STATE OF NEW YORK

CONSERVATION DEPARTMENT

A BIOLOGICAL SURVEY OF THE GENESEE RIVER SYSTEM

Supplemental to Sixteenth
Annual Report, 1926

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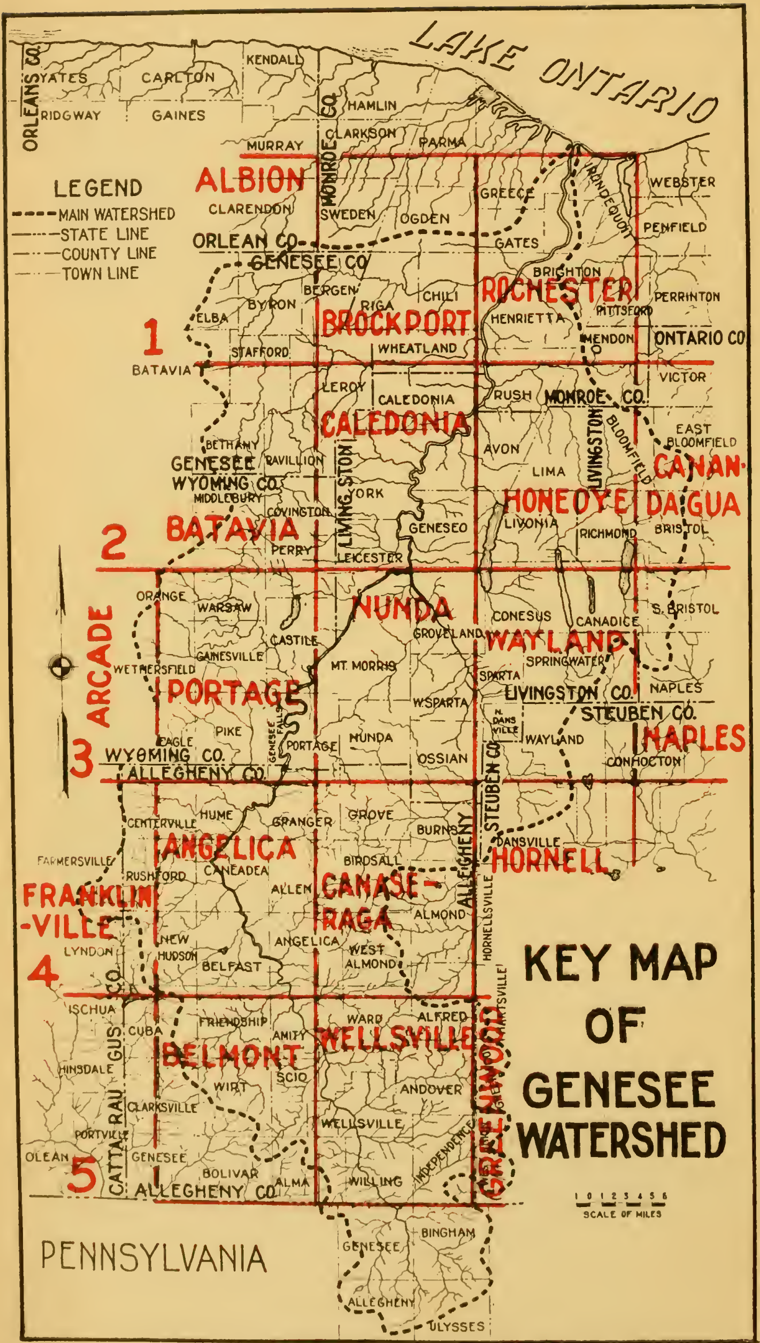
CONTENTS

	PAGE
Introduction	5
Authorization of survey	5
Area covered	5
Development of a stocking policy	5
Allotments of fish	6
Pollutional conditions in the Genesee river system	7
Fish population	8
Colored plates of minnows	8
Silver lake and Conesus lake	9
New lakes	9
Personnel	11
Presentation of data	11
Section I. Stocking policy for the Genesee river system	12
The problem	12
Water temperature	12
Cold springs	14
Stream bed	14
Shade	14
Oxygen and carbon dioxide	15
Purity	16
Size of water	17
Character of bottom in relation to natural spawning	17
Barriers to fish movements	18
Waters of the Genesee system worthy of stocking	18
Brook trout waters	18
Brown trout waters	19
Rainbow trout waters	19
Small-mouthed bass waters	20
Large-mouthed bass, sunfish and catfish waters	21
Pike-perch waters	21
Two new lakes	21
Streams not to be stocked	23
Number of fish to be planted	23
Area of stream available for trout	24
Abundance of primary food organisms	24
Pool conditions	24
Enemies, effects of angling	25
Productivity of a unit area	25
System of numbering streams	26
Abbreviations and symbols used	28
Section II. Chemical investigation of the Genesee river system	29
Types of pollution	29
Gaseous relations	29
Methods employed	30
Conditions encountered	30
Importance of character of stream	32
Summary	35
Section III. Biological studies of polluted areas	38
Milk pollution	38
Domestic sewage	40
Cannery and vinery wastes	40
Oil pollution	41
Salt pollution	43
Paper mill wastes	44
Miscellaneous wastes	44
Summary	44
Tabulation of pollution studies	45

