly growing fish were those in the 1939 collections from Graham Lake, with an average length, by age groups, of 2.6 inches above the average for all fish. The 1941-fish from Graham Lake and the fish from Beaver Pond also had made very rapid growth — 2.4 inches above the average. Growth of perch from Moose Pond was about the same as the average for fish from all localities. The perch from Sabattus Pond represented the extreme in dwarfing, being 2.0 inches below the average. Other lakes notable for very slow growth of the White Perch were Long Lake (P.309), Snow Pond, Tripp Pond, Auburn Lake, and Androscoggin Lake. In most lakes of the 1940 survey, perch were of much slower growth than in lakes of the 1938 survey.

Growth as related to other factors. Among the factors which might be expected to influence the rate of growth of the White Perch in lakes are: the extent to which the fish feed on different types of food, the abundance and availability of food, the population density of the White Perch itself and of other species which might compete with it for food, and the conditions of temperature and dissolved oxygen in the water. Some data were available for a comparison of rate of growth with these environmental factors in 20 of the lakes of the 1940 survey. These available data for individual lakes included: the preceding numerical values representing average growth of White Perch; average volumes of all bottom organisms per square foot of lake bottom; the percentages by volume of bottom organisms, fish, and plankton crustaceans in the diet of the White Perch; the density of the White Perch population, and of the total population of fishes (including the sucker, Yellow Perch, Horned Pout, and sunfish) which are primarily bottom feeders, expressed as the number of fish caught per 24 hours by the 375-foot gill net; and the type of lake or pond with respect to depth, temperature, and dissolved oxygen content of the water, as expressed by the percentage of water volume in the trout or salmon zone of each lake. These data, given in Table XV, do not reveal the degree of correspondence, between rapid growth of the White Perch and abundance of bottom food, which might be expected from the fact that 67 per cent of the volume of food contained by these fish was from the bottom fauna: the four lakes which provided the most-rapidly growing perch were among the poorest in bottom fauna, and the two lakes richest in bottom fauna provided the most-slowly growing perch — between these extremes in the data there appeared to be no significant relationship between growth and abundance of bottom food. No consistent relationship is indicated between growth and amount of plankton crustaceans in the diet; or between growth of the White Perch and the density of this and other species of bottom-feeding fishes, with the possible exception of Sabattus Pond. The best correlation apparently existed between growth of perch and the amount of fish in their diet, and between growth and the type of lake with respect to depth, temperature, and dissolved oxygen content of the water. The White Perch which contained the most fish in their diet were mostly those which had made the fastest growth; and the rapidly growing fish were mostly from deep lakes with a high oxygen content in the deep water (lakes which are classed as good trout or salmon lakes; see page 66). The tendency toward a faster rate of growth of perch in lakes where they had fed more on fish was also indicated by a comparison of perch from the lakes of the 1940 survey with perch from lakes surveyed in 1938: the perch from Beaver, Thomas, Sebago, Rattlesnake, Highland, Moose, Long, etc., (see Table XII) mostly had made a more-rapid growth and also contained more fish in their diet

(compare Tables XII and XI) than fish from lakes of the 1940 survey. However, a tendency toward more-rapid growth in deep lakes with a high content of dissolved oxygen in the deep water (i.e., good trout or salmon lakes) was not indicated by the data for the lakes of the 1938 survey, for most of these lakes in which the perch were growing rapidly (examples: Beaver, Thomas, Rattlesnake, and Highland) were found to be poor trout and salmon lakes (Cooper, 1939b).

Age and growth by sexes. The present data indicate some facts with respect to sex differences in age and growth. If those age groups from individual lakes with at least five fish of each sex are considered, the females exceeded the males in average body length in 33 separate groups; the males were longer in 8 groups; and the two sexes were of the same length in 6 groups. The figures for individual age groups, involving 1,101 fish from 15 lakes, were as follows:

Age group:	IV	V	VI	VII	VIII	IX	X	XI	Total
Males longer:	.	.	2	3	.	1	1	1	8
Females longer:	3	3	6	5	7	4	3	2	33
Same length:	2	1	1	.	1	1	.	.	6

This rather consistent greater length, and presumably faster growth, of the females is not of very great economic importance, for the greater average size of the females in these individual age groups was mostly not over 0.5 inch and commonly as little as 0.2 inch. Of the 1,827 White Perch used for studies on age and growth, the sex of 1,819 was determined. These included 856 males and 963 females, or a sex ratio of 0.89 male to 1 female. Their distribution by age class was:

Age group:	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
Number males:	2	105	66	143	134	135	109	68	60	26	5	1	1	0	1
Number females:	8	129	80	182	141	119	108	91	54	16	17	13	4	1	0
Males per female:	0.3	0.8	0.8	0.8	1.0	1.1	1.0	0.7	1.1	1.6	0.3	0.1	0.3	0	.

The above sex ratios are somewhat too erratic to reveal any definite trend in marked change of sex ratio with age, except for a rather definite preponderance of females over males above the XII-group. That this trend in sex ratio is erratic, was due largely to the fact that unusual numbers of fish of one sex and one age group were obtained from some lakes. For examples, the 14 fish from Auburn Lake were all females; the 103 fish from Cochnewagan included 71 males and 30 females (sex of two not determined) of which 82 fish were of the IX- to XI- groups; there were nine XII-males but no XII-females from Snow Pond; there were seven XII-males and only one XII-female from Cochnewagan; while 11 of the 20 fish from Echo Lake were IX-males. There was evidence that variations in average rate of growth had little or no effect on differences in age of the two sexes, for the distribution of sexes by age group of 1,323 perch from 17 lakes in which growth was slow was as follows:

Age group:	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
Number males:	0	74	26	102	101	109	79	58	53	23	3	1	1	0	1
Number females:	1	86	39	135	105	95	79	69	45	10	10	9	4	1	0
Males per female:	0	0.9	0.7	0.8	1.0	1.1	1.0	0.8	1.2	2.3	0.3	0.1	0.3	0	.

while the distribution of 469 perch from 12 lakes in which growth was relatively fast was as follows:

Age group:	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Number males:	1	31	39	41	29	22	28	10	7	2	2	0
Number females:	5	42	36	46	33	19	28	21	8	5	7	3
Males per female:	0.2	0.7	1.1	0.9	0.9	1.2	1.0	0.5	0.9	0.4	0.3	0

The differences between the above sex ratios for corresponding age groups are not regarded as of much significance. Instead of this comparison revealing any marked variation of difference in age of the sexes according to rate of growth, it indicated a degree of uniformity in that both sexes reached a greater age in lakes where growth was slow, and that females predominated in the older age groups among both slowly growing and rapidly growing fish.

Growing season. The collecting of White Perch continually throughout the summer, although at different times from the various lakes, has afforded a basis for determining the time when the fish commenced their scale growth, and thus, presumably, their body growth. The date at which fish begin a season's growth may be determined from the status of annulus formation on scales among fish collected on different dates. Observations on the scales indicated that the growing season of the White Perch in lakes of the 1940 survey extended from about the first or second week in July through August and possibly part of September. Typical scales, taken at different dates and revealing this trend in growth during the season, are reproduced on accompanying plates as follows: from Auburn Lake on June 28 showing no growth as yet in 1940 (Plates XV and XVI), from North and East ponds of the Belgrades on July 11 and 13 showing annuli just formed (Plates X and XI), from Maranacook Lake on August 3 showing a partly or nearly completed average summer's growth (Plates V, VI, and VII), and from South Pond on September 5 (Plate IV) and Webb Lake on September 10 (Plate XIV) showing what appear to be completed average summer's growths.

FOOD HABITS OF OTHER FISHES

Information on the food habits of 10 species, other than the White Perch, was also obtained by stomach analyses. These additional species were Small-mouthed Bass, Common Pickerel (*Esox niger*), Yellow Perch, Pike Perch (*Stizostedion vitreum*), Brook Trout, Togue, Land-locked Salmon, Chinook Salmon, Common Sucker, and Common Sunfish (*L. gibbosus*). All of the fish were collected by experimental gill nets, and all except those from Pushaw Lake were collected during the summer. The lakes are the same as given in Tables XII and XIV. Most of the fish were adults; and all, except some sunfish, were over six inches long. The results, therefore, represent summer food habits for the adults of these species. The results of these food analyses are summarized in Tables XVI to XIX, and discussed for the individual species in the following:

Small-mouthed Black Bass. The data on food of the Smallmouth are based on 66 fish of which 36 contained food in their stomachs. The total volume of this food (Table XVI) was 238.61 c.c.; this volume included 80 per cent fish of which 61 per cent was White Perch, and 14 per cent crayfish. All of the fish, so far as identified, were spiny-rayed forms. The absence of smelts in the diet of these bass is noteworthy, especially since smelts were known to be present in many of the lakes.

Common Pickerel. The stomachs of 110 Pickerel from 19 lakes were examined; 51 contained a total of 397 c.c. of food of which 55 per cent was White Perch, 40 per cent was other fish, and only 0.2 per cent was insects (Table XVII). The fish which had been fed upon mostly by the pickerel were those with which it is usually associated in lakes, namely, the White Perch and Yellow Perch.

Yellow Perch. The stomachs of 231 Yellow Perch from 19 lakes contained 147 c.c. of food of which 46 per cent was fish and most of the remainder was aquatic insects (Table XVIII). The most important of the fish were Yellow Perch and White Perch; the most important of the insects were Mayfly nymphs, dragonfly nymphs, and caddisfly larvae. The food eaten by these Yellow Perch was quite similar to that eaten by White Perch (see page 125) in these same lakes, the difference being that the Yellow Perch had fed somewhat more on fish, the White Perch more on insects.

Pike Perch. The eight adult Walleyed Pike taken from deep water in Great Pond contained practically nothing but fish which, by volume, was about half Smelt and half White Perch.

Salmonids. The data on stomach contents of 16 Brook Trout from 3 lakes, 10 Togue from 3 lakes, 7 Land-locked Salmon from 4 lakes, and 4 Chinook Salmon from 3 lakes, are summarized in Table XIX. The Brook Trout from Sabbathday Lake in New Gloucester contained mostly bottom organisms. The remaining trout and the Togue and salmon had fed mostly or entirely on fish which, in turn, were mostly smelts.

Common Sucker. The anterior part of the intestinal tracts of 28 suckers was examined for food contents. Their food was entirely organisms from the bottom fauna (Table XIX).

Common Sunfish. The food found in 66 Common Sunfish from 9 lakes was entirely organisms of the bottom fauna. Snails were, by far, their most important food, making up 63 per cent of the total volume. Dragonfly nymphs among the insects were next in importance. The large snail content in the diet of this fish is probably associated with the strong molar-like crushing teeth on the fifth pharyngeals of this species.

TABLE XVI. Volumes in cubic centimeters and numbers (in parentheses) of food organisms in stomachs of 66 Small-mouthed Bass from 20 lakes

Name of lake or pond	Date of collection: 1940	Fish Examined: Number of fish; and number of fish, in ( ), containing food	Fish Examined: Range in total length in inches	Fish Examined: Degree of infestation with bass tapeworm	Fish Examined: Total stomach contents	Crayfish (Decapoda)	Insects:* (Insecta)	Common Sunfish (*L. gibbosus*)	Yellow Perch (*Perca flavescens*)	White Perch (*Morone americana*)	Fish Remains	Vegetation
Sabattus	June 20–21	1(1)	14.0	None	2.5 (1)	..	.....	..	..	...	2.5 (1)	..
Tripp	Aug. 10–11	1(1)	17.4	None	1.5 (1)	..	.....	..	1.5 (1)	...	..	..
Thompson	July 11–12	5(3)	14.3–18.6	None	15.6 (3)	0.6 (1)	.....	..	..	15.0 (2)	..	..
Pleasant	June 21–22	1(1)	20.5	None	0.8 (1)	..	.....	..	..	...	0.8 (1)	..
Pocasset	Aug. 2–3	1(0)	13.7	Heavy	0.0 (0)	..	.....	..	..	...	..	..
Parker	July 15–16	1(1)	15.9	Medium	5.0 (1)	..	.....	5.0 (1)	..	...	..	..
Flying	July 18–19	2(1)	14.2–21.3	Heavy	1.1 (Remains)	..	1.1 (Remains)	..	..	...	..	..
Webb	Sept. 9–11	6(0)	8.5–17.9	None	0.0 (0)	..	.....	..	..	...	..	..
North (P.521)	Sept. 5	3(3)	10.0–14.8	None	36.1 (4)	..	.....	..	32.1 (4)	...	..	4.0
South	Sept. 4–5	1(1)	17.3	None	3.0 (2)	..	0.05 (1)	..	..	...	2.95 (1)	..
Sand	Aug. 15–16	1(1)	11.4	None	0.6 (2)	..	0.6 (2)	..	..	...	..	..
Cobbosseecontee	Aug. 9–10	3(3)	11.2–17.5	Heavy	19.8 (4)	19.7 (3)	0.1 (1)	..	..	...	..	..
Wilson (P.673)	July 30–31	1(1)	16.3	None	4.0 (2)	..	.....	..	..	4.0 (2)	..	..
Maranacook	Aug. 3–4	1(0)	16.9	None	0.0 (0)	..	.....	..	..	...	..	..
Snow	June 28–July 2	11(7)	9.3–18.5	Heavy	90.3 (13)	..	3.2 (7)	..	..	86.5 (5)	0.6 (1)	..
Great of Belgrades	June 21–Sept. 8	14(6)	9.2–17.3	Heavy	27.1 (6)	9.0 (2)	3.6 (1)	..	..	14.5 (3)	..	..
North of Belgrades	July 10–11	1(1)	16.1	Heavy	2.5 (1)	..	.....	..	..	2.5 (1)	..	..
East of Belgrades	July 11–12	5(2)	13.3–20.1	Heavy	5.5 (2)	5.0 (1)	.....	..	..	...	0.5 (1)	..
Embden	July 26–28	3(2)	10.5–15.7	None	0.21 (2)	..	0.01 (1)	..	..	...	0.2 (1)	..
Pushaw	Oct. 14–16	4(1)	16.5–19.4	None	23.0 (3)	..	.....	..	..	23.0 (3)	..	..
Totals	June 20–Oct. 16	66(36)	8.5–21.3		238.61 (48)	34.3 (7)	8.66 (13)	5.0 (1)	33.6 (5)	145.5 (16)	7.55 (6)	4.0

*Includes: Mayfly nymphs, dragonfly nymphs, caddisfly larvae, ants, beetles, and insect remains.

TABLE XVII. Volumes in cubic centimeters and numbers (in parentheses) of food organisms in stomachs of 110 Pickerel (*Esox niger*) from 19 lakes

Name of lake or pond	Date of collection: 1940	Fish Examined: Number of fish; and number of fish, in ( ), containing food	Fish Examined: Range in total length in inches	Fish Examined: Total stomach contents	Crayfish (Decapoda)	Aquatic nsects*	Smelt (*Osmerus mordax*)	Golden Shiner (*Notemigonus crysoleucas*)	Horned Pout (*Ameiurus nebulosus*)	Common Pickerel (*Esox niger*)	Yellow Perch (*Perca flavescens*)	White Perch (*Morone americana*)	Fish remains	Frog tadpoles
Sabattus	June 20–21	2(2)	12.8–14.0	3.204 (5)	.....	0.004 (4)	......	......	......	......	.....	2.7 (1)	0.5	....
Taylor	Aug. 13–14	7(3)	16.1–20.1	25.71 (3)	.....	.....	......	......	......	......	15.0 (1)	10.5 (1)	0.21 (1)	....
Tripp	Aug. 9–10	2(1)	14.8–17.7	2.2 (1)	.....	.....	......	......	......	......	.....	2.2 (1)	....	....
Allen	Aug. 15–16	2(1)	15.8–25.0	12.0 (2)	.....	.....	12.0 (2)	......	......	......	.....	.....	....	....
Androscoggin	June 25–26	3(2)	13.2–22.2	2.0 (2)	.....	.....	......	......	......	......	1.7 (1)	.....	0.3 (1)	....
Pocasset	Aug. 2–3	1(0)	17.8	0.0 (0)	.....	.....	......	......	......	......	.....	.....	....	....
David	Aug. 16–17	7(1)	12.7–20.7	0.3 (1)	.....	.....	......	......	......	......	.....	.....	0.3 (1)	....
Webb	Sept. 9–11	3(2)	18.4–22.8	20.3 (2)	.....	.....	......	......	......	......	.....	19.5 (1)	0.8 (1)	....
North (P.521)	Sept. 5	1(0)	16.2	0.0 (0)	.....	.....	......	......	......	......	.....	.....	....	....
Cobbosseecontee	Aug. 8–9	2(0)	15.1–15.4	0.0 (0)	.....	.....	......	......	......	......	.....	.....	....	....
Wilson (P.673)	July 30–31	1(0)	15.6	0.0 (0)	.....	.....	......	......	......	......	.....	.....	....	....
Maranacook	Aug. 2–3	1(1)	15.0	0.5	.....	.....	......	......	......	......	.....	.....	0.5	....
Torsey	July 30–31	4(4)	14.6–16.1	47.1 (25)	.....	0.4 (10)	......	26.5 (1)	......	......	2.0 (11)	.....	0.7 (1)	17.5 (2)
Snow	June 28–29	12(8)	14.0–21.3	70.87 (14)	.....	0.07 (7)	......	16.5 (1)	......	......	.....	54.3 (6)	....	....
Long of Belgrades	June 24–26	3(1)	19.7–21.7	0.9	.....	.....	......	......	......	......	.....	.....	0.9	....
Great of Belgrades	June 17–Sept. 7	19(7)	17.1–23.8	85.7 (16)	2.1 (1)	0.4 (3)	......	......	......	......	.....	74.3 (8)	8.9 (4)	....
North of Belgrades	July 9–11	3(3)	16.1–23.2	1.65	.....	.....	......	......	......	......	.....	.....	1.65	....
East of Belgrades	July 11–13	5(2)	14.3–15.1	9.6 (2)	.....	.....	......	......	......	......	.....	9.5 (1)	0.1 (1)	....
Pushaw	Oct. 14–16	32(13)	12.6–21.9	115.3 (19)	.....	.....	......	12.5 (1)	18.0 (1)	24.5 (1)	11.0 (1)	44.2 (9)	5.1 (6)	....
Totals	June 17–Oct. 16	110(51)	12.6–25.0	397.334 (92)	2.1 (1)	0.874 (24)	12.0 (2)	55.5 (3)	18.0 (1)	24.5 (1)	29.7 (14)	217.2 (28)	19.96 (16)	17.5 (2)

*Included Mayfly nymphs, dragonfly nymphs, and midge larvae.

TABLE XVIII. Volumes in cubic centimeters and numbers (in parentheses) of food organisms in stomachs of 231 Yellow Perch from 19 lakes

Name of lake or pond	Date of collection: 1940	Fish examined: Number of fish; and number of fish, in ( ), containing food	Fish examined: Range in total length in inches	Fish examined: Total stomach contents	Water fleas (Cladocera)	Fresh-water shrimp (Amphipoda)	Crayfish (Decapoda)	Alderfly larvae (*Sialis*)	Mayfly nymphs (Ephemerida)	Dragonfly nymphs (Anisoptera)	Caddisfly larvae (Trichoptera)	Midge larvae (Chironomidae)	Miscellaneous aquatic invertebrates*	Snails (Amnicolidae)	Pill clams (Sphaeridae)	Smelt (*Osmerus mordax*)	Common Sucker (*C. c. commersonnii*)	Red-bellied Sunfish (*Lepomis auritus*)	Yellow Perch (*Perca flavescens*)	White Perch (*Morone americana*)	Fish remains	Vegetation and unknown
Sabattus	June 19–21	16(12)	7.6–9.8	7.53 (137)	....	...	...	...	5.348 (38)	0.5 (1)	0.72 (46)	0.707 (42)	0.005 (9)	..	....	..	0.25 (1)	..	...	..	..	..
Auburn	June 27–29	25(20)	7.7–11.5	30.49 (24)	....	...	...	...	....	5.6 (8)	....	...	0.05 ...	..	....	2.9 (4)	..	..	4.6 (1)	15.3 (7)	2.04 (4)	..
Allen	Aug. 15–16	16(11)	7.6–11.7	3.25 (107)	....	...	...	0.52 (11)	2.63 (95)	0.1 (1)	....	...	...	..	....	..	..	..	...	..	..	..
Androscoggin	June 24–26	3(3)	7.5–11.1	2.15 (6)	....	...	...	...	0.45 (3)	1.7 (3)	....	...	...	..	....	..	..	..	...	..	..	..
Pocasset	Aug. 1–3	5(0)	7.7–11.5	0.0 (0)	....	...	...	...	....	....	....	...	...	..	....	..	..	..	...	..	..	..
David	Aug. 16–17	3(0)	8.1–11.4	0.0 (0)	....	...	...	...	....	....	....	...	...	..	....	..	..	..	...	..	..	..
Flying	July 18–19	2(0)	10.7–11.3	0.0 (0)	....	...	...	...	....	....	....	...	...	..	....	..	..	..	...	..	..	..
North (P.521)	Sept. 5	25(22)	7.4–9.1	7.37 (996)	0.45 (800)	...	...	...	3.21 (46)	2.84 (15)	0.55 (112)	...	...	0.14 (23)	....	..	..	..	...	..	..	0.18 ..
Cobbosseecontee	Aug. 9–10	3(0)	6.9–8.2	0.0 (0)	....	...	...	...	....	....	....	...	...	..	....	..	..	..	...	..	..	..
Wilson (P.673)	July 30–31	1(1)	8.3	0.4 (6)	....	...	...	...	0.39 (5)	....	....	...	...	0.01 (1)	....	..	..	..	...	..	..	..
Maranacook	Aug. 2–4	5(4)	8.3–11.4	5.55 (70)	....	0.002 (2)	...	...	1.45 (40)	4.098 (28)	....	...	...	..	....	..	..	..	...	..	..	..
Torsey	July 31–Aug. 1	23(18)	6.3–12.2	17.812 (214)	....	0.1 (23)	...	...	0.45 (13)	8.1 (76)	....	0.002 (2)	0.21 (2)	..	0.5 (33)	..	..	..	8.3 (64)	..	0.15 (1)	..
Snow	June 27–30	37(28)	7.2–12.8	23.56 (188)	....	...	...	...	11.235 (99)	1.07 (4)	0.85 (79)	0.005 (1)	...	..	....	..	..	..	...	7.0 (1)	3.3 (3)	0.1 (1)
Long of Belgrades South Part	June 26–27	3(2)	6.5–11.0	0.65 (73)	....	0.146 (67)	...	...	0.504 (6)	....	....	...	...	..	....	..	..	..	...	..	..	..
North Part	June 22–25	13(8)	7.6–12.8	26.55 (205)	....	0.08 (47)	...	...	0.717 (9)	0.348 (4)	6.0 (48)	0.005 (5)	0.3 (8)	0.1 (2)	4.0 (81)	..	..	15.0 (1)	...	..	..	..
Great of Belgrades	June 17–July 20	23(11)	8.3–11.4	13.13 (54)	....	...	3.1 (1)	...	2.855 (41)	0.1 (1)	0.015 (3)	0.01 (1)	0.05 (4)	..	....	..	..	..	2.2 (1)	2.3 (1)	2.5 (1)	..
North of Belgrades	July 9–11	8(6)	7.1–13.7	2.55 (61)	....	...	...	...	0.55 (8)	1.3 (4)	0.7 (49)	...	...	..	....	..	..	..	...	..	..	..
East of Belgrades	July 11–13	16(13)	6.3–9.1	5.8 (48)	....	0.006 (6)	1.91 (2)	...	2.214 (23)	....	0.336 (7)	0.034 (8)	...	..	....	..	..	..	1.3 (2)	..	..	..
Pushaw	Oct. 14–16	4(1)	6.9–8.3	0.01 (1)	....	...	...	...	....	....	0.01 (1)	...	...	..	....	..	..	..	...	..	..	..
Totals	June 17–Oct. 16	231(160)	6.3–13.7	146.802 (2190)	0.45 (800)	0.334 (145)	5.01 (3)	0.52 (11)	32.003 (426)	25.756 (145)	9.181 (345)	0.763 (59)	0.615 (23)	0.25 (26)	4.5 (114)	2.9 (4)	0.25 (1)	15.0 (1)	16.4 (68)	24.6 (9)	7.99 (9)	0.28 (1)

*Included water mites, beetle larvae, damselfly nymphs, back swimmers, and insect remains.

TABLE XIX. Volumes in cubic centimeters and numbers (in parentheses) of food organisms in stomachs of pike perch, trout, togue, salmon, suckers, and sunfish from Maine lakes

Species of fish, and name of pond	Date of collection: 1940	Fish examined: Number of fish: and number of fish, in ( ), containing food	Fish examined: Range in total length in inches	Fish examined: Total stomach contents	Water fleas (Cladocera)	Fresh-water shrimp (Amphipoda)	Mayfly nymphs (Ephemerida)	Dragonfly nymphs (Anisoptera)	Caddisfly larvae (Trichoptera)	Snails and pill clams (Mollusca)	Other aquatic invertebrates*	Terrestrial insects	Smelt (*Osmerus mordax*)	White Perch (*Morone americana*)	Yellow Perch (*Perca flavescens*)	Fish remains
Pike Perch Great of Belgrades	June 17–Sept. 7	8(8)	20.5–25.3	55.7 (49)	...	0.03 (25)	...	...	...	...	...	...	21.37 (12)	18.7 (2)	..	15.6 (10)
Brook Trout Sabbathday Lake	Aug. 27–29	6(6)	8.4–12.0	9.0 (192)	...	0.055 (12)	1.15 (12)	...	...	3.994 (125)	2.811 (40)	0.1 (1)	...	..	..	0.89 (2)
Pleasant Pond	June 21–22	9(8)	9.5–13.2	44.7 (90)	...	...	...	...	3.85 (52)	...	...	...	40.85 (38)	..	..	...
Great of Belgrades	July 8–9	1(1)	10.6	1.6 (2)	...	...	...	...	...	...	...	0.2 (1)	1.4 (1)	..	..	...
All trout		16(15)	8.4–13.2	55.3 (284)	...	0.055 (12)	1.15 (12)	...	3.85 (52)	3.994 (125)	2.811 (40)	0.3 (2)	42.25 (39)	..	..	0.89 (2)
Togue or Lake Trout South Pond	Sept. 5	2(2)	22.8–23.0	1.2 (5)	...	...	0.05 (1)	...	...	...	...	...	0.7 (1)	..	..	0.45 (3)
Narrows Pond	Aug. 13	4(3)	11.6–12.2	9.6 (14,009)	2.526 (14,000)	...	0.01 (2)	...	0.05 (1)	...	0.014 (5)	...	...	..	..	7.0 (1)
Embden Pond	July 28	4(2)	16.6–21.5	7.8 (9)	...	...	...	...	...	...	...	...	4.4 (3)	..	..	3.4 (6)
All Togue		10(7)	11.6–23.0	18.6 (14,023)	2.526 (14,000)	...	0.06 (3)	...	0.05 (1)	...	0.014 (5)	...	5.1 (4)	..	..	10.85 (10)
Land-locked Salmon Auburn Lake	June 28–29	3(3)	14.1–16.9	10.4 (4)	...	...	...	...	...	...	...	...	8.1 (1)	..	1.4 (1)	0.9 (2)
Sand Pond	Aug. 16	1(1)	13.8	0.2 (1)	...	...	...	...	...	...	...	...	...	..	..	0.2 (1)
Great of Belgrades	June 15–Aug. 31	2(2)	13.8	10.1 (43)	...	...	...	...	...	...	1.5 (Remains)	2.1 (22)	6.5 (21)	..	..	...
Embden Pond	July 27	1(1)	17.3	4.7 (5)	...	...	0.2 (3)	...	...	...	...	...	4.5 (2)	..	..	...
All L-l'k'd Salmon		7(7)	13.8–17.3	25.4 (53)	...	...	0.2 (3)	...	...	...	1.5 (Remains)	2.1 (22)	19.1 (24)	..	1.4 (1)	1.1 (3)
Chinook Salmon Cobbosseecontee Lake	Aug. 8	1(0)	17.5	0.0 (0)	...	...	...	...	...	...	...	...	...	..	..	...
Narrows Pond	Aug. 14	1(1)	21.5	3.0 (1)	...	...	...	...	...	...	...	...	...	..	..	3.0 (1)
Great of Belgrades	July 9	2(2)	23.4–23.4	9.0 (9)	...	...	...	...	...	...	...	...	9.0 (9)	..	..	...
All Chinooks		4(3)	17.5–23.4	12.0 (10)	...	...	...	...	...	...	...	...	9.0 (9)	..	..	3.0 (1)
Common Sucker Webb Lake	Sept. 10–11	24(18)	13.0–19.0	9.32 (168)	...	0.005 (5)	...	...	0.2 (3)	9.07 (115)	0.045 (45)	...	...	..	..	...
Great of Belgrades	June 19–20	4(4)	17.9–18.5	15.0 (Remains)	...	...	15.0 (Remains)	...	...	...	...	...	...	..	..	...
All suckers		28(22)	13.0–19.0	24.32 (168)	...	0.005 (5)	15.0 (Remains)	...	0.2 (3)	9.07 (115)	0.045 (45)	...	...	..	..	...
Common Sunfish Androscoggin Lake	June 25–26	1(0)	8.3	0.0 (0)	...	...	...	...	...	...	...	...	...	..	..	...
Pocasset Lake	Aug. 2–3	4(2)	8.7–9.4	1.1 (Remains)	...	...	...	...	...	1.1 (Remains)	...	...	...	..	..	...
Maranacook Lake	Aug. 2–3	4(3)	7.3–7.6	1.7 (109)	...	...	0.1 (3)	0.15 (2)	0.75 (84)	0.55 (18)	0.15 (2)	...	...	..	..	...
Torsey Pond	July 31–Aug. 1	38(28)	4.8–7.8	15.956 (174)	...	...	...	1.85 (18)	1.65 (32)	12.436 (123)	0.02 (1)	...	...	..	..	...
Snow Pond	June 27–29	3(2)	6.7–9.7	0.3 (2)	...	...	...	...	...	0.25 (2)	0.05 (Remains)	...	...	..	..	...
Great of Belgrades	June 18–Sept. 7	9(6)	4.5–9.1	5.66 (9)	...	...	1.2 (9)	...	...	4.46 (Remains)	...	...	...	..	..	...
North of Belgrades	July 10–11	3(3)	6.6–8.9	9.7 (31)	...	...	0.05 (2)	3.549 (2)	0.3 (16)	3.3 (Remains)	0.401 (6)	2.1 (5)	...	..	..	...
East of Belgrades	July 11–12	1(0)	6.7	0.0 (0)	...	...	...	...	...	...	...	...	...	..	..	...
Pushaw Pond	Oct. 15–16	3(1)	6.8–8.2	0.11 (4)	...	...	...	...	...	0.11 (4)	...	...	...	..	..	...
All sunfish		66(45)	4.8–9.7	34.526 (329)	...	...	1.35 (14)	5.549 (22)	2.70 (132)	22.206 (147)	0.621 (9)	2.1 (5)	...	..	..	...

*"Other aquatic invertebrates" include: aquatic earthworms, alderfly larvae, beetle larvae, midge larvae, mosquito larvae, and insect remains.

MAPS OF THE LAKES AND PONDS

The following outline maps and cross-section diagrams for the lakes (Figures 7 to 51) are included to show the results of depth soundings and our evaluations of the suitability of the water for trout or salmon. The lake outlines have been copied from United States Geological Survey Topographic Sheets, and in some instances have been modified slightly based on our own field observations. The numbers of soundings were presumably adequate for our evaluation of the water for different types of fishes; however, the intensity of soundings in some lakes was probably not sufficient to indicate the greatest depth of water. Areas of water of greater depth than is indicated on these maps must of necessity be very limited in extent. Data from Table III were used in preparing the cross-section diagrams headed "suitability for trout and salmon during late summer." A key to the symbols, figures, and terms used on these maps is as follows:

All numerical figures within outline of lake represent soundings in feet.

Water analysis stations indicated by the symbol ⊗.

In the cross-section diagram headed by "suitability for trout and salmon during late summer":

- **"Suitability" means only from the standpoint of temperature and oxygen.**
- **"Late summer" means during the end of the hot part of the summer, mostly during August.**
- **"Water volume" refers to all water in the lake.**
- **"Bottom area" refers to the entire lake bottom.**
- **"Warm" means above 70° Fahrenheit.**
- **"Trout" means trout, togue, or salmon, and probably applies also to such other cold-water fishes as smelt, whitefish, and cusk.**
- **"Low oxygen" means less than 5 p.p.m. of dissolved oxygen in the water.**
- **Blackened area represents proportionate amount of water volume or bottom area not available to trout or salmon during late summer.**
- **White area represents amount of water volume and bottom area available to trout and salmon during late summer.**
- **"No trout or salmon water" means during late summer.**

Pond reference numbers are indicated in the following form: P 389, P 409, P 719.

"Elev" means elevation in feet above mean sea level, obtained from United States Topographic Sheets.

Area in acres obtained by using planimeter on lake outline on United States Topographic Sheets.

Direction arrows indicate true north.

All maps by W. P. Strang.

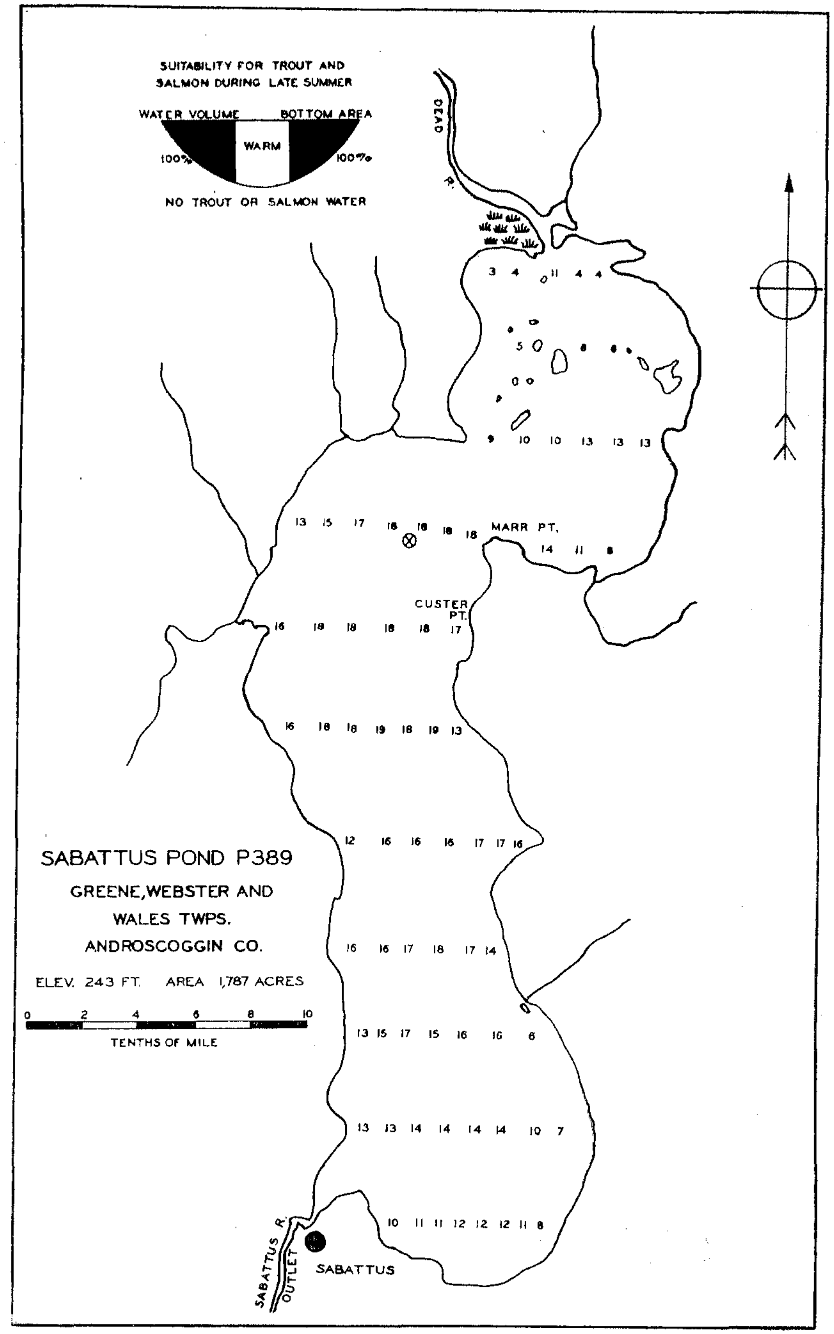


Figure 7. Sabattus Pond. Soundings in feet and suitability of the water for trout or salmon.

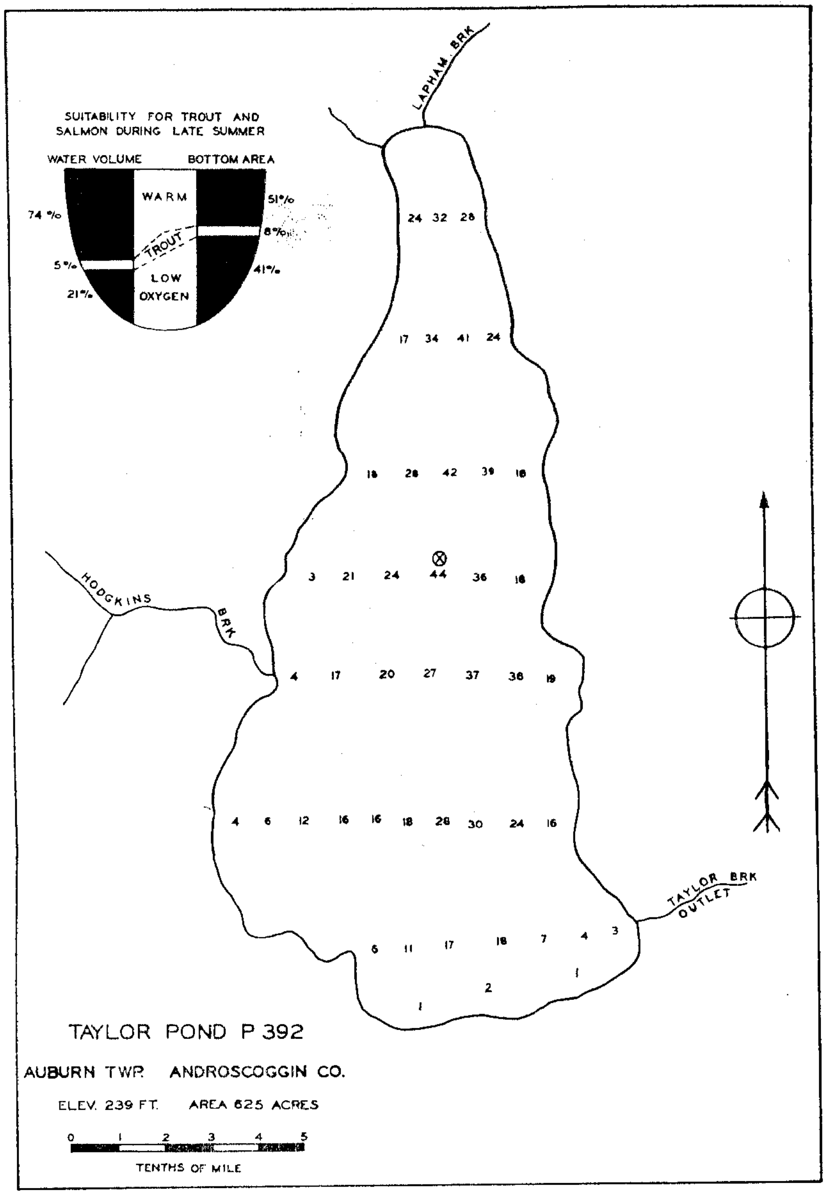


Figure 8. Taylor Pond. Soundings in feet and suitability of the water for trout or salmon.

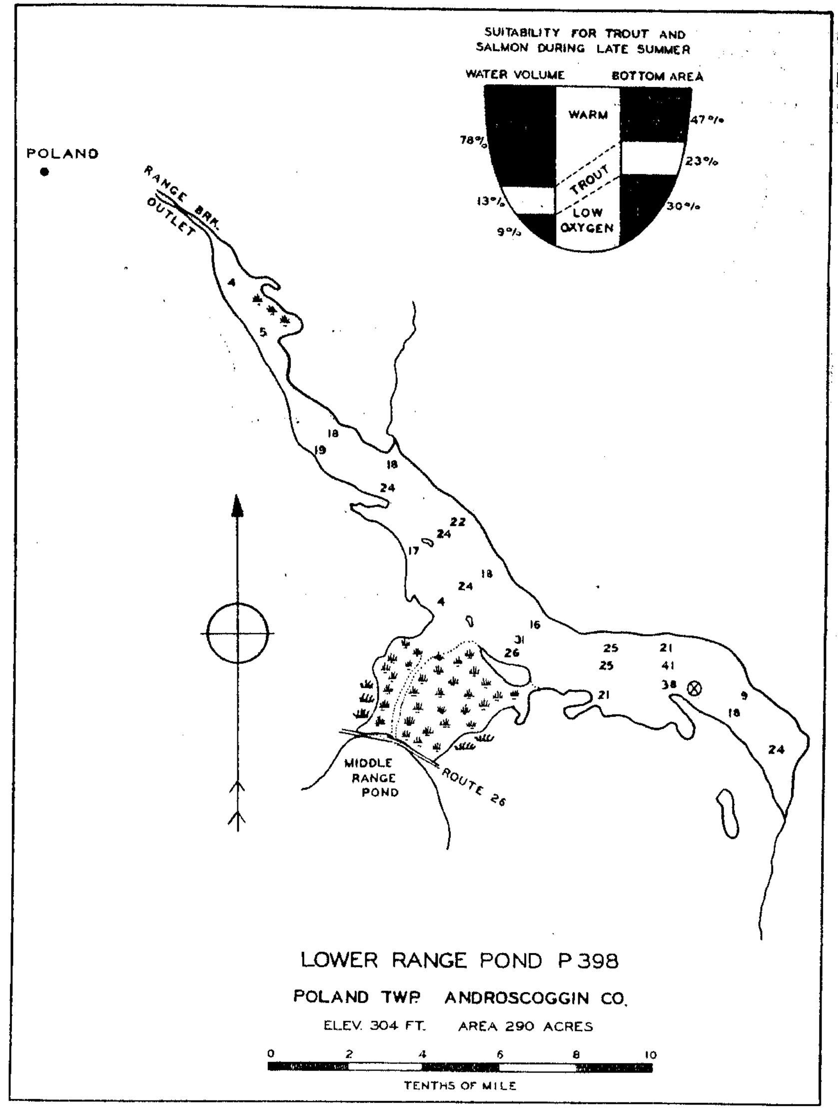


Figure 9. Lower Range Pond. Soundings in feet and suitability of the water for trout or salmon.

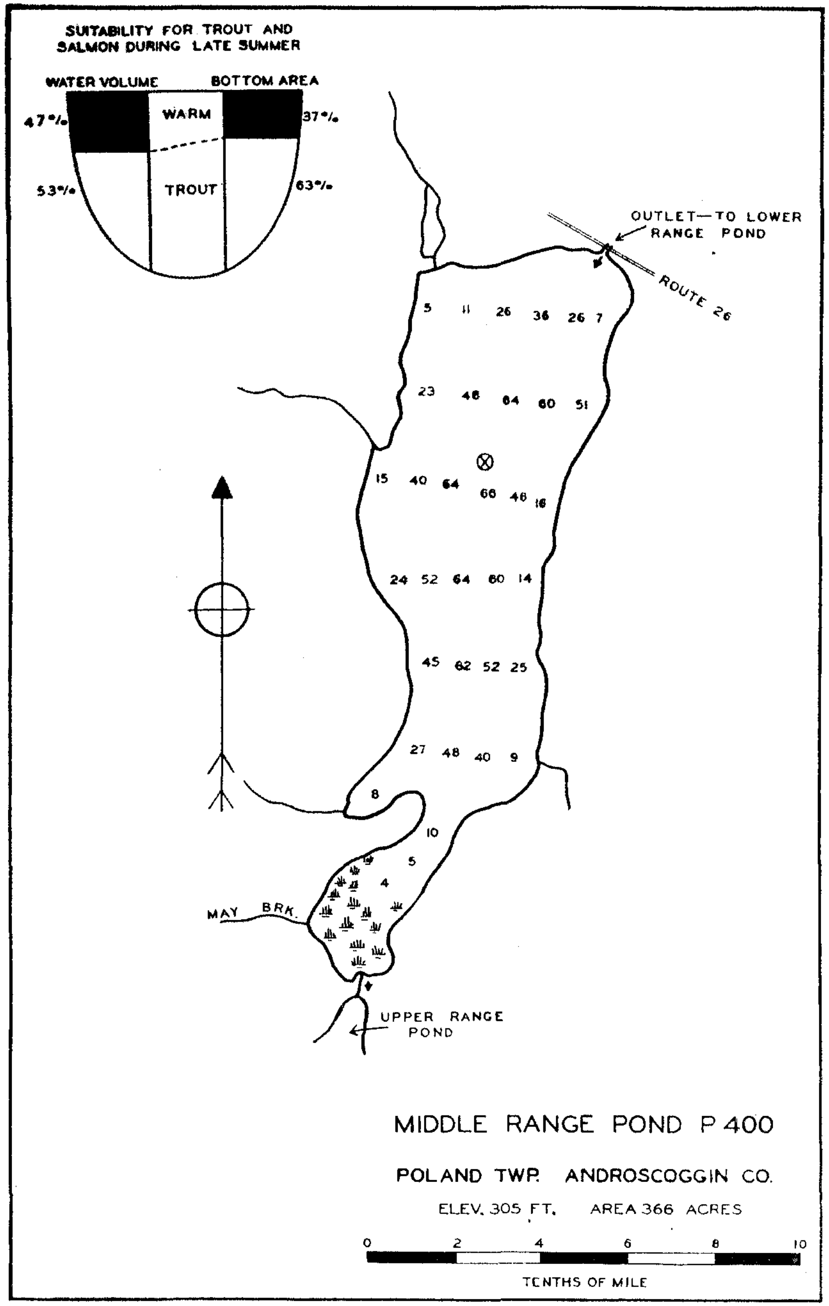


Figure 10. Middle Range Pond. Soundings in feet and suitability of the water for trout or salmon.

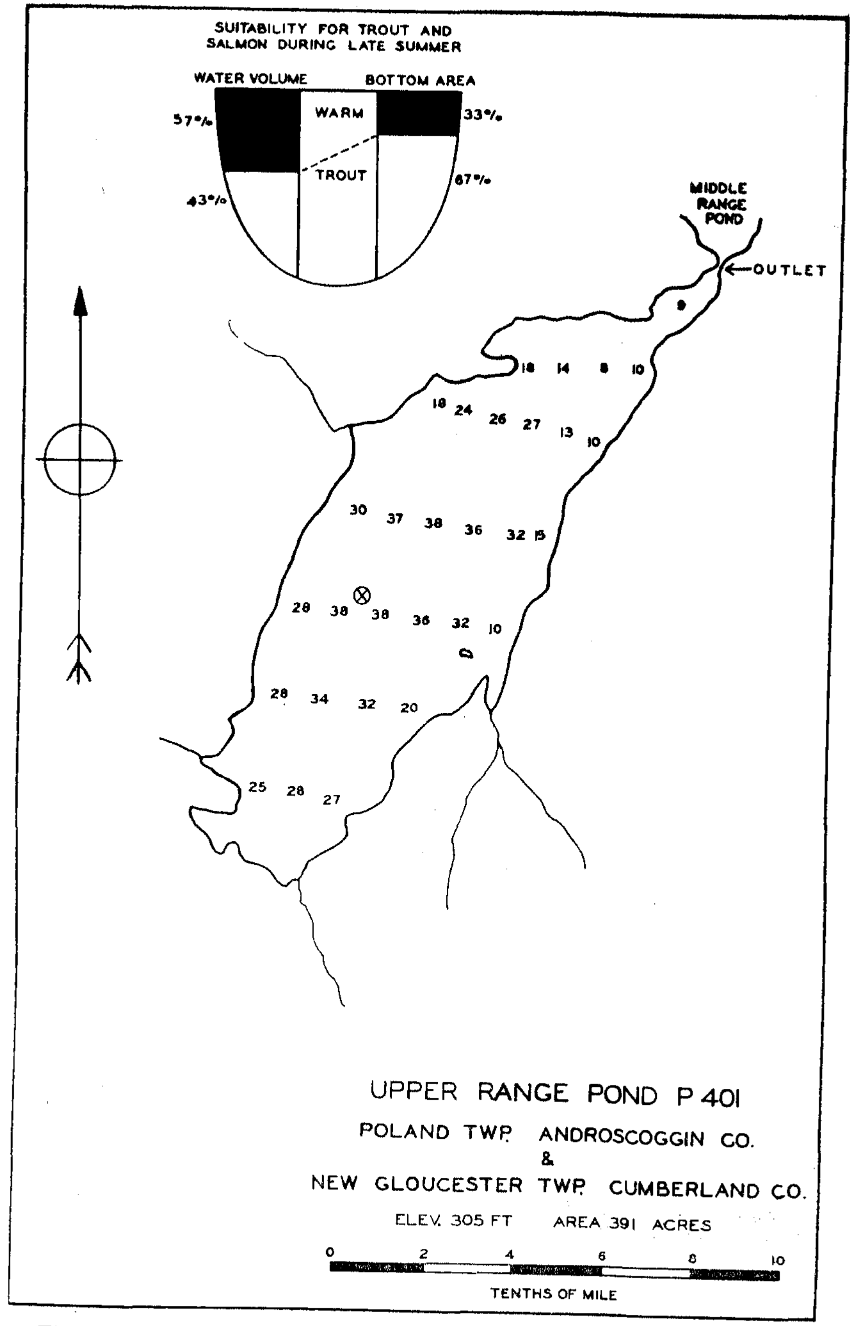


Figure 11. Upper Range Pond. Soundings in feet and suitability of the water for trout or salmon.

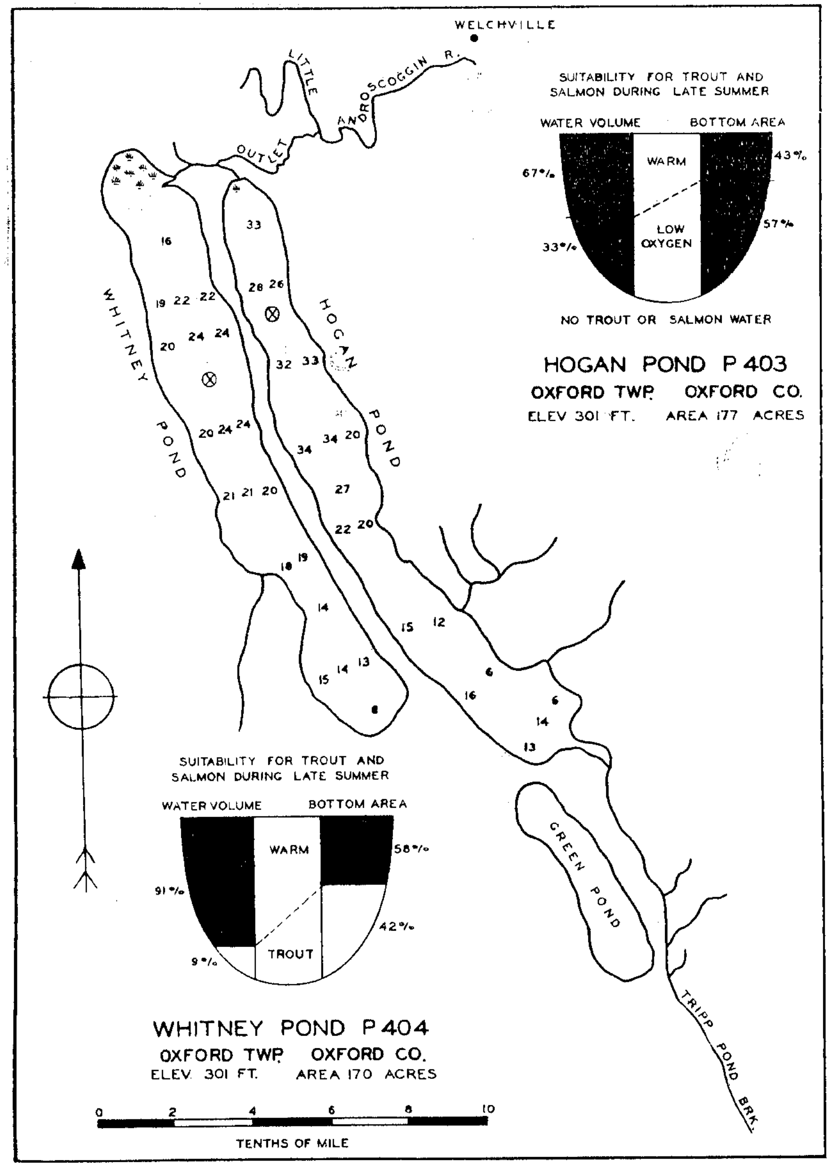


Figure 12. Hogan Pond and Whitney Pond. Soundings in feet and suitability of the water for trout or salmon.

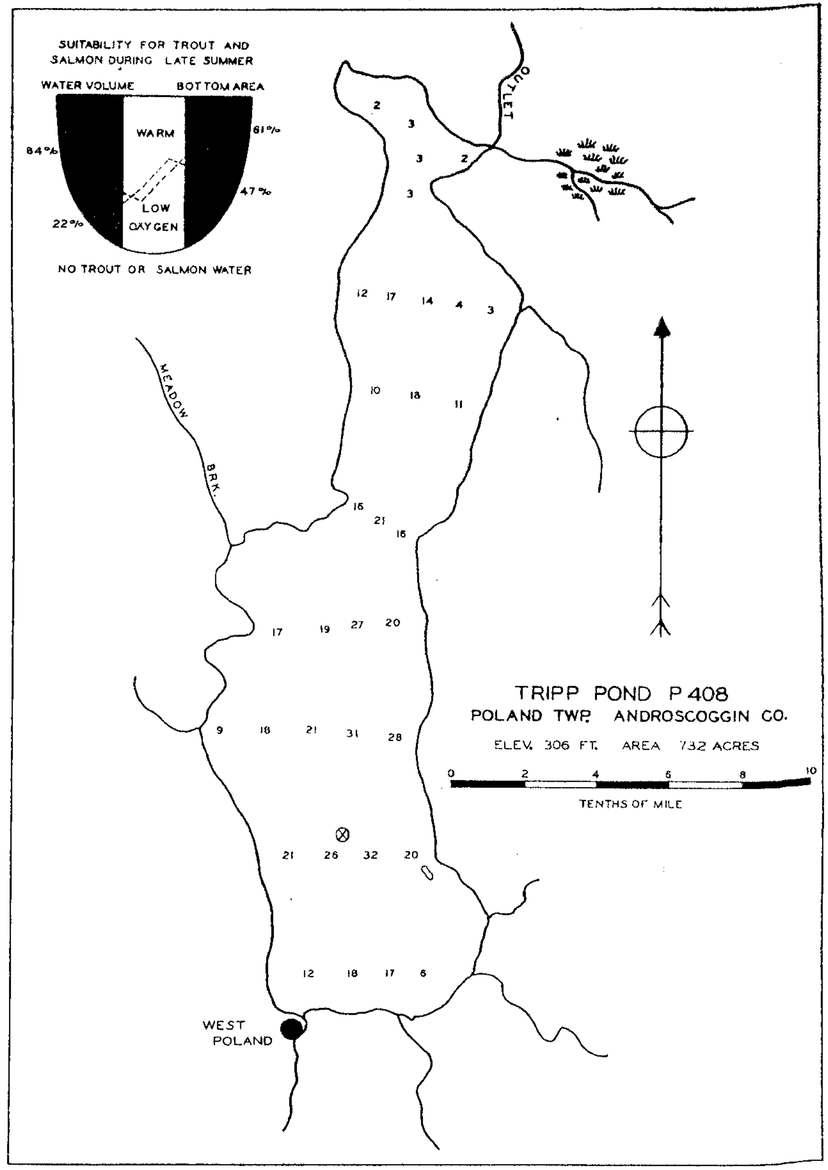


Figure 13. Tripp Pond. Soundings in feet and suitability of the water for trout or salmon.

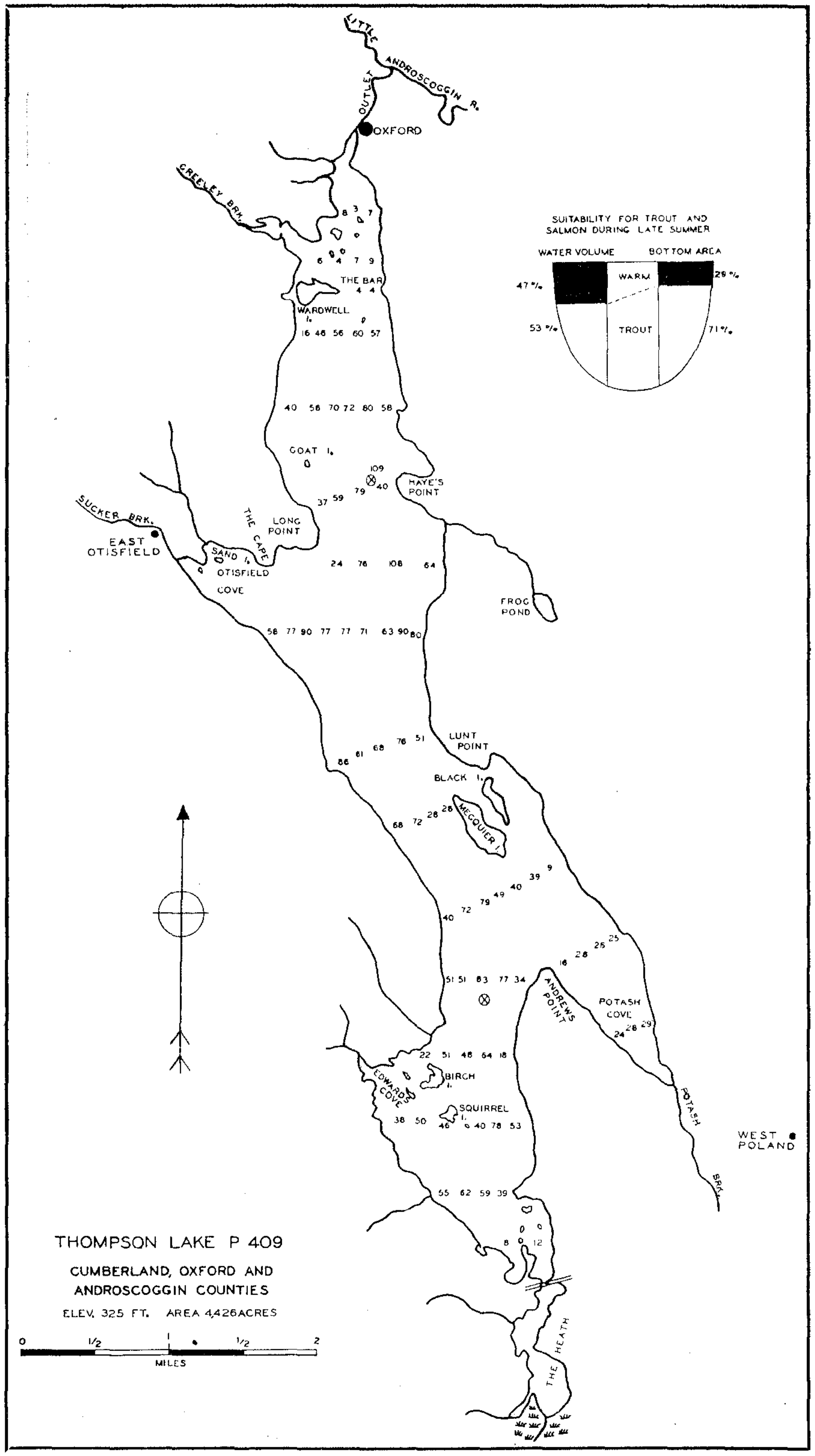


Figure 14. Thompson Lake. Soundings in feet and suitability of the water for trout or salmon.

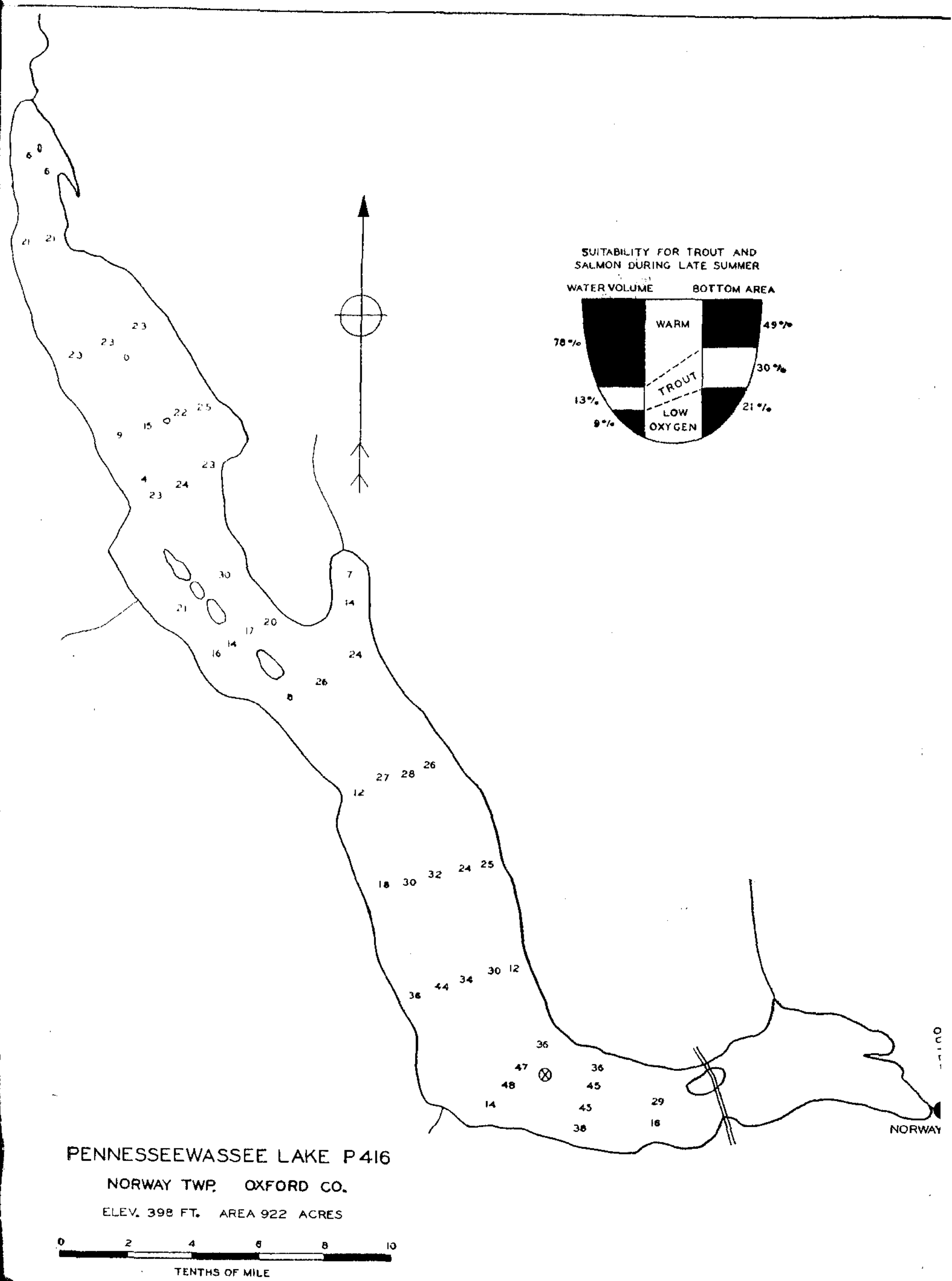


Figure 15. Pennesseewassee Lake. Soundings in feet and suitability of the water for trout or salmon.

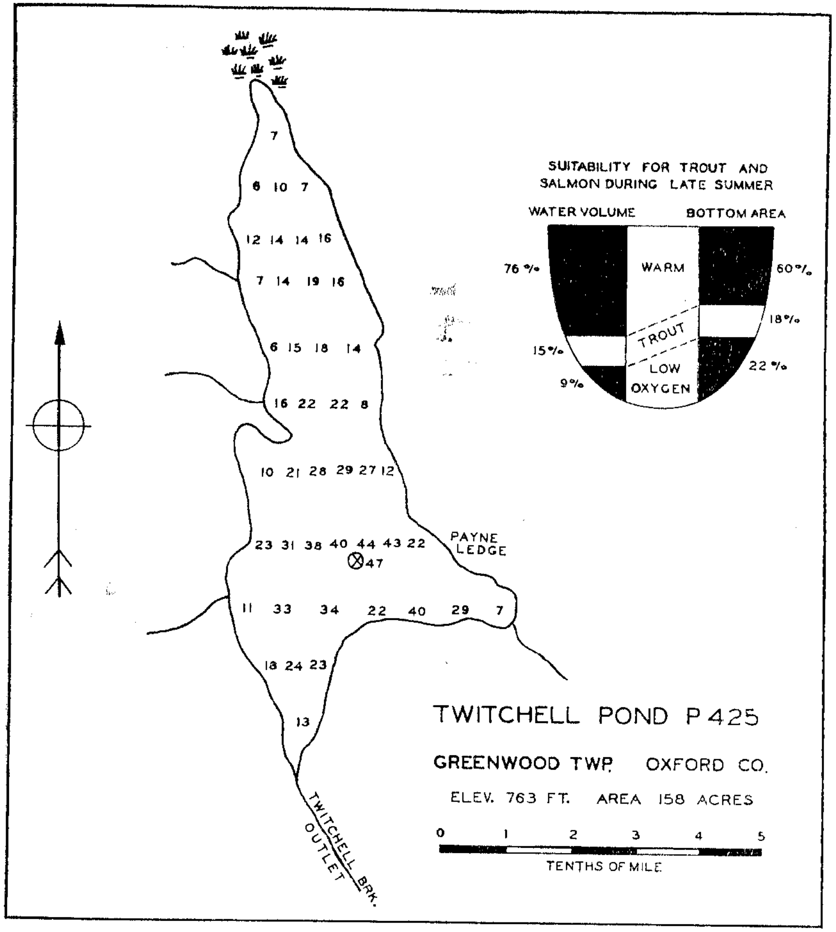


Figure 16. Twitchell Pond. Soundings in feet and suitability of the water for trout or salmon.

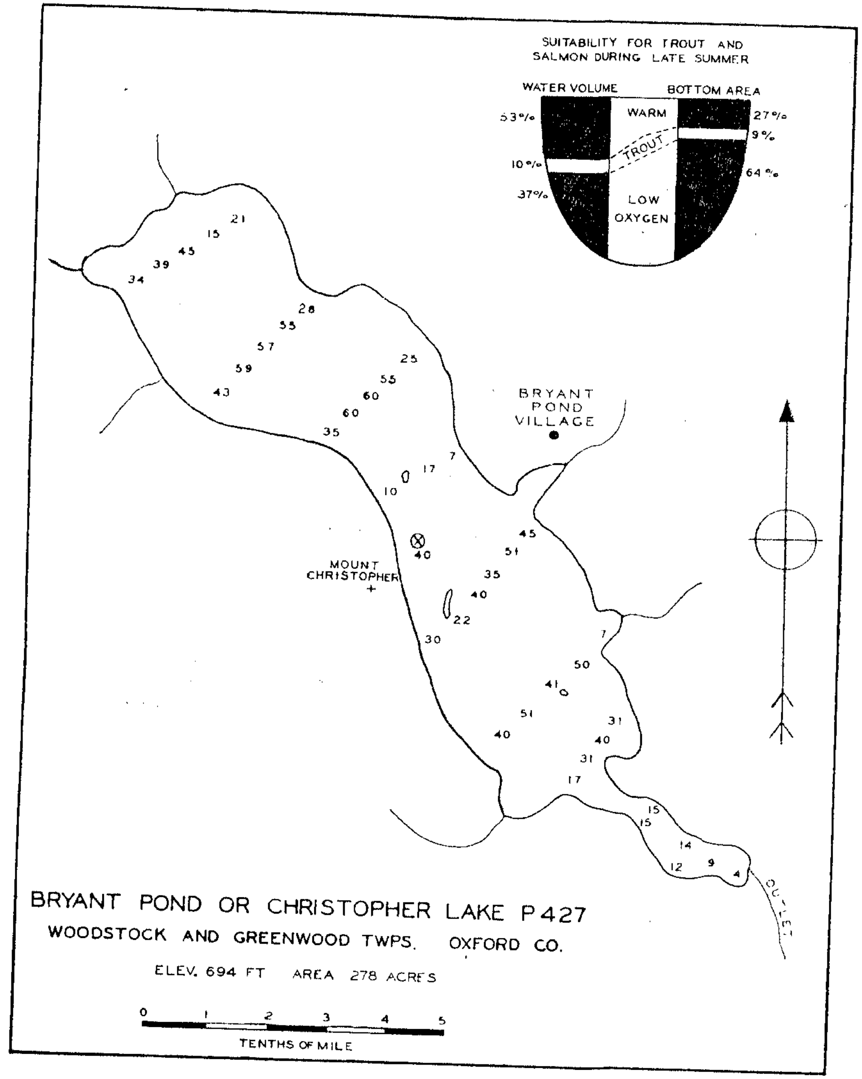


Figure 17. Bryant Pond or Christopher Lake. Soundings in feet and suitability of the water for trout or salmon.

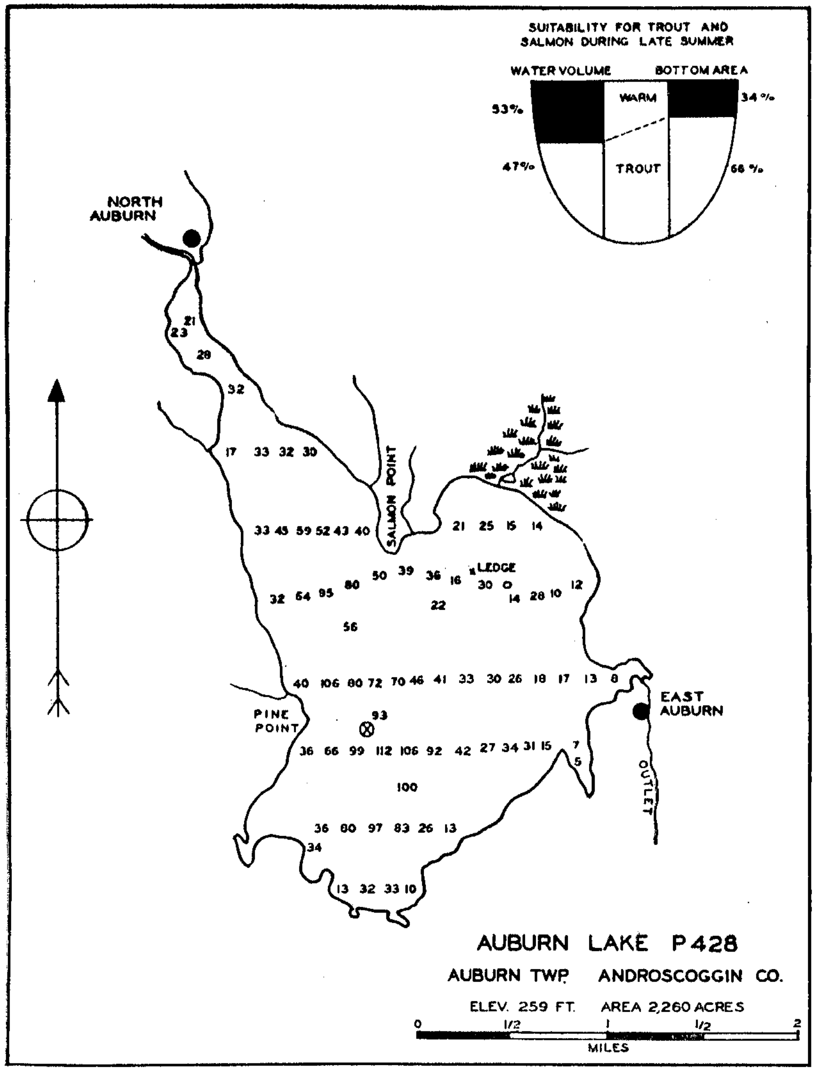


Figure 18. Auburn Lake. Soundings in feet and suitability of the water for trout or salmon.

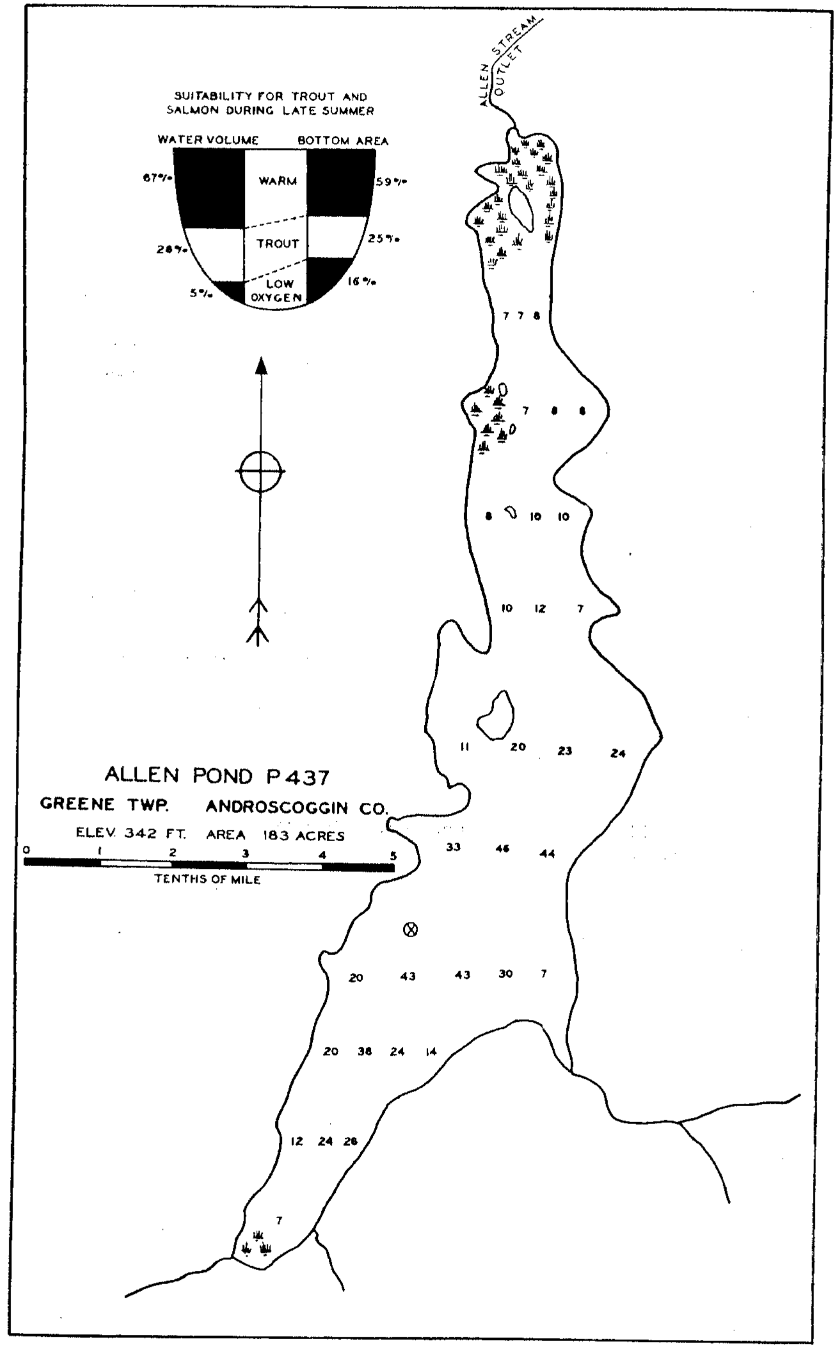


Figure 19. Allen Pond. Soundings in feet and suitability of the water for trout or salmon.

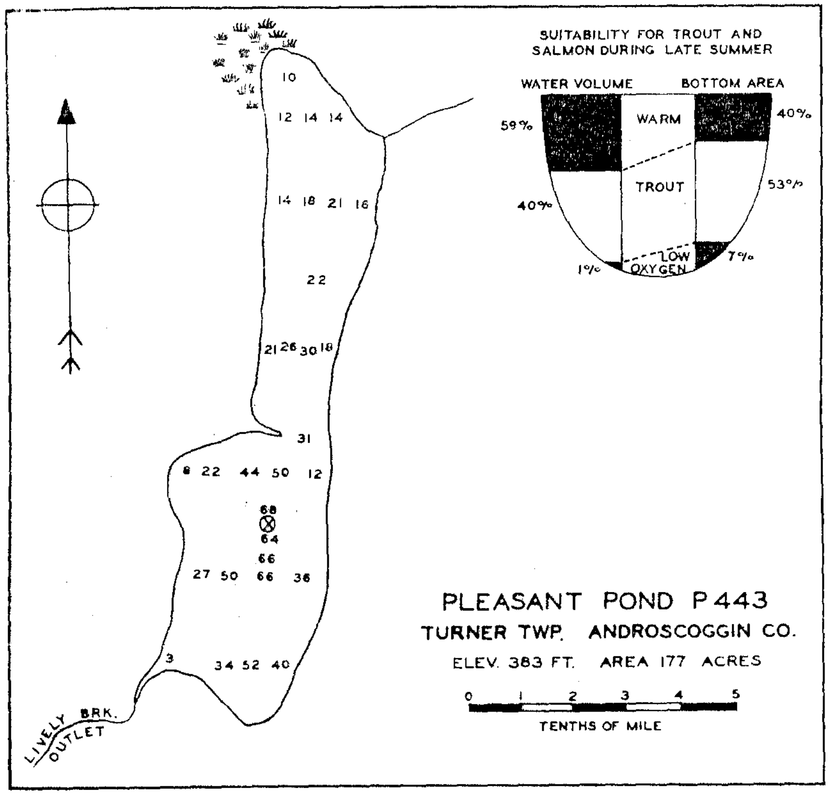


Figure 20 Pleasant Pond. Soundings in feet and suitability of the water for trout or salmon.

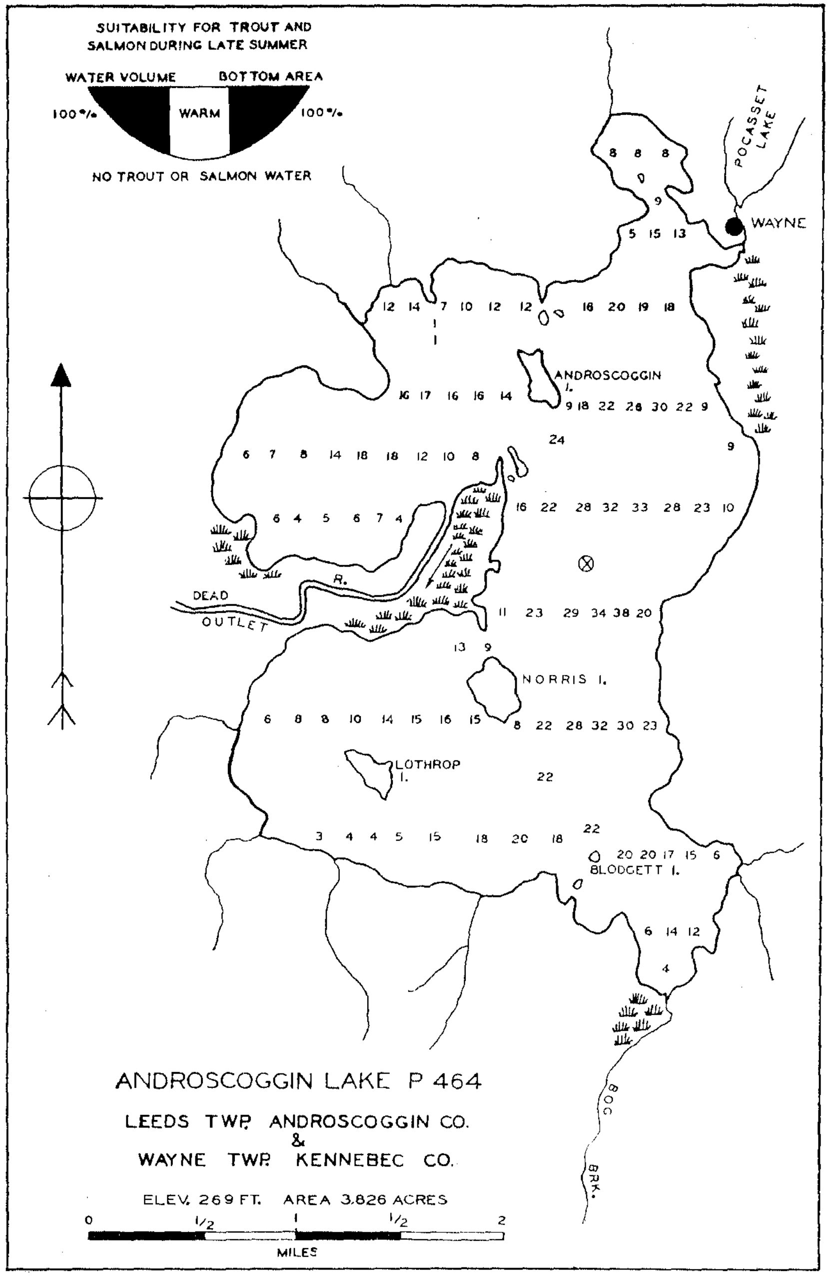


Figure 21. Androscoggin Lake. Soundings in feet and suitability of the water for trout or salmon.