		PAGE
Section IV. Fishes of the Genesee region		47
General nature of region		47
Changes in the character of the region		47
Genesee river		47
Fishes of the Genesee region		48
Food and game fishes		48
Miscellaneous other fishes		49
Fishes as food for game fishes		49
Bait fishes of the region		50
Ecology of fishes		50
Fishes and pollution		52
Typical fishes of a trout stream		53
The German carp		54
Annotated list of fishes		57
Acipenseridae	*Sturgeons*	57
Lepisosteidae	*Garpikes*	57
Amiidae	*Bowfins*	57
Ameiuridae	*Catfishes*	57
Castostomidae	*Suckers*	57
Cyprinidae	*Minnows*	57
Anguillidae	*Eels*	61
Clupeidae	*Herrings*	61
Coregonidae	*Whitefishes*	61
Salmonidae	*Salmons*	61
Umbridae	*Mud minnows*	62
Escidae	*Pikes*	62
Cyprinadontidae	*Killifishes*	62
Gasterosteidae	*Sticklebacks*	63
Percopsidae	*Trout perches*	63
Centrarchidae	*Sunfishes*	63
Percidae	*Perches*	64
Sciaenidae	*Drumfishes*	65
Cottidae	*Sculpins*	65
Literature cited		65
Section V. Vegetation of Silver lake and Conesus lake		66
Silver lake		66
Vegetation of Silver lake		67
Plankton		67
Bottom fauna		69
Conesus lake		69
Records from soundings in Conesus lake		70
Vegetation of Conesus lake		70
Appendix I.	Blank forms used in the field	72
" II.	Allotments of fry and fingerlings	73
" III.	Tables of chemical analyses	74
" IV.	Plants and animals of pollution	80
" V.	Tabulation of diatoms	82
" VI.	Soundings in Conesus lake	84
" VII.	Larger plants of Silver and Conesus lakes	86
" VIII.	Salt plants of Wolf creek	87
" IX–XIII.	Stocking lists	88-98

Map 1. Albion, Brockport, Rochester quadrangles
Map. 2. Batavia, Caledonia, Honeoye, Canandaigua quadrangles
Map. 3. Arcade, Portage, Nunda, Wayland, Naples quadrangles. } Follow page 100
Map 4. Franklinville, Angelica, Canaseraga, Hornell quadrangles
Map. 5. Belmont, Wellsville, Greenwood quadrangles



Genesee River System — Guide to Maps 1–5

A BIOLOGICAL SURVEY OF THE GENESEE RIVER SYSTEM

Introduction

By Emmeline Moore,

Investigator in Fish Culture, in Charge of Survey

Authorization of Survey.— In April, 1926, the Legislature appropriated from the conservation fund the sum of $15,000 for use by the Conservation Department to initiate its program of biological surveys. As defined in the enacting clause the purposes of such surveys are "to determine the most practical methods of increasing fish production." In pursuance of this provision the first investigation undertaken deals with the pressing problem of formulating a stocking policy based on information of the condition of the streams receiving the millions of fish propagated annually in the hatcheries of the State.

Area Covered.— The first stream system selected for study is the Genesee. This river system is typical of those included almost wholly within an agricultural area, with tributary headwaters rising for the most part in open and exposed hill country, easily accessible and subjected to intensive fishing. Moreover, it is a stream system in which both power and regulatory projects are contemplated in the immediate future, circumstances which project problems related to a stocking policy best studied in the period preceding the construction of dams and the flowage of lands.

The county unit frequently chosen for survey study has not been selected because it seemed more advantageous to enlarge considerably the area of operation by concentrating upon the more unified problems of a stream system. With the work as now completed the survey spreads over parts of eight counties and comprises a "full length" study of all the streams in the Genesee watershed from the headwaters at the Pennsylvania State line to Lake Ontario, a stream length of about 3,100 miles, including the main stream and tributaries besides ponds and lakes in the system aggregating about 172 square miles. The survey covered the period of three months, from June 15 to September 15.

Development of a Stocking Policy.—According to the records of the Department the number of fry and fingerlings distributed from the State hatcheries to the Genesee river system totals for the nine-year period,* 1917-1925, approximately 40,000,000 young

*Appendix II.

fish. They have gone into waters of a lesser mileage than indicated above because many of these streams are intermittently dry. Of the success of these plantings, information runs short. It may be assumed that some waters have received too many fish, others too few. It could hardly be otherwise under prevailing methods of distributing the fish on application of individuals and clubs who plant them often without experience in handling fish and without adequate knowledge of the capacity of the stream to absorb them.