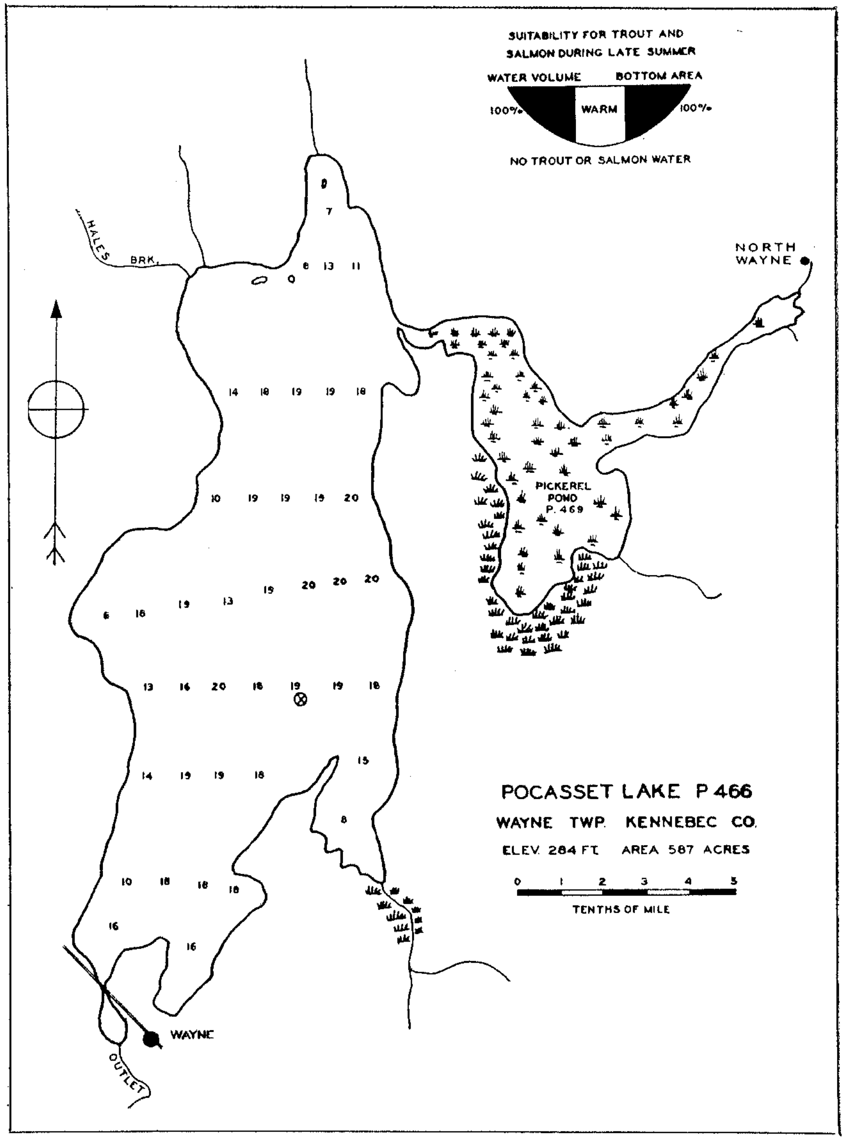


Figure 22. Pocasset Lake. Soundings in feet and suitability of the water for trout or salmon.

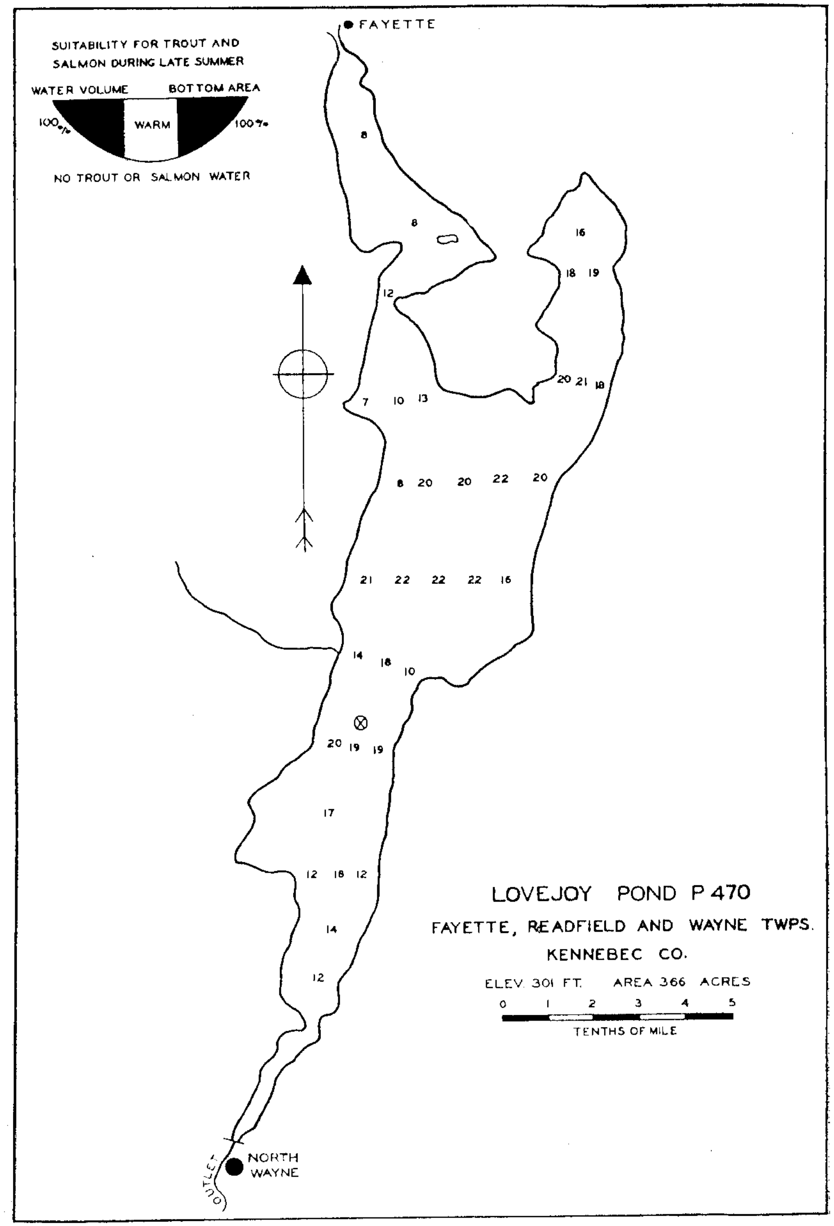
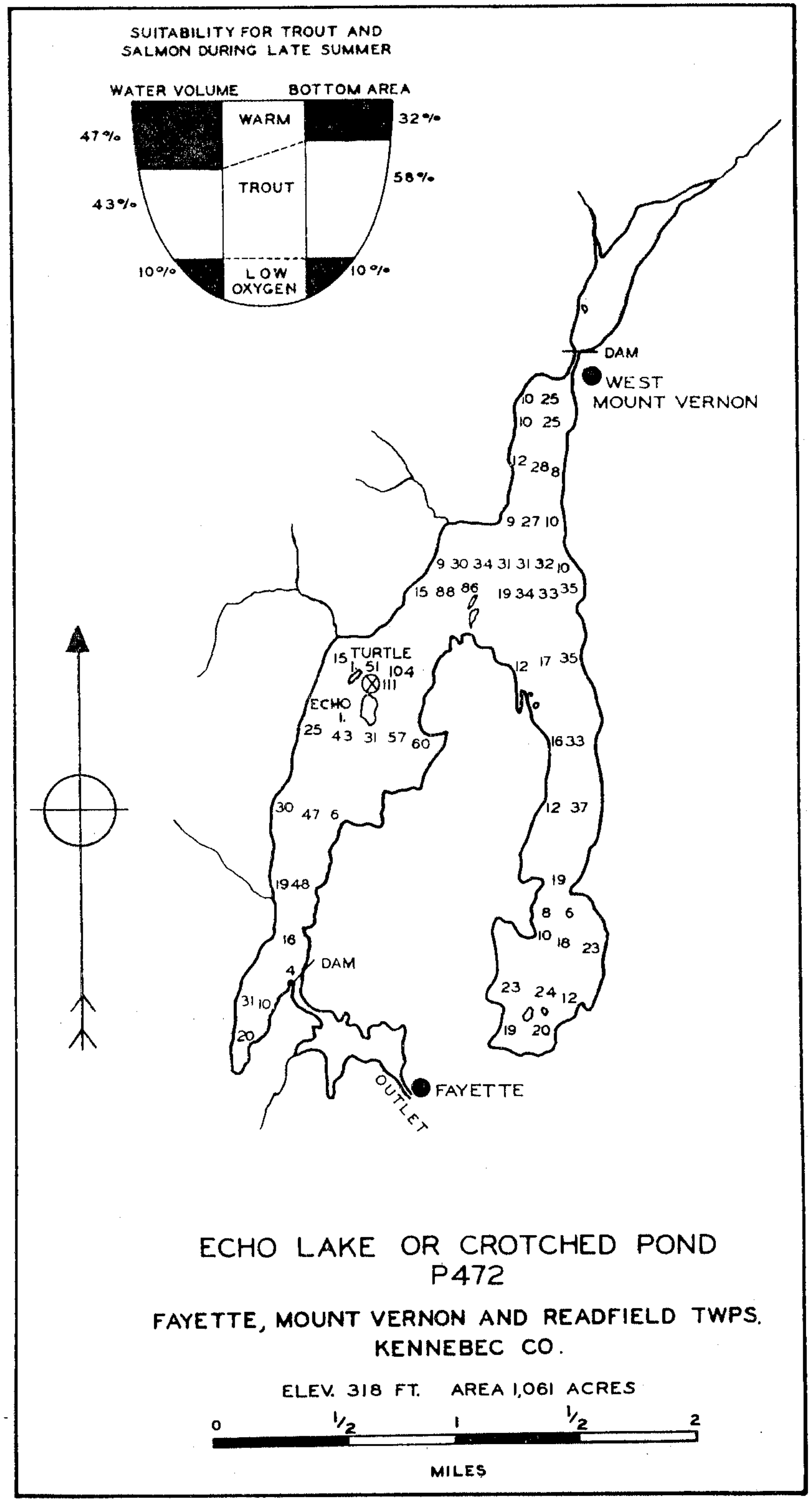


Figure 23. Lovejoy Pond. Soundings in feet and suitability of the water for trout or salmon.



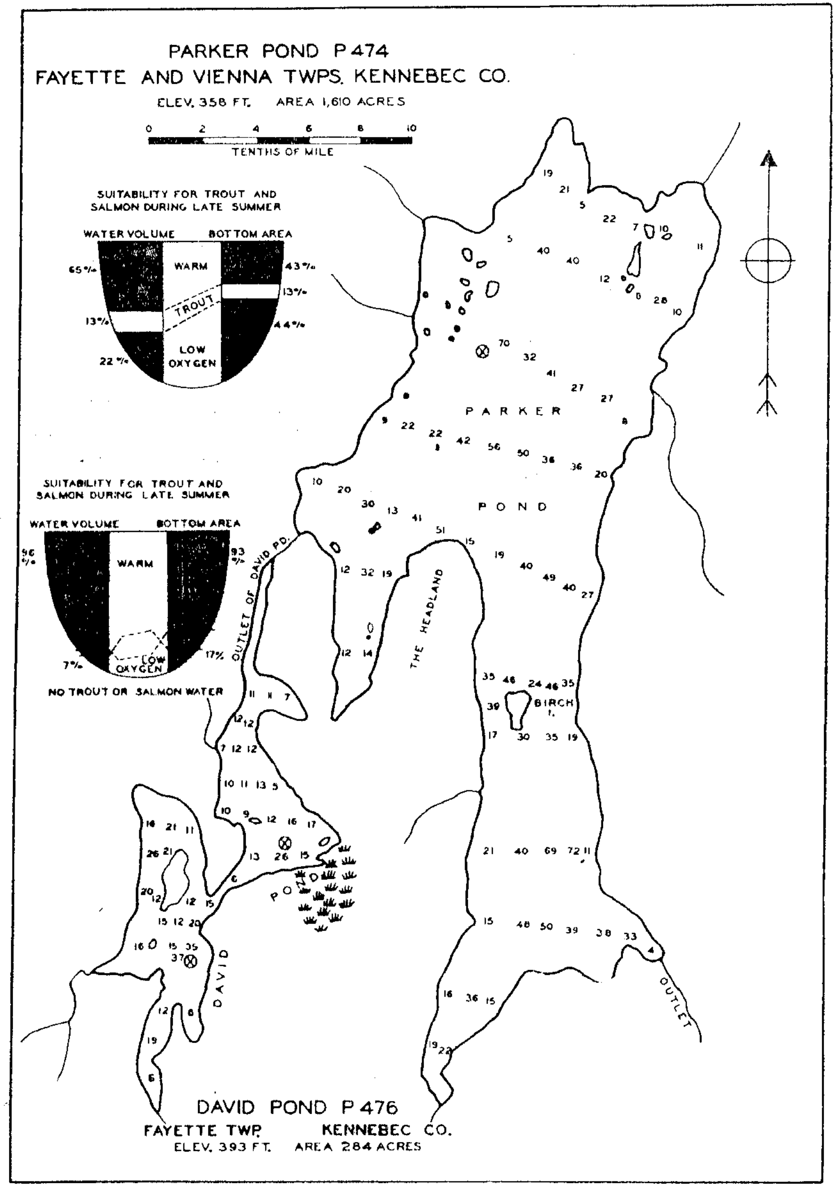


Figure 25. Parker Pond and David Pond. Soundings in feet and suitability of the water for trout or salmon.

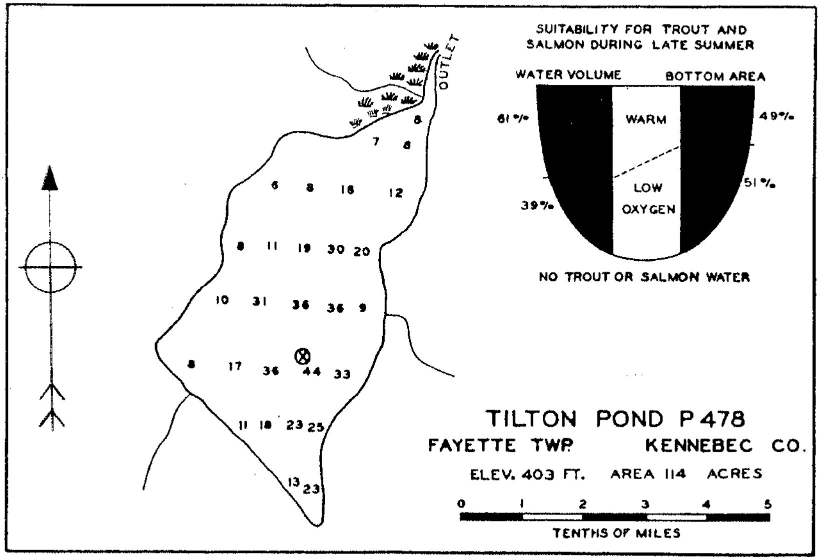


Figure 26. Tilton Pond. Soundings in feet and suitability of the water for trout or salmon.

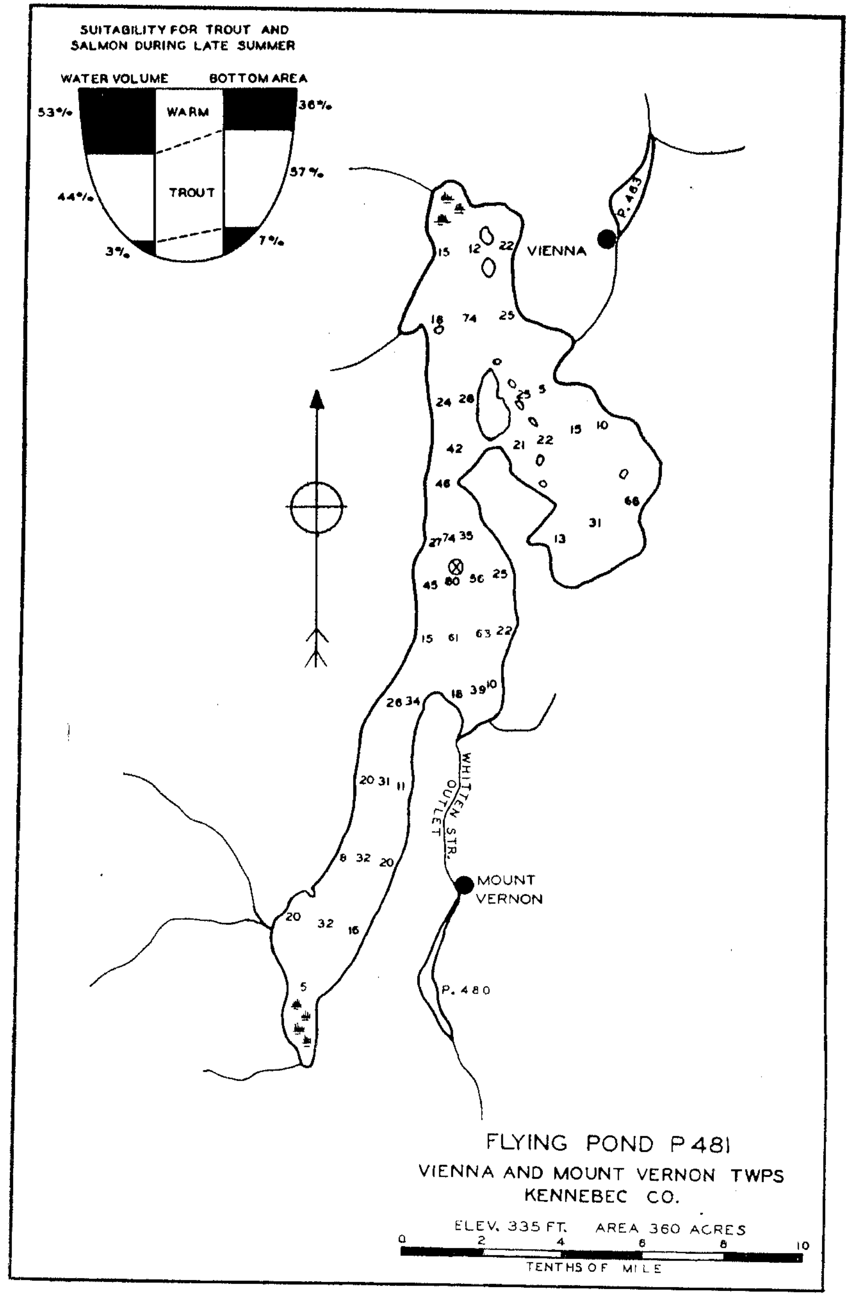


Figure 27. Flying Pond. Soundings in feet and suitability of the water for trout or salmon.

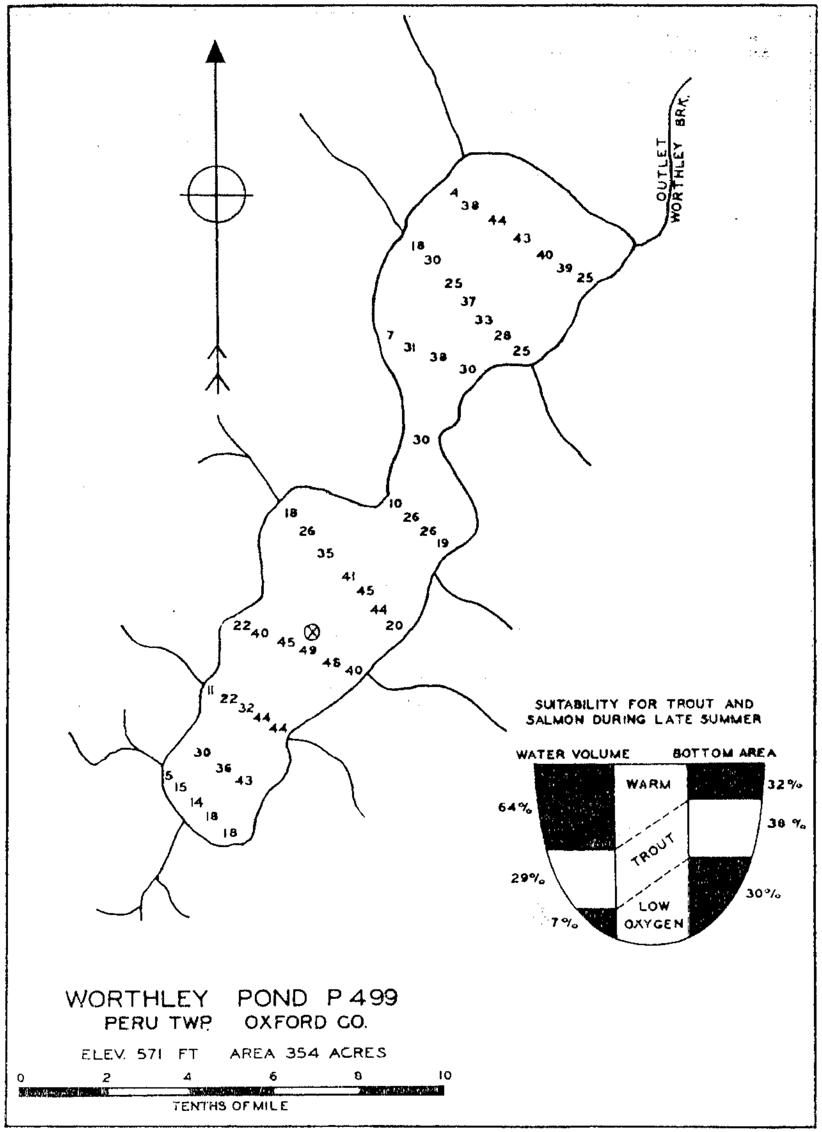


Figure 28. Worthley Pond. Soundings in feet and suitability of the water for trout or salmon.

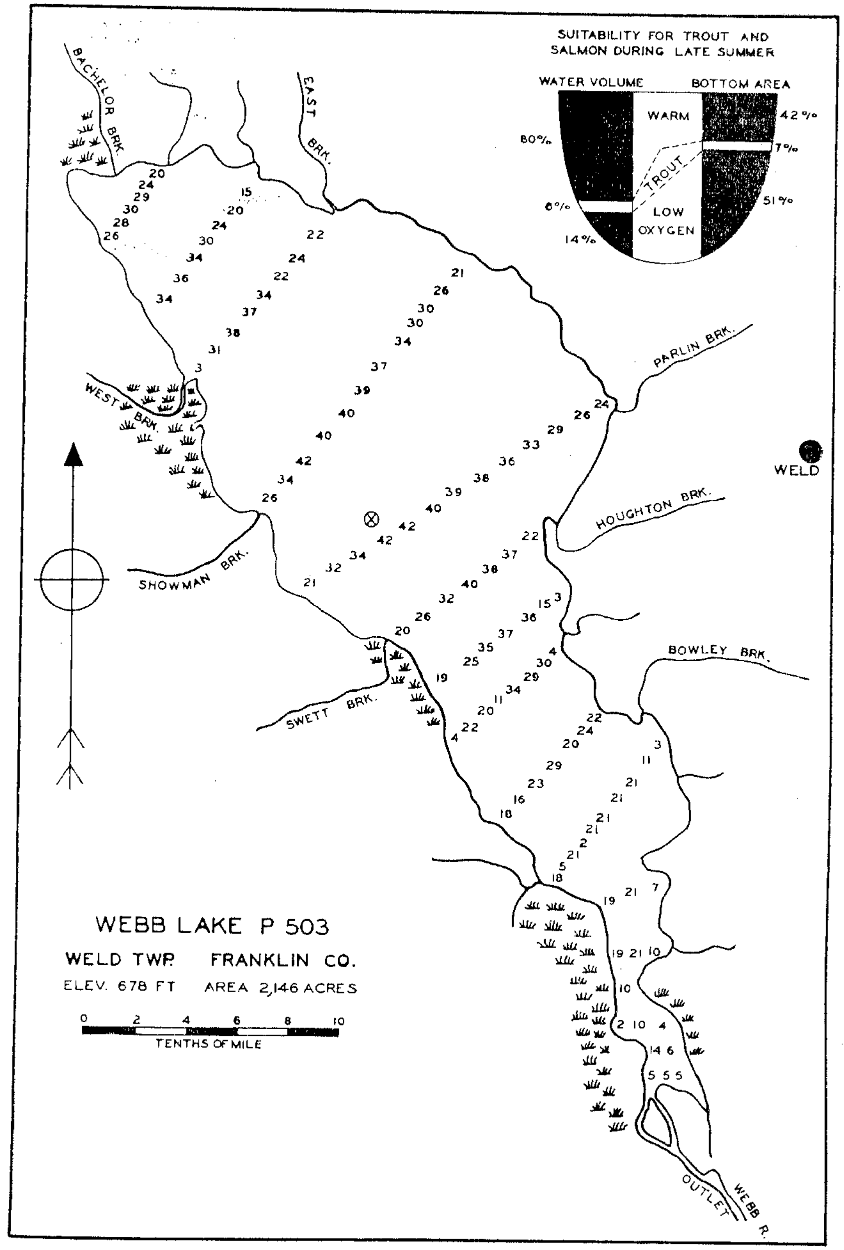


Figure 29. Webb Lake. Soundings in feet and suitability of the water for trout or salmon.

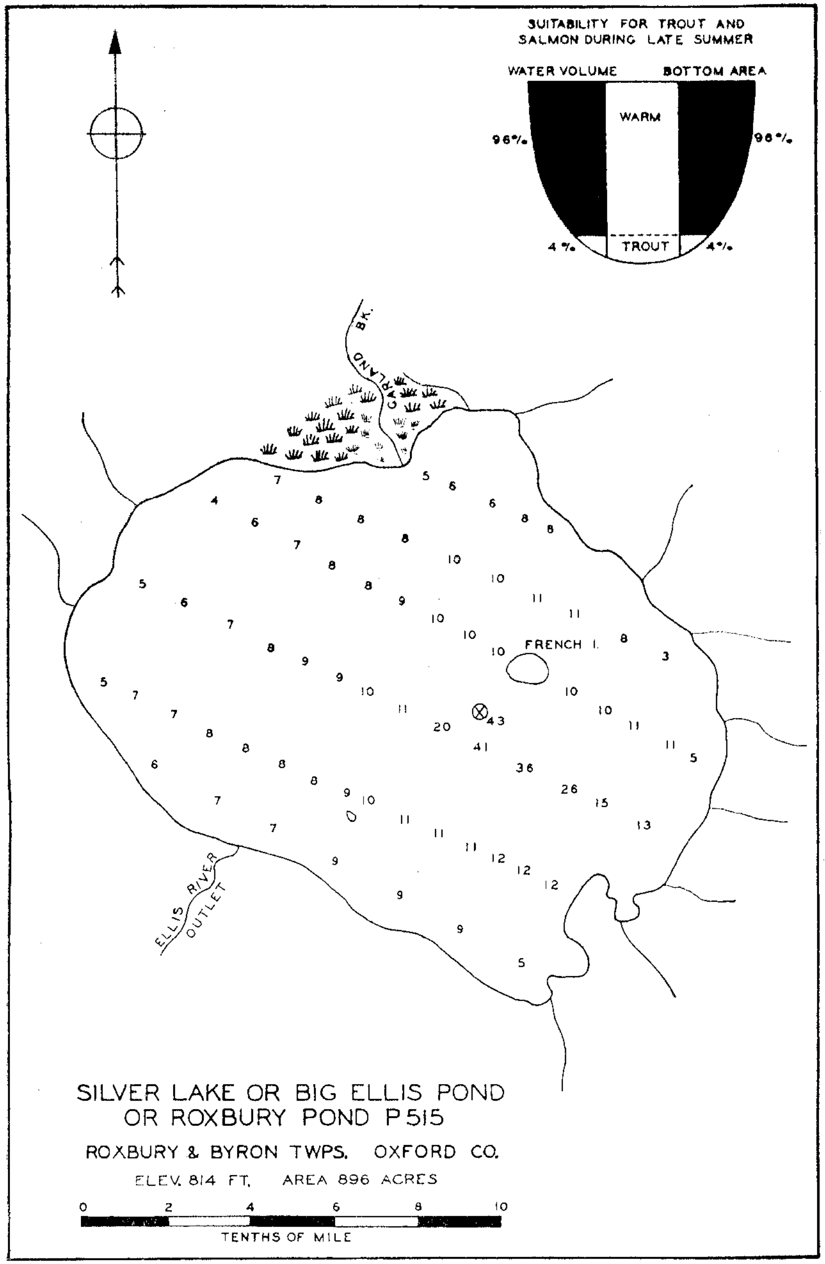


Figure 30. Silver Lake or Roxbury Pond. Soundings in feet and suitability of the water for trout or salmon.

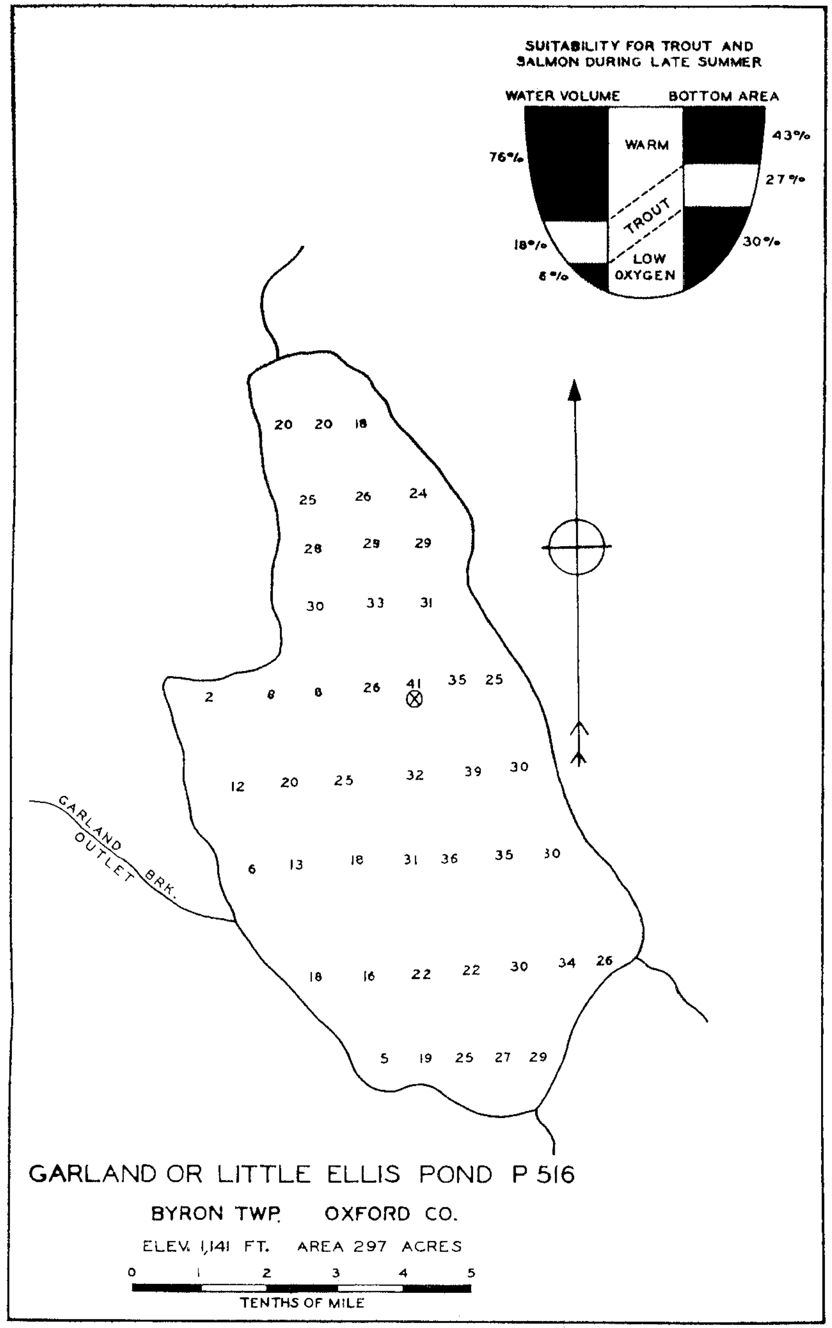
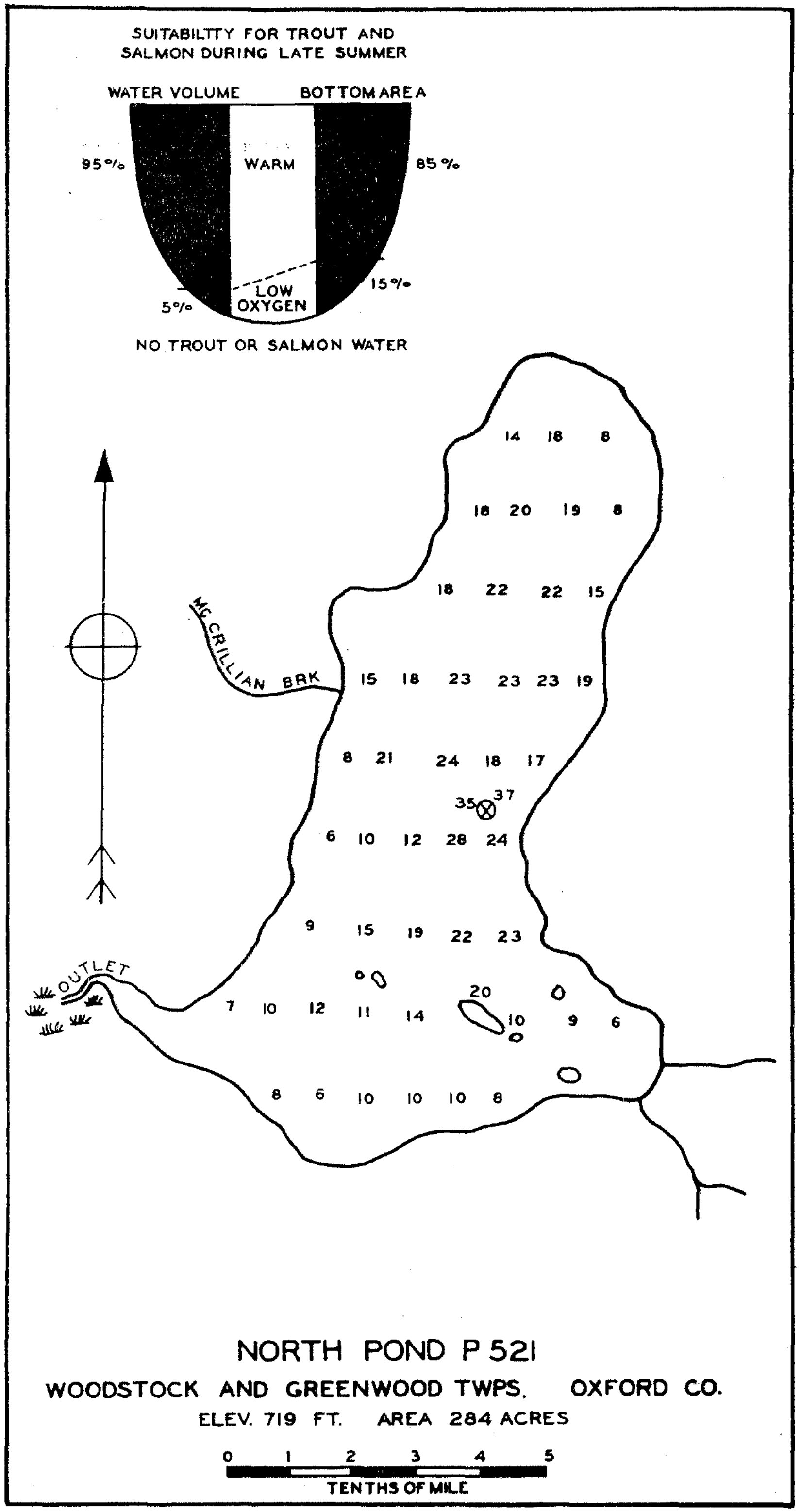


Figure 31. Garland or Little Ellis Pond. Soundings in feet and suitability of the water for trout or salmon.



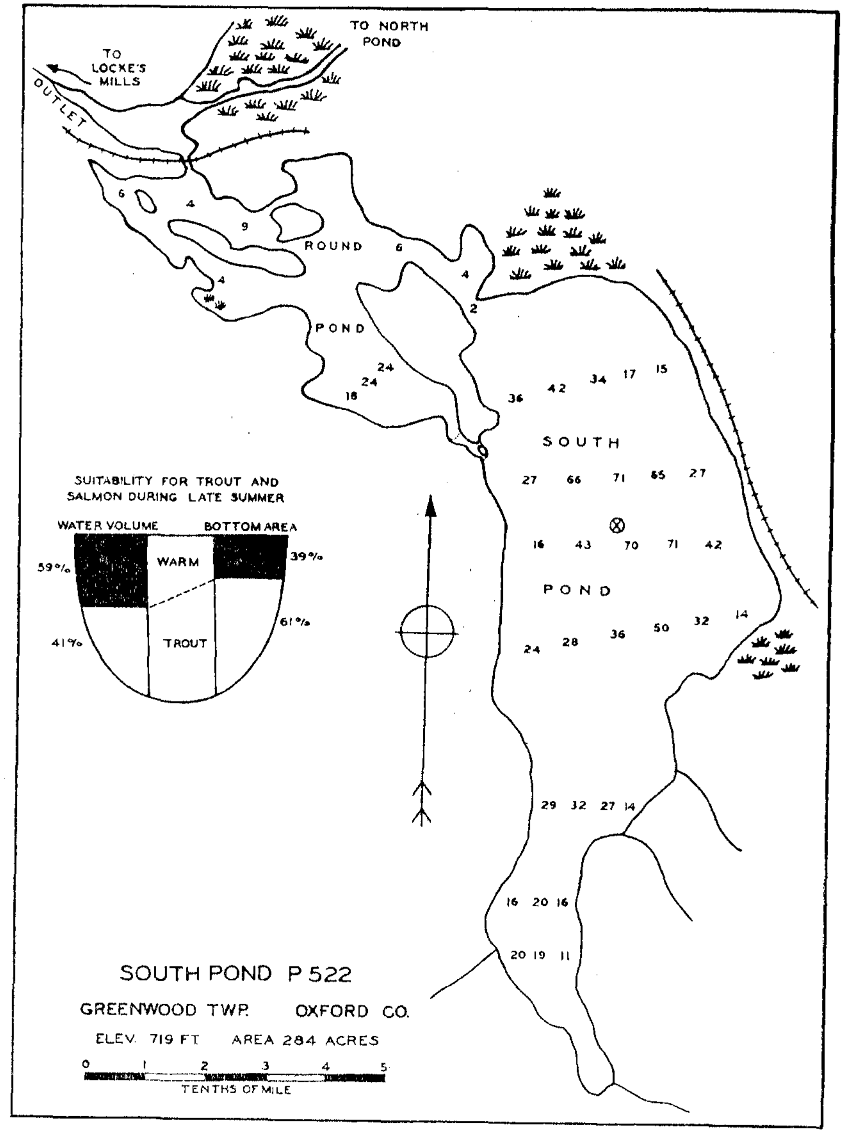


Figure 33. South Pond. Soundings in feet and suitability of the water for trout or salmon.

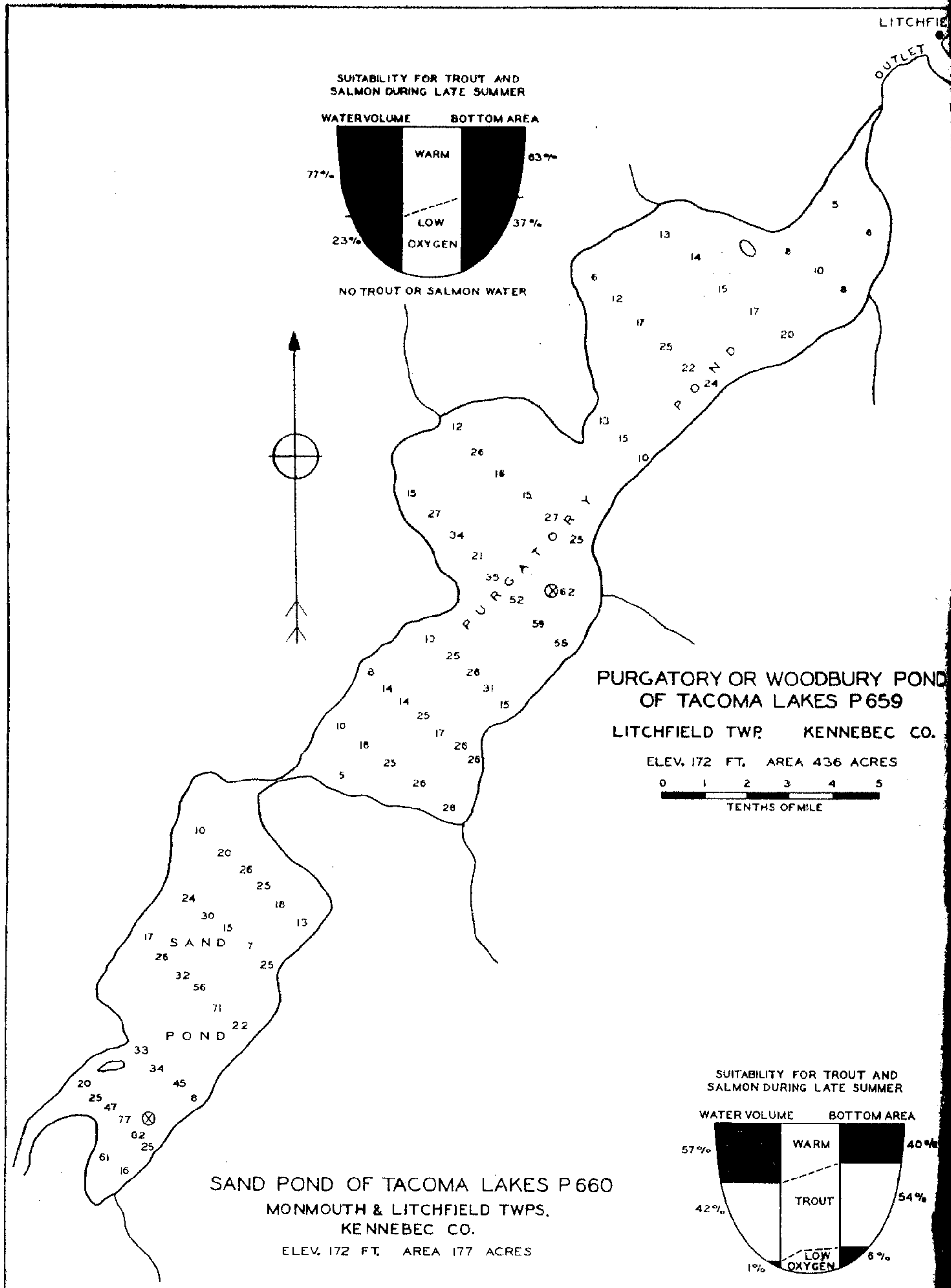


Figure 34. Purgatory Pond and Sand Pond. Soundings in feet and suitability of the water for trout or salmon.

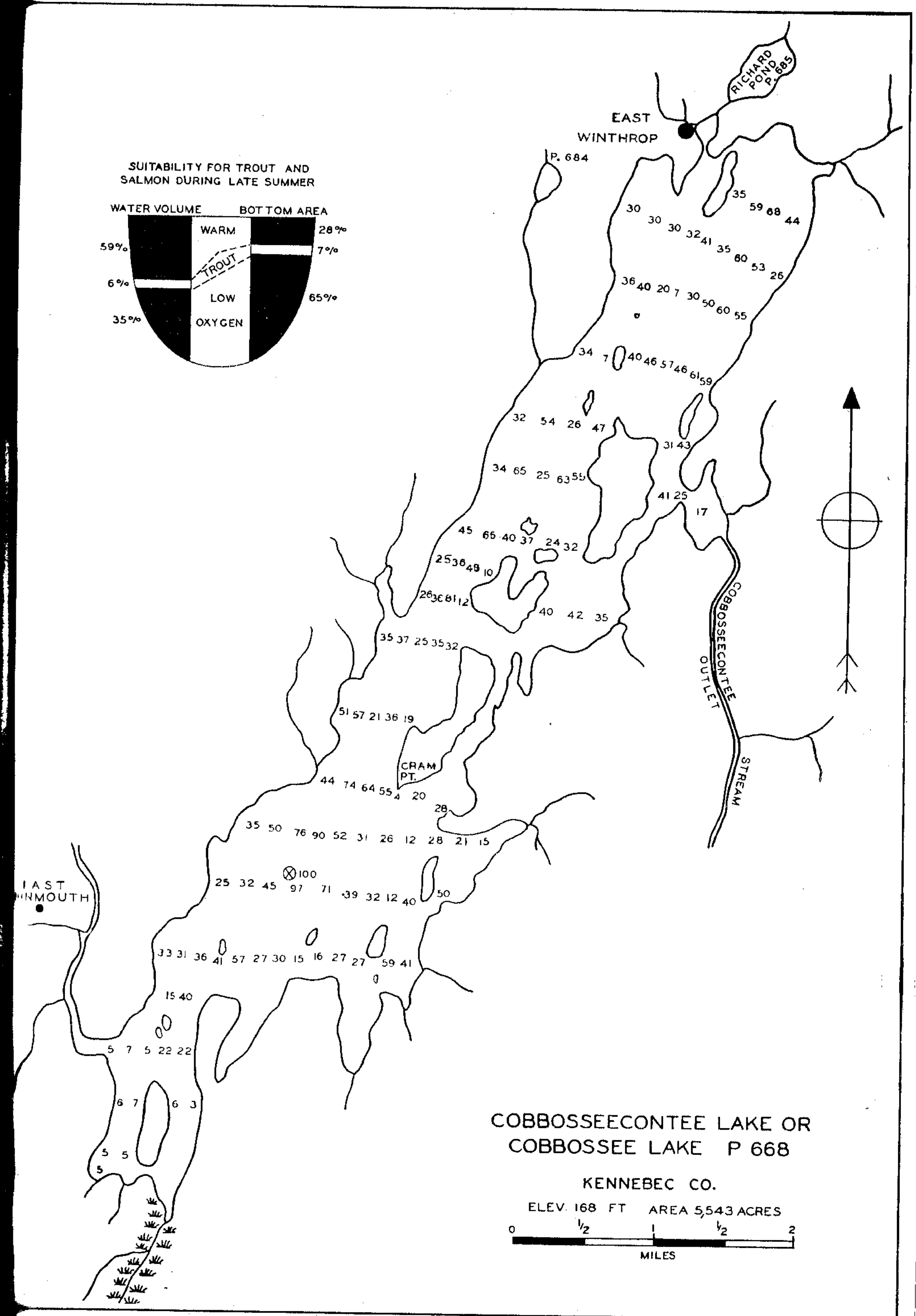


Figure 35. Cobbosseecontee Lake. Soundings in feet and suitability of the water for trout or salmon.

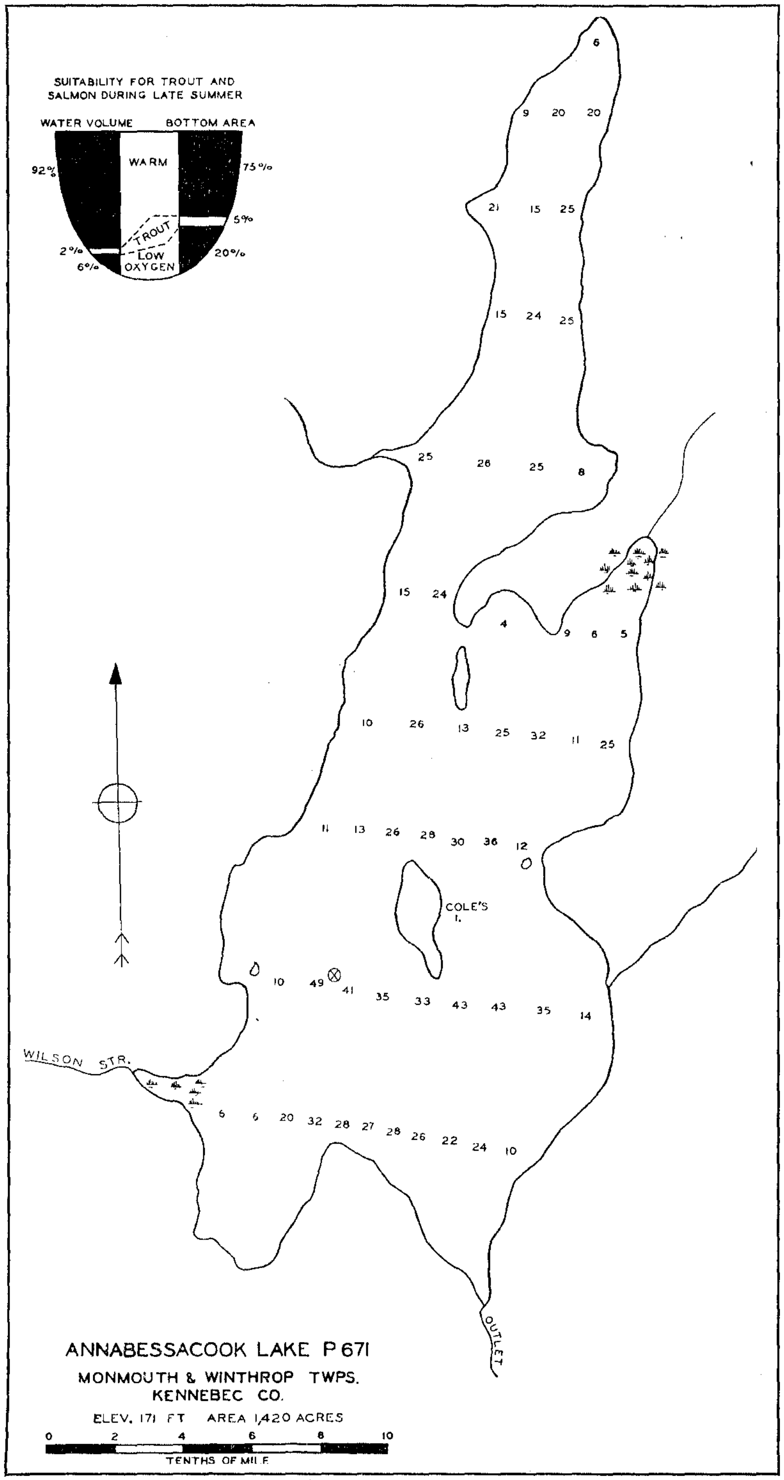


Figure 36. Annabessacook Lake. Soundings in feet and suitability of the water for trout or salmon.

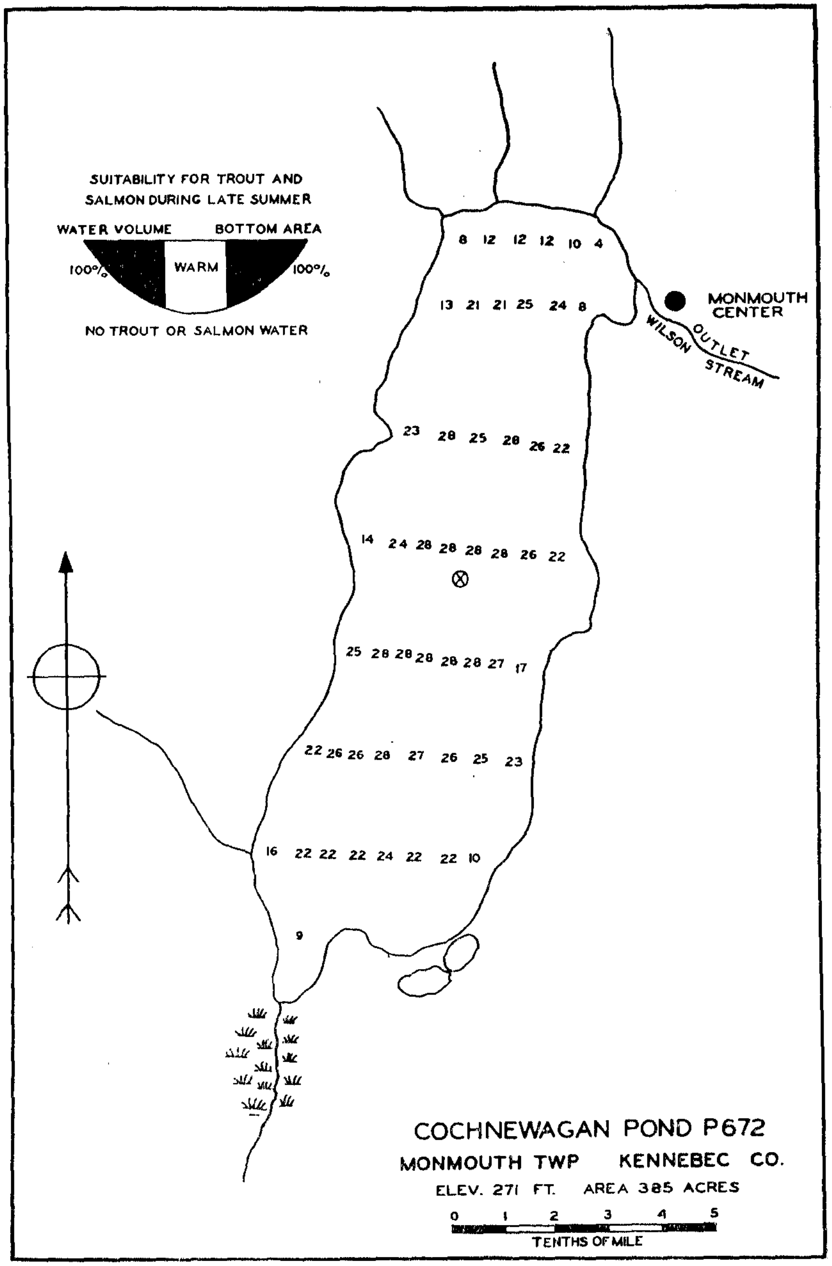


Figure 37. Cochnewagan Pond. Soundings in feet and suitability of the water for trout or salmon.

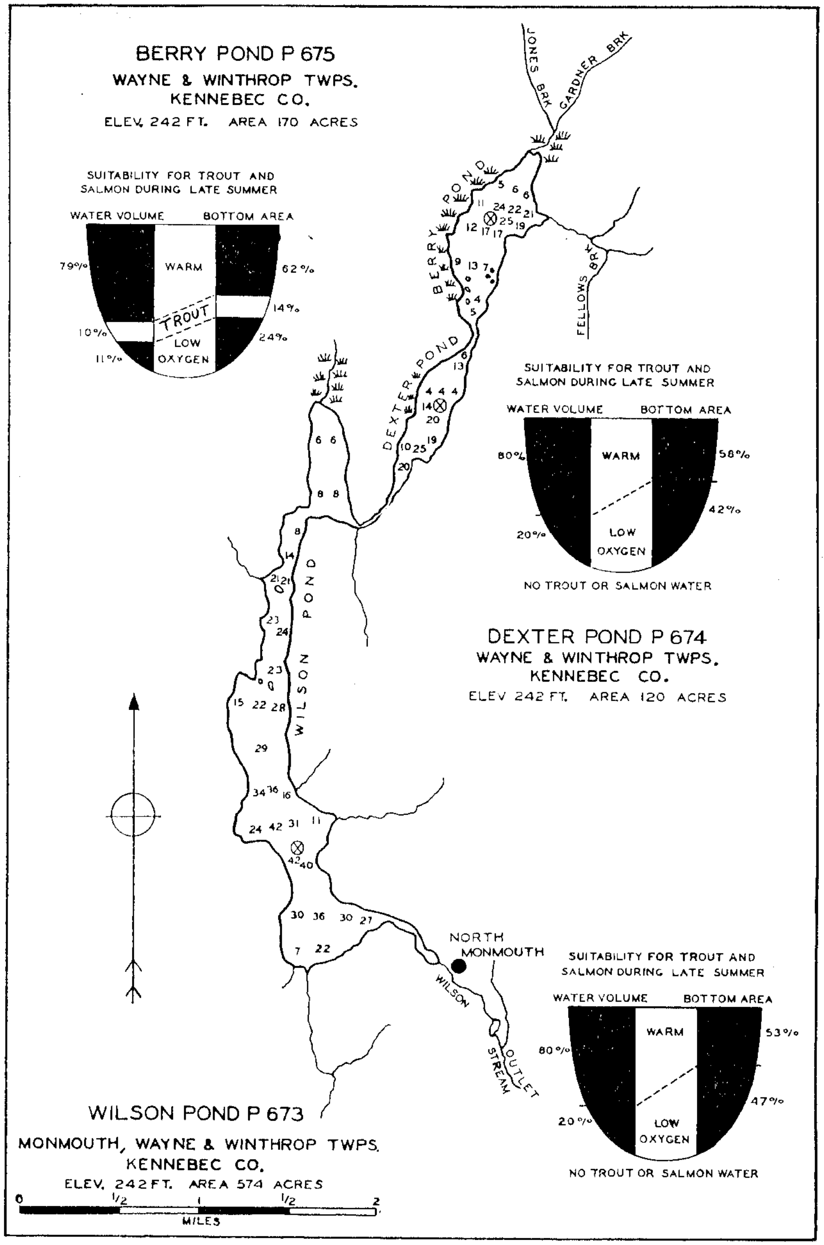


Figure 38. Wilson Pond, Dexter Pond, and Berry Pond. Soundings in feet and suitability of the water for trout or salmon.

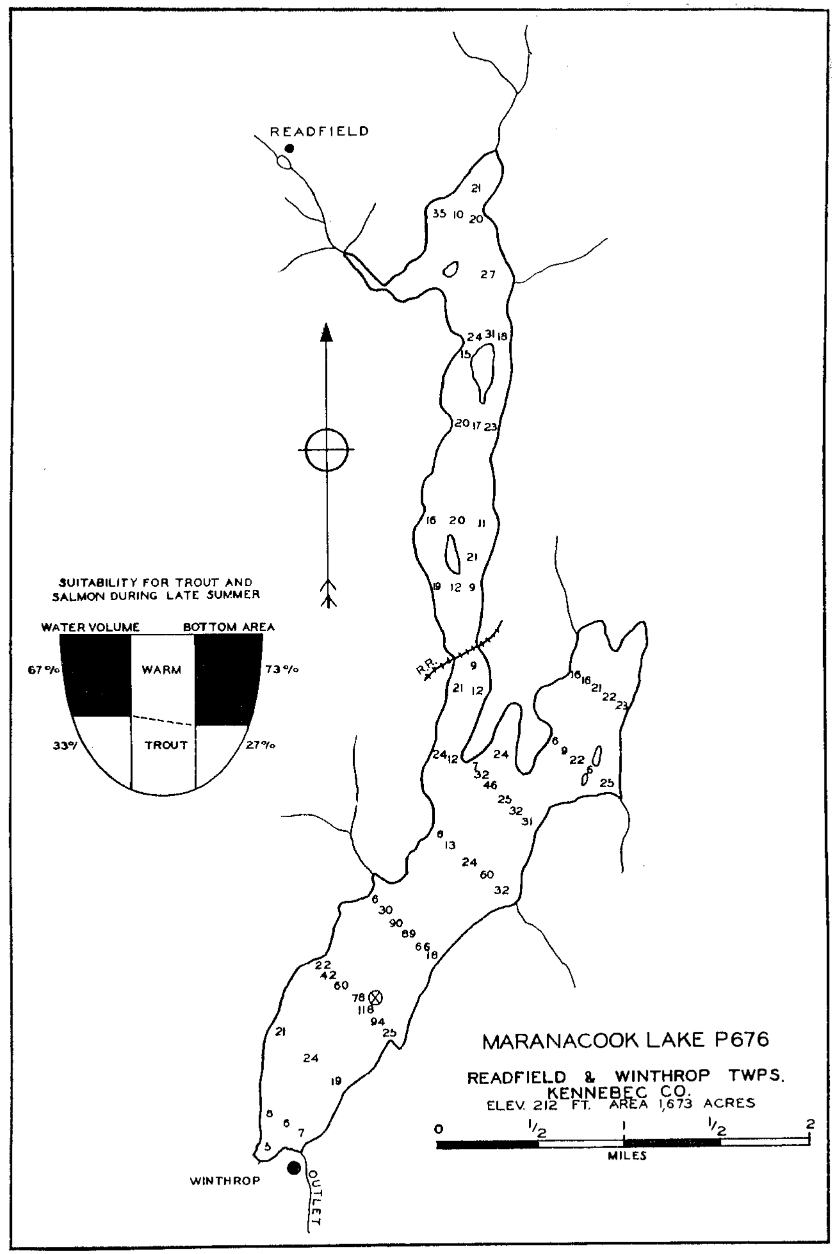


Figure 39. Maranacook Lake. Soundings in feet and suitability of the water for trout or salmon.

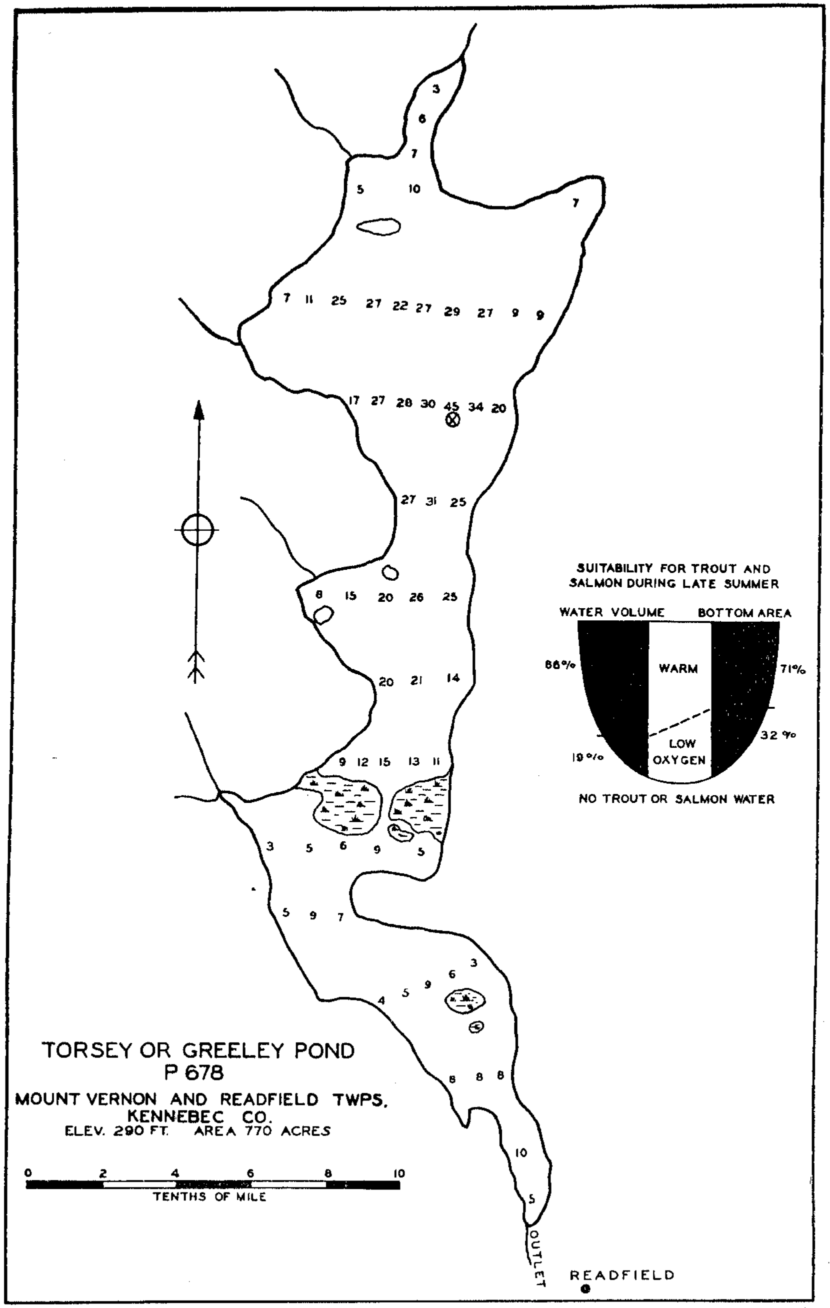


Figure 40. Torsey or Greeley Pond. Soundings in feet and suitability of the water for trout or salmon.

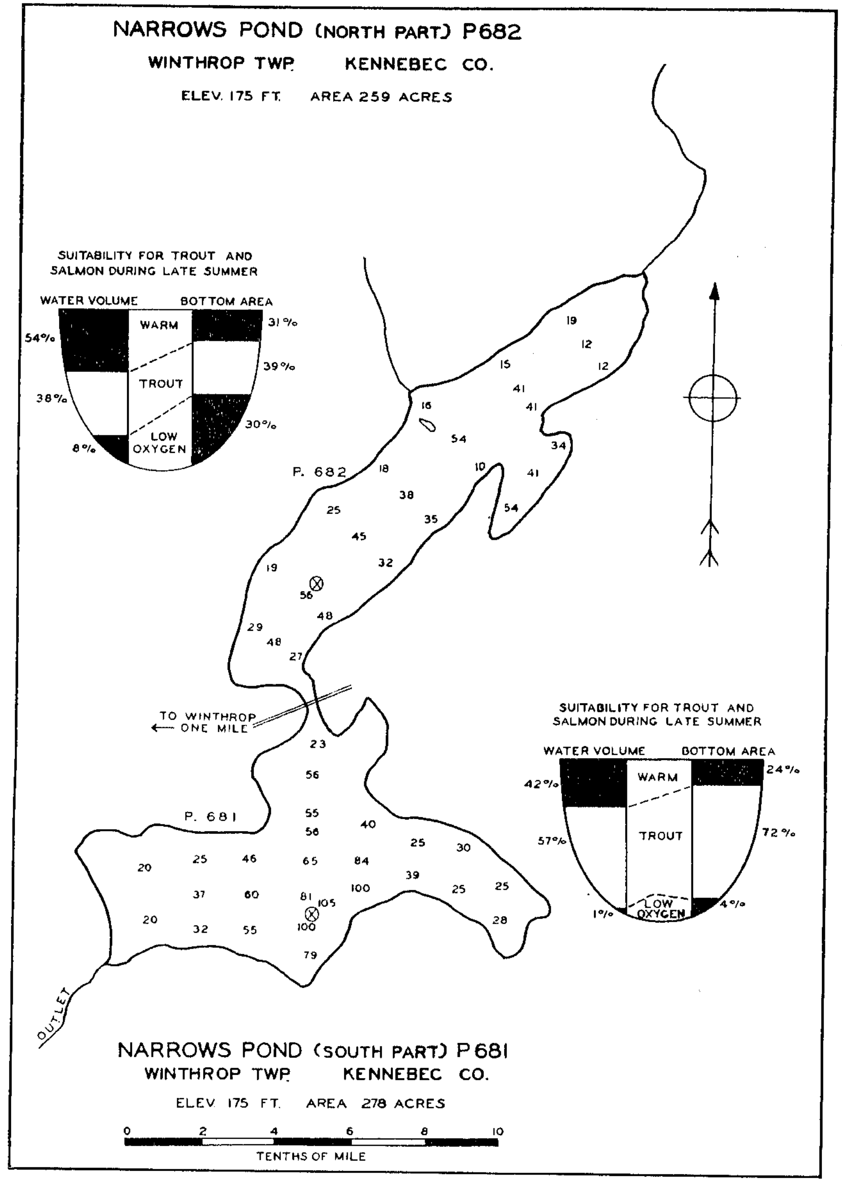


Figure 41. Narrows Pond (North and South parts). Soundings in feet and suitability of the water for trout or salmon.

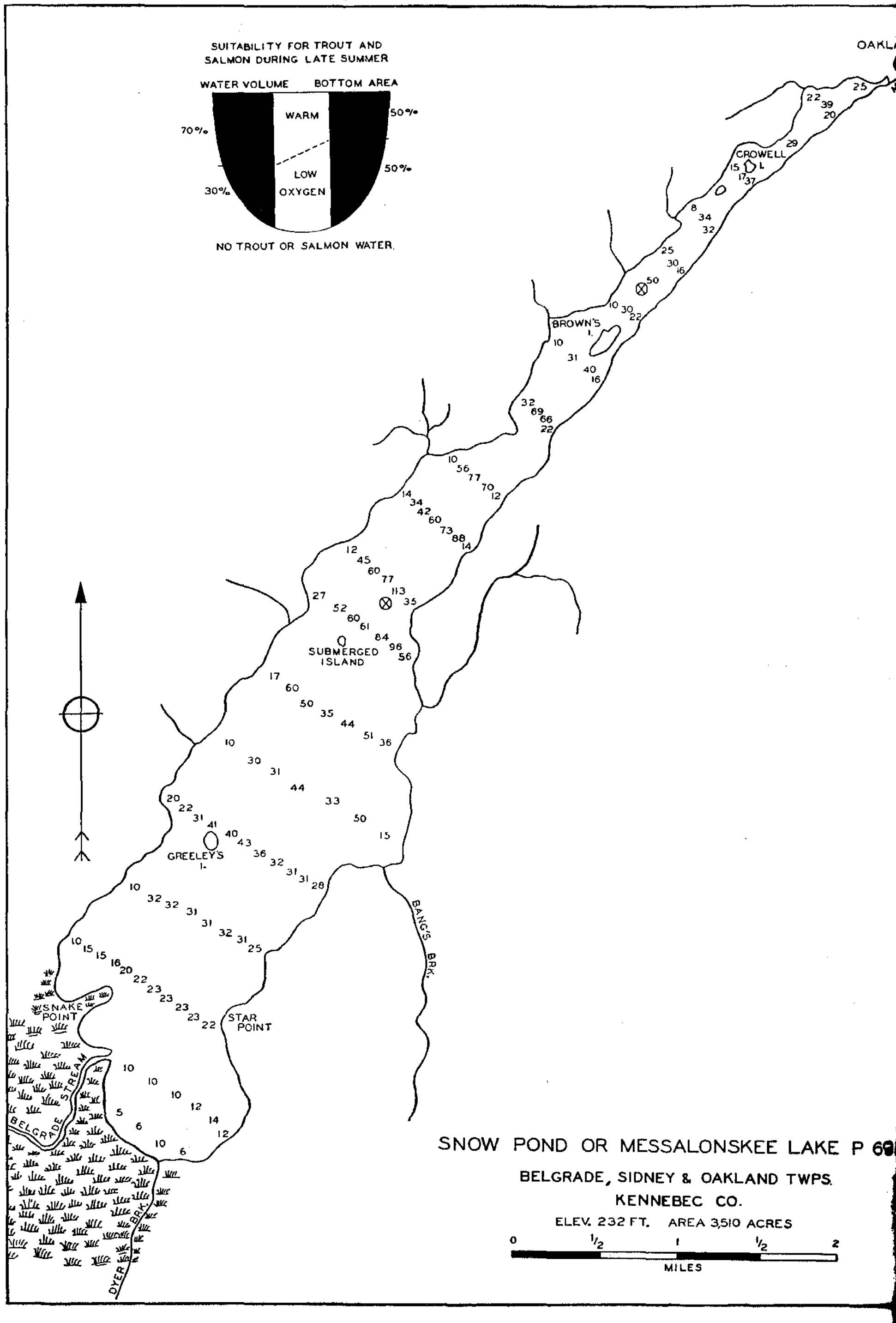


Figure 42. Snow Pond or Messalonskee Lake. Soundings in feet and suitability of the water for trout or salmon.

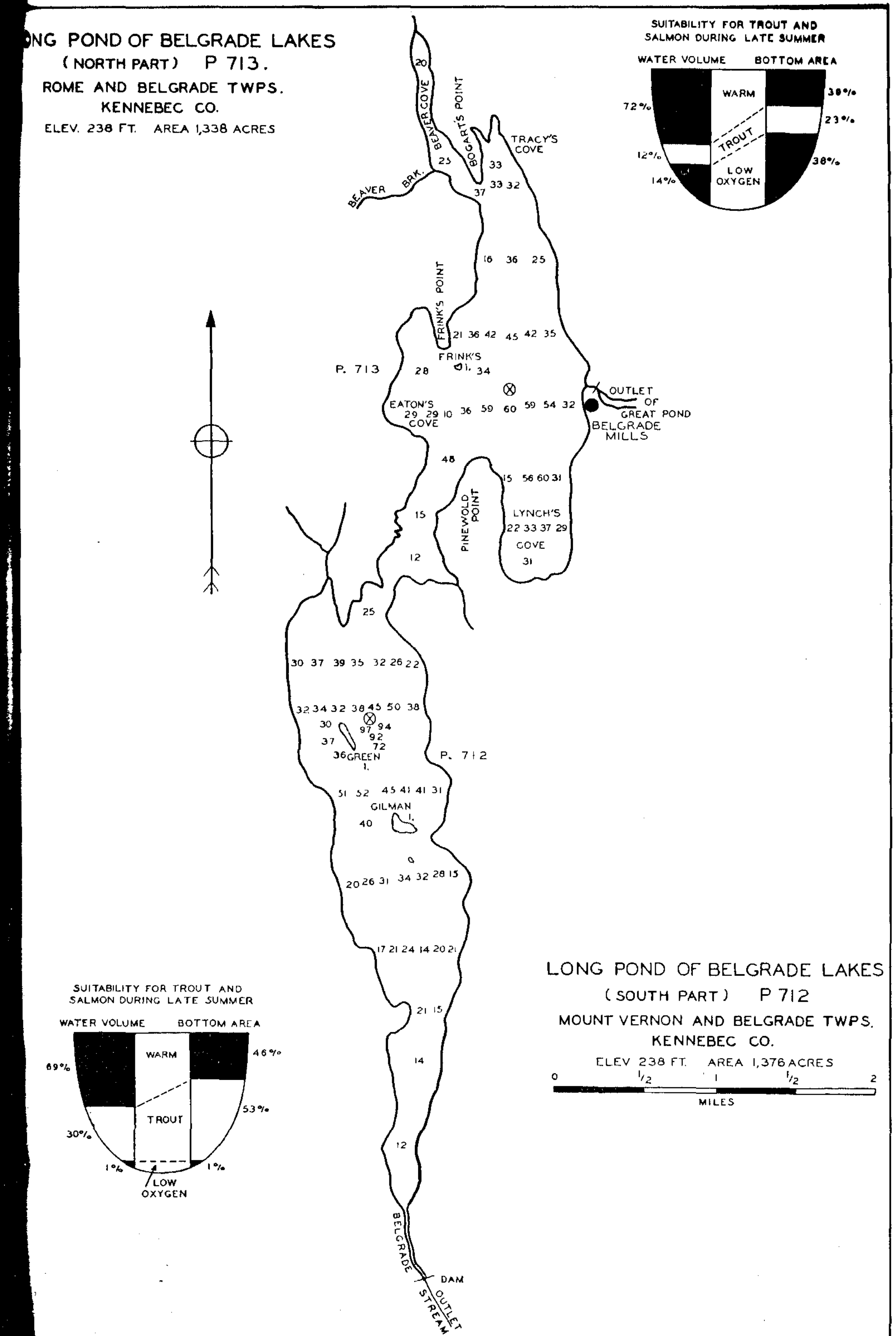


Figure 43. Long Pond of Belgrades (North and South parts). Soundings in feet and suitability of the water for trout or salmon.

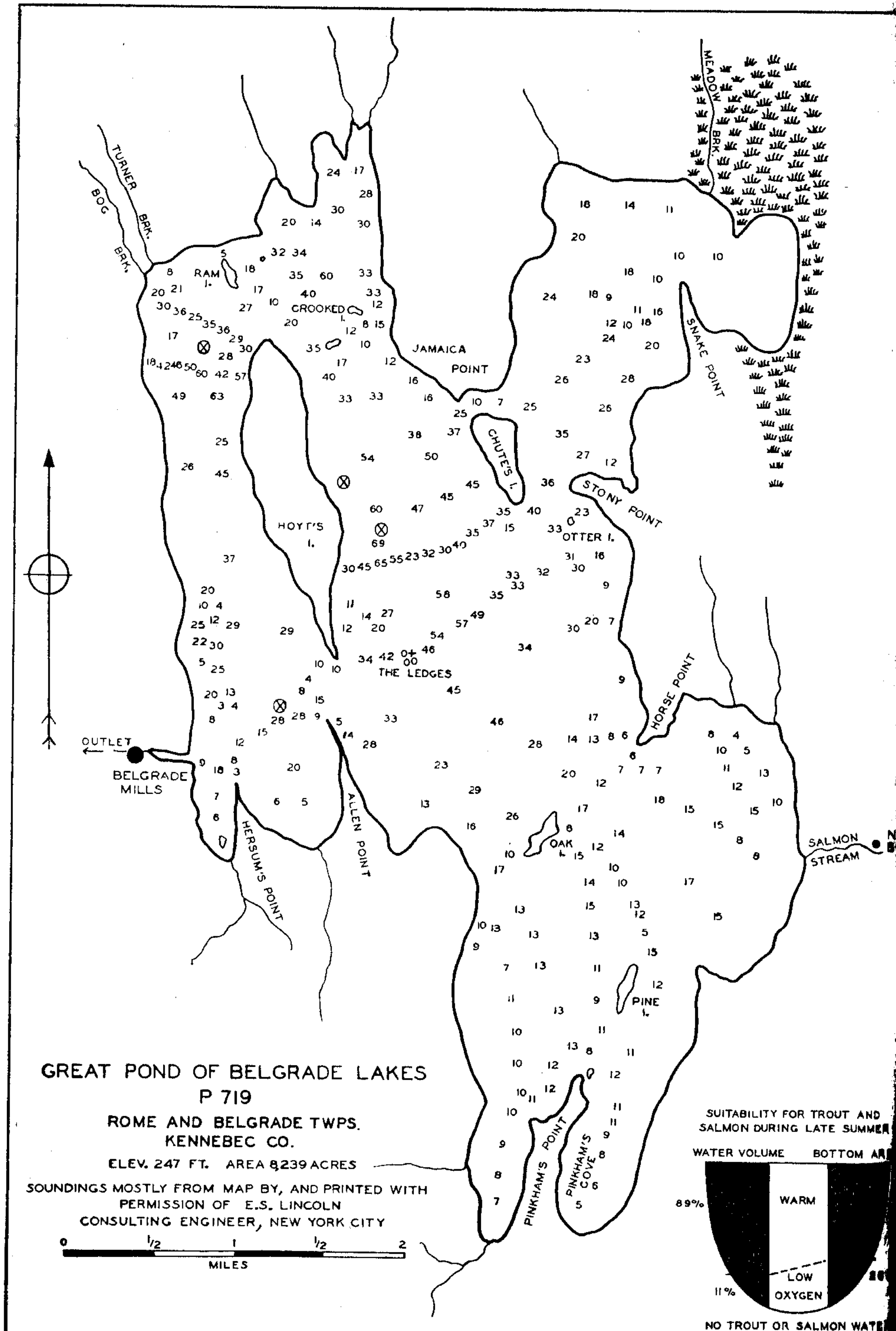


Figure 44. Great Pond of Belgrades. Soundings in feet and suitability of the water for trout or salmon.