This survey undertaken this summer is an attempt to place the matter of fish distribution on a more intelligent footing. To this end the entire river system has been made the subject of scientific

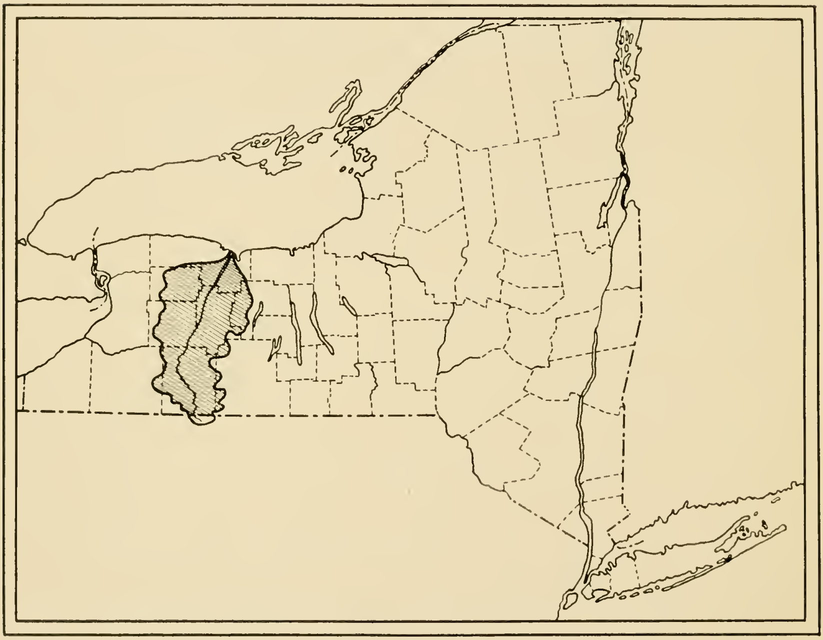


Fig. 1.— Shaded area is coverage included in the survey of the Genesee River system. Area = 2446 sq. mi.

study from such viewpoints as bear directly upon the development of a stocking policy and so far as possible inclusive of conditions that underlie and control production. Data (App. I) have been collected on the character and condition of the stream, the temperature, the food supply, the fish population, pollutional conditions and so on. These facts have been correlated for use and form the basis of a stocking program.

Allotments of Fish.— The number of fish per mile or per acre may still be regarded as disputable because of the difficulties involved in interpreting the many complex factors surrounding the problems of natural production and increase. In this initial survey, therefore, it is not attempted to state a hard and fast rule applicable to the different types of stream, a formula, that is, which would have the advantage of an established standard upon which to grade the numbers up or down though this should be the goal for the future. For the present the mode of procedure is by recommendation for each individual stream in the system. Maps of the U. S. Geological Survey (Maps 1–5) have been adapted to the purposes of record and all streams are shown thereon with suitable indications of dry and permanent streams, the presence of springs, pollution outfalls, and favorable places for fish planting. Accompanying the maps are lists (App. IX–XIII) which set forth in tabular form the names of the streams (if not named then numbered), the mileage available for stocking and the stocking policy per mile. By reference to these tables and maps as guides the location of the best places to plant fish and the calculation of the number per mile may be determined readily.

Pollutional Conditions in the Genesee River System.— The chief objective in directing studies upon this subject has been to secure information which would picture fairly and adequately the conditions of pollution existing throughout the watershed. For this purpose data were obtained during the summer months when pollutional conditions are generally at their worst and the effects upon the stream life are most sharply marked. Both biological and chemical studies were made and the results obtained give a helpful interpretation of the situation.

The dissolved oxygen profile of the river system (Fig. 5) presents an impressive picture of the effect upon the oxygen supply of a succession of pollution outfalls, and represents most graphically the cumulative effect of excessive and continuous overloads upon the stream despite the increased volume of water in the lower stretches of the river. The detailed data show in an interesting manner as regards oxygen depletion and recovery the contrast between the portions of the stream which are rapid and riffly and those which are sluggish and unruffled where except for the beneficial effects of plants and other sources the stream reoxygenates only by slow absorption from the surrounding atmosphere. Hence, one is impressed with the need of taking into consideration at all times the character of the stream.