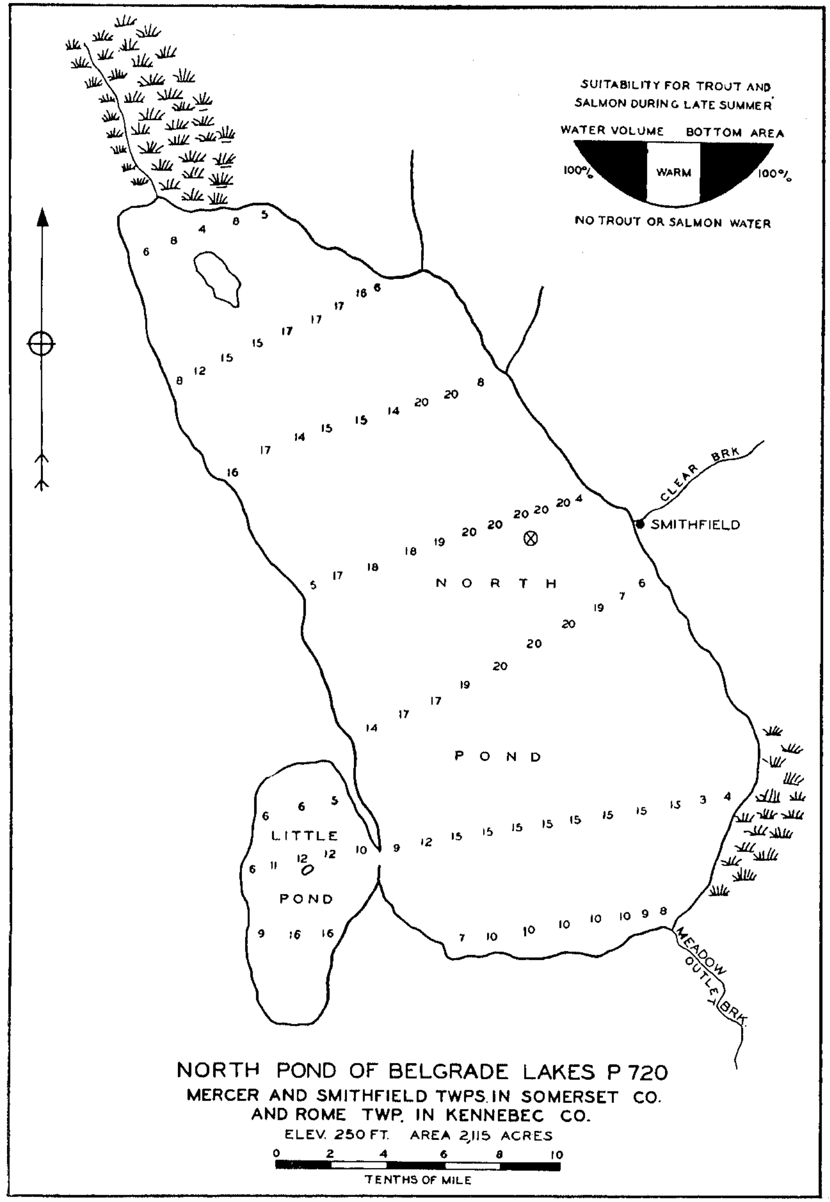


Figure 45. North Pond of Belgrades. Soundings in feet and suitability of the water for trout or salmon.

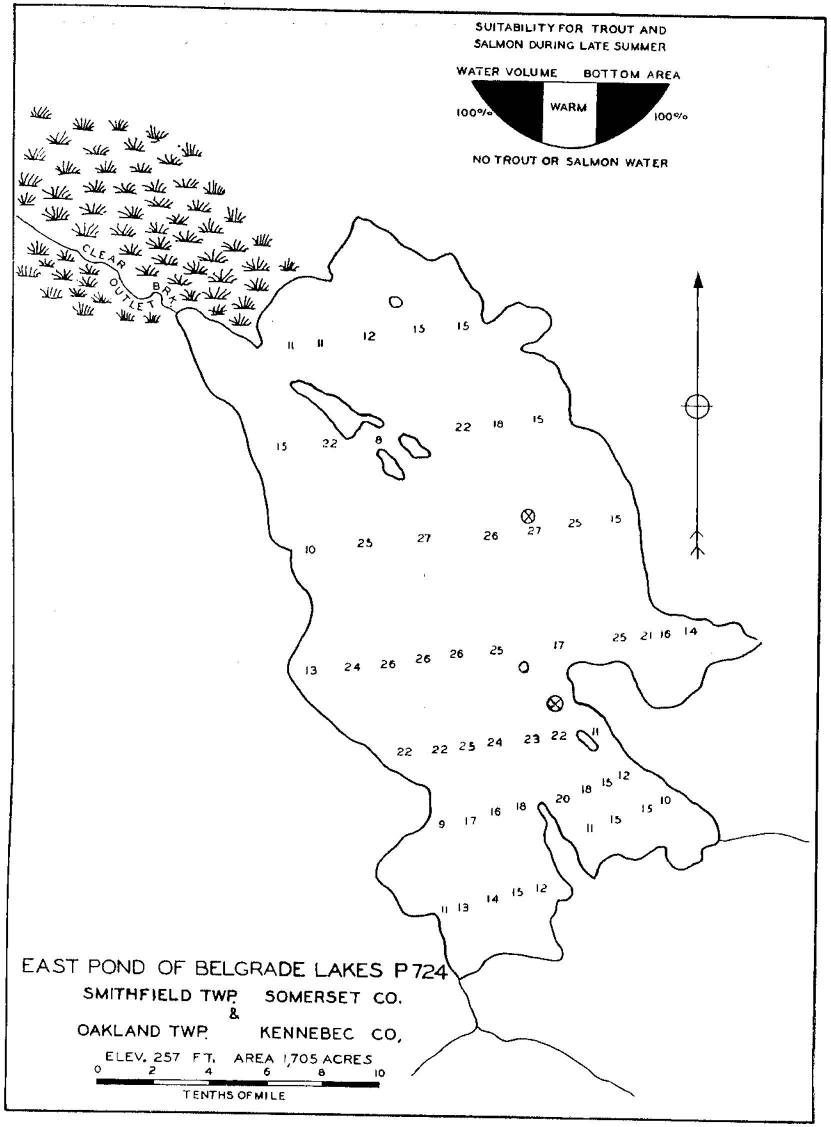


Figure 46. East Pond of Belgrades. Soundings in feet and suitability of the water for trout or salmon.

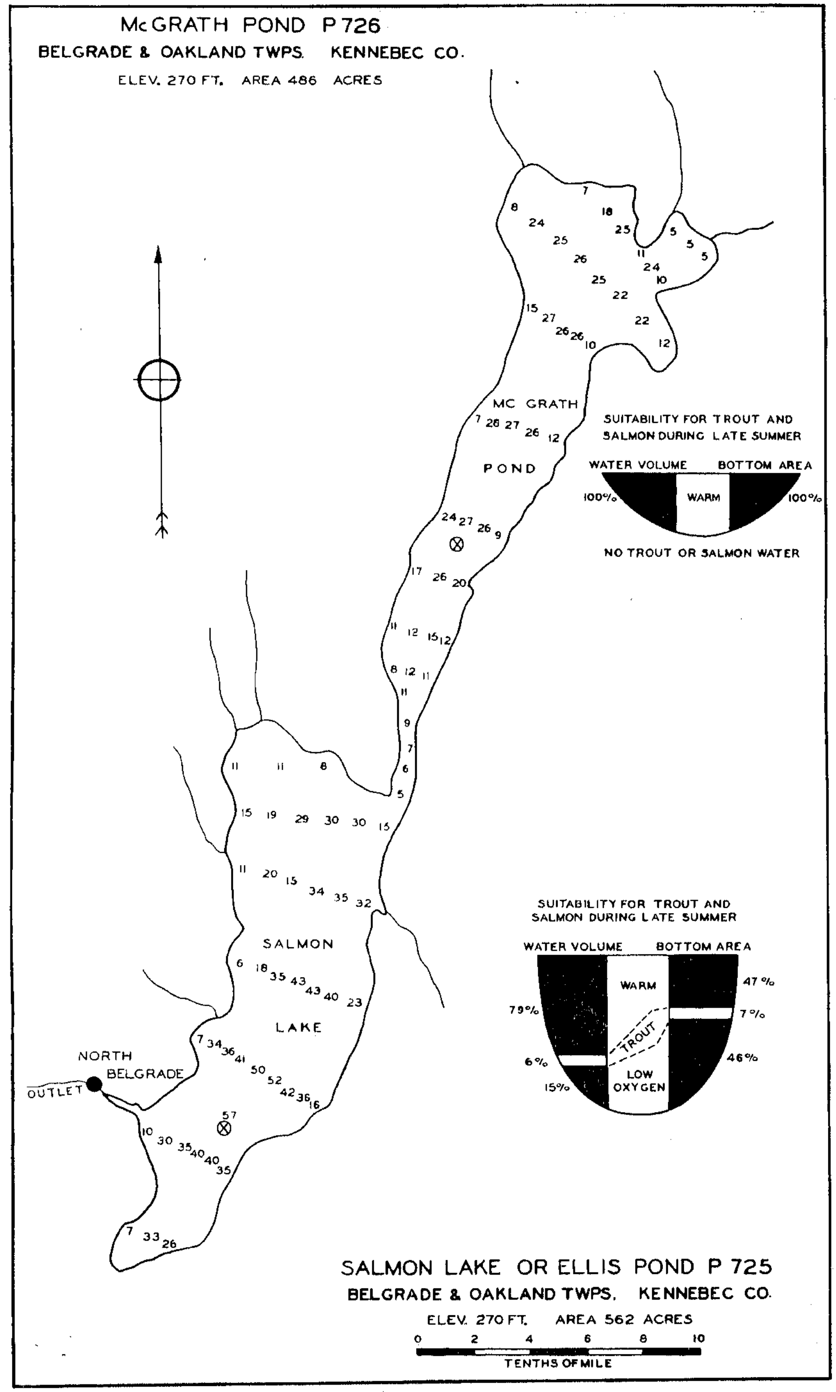


Figure 47. Salmon Lake and McGrath Pond. Soundings in feet and suitability of the water for trout or salmon.

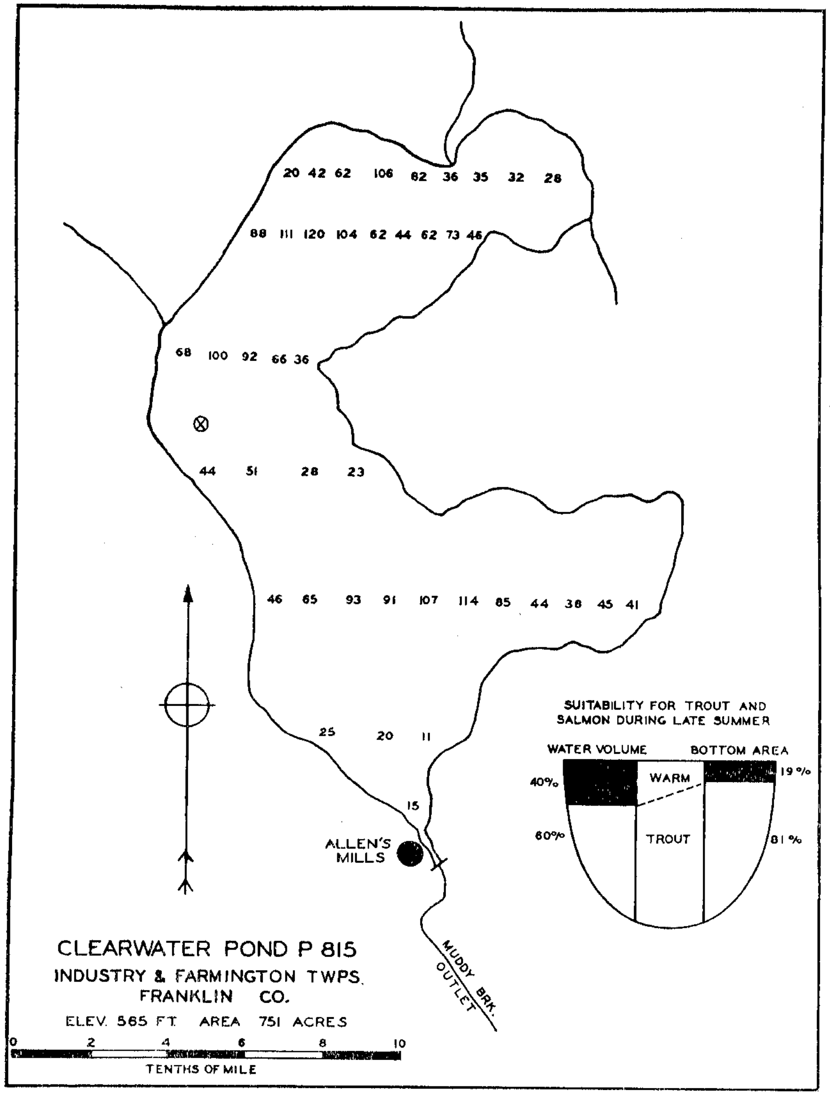


Figure 48. Clearwater Pond. Soundings in feet and suitability of the water for trout or salmon.

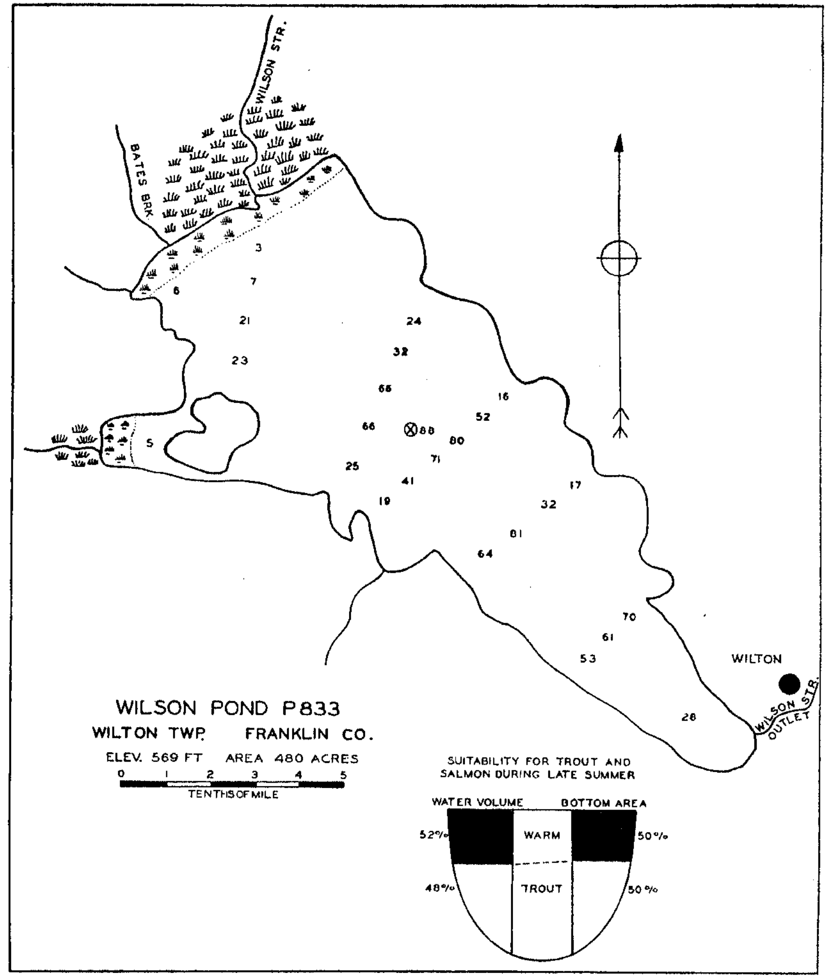


Figure 49. Wilson Pond. Soundings in feet and suitability of the water for trout or salmon.

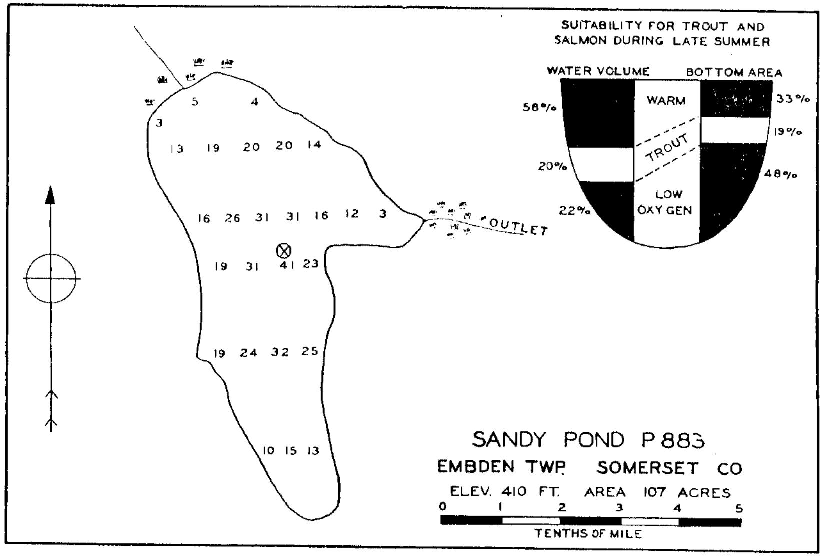


Figure 50. Sandy Pond. Soundings in feet and suitability of the water for trout or salmon.

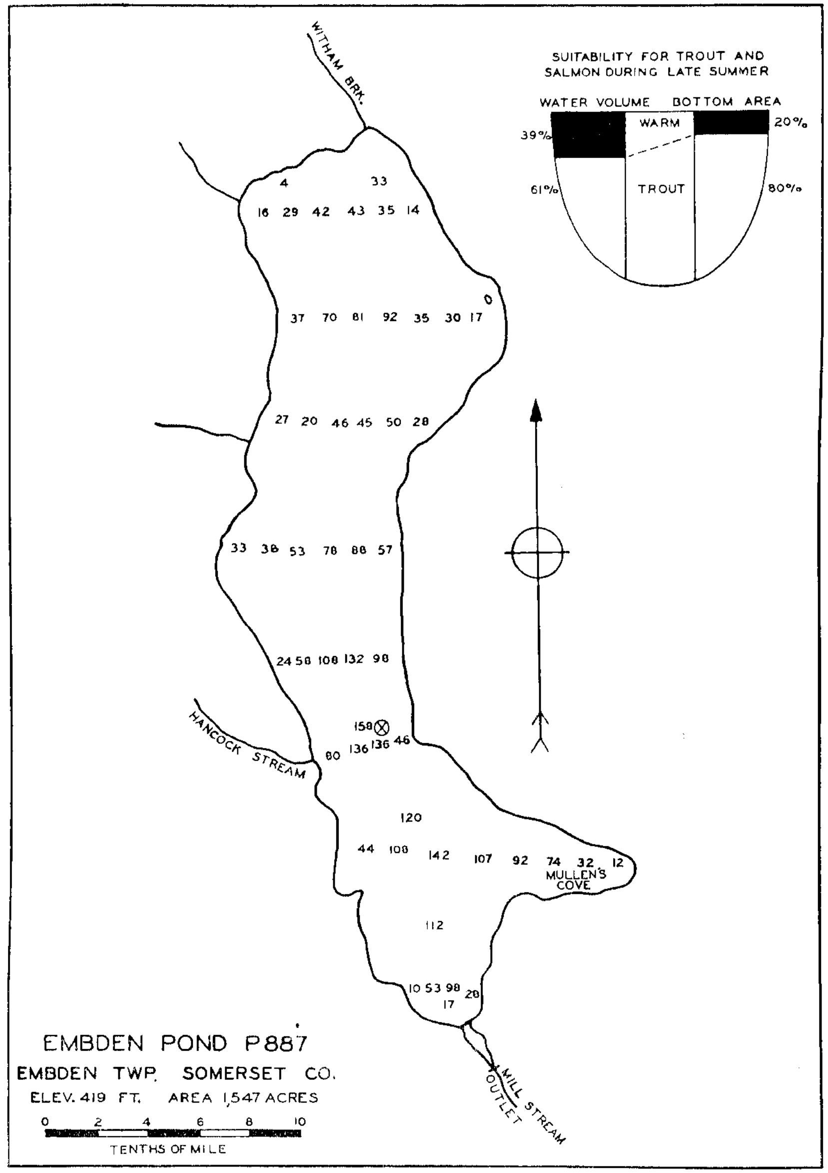


Figure 51. Embden Pond. Soundings in feet and suitability of the water for trout or salmon.

CONCLUSIONS AND RECOMMENDATIONS

The survey analyses on depth, temperature, and dissolved oxygen of the water revealed that the present group of 53 lakes and ponds includes distinctly different types of lakes with respect to their suitability for different kinds of game fishes: Many lakes were found to be good trout and salmon waters; others were found to be distinctly not good trout or salmon waters; and some lakes were somewhat intermediate in this respect. The classification of these lakes on the basis of water analyses is here repeated (and slightly modified) from page 66, as follows:

Excellent trout or salmon waters. Middle Range Pond, Upper Range Pond, Thompson Lake, Auburn Lake, Echo Lake, South Pond, Clearwater Pond, Wilson Pond in Wilton, Embden Pond, Pleasant Pond, Flying Pond, Sand Pond of Tacoma Lakes, and the south part of Narrows Pond.

Good trout or salmon waters. Maranacook Lake, south part of Long Pond of the Belgrades, north part of Narrows Pond, Worthley Pond, Allen Pond, and Garland Pond.

Marginal trout waters. Lower Range Pond, Pennesseewassee Lake, Twitchell Pond, Bryant Pond, north part of Long Pond of the Belgrades, and Sandy Pond.

Bass, perch, or pickerel waters. Parker Pond, Berry Pond, Taylor Pond, Whitney Pond, Webb Lake, Cobbosseecontee Lake, Salmon Lake, Hogan Pond, Tripp Pond, David Pond, Tilton Pond, Silver Lake, North Pond in Woodstock, Purgatory Pond, Annabessacook Lake, Wilson Pond in Monmouth, Dexter Pond, Torsey Pond, Snow Pond or Messalonskee Lake, Great Pond of the Belgrades, Sabattus Pond, Androscoggin Lake, Pocasset Lake, Lovejoy Pond, Cochnewagan Pond, North Pond of the Belgrades, East Pond of the Belgrades, and McGrath Pond.

Two implications to be drawn from this classification and which are of utmost importance in the present recommendations on stocking and other management policies are: (1) that the different species of game fishes have certain requirements and do best in certain types of waters, and (2) that good fishing for from six to eight game species cannot be maintained in one body of water, or, more specifically, that good fishing for trout, togue, or salmon cannot be maintained in lakes with abundant populations of from three to six species of warm-water game fishes. The validity of the above classification of these lakes on the basis of water analyses was substantiated to a considerable extent by the results of gill net sets made in most of

these lakes, for most of the few (25 of a total of 34) salmonids taken by the nets were from seven of the "excellent" or "good" trout or salmon lakes. The most conclusive evidence for the validity of this classification is from results of previous surveys on other Maine lakes, particularly the Rangeley Lakes, Sebago, Kezar, Adams Pond, etc. (see Maine Fish Survey Reports Nos. 2 and 3); most of these lakes, from which large numbers of trout and salmon were taken by gill nets, were deep and had little oxygen deficiency in the deep water, i.e., they were of the types listed above as "excellent" or "good" trout or salmon lakes. The lakes listed above as *bass, perch, or pickerel waters* were found to be unsuitable for trout or salmon, and, therefore, should be developed for these warm-water game species. It is recommended that this classification of the lakes be followed in the future stocking program, on the grounds that the best returns from stocking can be expected from those lakes in which conditions of the water are most ideal for a given species. Judging from the results of our fish collections, as compared to records of past fish plantings, it is evident that perch, pickerel, and (in some instances) bass become abundant in most lakes without aid from artificial propagation; trout and salmon, on the other hand, are able to maintain a fair degree of abundance in the presence of these warm-water game fishes, and with aid from artificial propagation, only in those lakes where conditions of the water are particularly suitable. It is, therefore, most important to stock salmonids in the best trout and salmon waters in order to maintain a balance of trout, salmon, bass, perch, and pickerel fishing.

A desirable balance between trout and salmon on the one hand, and perch, bass, and pickerel on the other, is not being maintained in this group of lakes, judging from our gill net collections. Trout and salmon are not so abundant as might be expected from past stocking. From the survey of 1939, we have information on the Rangeley Lakes for comparison with the present group of 53 lakes: Comparable gill netting effort took more than ten times as many trout and salmon from the Rangeleys, even though these two groups of lakes had been stocked at somewhat the same rate in proportion to their acreage. This difference may be partly attributable to the fact that many of the lakes studied in 1940 in which salmonids had been planted were not suitable for these fishes. The difference is partly due, however, to other factors; for returns of salmonids in nets from the better trout waters, such as Auburn, Embden, Narrows, Pleasant, and South, were about one-fifth the returns from the Rangeleys. In these better trout lakes of the 1940 survey, conditions of depth, temperature, dissolved oxygen, abundance of plankton, and abundance of bottom food, are as favorable as in the Rangeley Lakes. The most obvious difference is that the Rangeley Lakes have no perch, bass, pickerel, or sunfishes. Also, the Rangeleys apparently have a much greater smelt population, which may be partly attributable to the fact that there are no warm-water game species to help deplete the smelts. In other words, the abundance of warm-water game fishes and the relative scarcity of smelts in most of these better trout and salmon lakes of the 1940 survey are obviously the most important factors limiting the survival of stocked trout and salmon; and necessary measures should be taken to decrease the perch, bass, and pickerel and to increase the smelt in those lakes in which trouts and salmons are planted.

There may be considerable controversy over the proposed stocking recommendation for several of the present group of lakes. Among the lakes found by the survey to be "bass lakes," and therefore not suitable for trout or salmon, are several of the largest bodies of water, particularly Great Pond of the Belgrades, Snow Pond or Messalonskee Lake, and Cobbosseecontee Lake. These lakes have been stocked heavily with trouts and salmons; a very few salmonids were taken from them by our gill nets; and they produce some trout and salmon fishing, notably for large fish. In fact, judging from some local reports, they may be producing as good trout and salmon fishing as are some of the "better" trout and salmon lakes for which stocking is here recommended. Great Pond produces some Chinook Salmon, Land-locked Salmon, and Brook Trout fishing; Cobbosseecontee Lake, some Chinook fishing; and Snow Pond or Messalonskee Lake, some Brook Trout fishing. For example, a letter dated July, 1941 from Gene L. Letourneau of the *Waterville Sentinel* stated that "I personally took seven trout from Messalonskee this year, eight last year and six the season of 1939. They ranged from 2¾ pounds to 4¾, were unusually heavy fish and the majority were loaded with smelts." (See Plate XXIV.) These lakes are not, however, producing so good trout and salmon fishing, and they do not have trout and salmon so predominant in their fish populations, as might be expected from the extensive plantings which they have received. The preponderance of warm-water game fishes in Great, Snow, and Cobbosseecontee is quite obvious from the fact that twenty sets of our 375-foot gill net for a total of 464½ hours of fishing in these three lakes yielded 3 Brook Trout, 3 Chinook Salmon, 1 Land-locked Salmon, 439 White Perch, 67 Yellow Perch, 29 Small-mouthed Bass, 33 Pickerel, and 8 Walleyed Pike; or a total of 7 salmonids to 576 competing warm-water game fishes. The fact that Great, Snow, Cobbosseecontee, and some of the other "bass lakes," may produce as good trout and salmon fishing as do some of the "better" trout and salmon lakes is not, in the writer's opinion, a good argument for continued stocking of salmonids in Great, Snow, and Cobbosseecontee. Rather, the fact that some of the better trout and salmon lakes may not be producing any more salmonids than are Great, Snow, and Cobbosseecontee, is good evidence that stocking should be supplemented by other mea-

sures in order to improve the fishing in these better trout and salmon waters. Such recommendations of measures to supplement stocking are given in a later paragraph.

Most of the lakes classified above as *bass, perch, or pickerel waters* contain all three types of these warm-water game species: Small-mouthed Bass, White Perch, and Common Pickerel. The White Perch is at least fairly abundant in most of the lakes, and is the most abundant fish in many of them. The pickerel is quite abundant, that is, for a large predatory form, at least to the extent that there is no general complaint among fishermen of its scarcity. The Small-mouthed Bass is also quite abundant, but the demand by summer fishermen for bass fishing is so great that there is agitation for the improvement of bass fishing in many lakes. The number of adult-sized bass taken by our gill netting from the lakes was not very great (only 66), and would tend to indicate a greater scarcity of bass, as compared to other species, than actually exists; for, in the writer's opinion, the Small-mouthed Bass is much more difficult to catch in a gill net than are most other species, and it might be inferred from this that adult bass are more abundant than the results of our gill netting would indicate. The results of considerable seining on the shallows of many of the bass lakes during July and August revealed, however, that bass fry and fingerlings were very scarce: 23¾ hours of seining with seines 10 to 50 feet long yielded 3.5 bass fry and fingerlings per hour. This, to the writer, indicates an especially meagre population of young bass, especially for these lakes which have ideal spawning grounds for the Smallmouth; and a scarcity of young bass would certainly have some effect on the numbers which reach legal size. One of the reasons for the apparent scarcity of young bass is undoubtedly that present bass fishing interferes with the spawning fish. We found bass still on the spawning beds during the latter part of June, and most of the female bass taken by our nets during the last half of June and the first week in July still contained ripe eggs. The present law permitting fly-fishing for bass from June 1 to 20, and the regular bass season opening on June 21, make bass fishing legal during most if not all of the spawning season, and make it possible for fishermen to catch the adult bass which are guarding their nests. According to our observations and to reports by local wardens and fishermen, most June bass fishing is for fish on the spawning grounds. While fishermen are permitted to keep only three bass per day during the June 1 to 20 fly fishing, there is no legal limit to the number which can be caught and released. In fact, many of these lakes have been famous for the number of bass which could be caught per day per fisherman by spring fly-fishing. Most of these fish, i.e., those in excess of the daily limit of three, presumably were released, but this continual catching of adult bass from their nests could not do otherwise than have some bad effect on the eggs or fry. It is not known just how much damage is done by removing these spawning bass, in terms of the percentage of loss to eggs or fry, either when the fish are lightly hooked and immediately return to the nests, or when the bass are hooked seriously and killed. In the latter event, it seems safe to assume that few if any of the eggs or helpless fry would survive predation by other fishes or predators. In any event, the removal of these parent bass from the task of guarding their eggs and fry is entirely out of accord with the value of parental care in the maintenance of the species; and, since a scarcity of bass fry was found to exist in these lakes, this June fishing for bass on their spawning grounds must be at least partly responsible for a reported scarcity of bass in some lakes. It also could have accounted for a general decline in bass fishing over the past few years, which was reported for some lakes. *This June fly fishing for bass on their spawning grounds should be stopped in those lakes where it is desirable to maintain or improve bass fishing.* In this connection it is necessary to distinguish between bass fishing in "bass lakes" and bass fishing in trout and salmon lakes; in lakes which are stocked heavily with trout and salmon in an effort to provide good fishing for these cold-water species, it is desirable to keep bass, perch, pickerel, and other warm-water game species at a minimum, and, therefore, June fishing for spawning bass in these lakes is presumably beneficial for trout and salmon fishing. In addition to protecting spawning bass in the "bass lakes," it is also recommended that these lakes receive annual stocking of young Small-mouthed Bass by the State Fish and Game Department. The adoption of this proposed stocking program for bass will entail a considerable amount of money and effort, for the 28 bass lakes of the present area have a greater area than the 25 trout and salmon lakes, and more bass than salmonids are recommended for stocking. Stocking of bass in these 28 lakes can be justified on the grounds that the lakes are among the most-heavily fished waters of the state, the bass is one of the most important species for fishing, and there is a scarcity of young bass in these lakes at the present time. While stocking bass at the rate which is recommended (see Table XX) would represent a considerable cost to the Fish and Game Department, the actual number of these stocked fish when spread over the 39,639 acres of bass waters would represent a small number of fish as compared to what might be produced by natural reproduction in the lakes themselves. Therefore, the improvement of conditions for natural reproduction offers better possibilities for greatly increasing the bass populations of these lakes; and the expensive artificial propagation of bass might be justified in a supporting role only if fishermen would allow natural reproduction to play its part, or, in other words, discontinue taking spawning fish from their beds. It hardly seems justifiable for the State to raise young bass for a lake while fishermen are taking adults from beds where they are guarding several thousand eggs or fry.

The White Perch is the most abundant species of game fish in the majority of the present group of lakes — our gill nets took from the lakes as a whole a greater number of White Perch than of all other species combined. Our gill net sets indicated that the White Perch was generally more abundant in the shallow lakes than in the deep ones, but that it also predominated over other species in most of the deep lakes. The perch provides a major part of the fishing in many of the lakes and is therefore a big asset to our sport fisheries. On the other hand, the warm-water game fishes in general, and the White Perch in particular, are distinct menaces to trout and salmon in the "good" trout and salmon lakes; for it is generally true in Maine, and recognized also for most other northern states, that salmonids do not thrive in the presence of abundant populations of warm-water game fishes. Therefore the White Perch should be treated as a valuable asset in those lakes which are best adapted for warm-water species, but should be eliminated as much as possible in good trout and salmon lakes for which stocking and other efforts are employed to improve fishing for salmonids.

The present studies on age and growth of the White Perch have revealed that this species requires about 4 to 5 years to reach a legal length of 6 inches, less time in some lakes, more in others. Fishermen hardly regard perch with much interest unless they are at least 8 to 10 inches long, and to attain this length requires from 8 to 10 years of growth on the average. Especially prized fish of over a pound in weight are mostly over 12 years of age. Such a rate of growth is slow as compared to our other game species, and means that the turn-over in production of White Perch is comparatively slow in most lakes. In other words, if very heavy fishing removes a large percentage of the larger perch, it requires a period of several years for these fish to be replaced; in comparison, the rapidly growing trout and salmon in lakes have a much more rapid turn-over. The rate of growth of White Perch was found to vary greatly among different lakes. Growth was so slow in some lakes that it was requiring from 6 to 10 years for most fish to reach a length of 6 to 8 inches; after an age of ten years and a size of 8 inches were reached, a majority of the fish were either dying of old age or were being removed by fishermen. In other lakes the perch had grown to a length of over 9 inches in 6 to 8 years or less. The food of the White Perch was found to be mostly bottom organisms, and this bottom fauna must be to a certain extent the limiting factor in perch production. However, the rapidly growing perch were mostly from lakes where they had been supplementing their diet of bottom food with from 20 to 50 per cent fish. The present study therefore seems to indicate that fast growth, a rapid turnover, and greater production of White Perch, are generally more dependent upon a diet of fish, of which the Smelt, Yellow Perch, White

Perch, and Golden Shiner are the most important in this group of lakes.

There is considerable evidence to show that food is one of the most important limiting factors in the production of trout, salmon, perch, and possibly most other species of game fishes in Maine lakes. The decline in salmon fishing in some lakes has been coincident with a decrease in the abundance of smelt, and practically all good salmon fishing is in lakes where the smelt is abundant; the same is true for Brook Trout in some large lakes such as the Rangeleys. The great variation in rate of growth of the White Perch apparently is due to a large extent to variation in the type of food which they eat. Probably also the production of pickerel and bass is limited at least to some extent by food. The two important sources of basic food production in our lakes are the plankton and the bottom fauna. The total quantity by volume of plankton in the lakes is many times that of the bottom fauna. However, adult perch, trout, and to some extent salmon and bass, feed directly upon the bottom fauna to a much greater extent than they do upon the plankton. The major importance of the plankton is its role in the diet of small fishes which are in turn fed upon by the larger game fishes. The smelt is apparently the most important plankton feeder and food of adult game fishes in Maine lakes in general, although young Yellow Perch, White Perch, and Golden Shiners are important rivals of the smelt in this respect in many lakes of southern Maine. The fact that there are so few species of plankton-feeding forage fishes in Maine lakes places greater emphasis on the importance of the smelt. Furthermore, the fact that the plankton is the biggest source of basic food in most lakes of southern Maine places greater emphasis on the importance of the smelt and other plankton feeders to the production of all species of game fishes. The situation in regards to the smelt might be summarized to the effect that it is a necessity to the production of salmon, a big asset to trout, and of considerable importance to perch, pickerel, and other warm-water game species. To the same degree, it is a necessity to protect and preserve the smelt in salmon lakes, it is very desirable in trout lakes, and it probably would be justifiable to give the smelt legal protection in perch, pickerel, and bass lakes — in other words, it is probably desirable to protect the spawning runs of smelts in all lakes.

According to our gill net catches, the Common Sucker is the second most abundant of the larger species of fish in the lakes as a whole. Among the lakes from which our nets took the greatest number of suckers were Taylor (see Plate III), Pocasset, Lovejoy, Webb (Plate II), Annabessacook, North Pond of the Belgrades, and East Pond of the Belgrades; all of these lakes are shallow perch and bass lakes. The chief food of adult suckers is from the bottom fauna, as indicated by stomach contents of suckers from three lakes in Maine (Tables XIX and XXIV) and especially as indicated from studies by numerous other investigators (quoted by Adams and Hankinson, 1928); thus suckers are direct competitors with White Perch which also feed mostly upon the bottom fauna. We found no suckers in the stomachs of 1,757 White Perch, 66 Small-mouthed Bass, and 110 Common Pickerel, from which it may be concluded that the sucker contributes directly very little if anything to populations of these warm-water game fishes. This evidence obviously favors a reduction of the number of suckers, as a means of making more food available to the White Perch.

Recommendations. The recommendations for stocking and other management methods for the present group of 53 lakes and ponds, as based on the present survey, are summarized as follows: The lakes should be considered as of two distinctly different types: (a) *trout or salmon lakes*, and (b) *bass, perch, or pickerel lakes*. Recommendations for the two types of lakes are distinctly different.

For the 25 *trout or salmon lakes*, which are here classified as "excellent," "good," or "marginal" trout or salmon waters (as listed on page 210): Stock trout, togue, or salmon as recommended in Table XX. The formulation of this stocking policy is discussed in a later paragraph. In these 25 trout and salmon lakes, give the smelt complete protection (the smelt is already protected in most of them). Reestablish the smelt in any of these lakes if the smelt population becomes reduced. Do not stock any bass, perch, pickerel, or other warm-water game species. On the other hand, remove all legal restrictions on fishing for bass, perch, and pickerel, and thereby favor the depletion of these warm-water game species, in these trout and salmon lakes.

For the 28 *bass, perch, or pickerel lakes* (as listed on page 210): Stock Small-mouthed Bass at the rate recommended in Table XX. The formulation of the stocking policy for bass is discussed in a later paragraph. Give protection to adult bass on the spawning beds by either one of the following two methods: (1) prohibit bass fishing in all "bass lakes" (not in lakes stocked with trout or salmon) at least until after June 20 and preferably until July 1, or (2) in lakes where spawning bass are greatly congregated, mark the principal spawning grounds and prohibit fishing within 100 yards of such spawning areas until July 1. The protection of the smelt in these lakes, as well as in trout and salmon lakes, would probably be beneficial to sport fishing. Measures of controlling the numbers of suckers in these lakes apparently are desirable.

The formulation of stocking policies for the 25 trout or salmon lakes and for the 28 bass, perch, or pickerel lakes is given in the following paragraphs:

Stocking Recommendations. Stocking of trout, togue, or salmon is here recommended (Table XX) for those 25 lakes which were found by the present survey to be "excellent," "good," or "fair" trout or salmon waters; these lakes had more than approximately 10 to 15 per cent of their total water volume and bottom area within the zone of good trout or salmon water during late summer. Lakes with less than about 10 to 15 per cent of their water volume and bottom area within the trout or salmon zone are here considered to be unsuitable for stocking trout, togue, or salmon of any kind. The particular species of salmonids have been recommended for the suitable lakes partly on the basis of the characteristics of the individual lakes and partly in view of the past stocking program. The annual rate of stocking has been based on the "planting table for trout and salmon in lakes" given in *Fish Survey Report No. 2* (Cooper, 1939b, Table XI), which planting table is being applied generally by the Survey to lakes and ponds of southern Maine. By applying this planting table, the rate of stocking is in proportion to the amount of lake area which will support trout or salmon, and is dependent upon the amount of food present, available spawning grounds, competition by warm-water game fishes, and fishing intensity. An appraisal of these factors for each lake, as based on survey findings, together with recommendations for annual stocking of trout, togue, or salmon, is given in Table XX. These factors, upon which the rate of stocking has been based, were discussed in detail in Fish Survey Report No. 2, but warrant some explanation in connection with the present report. "Area supporting trout or salmon," in the accompanying Table XX, is cited as "none" for lakes with no "trout or salmon zone" during late summer; as "almost none," if not more than 5 per cent of the total volume or bottom area was included by the trout and salmon zone; and as "small per cent," if from 5 to approximately 10 to 15 per cent of the total water volume and bottom area was included by the trout or salmon zone. If more than about 10 to 15 per cent of the total water volume and bottom area was included, the "area in acres supporting trout or salmon" was calculated as the average between the total area of the lake (from Table I) and the bottom area confined to the trout and salmon zone during late summer (from Table III). The food grades for individual lakes are based mostly on the abundance of plankton, bottom organisms, smelt, and minnows, and to some extent on the growth index of the White Perch. The abundance of smelt has been appraised on the basis of the occurrence of smelt in the stomachs of game fishes, and on the basis of reports by the local Fish and Game Wardens. These food grades (grade I indicating greatest abundance of food) have been assigned to the individual

lakes with respect to the food requirements of the type of fish for which stocking is recommended. Available "spawning streams for trout or salmon" refers to tributary streams in which the fish can spawn and the young can live until they reach a length of from five to six inches. The "game fish competition factor" is a numerical expression of the occurrence and abundance of different species of warm-water game fishes, and was obtained by adding abundance factors of 3 (= abundant), 2 (= common), and 1 (= rare) for perch, bass, pickerel, horned pouts, and eels. The theory in applying this competition factor is to decrease the numbers of trout or salmon to be stocked, with increase in abundance of the warm-water species. The numbers of trout, togue, or salmon recommended for stocking are for six-inch fish; if fish of different sizes are to be planted, multiply the numbers given in Table XX by the following:

For 8- to 10-inch fish, multiply by 0.6
For 6- to 8-inch fish, multiply by 0.8
For 4- to 6-inch fish, multiply by 1.1
For 2-to 4-inch fish, multiply by 2
For 1-inch fry, multiply by 20

These conversion figures are based approximately on the expected rate of mortality.

Six of the 25 lakes and ponds, for which stocking of trouts, togue, or salmons is recommended, are "marginal trout waters" in that the amount of suitable trout water is greatly reduced by late summer; these are Lower Range, Pennesseewassee, Twitchell, Bryant, north part of Long Pond of the Belgrades, and Sandy Pond. These lakes are actually better bass lakes than trout lakes; but stocking of trouts in them is possibly justifiable on the grounds that the entire area contains more bass waters than trout waters, and it may be desirable to promote trout fishing in all waters which offer the best possibilities. Brown Trout or Rainbow Trout are recommended for Pennesseewassee, Twitchell, Bryant, and Sandy in view of the fact that these species will tolerate warmer water than will Brook Trout. Brook Trout are recommended for the north part of Long Pond because of its connection with the south part of Long Pond which is good Brook Trout water; and Brook Trout are recommended for Lower Range Pond because of its connection with Middle and Upper Range which are good Togue and Brook Trout waters. Continued stocking of trouts in these six marginal trout lakes will not be justifiable if these lakes cannot be made to produce some trout fishing; for this reason, alternative recommendations are given (Table XX) for stocking these six lakes with Small-mouthed Bass.

Stocking of the Small-mouthed Bass is recommended for the 28 lakes and ponds for which no type of trout or salmon is recommended,

TABLE XX. Yearly stocking recommendations for the lakes and ponds, and a partial summary of the factors upon which the recommendations are based

For explanation, see Text

Name and number of pond	Township	Food grade	Game fish competition factor: CF	Trout or salmon spawning streams: (for lakes suitable for these fish)	Area supporting trout or salmon: acres	Yearly stocking recommendations: number of 6-inch trout or salmon; or number of 3-inch Small-mouthed Bass
Sabattus Pond (P.389)	Greene and Wales	II	11	....	None	13,000 Small-mouthed Bass
Taylor Pond (P.392)	Auburn	III	10	....	Small per cent	2,400 Small-mouthed Bass
Lower Range Pond (P.398)	Poland	III	13	Fair	180	1,400 Brook Trout; alternative 600 Small-mouthed Bass
Middle Range Pond (P.400)	Poland	II	14	Fair	300	2,400 Togue
Upper Range Pond (P.401)	Poland and New Gloucester	II	14	Fair	325	2,800 Brook Trout
Hogan Pond (P.403)	Oxford	III	13	....	None	500 Small-mouthed Bass
Whitney Pond (P.404)	Oxford	III	12	....	Small per cent	500 Small-mouthed Bass
Tripp Pond (P.408)	Poland	III	14	....	None	2,800 Small-mouthed Bass
Thompson Lake (P.409)	Oxford and Otisfield	II	11	Good	3,780	30,000 Togue and 25,000 Land-locked Salmon
Pennesseewassee Lake (P.416)	Norway	II	14	Good	590	4,600 Brown Trout or Chinook Salmon; alternative 7,000 Small-mouthed Bass
Twitchell Pond (P.425)	Greenwood	II	11	Fair	90	1,200 Brown Trout or Rainbow Trout; alternative 1,000 Small-mouthed Bass
Bryant Pond (P.427)	Woodstock	I	9	Fair	150	4,200 Brown Trout or Rainbow Trout; alternative 3,000 Small-mouthed Bass
Auburn Lake (P.428)	Auburn	II	12	Fair	1,875	21,000 Land-locked Salmon
Allen Pond (P.437)	Greene	II	10	Poor	115	2,200 Brook Trout
Pleasant Pond (P.443)	Turner	II	5	None	135	4,000 Brook Trout
Androscoggin Lake (P.464)	Wayne and Leeds	III	13	....	None	15,000 Small-mouthed Bass
Pocasset Lake (P.466)	Wayne	III	14	....	None	2,300 Small-mouthed Bass
Lovejoy Pond (P.470)	Fayette and Readfield	II	15	....	None	1,400 Small-mouthed Bass
Echo Lake (P.472)	Fayette and Mount Vernon	II	13	Poor	840	13,000 Togue
Parker Pond (P.474)	Fayette	II	8	....	Small per cent	13,000 Small-mouthed Bass
David Pond (P.476)	Fayette	I	8	....	None	1,600 Small-mouthed Bass
Tilton Pond (P.478)	Fayette	II	6	....	None	500 Small-mouthed Bass
Flying Pond (P.481)	Vienna and Mount Vernon	II	8	Fair	280	4,500 Brook Trout
Worthley Pond (P.499)	Peru	II	7	Good	240	3,400 Brook Trout
Webb Lake (P.503)	Weld	II	12	....	Small per cent	16,000 Small-mouthed Bass
Silver Lake (P.515)	Roxbury	III	14	....	Almost none	1,700 Small-mouthed Bass
Garland Pond (P. 516)	Byron	I	0	Poor	190	8,000 Brook Trout
North Pond (P.521)	Woodstock	II	12	....	None	2,200 Small-mouthed Bass
South Pond (P.522)	Greenwood	II	10	Poor	230	5,500 Togue
Purgatory Pond (P.659)	Litchfield	I	15	....	None	3,000 Small-mouthed Bass
Sand Pond (P.660)	Monmouth and Litchfield	III	15	Poor	135	1,000 Brook Trout
Cobbosseecontee Lake (P.668)	Monmouth, Winthrop, etc.	II	14	....	Small per cent	40,000 Small-mouthed Bass
Annabessacook Lake (P.671)	Monmouth and Winthrop	II	12	....	Almost none	11,000 Small-mouthed Bass
Cochnewagan Pond (P.672)	Monmouth	I	15	....	None	4,000 Small-mouthed Bass
Wilson Pond (P.673)	Monmouth and Wayne	II	12	....	None	4,500 Small-mouthed Bass
Dexter Pond (P.674)	Wayne	II	13	....	None	900 Small-mouthed Bass
Berry Pond (P.675)	Wayne and Winthrop	II	12	....	Small per cent	1,200 Small-mouthed Bass
Maranacook Lake (P.676)	Readfield and Winthrop	I	13	Good	1,060	15,000 Brook Trout

TABLE XX. Yearly stocking recommendations for the lakes and ponds — Concluded

Name and number of pond	Township	Food grade	Game fish competition factor: CF	Trout or salmon spawning streams: (for lakes suitable for these fish)	Area supporting trout or salmon: acres	Yearly stocking recommendations: number of 6-inch trout or salmon; or number of 3-inch Small-mouthed Bass
Torsey Pond (P.678)	Readfield and Mount Vernon	I	15	....	None	9,000 Small-mouthed Bass
Narrows Pond South Part (P.681)	Winthrop	II	9	None	240	2,800 Togue and 2,000 Chinook Salmon
North Part (P.682)	Winthrop	II	10	Fair	180	2,500 Brook Trout
Snow Pond (P.698)	Sidney and Belgrade	II	16	....	None	28,000 Small-mouthed Bass
Long of Belgrades South Part (P.712)	Mount Vernon and Belgrade	III	14	Good	1,050	7,500 Brook Trout
North Part (P.713)	Rome and Belgrade	III	14	Good	820	5,800 Brook Trout; alternative 5,000 Small-mouthed Bass
Great of Belgrades (P.719)	Rome and Belgrade	II	16	....	None	50,000 Small-mouthed Bass
North of Belgrades (P.720)	Smithfield	II	12	....	None	16,000 Small-mouthed Bass
East of Belgrades (P.724)	Smithfield	I	14	....	None	20,000 Small-mouthed Bass
Salmon Lake (P.725)	Belgrade and Oakland	III	12	....	Small per cent	2,200 Small-mouthed Bass
McGrath Pond (P.726)	Belgrade and Oakland	III	12	....	None	1,900 Small-mouthed Bass
Clearwater Pond (P.815)	Industry	II	7	Poor	680	8,000 Togue and 7,000 Land-locked Salmon
Wilson Pond (P.833)	Wilton	II	8	Good	360	2,700 Togue and 2,000 Land-locked Salmon
Sandy Pond (P.883)	Embden	III	8	None	60	500 Brown Trout; alternative 500 Small-mouthed Bass
Embden Pond (P.887)	Embden	II	6	Good	1,390	10,000 Togue, and 11,000 Land-locked Salmon or Chinook Salmon

TABLE XXI. The total numbers (in thousands) of game fishes of d Department of Inland Fisheries and Game during the sever

Name of pond	Pond number	Brook Trout: Fry	Brook Trout: 2″–4″	Brook Trout: 4″–6″	Brook Trout: Mature: over 6″	Brown Trout: 2″–4″	Brown Trout: 4″–6″	Brown Trout: Mature: over 6″	2″–4″
Sabattus Pond Tributaries	389	..	....	4	....	....	....	....	....
Taylor Pond Tributaries	392	2	....	1	....	10	10	15	....
Lower Range Pond Tributaries	398	10	....	....	....	....	....	....	....
Middle Range Pond	400	..	....	23	....	....	....	....	....
Upper Range Pond	401	..	....	....	2	....	....	....	....
Whitney Pond	404	..	....	....	....	....	7	....	....
Thompson Lake Tributaries	409	10	....	88 11	11	....	....	....	....
Pennesseewassee Lake Tributaries	416	..	9	31	....	....	15	....	....
Twitchell Pond Tributaries	425	6	5	3 22	....	....	....	....	....
Bryant Pond	427	..	4	37	27	5	....	....	....
Auburn Lake Tributaries	428	..	2	1	6	....	2 2	....	....
Allen Pond Tributaries	437	25	....	4	1 2	....	....	....	....
Pleasant Pond Tributaries	443	19	....	48	39	....	....	....	....
Androscoggin Lake Tributaries	464	65	8	4	2	17	32	31	....
Pocasset Lake	466	..	....	....	....	18	....	....	....
Echo Lake	472	..	....	....	....	....	....	....	....
Parker Pond	474	..	....	....	....	....	....	....	....
Flying Pond	481	..	....	20	....	20	....	....	5
Worthley Pond Tributaries	499	..	....	....	3	10	....	....	5
Webb Lake Tributaries	503	211	4	10 69	3 14	....	....	....	....
Silver Lake Tributaries	515	15	9	7	2	....	....	....	....
Garland Pond Tributaries	516	..	5	12	16	....	....	....	....
North Pond	521	..	2	6	4	....	....	....	....
South Pond	522	..	....	....	....	....	....	....	....
Purgatory Pond	659	..	....	....	....	....	....	3	....
Sand Pond	660	..	....	4	....	....	12	5	....
Cobbosseecontee Lake Tributaries	668	31	....	4 5	2	41	4	1	50
Annabessacook Lake Tributaries	671	27	....	25 2	4	....	....	....	11
Cochnewagan Pond Tributaries	672	..	....	5	1	21	....	2	....
Wilson Pond	67[illegible]	..	....	....	....	....	....	....	....

Sandy Pond (P.883) | Embden | III | › | Good | 360 | 2,700 Togue and 2,000 Land-locked Salmon

Embden Pond (P.887) | Embden | II | 6 | 8 | Good | None | 1,390 | 60 | 500 Brown Trout; alternative 500 Small-mouthed Bass | 10,000 Togue, and 11,000 [illegible]

... The total numbers (in thousands) of game fishes of different sizes planted in the lakes and ponds* and their [illegible] tributaries by [illegible] Department of Inland Fisheries and Game during the seven years from July 1, 1933 to June 30, 1940, as summarized from department records

Fish planted** (in thousands, add ,000)

Name of pond	Pond number	Brook Trout Fry	Brook Trout 2″–4″	Brook Trout 4″–6″	Brook Trout Mature: over 6″	Brown Trout 2″–4″	Brown Trout 4″–6″	Brown Trout Mature: over 6″	Rainbow Trout 2″–4″	Rainbow Trout 4″–6″	Rainbow Trout Mature: over 6″	Togue Fry	Togue 2″–4″	Togue 4″–6″	Togue Mature: over 6″	Land-locked Salmon Fry	Land-locked Salmon 2″–4″	Land-locked Salmon 4″–6″	Land-locked Salmon Mature: over 6″	Chinook Salmon Fry	Chinook Salmon 2″–4″	Chinook Salmon 4″–6″	Chinook Salmon Mature: over 6″	Chum Salmon 2″–4″	Small-mouthed Bass 2″–4″	Small-mouthed Bass Mature: over 6″
…ne Pond	389															4		4	3			31				
Tributaries				4																						
…t Pond	392					10	10	15																		
Tributaries		2		1																						
…r Range Pond	398																									
Tributaries		10																								
…dle Range Pond	400			23							20	58	15													
…per Range Pond	401				2																					
…tney Pond	404						7																			
…mpson Lake	409			88	11							255	10				30	10	10							
Tributaries		10		11																						
…wassee Lake	416			31			15																10			
Tributaries			9																							
…chell Pond	425			3													9				5					
Tributaries		6	5	22																						
…ant Pond	427		4	37	27	5																				
…burn Lake	428				6		2										49	16								
Tributaries			2	1			2										5									
…len Pond	437			4	1																					
Tributaries		25			2																					
…asant Pond	443			48	39																					
Tributaries		19																								
…ndroscoggin Lake	464					17	32	31			5															
Tributaries		65	8	4	2																					
…nasset Lake	466					18																				
…cho Lake	472												15	23												
Parker Pond	474																3	2								
Flying Pond	481			20		20			5	8			6	10				4								
Worthley Pond	499				3				5																	
Tributaries						10																				
Webb Lake	503			10	3							8					42									
Tributaries		211	4	69	14												10									
Silver Lake	515																									
Tributaries		15	9	7	2												13									
Harland Pond	516			12	16												1									
Tributaries			5																							
North Pond	521		2	6	4																					
South Pond	522											64	24	10			41									
Purgatory Pond	659							3			3															
Sand Pond	660			4			12	5			3															
Cobbosseecontee Lake	668			4	2	41		1	50	128	21									50	40	191	32	119		
Tributaries		31		5			4													100	62			31		
Annabessacook Lake	671			25	4				14		1															
Tributaries		27		2																						
Cochnewagan Pond	672				1	21		2																		
Tributaries				5																						
Wilson Pond	673																					6	10			
Berry Pond	675																									
Tributaries			8																							
Maranacook Lake	676		23	59	49																					
Tributaries			6	19																						
Narrows Pond	681, 682			3	3								14	23	7								20			

	416			31			18																10			
			9																							
	425			3													9				5					
		6	5	22																						
	427		4	37	27	5																				
	428				6		2										49	16								
			2	1			2										5									
	437			4	1																					
		25			2																					
	443			48	39																					
		19																								
Lake	464					17	32	31			5															
		65	8	4	2																					
ke	466					18																				
	472												15	23												
nd	474																3	2								
nd	481			20		20			5	8			6	10				4								
Pond	499				3				5																	
taries						19																				
ke	503			10	3							8					42									
utaries		211	4	69	14												10									
ke	515																									
utaries		15	9	7	2												13									
Pond	516			12	16												1									
butaries			5																							
ond	521		2	6	4																					
ond	522											64	21	10			41									
ry Pond	659							3			3															
ond	660			4			12	5			3															
seecontee Lake	668			4	2	11		1	50	128	21									50	40	191	32	119		1
ibutaries		31		5			4													100	62			31		
essacook Lake	671			25	4				14		1															
ibutaries		27		2																						
ewagan Pond	672				1	21		2																		
ributaries				5																						
on Pond	673																					6	10			
y Pond	675																									
Tributaries			8																							
ranacook Lake	676		23	59	49																					
Tributaries			6	19																						
rows Pond	681 } 682 }			3	3								14	23	7								29			
w Pond	698			120	80																					
Tributaries																				21						
g Pond of Belgrades	712 } 713 }			79	112											9		20								
Tributaries		25	7																							
t Pond of Belgrades	719			45	62												15	60	5			523	11			
Tributaries		118	5	4								4				12	8				76			16		
h Pond of Belgrades	720								10	10												29			1	
Pond of Belgrades	724								10	27												25				
ion Lake	725			45	3																	27				
rath Pond	726			5																						
water Pond	815			15								60	14	20		15	4		5							
on Pond	833			4	18							10	11	10		5	29									
Tributaries				11	3											15										
len Pond	887											68	20	11		10	41	10				4	17			
Totals		564	97	855	469	142	84	57	94	173	53	527	129	107	7	70	300	126	23	171	183	836	100	166	1	1

*The following ponds, included by the survey, had no records of stocking: Lower Range Pond, Hogan Pond, Tripp Pond, Lovejoy Pond, David Pond, Tilton Pond, Silver Lake, Dexter Pond, Berry Pond, Torsey Pond, and Sandy Pond.

**Approximately one-fifth of the fish listed above as 2" to 4" fish were listed in the stocking records as 2" to 3" fish.

and alternative stocking of bass is recommended for six marginal trout lakes. These lakes for which bass are recommended are either the shallow lakes with warm water extending to their maximum depth, or deep lakes with considerable oxygen depletion in the deep water. The Small-mouthed Bass is recommended in preference to the Large-mouthed Bass because, in the writer's opinion, these lakes of southern Maine, with their rock-bottomed shallows and scarcity of vegetation, are much better adapted to the Smallmouth. The recommended annual rate of stocking has been based on the "stocking table for Small-mouthed Bass" given in *Fish Survey Report No. 2* (Cooper, 1939b, Table XIII). This recommended rate of stocking is in proportion to the total acreage of each lake (from Table I), the abundance of food, and fishing intensity. The numbers of Small-mouthed Bass recommended for annual stocking in the bass lakes are given in Table XX.

The present stocking recommendations for the 53 lakes and ponds call for an annual hatchery output of: 211,000 six-inch trouts or salmons for 25 of the lakes with a total area of 19,793 acres, and 264,600 three-inch Small-mouthed Bass for 28 lakes with a total area of 39,639 acres. The slightly greater number of bass over salmonids is in proportion to the slightly greater number of bass lakes; the total acreage of bass waters, however, is twice the acreage of the trout and salmon lakes. The numbers for individual species (summarized from Table XX) recommended for annual stocking are as follows:

58,100	six-inch	Brook Trout	for 12 lakes, area 6,875 acres.
74,400	" "	Togue	for 13 lakes, area 12,918 acres.
60,500	" "	Land-locked Salmon	
9,800	" "	Chinook Salmon	
5,500	" "	Brown Trout	
2,700	" "	Rainbow Trout	
264,600	three-inch	Small-mouthed Bass	for 28 lakes, area 39,639 acres.

The adoption of the stocking policy for these 53 lakes and ponds, as here recommended, will require a considerable change in hatchery output, from the present emphasis on trouts and salmons to an equal balance between salmonids and the Small-mouthed Bass. During the seven years from July 1, 1933 to June 30, 1940 the State Fish and Game Department stocked these lakes and their tributaries with 5,333,000 trouts and salmons and 2,000 Small-mouthed Bass, according to the department records (Table XXI). The salmonids were of various sizes ranging from fry to "mature" fish over six inches long. Of the 5,333,000 salmonids, 4,497,000 fish can be attributed to stocking of the lakes and ponds; while the remaining 820,000 Brook Trout and 16,000 Brown Trout, which were planted in tributaries, may have remained in those tributaries — presumably the survivors of togue and salmons planted in tributaries would enter the lakes. If these

4,497,000 fish are evaluated in terms of their equivalents of six-inch fish by applying the conversion factors given on page 219, they represented the equivalent of stocking 3,241,000 six-inch fish or an average of 463,000 per year for the seven-year period. The numbers (in thousands) of fish planted in these 53 lakes and their tributaries during the period from July 1, 1933 to June 30, 1940, the total stocking represented for the lakes themselves, and the total and average equivalents of these plantings in terms of six-inch fish, for the different species, may be summarized from Table XXI as follows:

Species	In lakes	In tributaries	Total for lakes*	Total equivalent of 6″ fish	Equivalent of 6″ fish: average per year
Brook Trout	1,165	820	1,165	1,200	171
Brown Trout	267	16	267	208	30
Rainbow Trout	320	0	320	270	39
Togue	766	4	770	197	28
Land-locked Salmon	456	63	519	297	42
Chinook Salmon	1,052	238	1,290	986	141
Chum Salmon	119	47	166	83	12
Totals	4,145	1,188	4,497	3,241	463

*Includes Togue and salmons planted in tributaries.

As compared to the average yearly stocking, in the past, of the equivalent of 463,000 six-inch trout, togue, and salmon, recommendations from the present survey are for about the same number of fish (475,000), but for about half as many (211,000) trouts and salmons, and for 264,000 Small-mouthed Bass.

The major change recommended for the stocking policy for these lakes has been due to the elimination of many lakes as unsuitable for trouts and salmons; salmonids had been planted in 42 lakes, but are here recommended for 25. The proposed reduction by 55 per cent in stocking salmonids, and the substitution of 264,000 bass, are attributable mostly to a few of the larger lakes which had been stocked heavily with salmonids but which were found to be bass waters, namely: Great Pond of the Belgrades, Cobbosseecontee Lake, Snow Pond or Messalonskee Lake, Androscoggin Lake, Webb Lake, Annabessacook Lake, North Pond of the Belgrades, and East Pond of the Belgrades. The recommended annual stocking for these eight lakes, which have a combined area of 28,504 acres, totals 196,000 three-inch Small-mouthed Bass.

APPENDIX A

A Biological Survey of Anasagunticook Lake*

By Joel W. Marsh

Leader of Development Unit, Maine Pittman-Robertson Projects

Anasagunticook Lake, also called Canton Lake, is located in the towns of Canton and Hartford in Oxford County and within the general area which includes the lakes and ponds considered in the present Survey Report No. 4. It is in the Androscoggin River drainage system, and is pond number 497 according to the present system of numbering. The lake is easily accessible from the more-heavily populated sections of the state. The shore is well developed as a resort area, and a great deal of interest is exhibited in the fishing by both local residents and summer tourists.

Measurements made on the outline of the lake as given on the United States Geological Survey Topographic Sheet have given the following information: The lake has an area of 568 acres (0.87 square mile), a shore line of approximately 5.1 miles, a maximum length of 1.9 miles, a maximum width of 0.7 mile, and an average width of 0.6 mile. The main axis has a north-south direction.

The present field studies on Anasagunticook Lake were made during the period from June to October, 1937. Methods used in this survey, unless otherwise indicated, were the same as the methods now in general use in lake survey work in Maine (see previous pages of Survey Report No. 4).

Depth soundings were taken between flag stations located at equal intervals along the east and west shores. The flag stations were numbered in pairs, as for example, Number 1 flag on the west shore was directly opposite Number 1 flag on the east shore (see Figure 52). Soundings were made approximately 100 feet apart along each of the 13 east-west lines between corresponding flags. This distance between soundings was measured with a 100-foot string attached to a small float. Data on depth of water, as obtained by these soundings, are given in Figure 52. A maximum depth of 54 feet was found on flag line 11 near the south end of the lake and mid-way between the east and west shores. A large part of the southern half of the lake bottom is over 40 feet deep and is relatively flat; while the northern half of the lake is much shallower and the bottom slope is much more gradual.

* An abstract of a thesis submitted in partial fulfillment of the requirements for the Degree of Master of Science in Wildlife Conservation at the University of Maine, 1938.

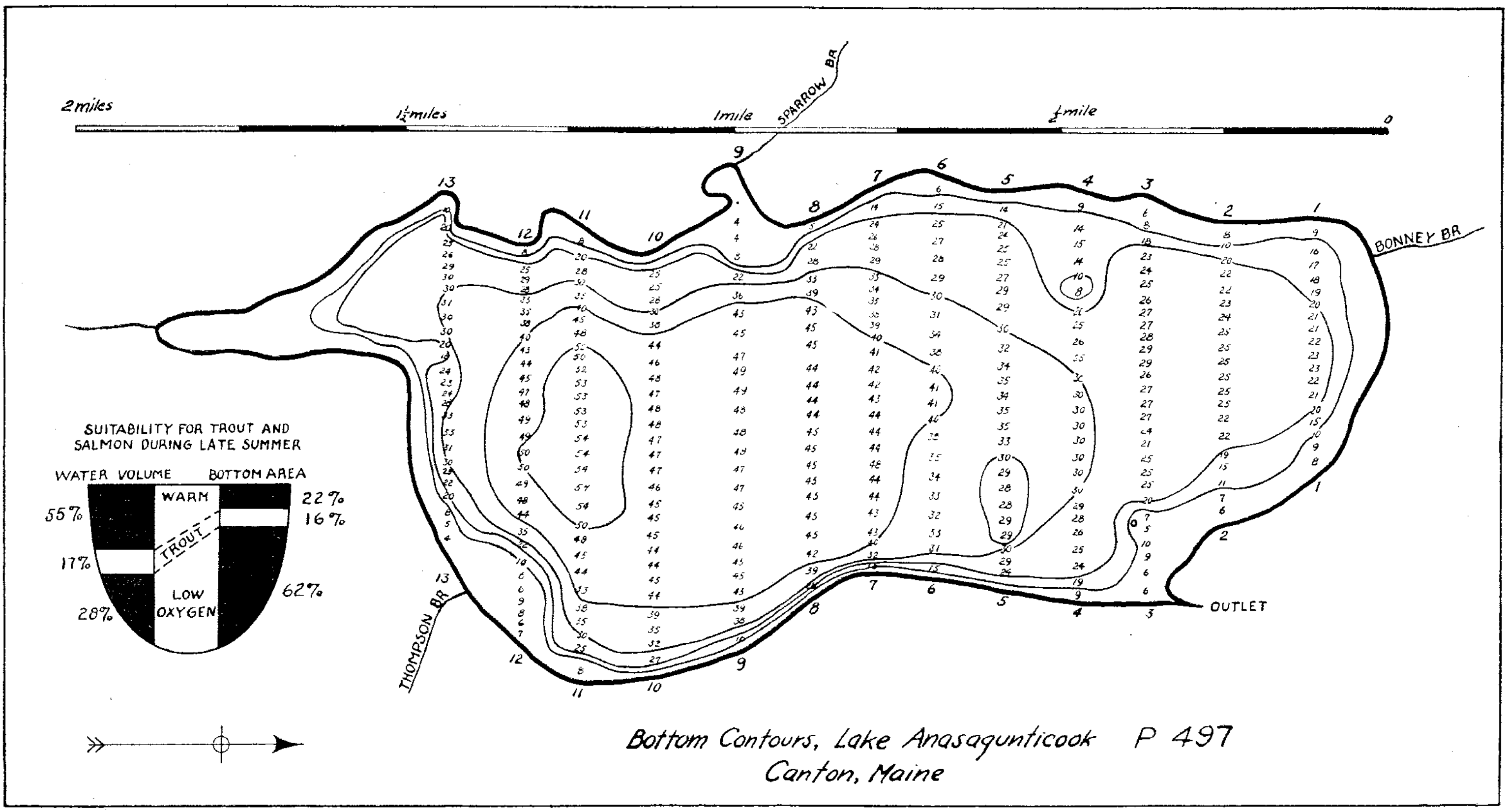


Figure 52. Anasagunticook Lake. Soundings in feet along lines between numbered flag stations, depth contours, and suitability of the water for trout or salmon.

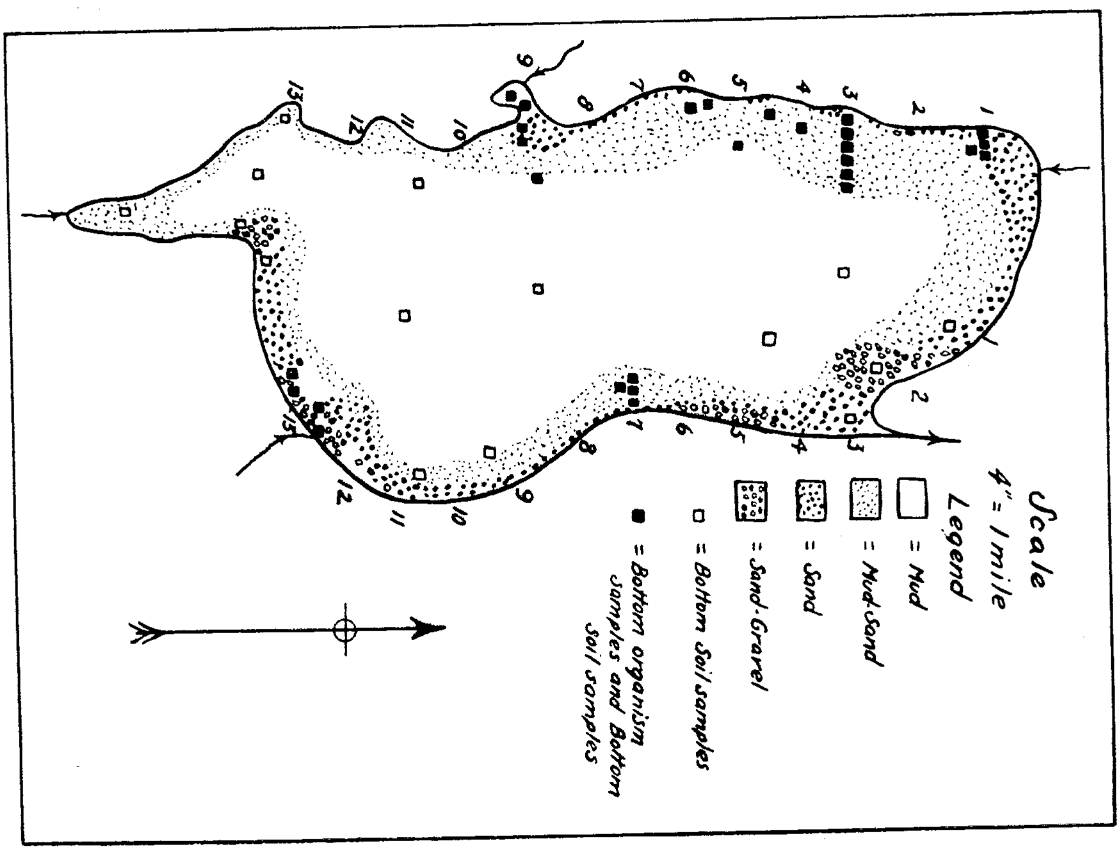


Figure 53. Map of Anasagunticook Lake showing the distribution of bottom soil types, and the location of stations where bottom samples were taken.

It was found from 43 bottom soil samples that, of the total bottom area of 568 acres, about 67 per cent was mud, 18 per cent was sand-mud, 10 per cent was sand, and 5 per cent was sand-gravel (Figure 53). The mud and mud-sand were confined mostly to the region below the 18-foot contour, and sand was confined mostly to the region above the 18-foot contour. The areas in acres of different types of bottom soil according to depth were as follows:

Depth in feet	Sand-gravel	Sand	Mud-sand	Mud	Total acreage
0–10	19	48	16	3	86
10–18	7	7	14	12	40
18–25	..	3	35	51	89
25–30	..	..	28	49	77
30–40	..	..	12	98	110
40–50	..	..	..	150	150
50–54	..	..	..	16	16
0–54	26	58	105	379	568

Some of the results of water analyses made during July and August are given in Table XXII and Figure 54. The pH on August 7 was found to be slightly acid at the surface and strongly acid (6.1 and 5.9) at 45 feet. Vertical series of temperatures taken at seven different stations on the lake during August revealed a thermal stratification extending uniformly over the lake, with 70° F. water extending to a depth of 15 feet in early August and to 18 feet by late August. The dissolved oxygen content was above 6 p.p.m. at all depths on July 2, but had been decreased somewhat in the deeper water by August 7. From the August 7 analyses it was estimated that an oxygen deficiency (less than 5 p.p.m.) would extend up to a depth of 25 feet by the end of August. These depths of 18 feet for temperature and 25 feet for dissolved oxygen were used in calculating the distribution of the water in the lake with respect to its suitability for trout and salmon during the most critical part of the summer, i.e., in late August. The amounts of water volume and bottom area within the three zones, as delimited by these two depths, were calculated to be as follows:

Upper warm water, surface to 18 feet, *no trout or salmon*: 8,939 acre feet (55%) of water, 126 acres (22%) of bottom area.

Middle layer, 18 to 25 feet, suitable for *trout and salmon*: 2,777 acre feet (17%) of water, 89 acres (16%) of bottom area.

Lower layer, 25 to 54 feet, oxygen deficient, *no trout or salmon*: 4,555 acre feet (28%) of water, 353 acres (62%) of bottom area.

The amount of water volume (17%) and bottom area (16%) within the trout and salmon zone indicates that, from the standpoint of

temperature and oxygen, Anasagunticook Lake is at best a fair trout and salmon lake. (For comparison with other lakes, see page 66.)

The organisms collected in 62 bottom samples (9″ x 9″ Ekman Dredge) were used as a basis for computing the number of organisms per square foot of lake bottom, according to the depth of water and type of bottom (Table XXIII and Figure 55). The types of bottom organisms encountered in these samples, in the approximate order of their numerical abundance, were: Diptera larvae, fresh-water shrimp,

TABLE XXII. Vertical distribution of temperature, dissolved oxygen, and pH in Anasagunticook Lake during the summer of 1937

Depth in feet	Temperatures* (°F.)		Oxygen (p.p.m.)		pH	
	August 7	August 27	July 2	August 7	July 2	August 7
Surface	79	76	9.3	8.7	6.8	7.1
5	75	74	...	...	...	7.0
10	73	73	...	...	...	6.9
15	71	72	...	7.6	...	6.6
16	..	..	8.4	...	6.5	...
17	67	..	...	...	...	6.4
19	..	64	...	...	...	...
20	58	62	...	6.0	...	6.1
21	..	..	8.2	...	6.3	...
22	55	55	...	...	...	6.0
25	52	..	...	5.3	...	6.0
27	..	..	7.8	...	6.2	6.0
30	50	53	...	...	...	...
35	49	50	...	5.0	...	6.0
40	49	49	...	...	...	5.9
45	48	..	6.4	3.0	6.1	5.9
46	..	..	...	...	6.0	...
47	48	..	...	...	...	...
50	..	48	...	...	...	...

*Temperatures taken with a Taylor Maximum and Minimum registering thermometer.

Mayfly nymphs, caddisfly larvae, molluscs, alderfly larvae, dragonfly nymphs, aquatic earthworms, and beetle larvae. The Diptera larvae were mostly midges, and a few *Corethra*. The relative numerical abundance of these organisms, as given in Table XXIII, does not give an accurate picture as to the volumes of different types of available fish food, because of differences in size of the various organisms. Such large organisms as the Mayflies, dragonflies, and caddisflies made up as large a volume as did the midges and fresh-water shrimp, even though the latter were much more abundant. Bottom organisms were much more abundant between depths of 0 to 20 feet than between depths of 20 to 30 feet, and very few were found below a depth of 30 feet. Mud-sand was the most productive type of bottom soil at all depths.

Plankton samples were collected with a Birge closing net at six stations on the lake and at three dates, i.e., in June, July, and August. Diatoms were found to be the most abundant plankters within all

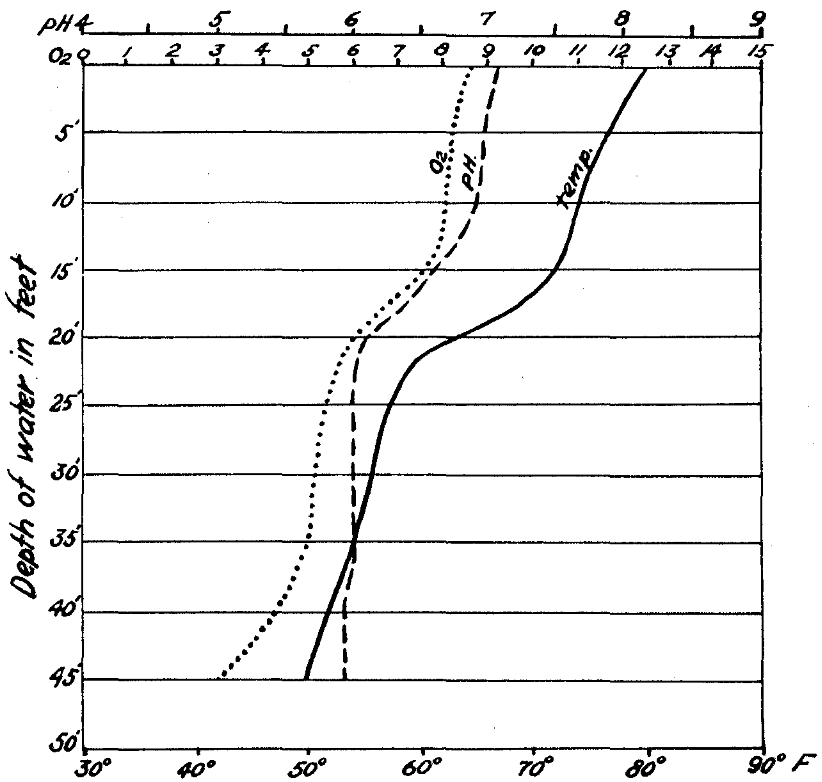


Figure 54. Vertical distribution of temperature, dissolved oxygen, and pH in Anasagunticook Lake on August 7, 1937. Data are from Table XXII.

TABLE XXIII. Average number of bottom organisms per square foot according to depth of water and type of bottom, and the distribution by acres of different types of bottom soil, in Anasagunticook Lake during the summer of 1937

Bottom soil type	Depth range in feet	Area in acres	No. of samples	Aquatic earthworms (Oligochaeta)	Fresh-water shrimp (Amphipoda)	Alderfly larvae (*Sialis*)	Mayfly nymphs (Ephemerida)	Dragonfly nymphs (Anisoptera)	Beetle larvae (Coleoptera)	Caddisfly larvae (Trichoptera)	Fly larvae (Diptera)	Molluscs (Mollusca)
Mud	0-20	20	14	0.5	6.0	0.5	2.4	0.9	0.8	2.3	5.7	3.0
Mud-sand	0-20	34	22	0.5	6.1	1.5	8.9	0.6	...	1.3	31.6	1.2
Sand	0-20	58	7	0.3	5.3	0.9	0.8	1.3	...	4.6	5.1	1.5
Sand-gravel	0-20	26	5	0.7	4.3	0.4	1.4	...	...	0.4	3.9	2.1
Mud	20-40	193	10	...	...	0.2	0.7	...	...	2.7	2.7	...
Mud-sand	20-40	71	4	...	8.4	0.4	0.4	0.4	...	3.6	5.3	2.7

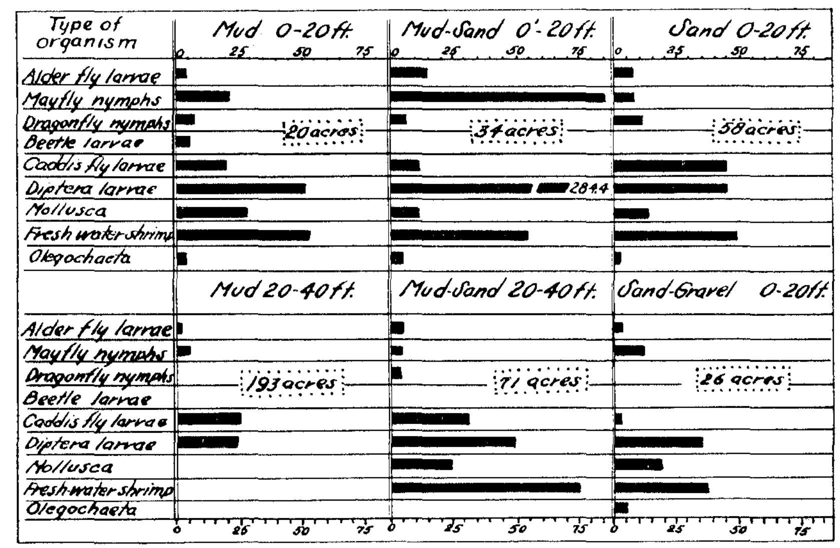


Figure 55. Average numbers of different types of bottom organisms per square yard according to depth and type of bottom soil, and the total acreage of each type of bottom soil, in Anasagunticook Lake. Data are modified from Table XXIII.

depth ranges; they varied in abundance from about 5,000 to 40,000 individuals per cubic foot. Next in order of abundance were the blue-green algae, flagellate protozoans, and rotifers. The cladocerans and copepods together averaged about 200 to 500 per cubic foot. The vertical distribution of different types of plankters, encountered in samples taken on July 2, is given in Figure 56. As compared to these July 2 samples, collections made on August 8 showed a marked decrease at all depths, and a complete disappearance below a depth of 30 feet, of all plankters except the diatoms.

Samples of fish were collected by gill nets, seines, and hook and line. Two gill nets, with six different sizes of mesh ranging from 2 3/8 inches to 3¾ inches stretched measure, were fished for a total of 424½ hours at nine separate stations. They collected 314 fish which were practically all adults: 160 Common Suckers, 136 White Perch, 11 Small-mouthed Black Bass, 6 Yellow Perch, and 1 Fallfish. Four seine collections from the lake shoals included mostly young White Perch, Yellow Perch, and Common Suckers, some young Small-mouthed Black Bass and Fallfish, and a few young Common Pickerel, Red-bellied Sunfish, and Horned Pout. Fish collected by hook and line included 18 Small-mouthed Bass, 3 juvenile Fallfish, 1 Common Pickerel, 1 Red-bellied Sunfish, 1 Common Bullhead, and 3 Land-locked Salmon. There were no trout or smelt collected from the lake, although these fish had been reported by local residents to be present in small numbers; and no smelt were identified from the stomach contents of any fish collected.

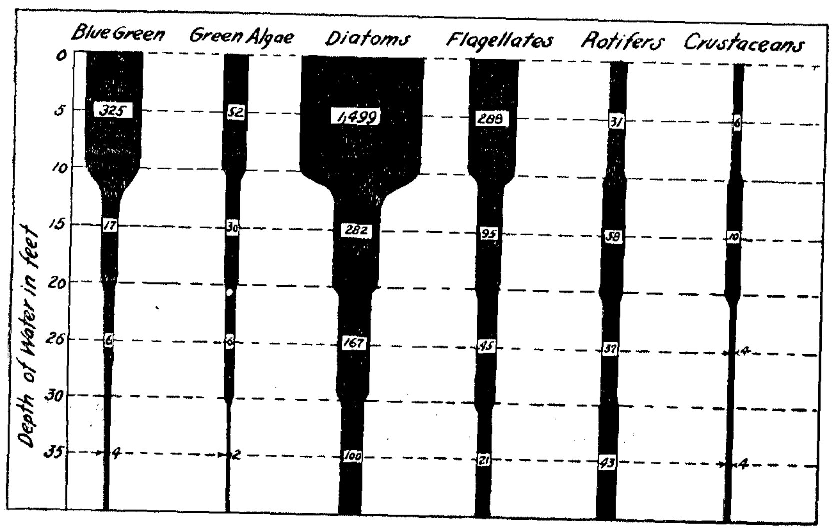


Figure 56. Average numbers of plankters per liter of lake water within successive 10-foot depth strata in Anasagunticook Lake on July 2, 1937 (Samples taken from 3:30 to 5:30 P.M.).

A study of food habits was made on the stomach contents of 25 Small-mouthed Black Bass, 125 White Perch, 75 Common Suckers (see Table XXIV), and one Land-locked Salmon. The single salmon contained mostly fish and some worms (bait). The bass contained mostly surface insects, fish and crayfish. The White Perch had fed mostly on bottom organisms and water fleas, and to some extent on fish and surface insects. The suckers had fed almost entirely on bottom organisms. The strongest competition for food, as indicated by these data, occurred between the perch and suckers, both having fed to a large extent on bottom organisms.

The ages of 27 Small-mouthed Bass, 136 White Perch, 31 Common Suckers, and one Land-locked Salmon, were determined by the scale method. The salmon was a male, 14.2 inches long, with a weight of 13.2 ounces, and was in its 4th summer of life. The 31 Common Suckers were from 13.0 to 21.6 inches long and were from 4 to 8 years old. The 27 bass ranged in length from 7.3 to 18.9 inches; and in age, from three to eleven years (Table XXV). Without adequate

TABLE XXIV. The total and average volume in cubic centimeters of different types of food organisms from stomachs of Small-mouthed Bass, White Perch, and Common Suckers from Anasagunticook Lake during the summer of 1937

Food organisms	25 Small-mouthed Bass		126 White Perch		75 Common Suckers	
	Total vol.	Av. vol. per fish	Total vol.	Av. vol. per fish	Total vol.	Av. vol. per fish
Surface food						
Grasshoppers (Orthoptera)	4. 5	0. 18	0. 6	0. 005	.....	.....
Beetles (Coleoptera)	6. 1	0. 24	0. 2	0. 002	0. 21	0. 003
Adult flies (Diptera)	1. 2	0. 05	.....	.....	.....	.....
Ants and bees (Hymenoptera)	9. 1	0. 36	14. 55	0. 116	.....	.....
Free swimming						
Water fleas (Crustacea)	....	....	21. 73	0. 173	.....	.....
Fish remains	6. 9	0. 27	12. 7	0. 101	.....	.....
Bottom food						
Alderfly larvae (Neuroptera)	....	....	3. 24	0. 026	5. 32	0. 071
Mayfly nymphs (Ephemeridae)	....	....	18. 57	0. 148	12. 33	0. 164
Dragonfly nymphs (Odonata)	1. 3	0. 05	17. 02	0. 136	.....	.....
Fly larvae and pupae (Diptera)	....	....	13. 82	0. 11	40. 7	0. 539
Caddisfly larvae (Trichoptera)	....	....	.....	.....	12. 64	0. 168
Crustacea						
Shrimps (*Hyallela*)	....	....	10. 19	0. 081	15. 95	0. 212
Crayfish (*Cambarus*)	27. 7	1. 19	.....	.....	.....	.....
Clams, snails (Mollusca)	....	....	.....	.....	5. 49	0. 07
Plant material (Juncaceae)	3. 0	0. 12	.....	.....	.....	.....
Miscellaneous	2. 4	0. 09	9. 40	0. 075	32. 81	0. 437
Total	62. 2	2. 55	122. 02	0. 973	125. 45	1. 664

TABLE XXV. Average and range of lengths and weight of each age group of Small-mouthed Bass from Anasagunticook Lake during the summer of 1937

Age in growing seasons*	Number of fish	Standard length in inches		Total length in inches		Weight in ounces	
		Range	Average	Range	Average	Range	Average
III	4	5.9–7.9	6.9	7.3–9.7	8.5	3.0–7.5	5.1
IV	1	7.9	7.9	9.6	9.6	7.8	7.8
V	5	8.7–9.6	9.0	8.5–11.9	10.7	8.6–11.1	9.8
VI	5	9.0–10.4	9.7	11.0–13.1	12.0	9.5–15.6	12.7
VII	2	9.7–10.0	9.8	11.9–12.5	12.2	12.0–12.8	12.4
VIII	7	9.4–14.6	12.6	11.7–18.0	14.4	12.0–34.7	23.0
IX	1	9.4	9.4	11.5	11.5	9.8	9.8
XI	2	13.7–15.5	14.6	16.7–18.9	17.8	32.8–50.3	41.5

*Includes the 1937 growing season.

TABLE XXVI. Average and range of lengths and weight for each sex of each age group of White Perch from Anasagunticook Lake during the summer of 1937

Age in growing seasons*	Sex	Number of fish	Standard length in inches		Total length in inches		Weight in ounces	
			Range	Average	Range	Average	Range	Average
V	Male	1	5.8	5.8	7.2	7.2	2.8	2.8
VI	Female	12	5.5–8.0	7.3	6.9–10.0	9.1	2.6–8.9	5.9
VI	Male	21	7.1–8.7	7.7	8.1–10.2	9.4	5.4–8.0	6.1
VII	Female	20	6.9–8.9	7.8	8.7–10.7	9.6	5.5–10.3	6.7
VII	Male	11	7.1–8.9	7.9	8.7–10.9	9.7	5.0–8.9	6.8
VIII	Female	13	7.5–8.7	8.1	9.2–10.8	10.0	5.3–10.0	7.6
VIII	Male	18	7.2–9.1	8.0	8.9–11.1	9.9	4.9–9.9	7.2
IX	Female	14	7.9–9.0	8.4	9.7–11.0	10.4	7.0–10.6	8.7
IX	Male	14	7.8–9.3	8.3	9.3–11.4	10.2	6.2–10.0	7.9
X	Female	4	8.3–10.2	9.3	10.1–12.5	11.3	7.9–14.1	10.9
X	Male	3	8.0–8.7	8.3	9.8–10.5	10.2	7.1–8.6	7.8
XI	Male	3	9.6–10.2	9.8	11.9–12.5	12.2	12.0–12.7	12.3
XII	Male	1	10.0	10.0	12.5	12.5	11.9	11.9
XIII	Female	1	9.7	9.7	11.9	11.9	12.2	12.2
All fish	Female	64	5.5–10.2	8.0	6.9–12.5	9.9	2.6–14.1	7.5
All fish	Male	72	5.8–10.2	8.0	7.2–12.5	9.9	2.8–12.7	7.2

*Includes the 1937 growing season

data for comparison with other Maine lakes, it is believed that these bass from Anasagunticook Lake had a fairly rapid rate of growth. The 136 White Perch ranged from 6.9 inches to 12.5 inches in total length, and were in their 5th to 13th summer of life. Their average lengths indicated no marked sex differences in rate of growth (see Table XXVI). The average body lengths in inches by age group of these White Perch from Anasagunticook Lake, as compared to the average growth of perch from 43 other Maine lakes (see page 136 of the present Survey Report No. 4), were as follows:

Age group:	V	VI	VII	VIII	IX	X	XI	XII	XIII
Anasagunticook Lake:	5.8	7.6	7.8	8.0	8.4	8.9	9.8	10.0	9.7
43 other Maine lakes:	6.5	6.7	7.1	7.6	8.0	8.3	8.7	9.5	9.8

It was computed from these figures that the lengths of perch from Anasagunticook Lake by age group averaged 0.4 inch longer than perch from these other lakes in Maine. This growth index of +0.4 represents a rate of growth only slightly above the average, for growth indices of from +1.5 to +2.6 have been found for perch from several other Maine lakes (page 151).

Conclusions. The present study has revealed that Anasagunticook Lake is, at best, a fair trout and salmon lake from the standpoint of depth, temperature, and dissolved oxygen, with 17 per cent of its water volume and 16 per cent of its bottom area available to trout and salmon during late summer. The records of fish taken by gill nets indicated, furthermore, that there had been relatively poor survival of salmonids from the extensive plantings made during the 10 years previous to 1937. During this 10-year period the State Fish and Game Department planted the following: 31,800 Land-locked Salmon, 33,000 Chinook Salmon, and 275 mature Brook Trout. The Chinook Salmon and a large proportion of the Land-locked Salmon were planted from 1933 to 1935; and by 1937 these fish should have been of a size readily captured by the gill nets; yet no salmon or trout were taken by the 424½ hours of fishing with the gill nets. This apparent scarcity of salmon in the lake was verified by reports from local residents, and by a report from the Warden Supervisor of the district, to the effect that very few Land-locked Salmon and no Chinook Salmon were caught during the period from 1933 to 1937. In the writer's opinion, this poor survival of stocked salmon can be partly attributed to the fact that the lake is not first-class trout and salmon water. Other factors also must have been of considerable importance in the poor showing of these salmon, judging from reports of better salmon fishing previous to 1933. Evidence from the 1937 study indicated that the scarcity or absence of smelt was undoubtedly an important factor. No smelts were found in the stomachs of any of the 136 White Perch, nor in any of the other fish from this lake; yet it is known that, in Maine lakes in general, perch feed extensively on smelt where they are available. Also no smelts were taken by seining. It is a well known fact that smelts are necessary in most lakes to maintain a population of Land-locked Salmon, and the same statement might be made for Chinooks in most Maine lakes. An additional factor which may have affected, adversely, the salmon in this lake was the abundance of White Perch, Small-mouthed Bass, and Common Suckers, together with some Yellow Perch and Pickerel, all of which are food competitors with salmon to some extent. It is, in fact, surprising that even a few salmon survived from the plantings in the lake, since the lake is only fair salmon water, its principal food (the Smelt) was apparently rare or absent, and there was an abundant population of at least five competing species of fishes. It is improbable that much better survival will result from future plantings of salmon or trout unless these adverse conditions are corrected to some extent. The planting and protection of smelts together with a reduction in the population of warm-water game species and suckers are, in the writer's opinion, the most promising methods of improving conditions for salmon or trout.

The fish population of the lake consisted mostly of the four species of warm-water game fishes which are common to southern Maine, namely: the White Perch, bass, pickerel, and Yellow Perch; and the sucker. The growth of the White Perch, and presumably also of the sucker. The growth of the White Perch, and presumably also of the bass, was somewhat better than average. The basic fertility of the lake in production of plankton and bottom organisms was found to be about average for the 53 lakes and ponds considered in the present Survey Report No. 4. The suckers were competing to a considerable extent with the White Perch for bottom food. The suckers, furthermore, were more abundant than the perch and were growing much more rapidly. The suckers obviously were making better use of the bottom organisms than were the White Perch, and the inference is that they were feeding at the expense of the White Perch, at least to some extent.

Recommendations. It is assumed that the sportsmen and local residents are in favor of maintaining trout or salmon fishing in Anasagunticook Lake. From data obtained by the present survey, recommendations are made to continue the stocking of Brook Trout. Trout are favored over salmon because, as previously shown, the lake approaches marginal conditions (for cold-water fishes) to which the trout is presumably more tolerant than is the salmon. The number

of Brook Trout recommended for stocking is based on the stocking table which is being used for Maine lakes in general: Table XI in Fish Survey Report No. 2 (Cooper, 1939b). On the basis of the present study, Anasagunticook Lake was accredited with a food grade of II, medium fishing intensity, good spawning grounds for trout, and a competition factor of 9 for competing warm-water game fishes. Applying these evaluations to the stocking table gives an annual rate of stocking of twelve 6-inch fish per acre, for 328 acres which is the average between the total area of the lake and the bottom area within the trout zone during late summer. This calculation gives an annual stocking of 3,900 six-inch Brook Trout, which is recommended. Along with this stocking of trout, efforts should be made to greatly reduce the population of White Perch and Common Suckers, and to protect and maintain the smelt population.

NOTE. Since 1937, when this survey of Anasagunticook Lake was made, considerable stocking of fish has been done by the Fish and Game Department. In June of 1938, 5,000 mature Rainbow Trout were planted, and local residents of Canton reported that none of these fish were caught up to the summer of 1941. During the fall of 1939, 10,000 Brook Trout (4 to 6 inches long), and during May, 1940, 3,000 Brook Trout (mature fish), were stocked in this lake. The majority of the mature fish were reported to have been caught within a few weeks after being released. Through the efforts of the Canton Fish and Game Association, from 4 to 5 million smelt eggs were placed in Sparrow Brook during the springs of 1938 and 1940. It was reported by members of the association that there was a good percentage of hatch from these eggs, and that smelts have been on the increase in the lake during 1939, 1940, and 1941. This program of trout stocking, and planting and protection of the Smelt should be supplemented by drastic reduction of perch and suckers.

LITERATURE CITED

Adams, Charles C. and Hankinson, T. L.

1928. The ecology and economics of Oneida Lake fish. *Roosevelt Wild Life Annals, Vol. 1, Nos. 3 and 4, pp. 235–548.*

Cooper, Gerald P.

1939a. A biological survey of the waters of York County and the southern part of Cumberland County, Maine. *Maine Dept. Inland Fish. and Game, Fish Survey Rept. No. 1, pp. 1–58.*

1939b. A biological survey of thirty-one lakes and ponds of the upper Saco River and Sebago Lake drainage systems in Maine. *Maine Dept. Inland Fish. and Game, Fish Survey Rept. No. 2, pp. 1–147.*

1940. A biological survey of the Rangeley Lakes, with special reference to the trout and salmon. *Maine Dept. Inland Fish. and Game, Fish Survey Rept. No. 3, pp. 1–182.*

Creaser, Charles W.

1926. The structure and growth of the scales of fishes in relation to the interpretation of their life-history, with special reference to the sunfish Eupomotis gibbosus. *Misc. Publ. Mus. Zool. Univ. Mich., No. 17, pp. 1–82.*

Jordan, David Starr, Evermann, Barton Warren, and Clark, Howard Walton.

1930. Check list of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of Venezuela and Colombia. *Rept. U. S. Comm. Fish. for 1928, Pt. II, pp. 1–670.*

Kemmerer, George, Bovard, J. F., and Boorman, W. R.

1923. Northwestern lakes of the United States: biological and chemical studies with reference to possibilities in production of fish. *Bull. U. S. Bur. Fish., Vol. 39, pp. 49–140.*

Kendall, William Converse.

1914. The fishes of Maine. *Proc. Portland Soc. Nat. Hist., Vol. 3, Pt. 1, pp. 1–198.*

1935. The fishes of New England. The salmon family. Part 2.— The salmons. *Mem. Boston Soc. Nat. Hist., Vol. 9, No. 1, pp. 1–166.*

Smith, Gilbert M.

1933. The fresh-water algae of the United States. *McGraw-Hill Book Co., pp. 1–716.*

Ward, Henry Baldwin, and Whipple, George Chandler.

1918. Fresh-water biology. *John Wiley and Sons, pp. 1–1111.*

Welch, Paul S.

1935. Limnology. *McGraw-Hill Book Co., pp. 1–471.*

PLATES I TO XXV

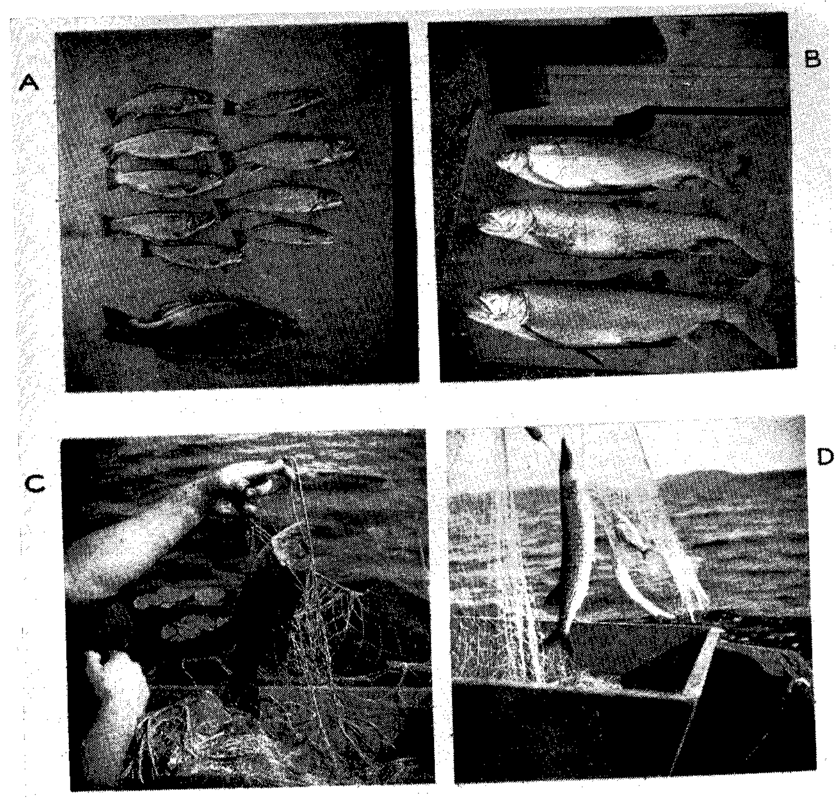


PLATE I

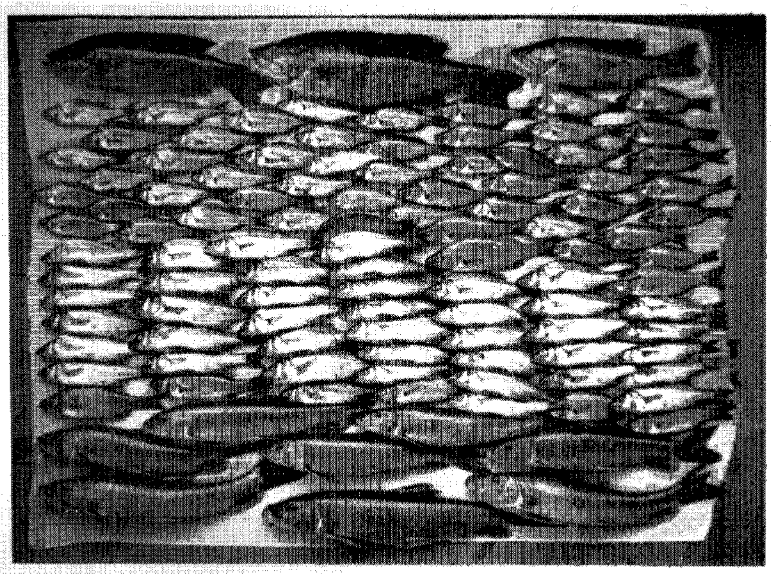
Fish taken by gill nets:

A — From Pleasant Pond in Turner on June 22, 1940. Brook Trout (9) and Small-mouthed Bass (1). The bass weighed 4 lbs. 1 oz.; the largest trout weighed 13.3 ounces.

B — From South Pond in Greenwood on September 5, 1940. Togue or Lake Trout (2) and Common Whitefish (1). The largest Togue weighed 4 lbs. 1 oz.

C — A 2½-pound Small-mouthed Bass in the net in Tripp Pond in Poland on August 10, 1940.

D — Two Pickerel and one White Perch in the net in Androscoggin Lake on June 26, 1940. The largest Pickerel (in the foreground) weighed 40.5 ounces.



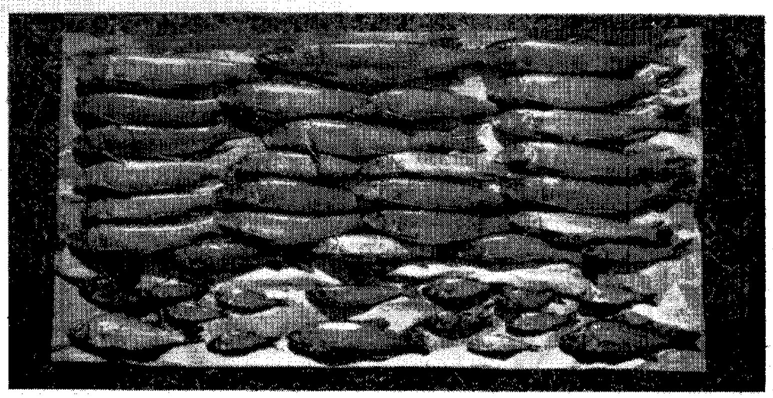


PLATE II

Two gill net collections from Webb Lake in Weld.

A — September 10, 1940. Small-mouthed Bass (3), White Perch (98), and Common Suckers (8). The largest bass weighed 2 lbs. 13 ozs.

B — September 11, 1940. Pickerel (1), Common Suckers (25), White Perch (13), Land-locked Salmon (1), and Small-mouthed Bass (1). The pickerel weighed 2 lbs. 13 ozs.

PLATE III

Gill net catch from Taylor Pond in Auburn on August 14, 1940. Common Suckers (16), White Perch (4), Golden Shiners (2), and Common Pickerel (7). The largest pickerel weighed 1 lb. 10 ozs.

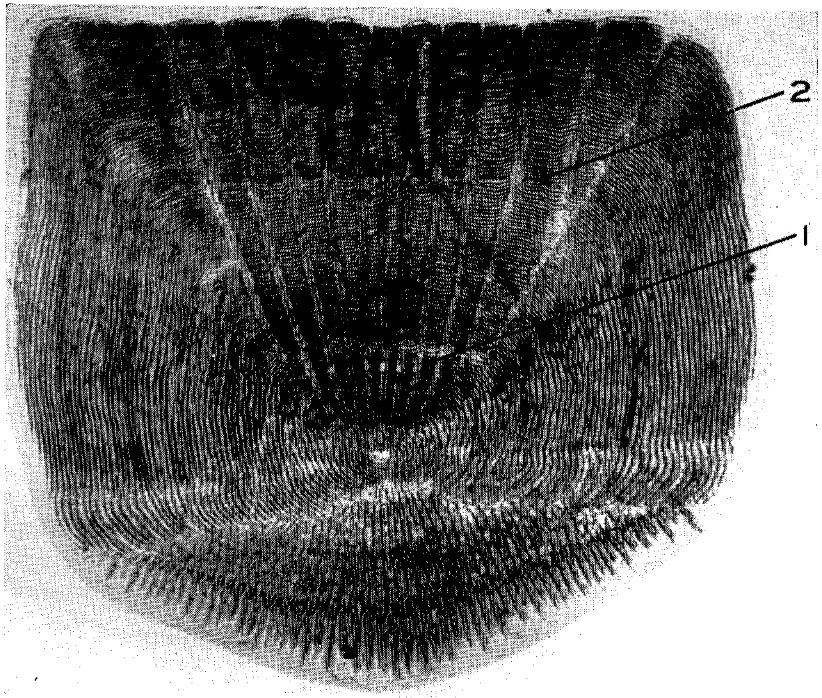


PLATE IV

Scale of White Perch (*Morone americana*); female; standard or body length, 7.1 inches; total length, 8.7 inches; weight, 5.9 ounces. From South Pond (P.522), September 5, 1940. Fish at the end of its 3rd summer. Annuli or "winter marks" are numbered 1 to 2.

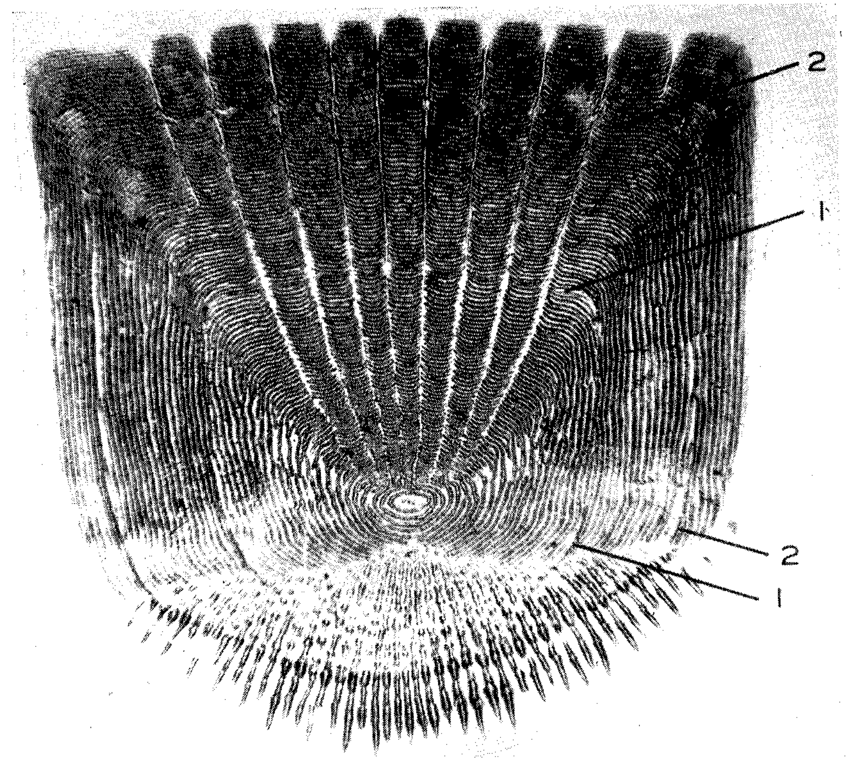


PLATE V

Scale of White Perch (*Morone americana*); immature female; standard length, 5.0 inches; total length, 6.1 inches; weight, 1.6 ounces. From Maranacook Lake, August 3, 1940. Fish in 3rd summer of life, and apparently has nearly completed an average 3rd-summer scale growth. Annuli numbered 1 to 2.

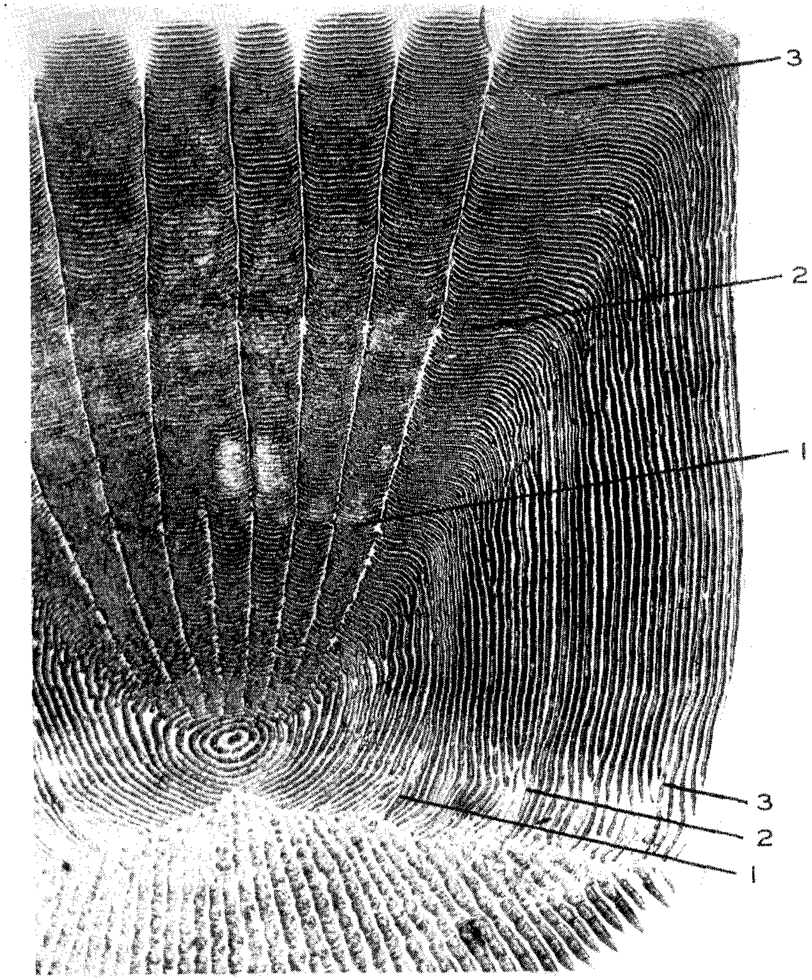


PLATE VI

Part of scale of White Perch (*Morone americana*); female; standard length, 5.7 inches; total length, 7.0 inches; weight, 2.5 ounces. From Maranacook Lake, August 3, 1940. Fish in 4th summer of life, and apparently has nearly completed an average 4th-summer scale growth. Annuli numbered 1 to 3.

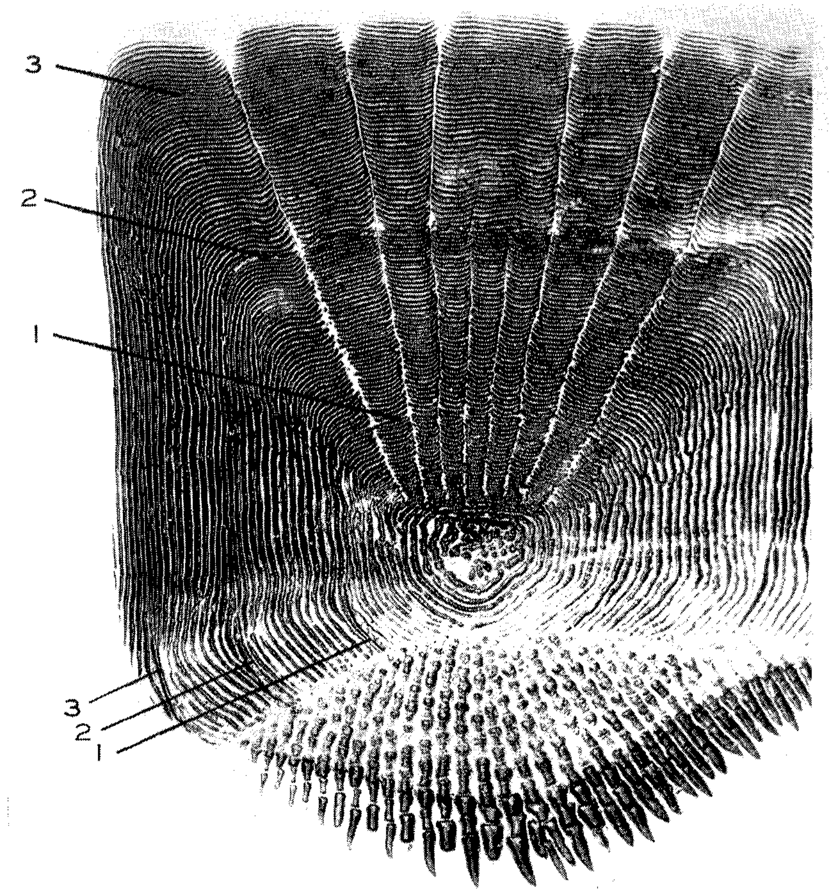


PLATE VII

Part of scale of White Perch (*Morone americana*); female; standard length, 5.9 inches; total length, 7.1 inches; weight, 2.8 ounces. From Maranacook Lake, August 3, 1940. Fish in 4th summer of life. Annuli numbered 1 to 3.

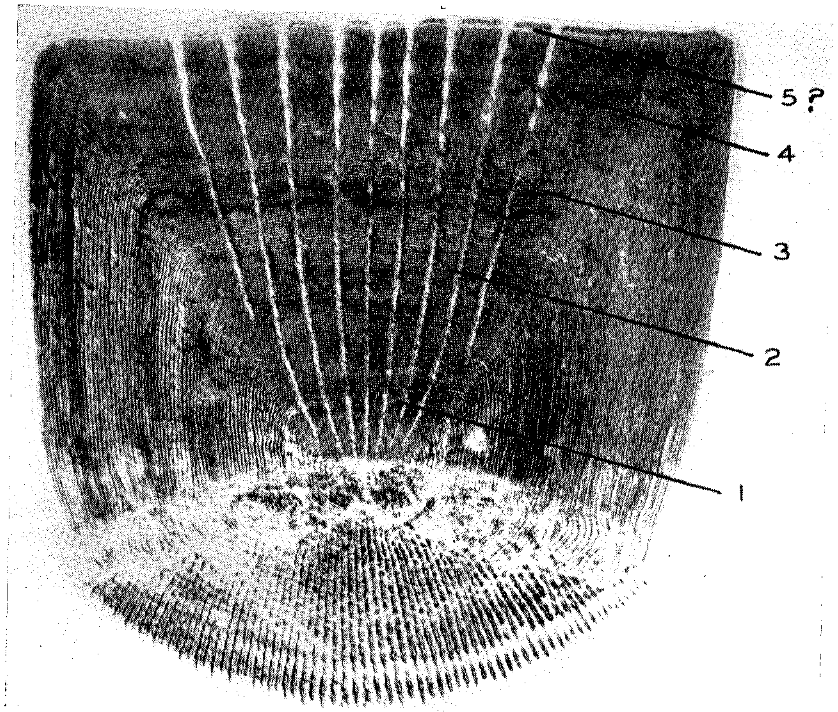


PLATE VIII

Scale of White Perch (*Morone americana*); female; standard length, 8.3 inches; total length, 10.2 inches; weight, 8.5 ounces. From Maranacook Lake, August 3, 1940. Fish in 6th (possibly the 5th) summer of life; 5th annulus apparently forming along anterior margin of scale. Annuli numbered 1 to 5.

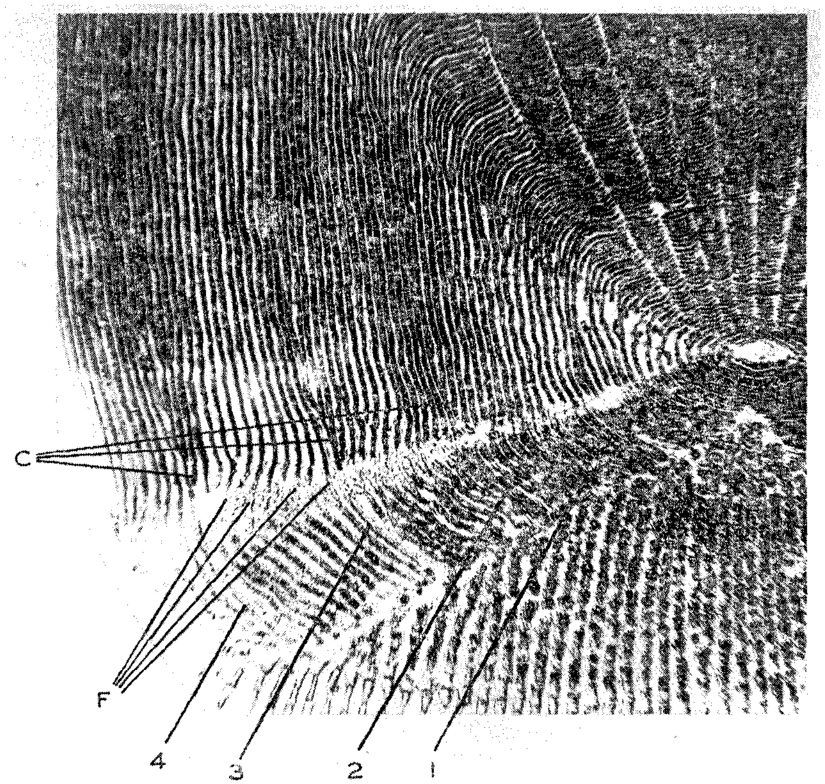


PLATE IX

Part of scale of White Perch (*Morone americana*) from Maranacook Lake, August 3, 1940. This scale and the scale on Plate VIII are different scales from the same fish. Enlargement of lateral field with 4 annuli (numbered 1 to 4); to show "cutting over" of the circuli by the annulus (at C), and the increase in degree of flaring of circuli between two annuli along the posterior-lateral field of the scale (at F).

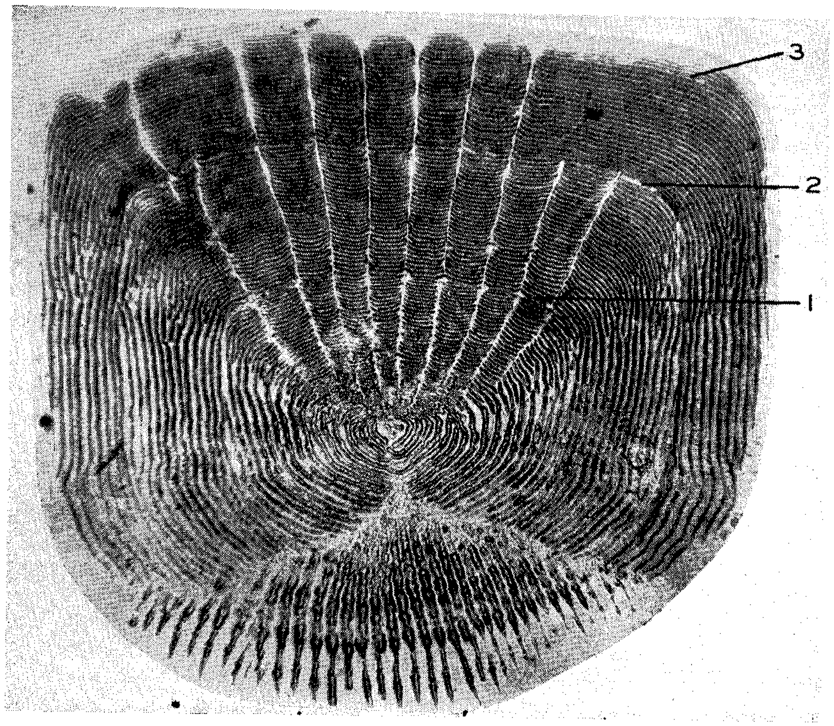


PLATE X

Scale of White Perch (*Morone americana*); female; standard length, 5.2 inches; total length, 6.3 inches; weight, 1.7 ounces. From North Pond of Belgrades, July 11, 1940. Fish in 4th summer of life; the 3rd annulus has just recently been formed along the anterior margin of the scale. Annuli numbered 1 to 3.

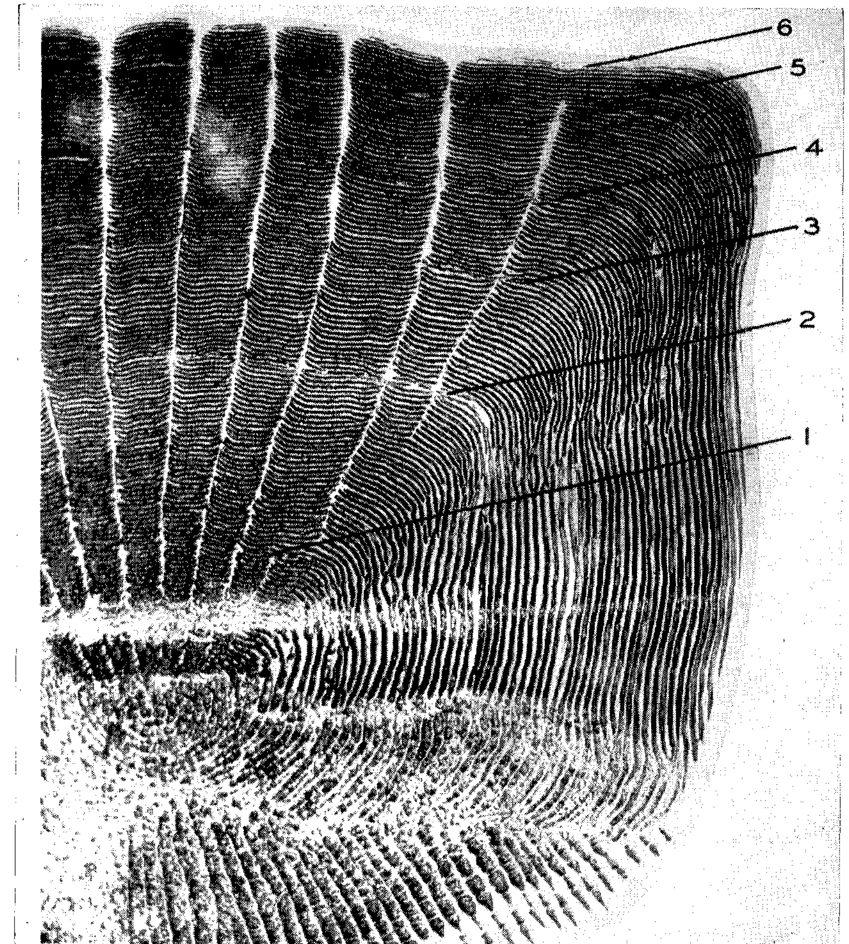


PLATE XI

Part of scale of White Perch (*Morone americana*); male; standard length, 6.6 inches; total length, 7.9 inches; weight, 3.7 ounces. From East Pond of Belgrades, July 13, 1940. Fish in 7th summer of life; the 6th annulus is just forming along the anterior margin of the scale. Annuli numbered 1 to 6.

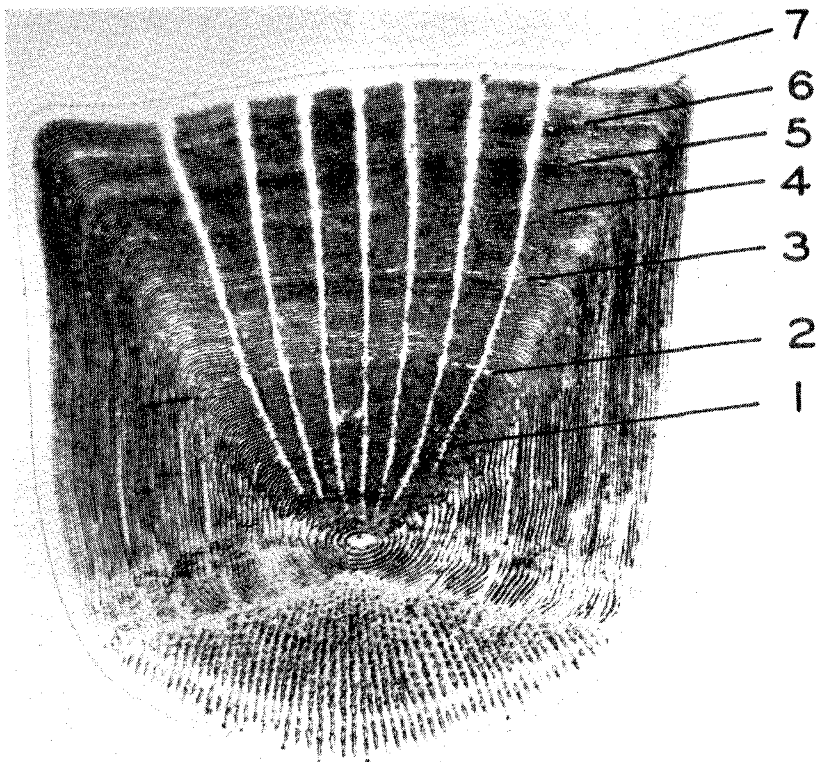


PLATE XII

Scale of White Perch (*Morone americana*); male; standard length, 5.8 inches; total length, 6.9 inches; weight, 2.2 ounces. From Great Pond of Belgrades, June 21, 1940. Fish in 8th summer of life; but scale shows no growth as yet for the 8th summer (1940). Annuli numbered 1 to 7.

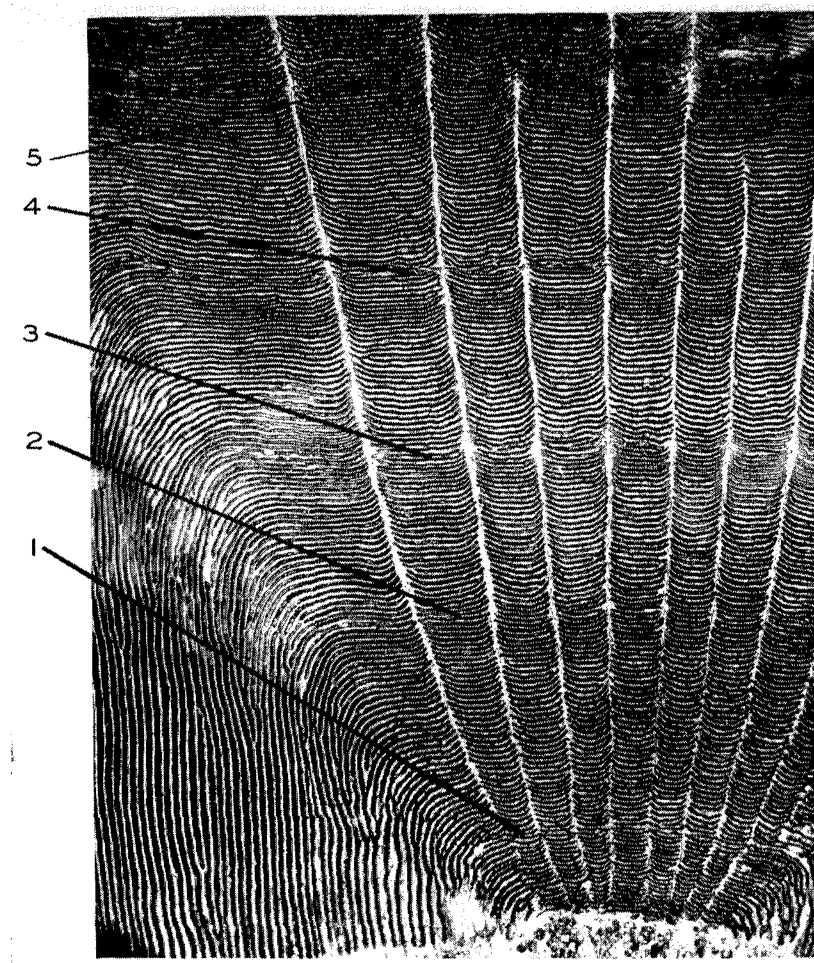


PLATE XIII

Part of scale of White Perch (*Morone americana*); male; standard length, 8.7 inches; total length, 10.6 inches; weight, 9.5 ounces. Fish in 8th summer of life. From Long Pond of Belgrades (South Part), June 27, 1940. Enlarged portion of anterior and lateral fields showing the first 5 annuli, and showing details of the arrangement of the circuli and characteristics of the annuli. Annuli numbered 1 to 5.

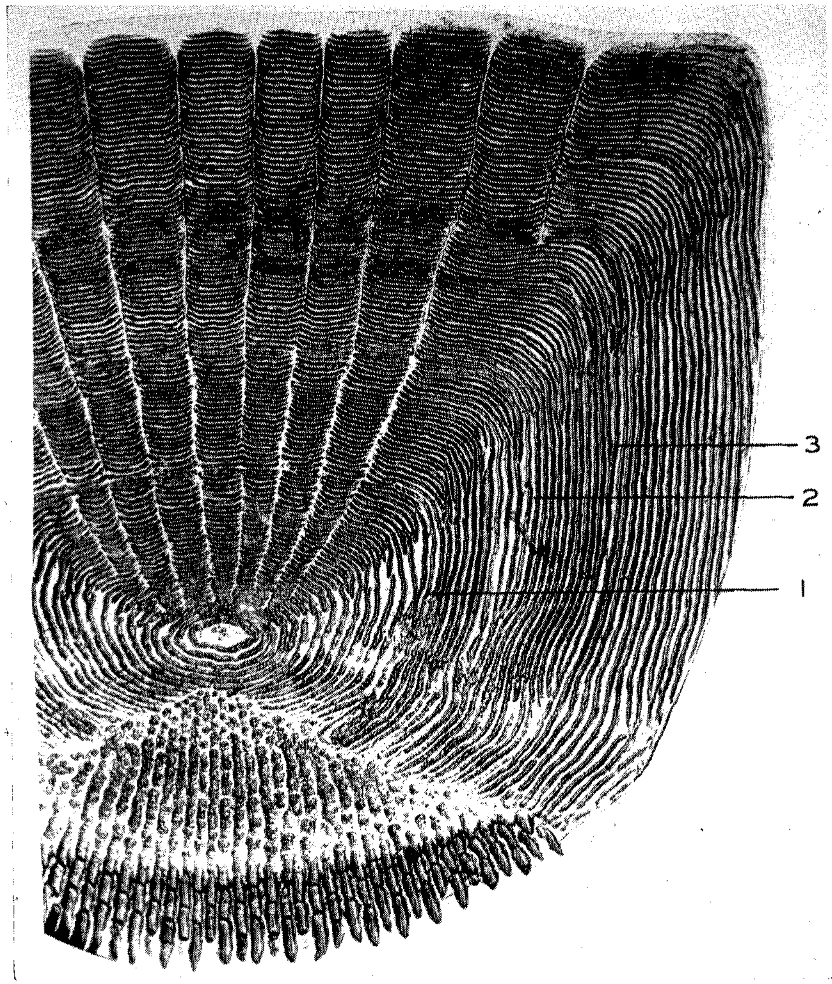


PLATE XIV

Part of scale of White Perch (*Morone americana*); female; standard length, 5.0 inches; total length, 6.7 inches; weight, 2.1 ounces. From Webb Lake in Weld, September 10, 1940. Fish at end of its 4th summer. An accessory "check" may be seen in the anterior field between the 2nd and 3rd annuli. Annuli numbered 1 to 3.

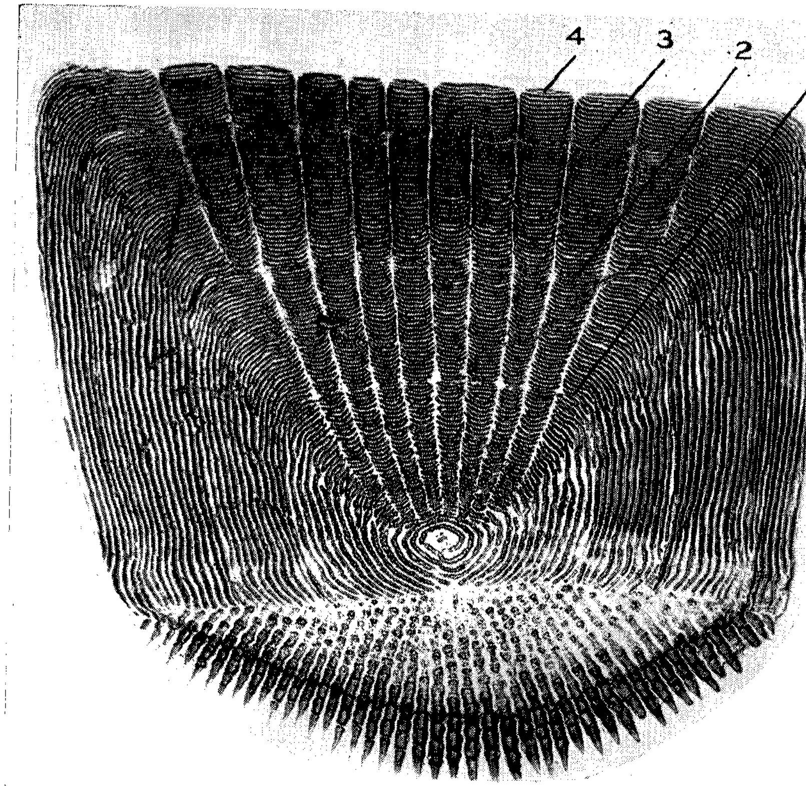


PLATE XV

Scale of White Perch (*Morone americana*); female; standard length, 5.5 inches; total length, 6.5 inches; weight, 1.7 ounces. From Auburn Lake, June 28, 1940. Fish in 5th summer of life; the 4th annulus apparently is just forming along the anterior margin of the scale. Annuli numbered 1 to 4.

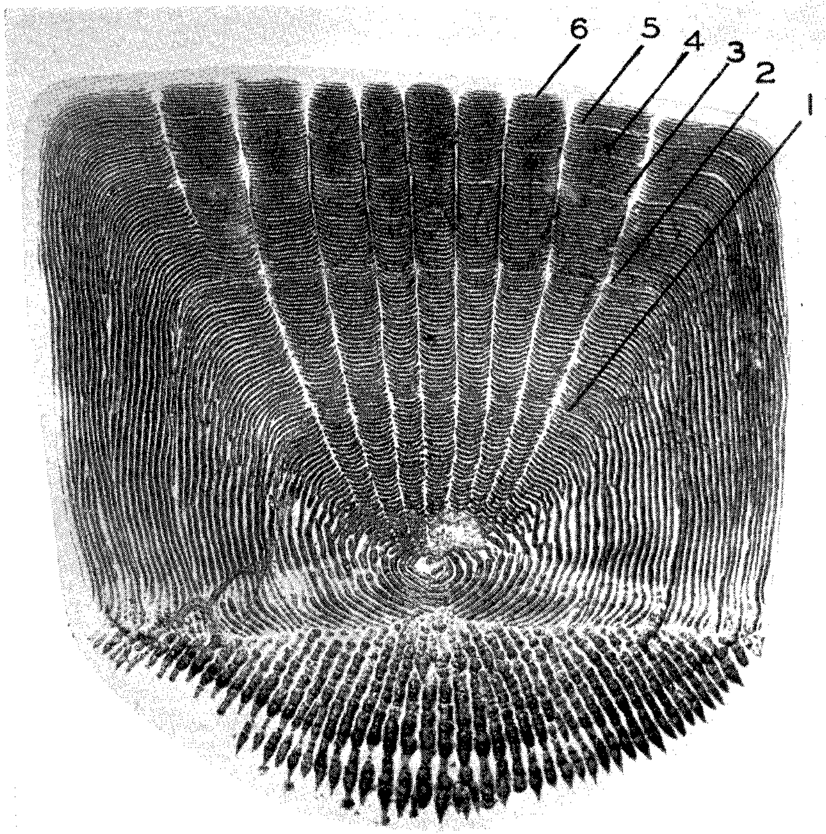


PLATE XVI

Scale of White Perch (*Morone americana*); female; standard length, 5.4 inches; total length, 6.7 inches; weight, 1.8 ounces. From Auburn Lake, June 28, 1940. Fish in 7th summer of life; the 6th annulus is just forming along the anterior margin of the scale. Annuli numbered 1 to 6.

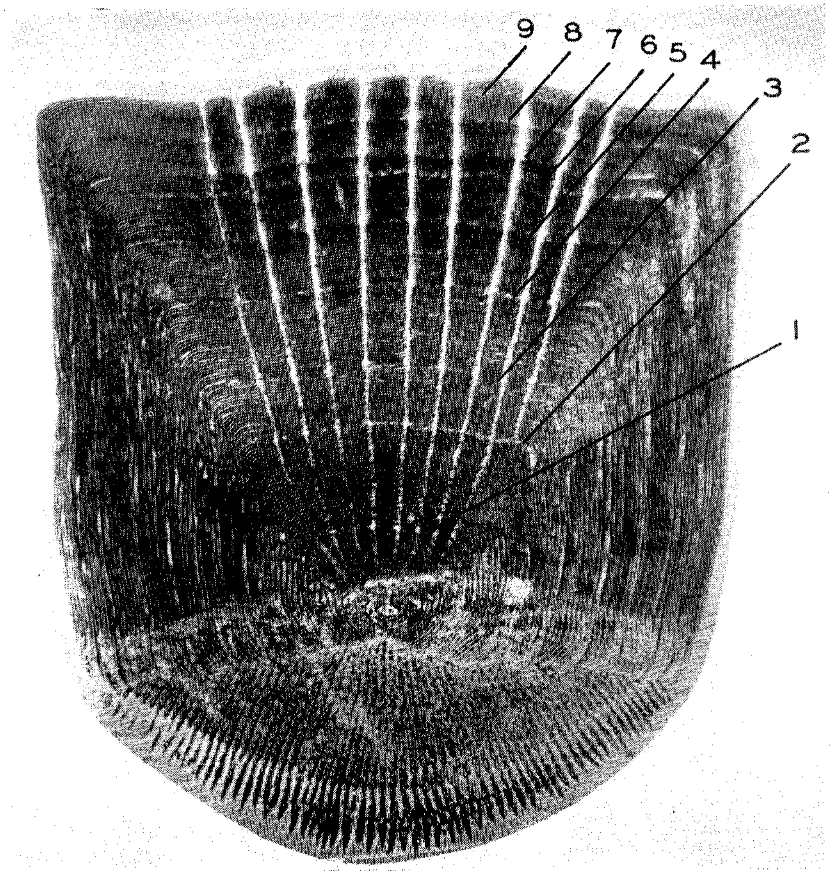


PLATE XVII

Scale of White Perch (*Morone americana*); female; standard length, 7.6 inches; total length, 9.3 inches; weight, 6.3 ounces. From Great Pond of Belgrades, September 7, 1940. Fish at end of its 10th summer. Annuli numbered 1 to 9.

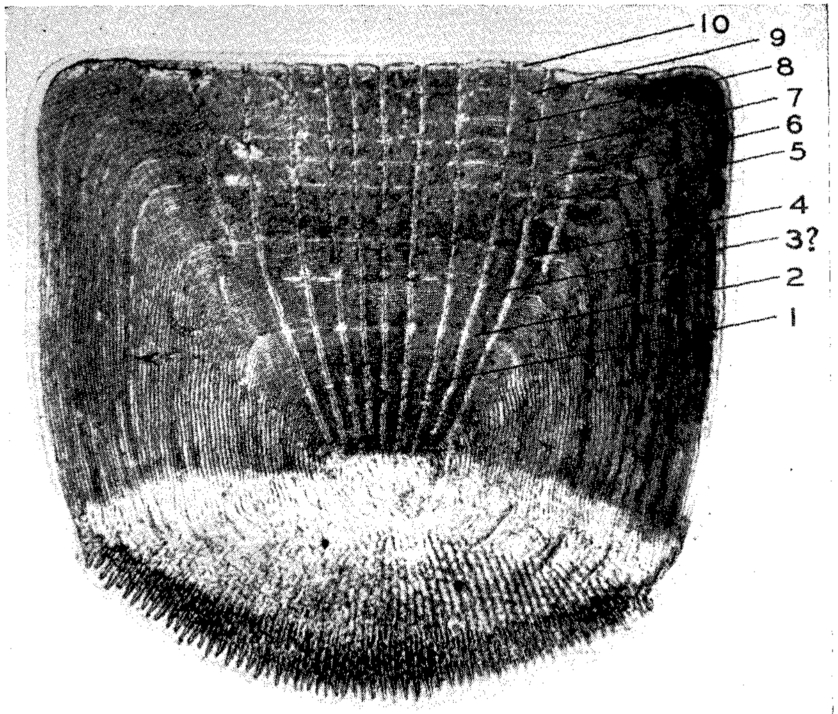


PLATE XVIII

Scale of White Perch (*Morone americana*); male; standard length, 8.1 inches; total length, 9.7 inches; weight, 6.3 ounces. From Cochnewagan Pond, June 18, 1940. Fish in 11th summer (possibly the 10th, for the 3rd annulus indicated above is doubtful); the last annulus is just forming at the margin. Annuli numbered 1 to 10.

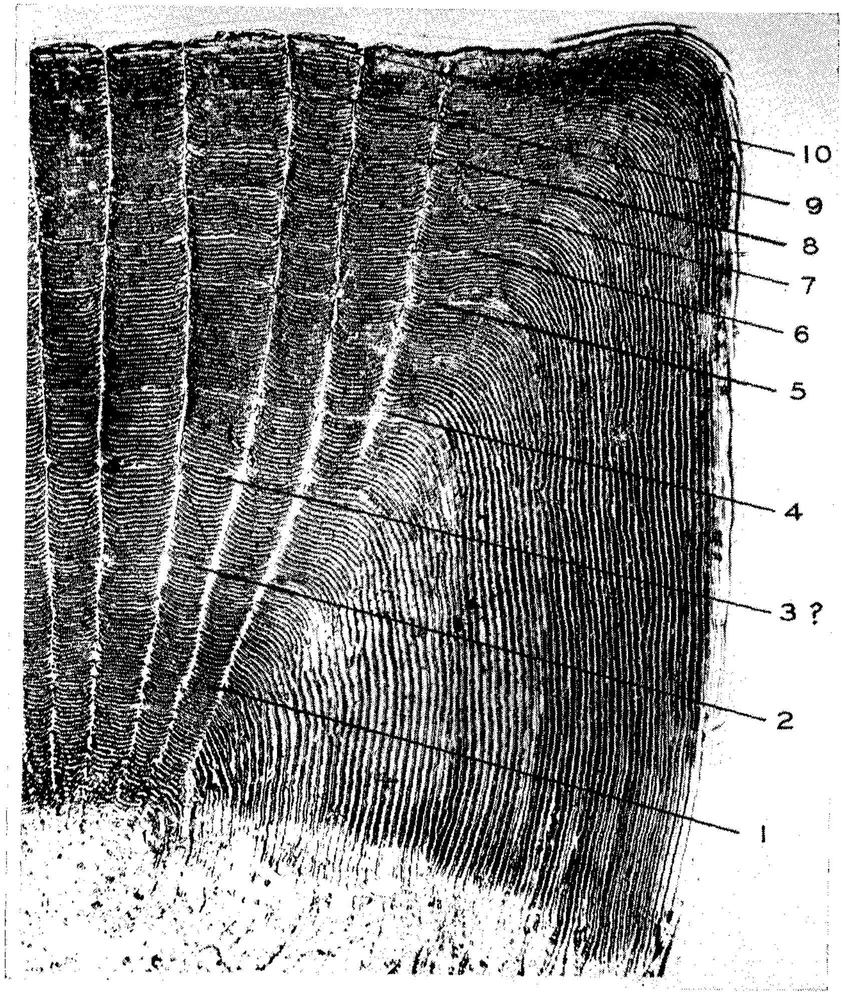


PLATE XIX

Part of scale of White Perch (*Morone americana*). Same scale as shown on Plate XVIII. Annuli numbered 1 to 10.

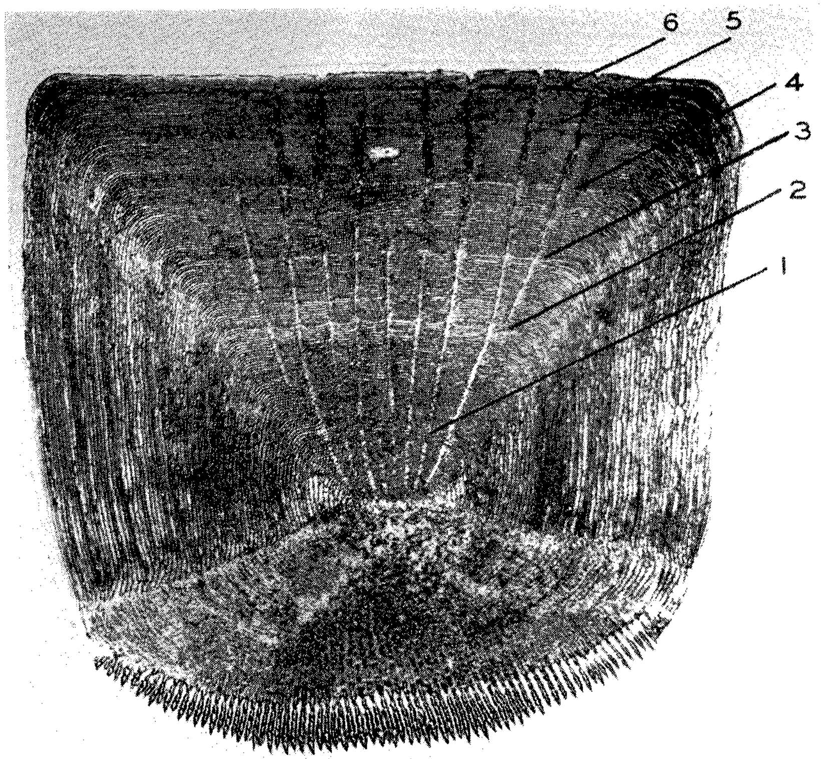


PLATE XX

Scale of White Perch (*Morone americana*); male; standard length, 9.8 inches; total length, 11.6 inches; weight, 14.0 ounces. From Graham Lake in Waltham, January 30, 1941. The fish has completed its 7th summer of life. Annuli numbered 1 to 6.

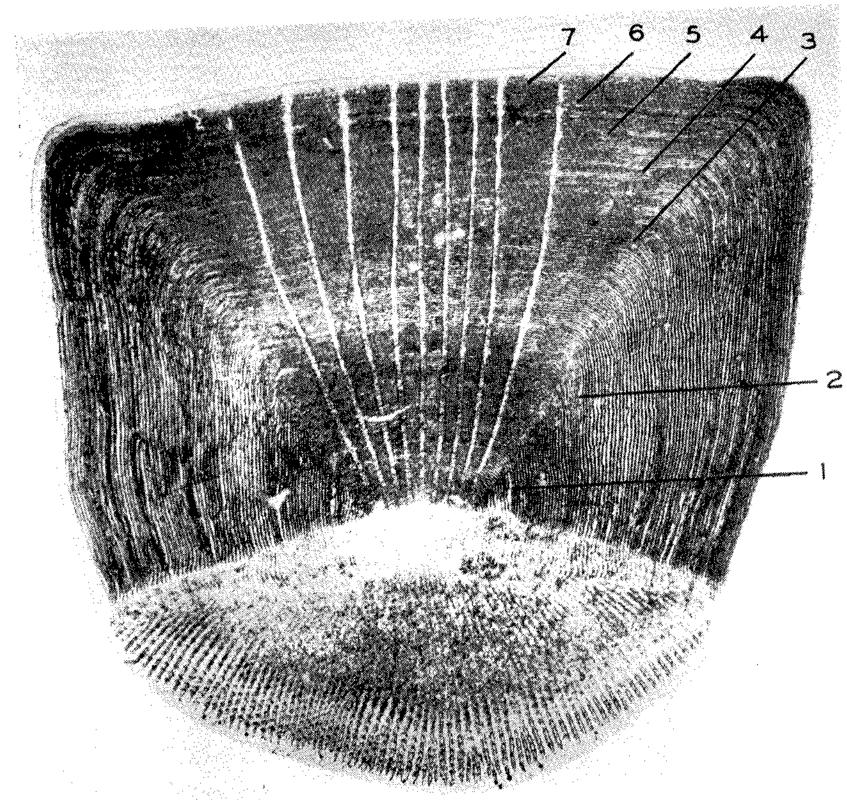


PLATE XXI

Scale of White Perch (*Morone americana*); male; standard length, 11.4 inches; total length, 13.9 inches; weight, 23.5 ounces. From Graham Lake in Waltham, January 30, 1941. The fish has completed its 8th summer of life. Annuli numbered 1 to 7.

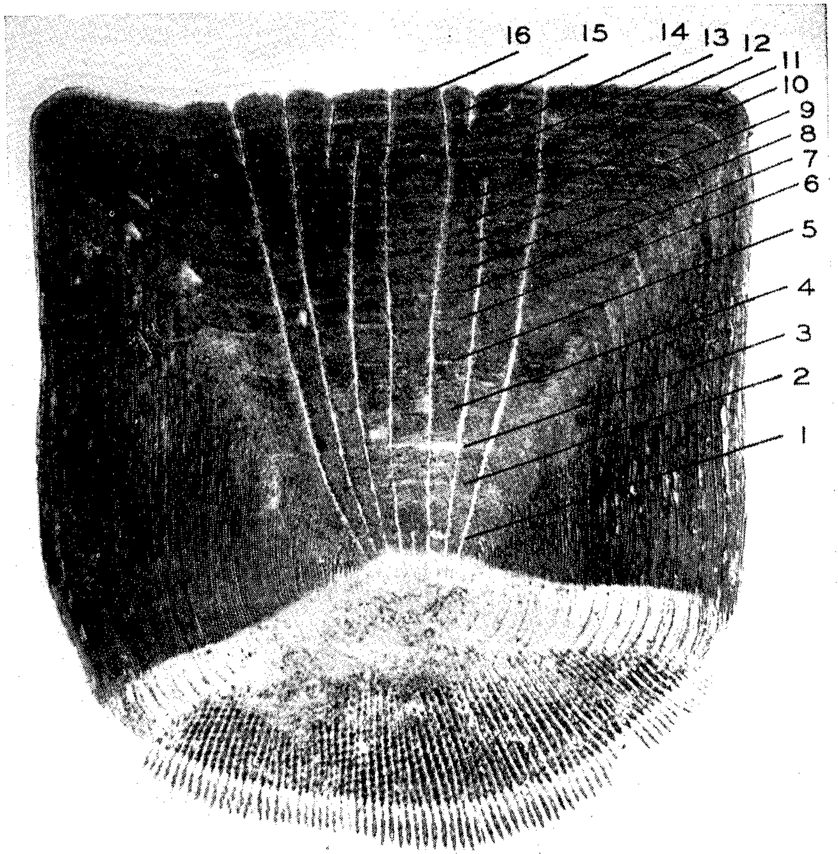


PLATE XXII

Scale of White Perch (*Morone americana*); male; standard length, 10.0 inches; total length, 12.3 inches; weight, 14.6 ounces. From Webb Lake in Weld, September 11, 1940. The writer interprets this scale as indicating that this fish was completing its 17th summer of life. Annuli numbered 1 to 16. For details of a portion of this scale, see Plate XXIII.

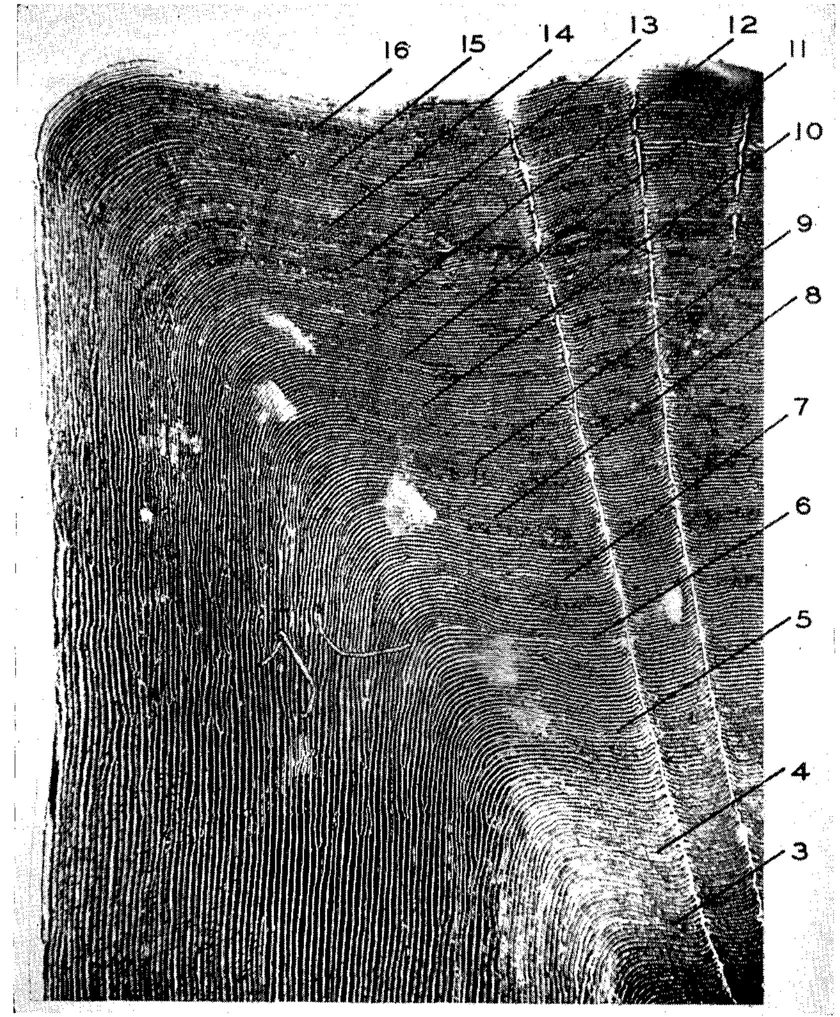
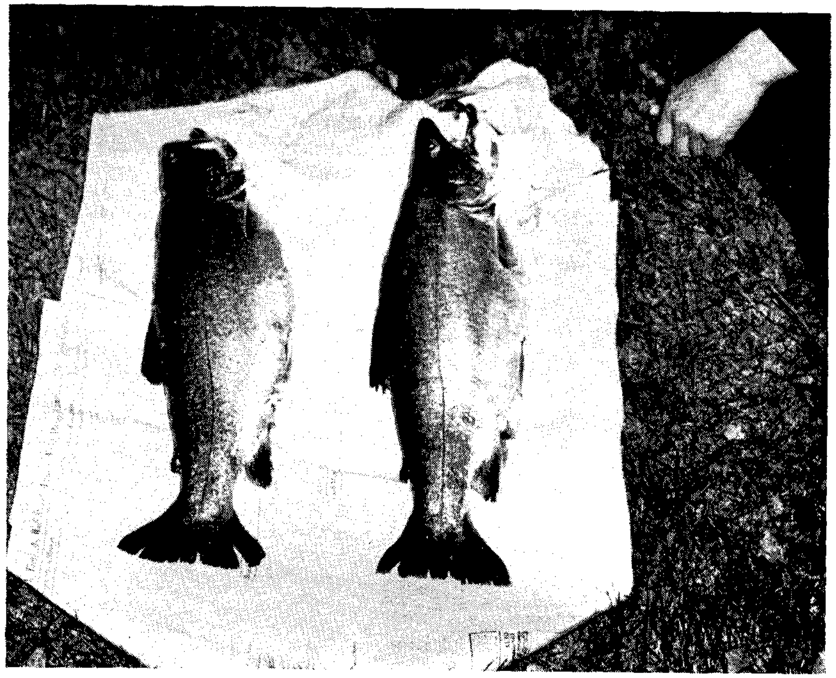


PLATE XXIII

Part of scale of White Perch (*Morone americana*), from Webb Lake in Weld. Same scale as on Plate XXII. Enlargement of anterior and lateral fields, including annuli 3 to 16.



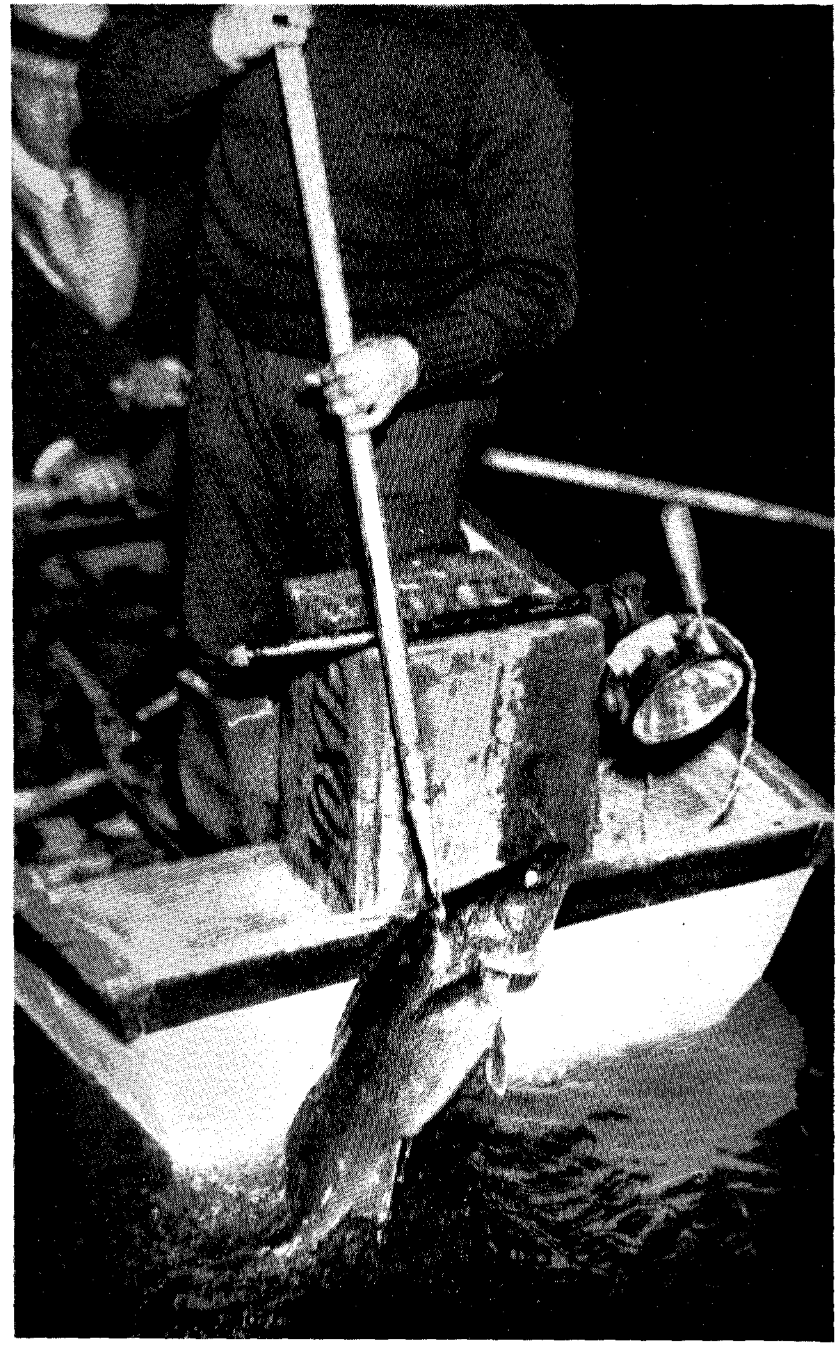
COURTESY OF GENE LETOURNEAU OF THE WATERVILLE SENTINEL

COURTESY OF GENE LETOURNEAU OF THE WATERVILLE SENTINEL

PLATE XXIV

Upper: Two Brook Trout caught from Snow Pond or Messalonskee Lake during the spring of 1941. One was a male, the other a female. Each fish, 23 inches long, weighed 5 lbs. 14 ozs.

Lower: Walleyed Pike speared from Great Pond of the Belgrades, Spring of 1941.



COURTESY OF GENE LETOURNEAU OF THE WATERVILLE SENTINEL

PLATE XXV

Spearing Walleyed Pike at night on their spawning grounds in Great Pond of the Belgrades during the Spring of 1941. This spearing is most successful in shallow water and when the water surface is quiet.