The evidence from the biological investigations is equally instructive and interesting. The types of polluting substances which enter the river system are discussed in their relation to fish life and to the organisms associated with them in the capacity of food of fish either directly or remotely. The mileage of stream noticeably affected by the polluting wastes is estimated at about 125 miles, an approximation based upon the condition of the stream as shown both by oxygen depletion and the presence of biological indicators of pollution. Within this mileage of polluted streams conspicuous examples occur of stream defilement in which the normal fauna and flora are completely replaced by pollutional forms and by gaseous or other conditions inimical to fish life. Mention is made of a notable instance in which an industry using the stream for disposal has developed and installed a precipitation plant for the partial recovery of wastes before emptying them into the stream. A useful tabulation provides data of importance to each community in which pollution studies have been made.

Fish Population.— In studying the species of fish an effort has been made to secure representatives of the entire stream system together with a study of their food preferences and the conditions favoring their natural development. Sixty-six different species are represented. Twenty-six of these fall in the group of food and game fishes, twenty-three belong in the minnow family, and the others represent miscellaneous species. Of the minnows five are of excellent bait variety and one of them, a mud-eating species, possesses important qualities of fish cultural value. The carp, contrary to expectation, is unimportant above Rochester Falls.

Fresh light is thrown on various problems concerned with fish distribution as for example the fish associations of the game and other fishes, the dominating species under certain conditions of pollution and the adjustments to temperature.

Colored Plates of Minnows.—All efforts to increase the production of food and game fish are closely linked with an understanding of this group of fishes. They contribute fundamentally to the food supply of other fishes, they are competitors or noncompetitors. Some of them are important enemies of fish life. Of the twenty-two species found in the Genesee system less than a half dozen are known familiarly and these only because they are attractive as bait. Quite generally the popular bait fishes are confined to a few species only. Doubtless others are valuable or have possibilities of fish cultural value. These are important questions to consider as interest in the sport of fishing is expanding, and questions on restrictions and vending of minnows are receiving attention in conservation programs.

The colored plates will help to arouse greater interest in minnow life. A dry order of facts about minnows is not adapted for popular consumption. It is stimulating and it engages the imagination, for example, to point out that the typical brook-trout-stream minnow is the pearl minnow sharing with the trout the coldest waters. And that another competitor with the trout, though in the less cold waters, is the red-sided minnow. It is important to know that the minnow associate of the small-mouthed bass in the swift waters of the larger streams is the long-nosed dace, an algal eater in part and not a competitor with the bass. The beautiful satin-fin is a tolerant form and a good aquarium minnow. The black-nosed dace, an ubiquitous minnow of the smaller tributaries, is one of the most tolerant of all the minnows occupying waters in clean streams or in heavily polluted ones. The common shiner is one of the best of bait minnows. The blunt-nosed minnow is a species with fish cultural possibilities. And the sculpin is a known trout-spawn eater.

It is hoped that the work of illustrating the minnows will be carried over from year to year as the survey progresses, and that they may serve not only as a delight but a guide indicating the importance of wise conservation methods for the species that contribute to the food supply of other fishes or that compete with them through excessive reproduction.

Silver Lake and Conesus Lake.— Time availed only for a brief study of a few outstanding factors influencing productivity in these waters. The two lakes afford interesting contrasts in environmental conditions and adjustments of the game fish of the region.

Silver lake is a typical, shallow, brown water lake characterized by a fair amount of muddy shore line, an abundance of vegetation and a rich bottom of mud. From the standpoint of food resources, both plant and animal, the lake is capable of a high yield of fish. The dominant species of game fish are the bullhead, great northern pike, and the pike-perch. The small-mouthed bass, although dominant in the main stream of the Genesee and having free access to the lake, is inconspicuous in the fish output, suggesting inadaptability here. The lake apparently falls in the class of typical, brown water, non-bass (small-mouthed) lakes.

Conesus lake is deep, characterized by a high transparency, an abundant but less luxuriant vegetation, a rocky and sandy shore line and a rich, muddy bottom. The basic food supply in this lake also is very rich. The dominant species of game fish are the small-mouthed bass and the pike-perch. In this instance the white water favors the dominance of the small-mouthed bass, the pike-perch representing a species showing considerable adaptability.

New Lakes.— The power and regulatory projects proposed by damming the Genesee at Mt. Morris and the tributary at Caneadea introduce new problems in the stocking of lakes due primarily to conditions of instability in water level.

The larger project located in the region of the High Banks will possess the physiographic features of a narrow, deep lake confined within the boundaries of the Genesee gorge. The lake to be created will be about 12½ miles long, or, as the river flows, about 16 miles long, 192 feet deep at the head and from a quarter to about a mile wide. The crest of the dam at Mt. Morris will coincide with the 760 contour line and its height will be 180 feet above the present water level. Fluctuations in lake level will vary from a high of about 192 feet to a low of 80 feet with the possibility of a low of 40–50 feet one year in ten. The periods of low water level will occur in the months of November to March. The flood area will comprise about 2,500 acres. There will be two tributaries only of importance, Silver lake outlet and Wolf creek, the latter badly polluted by salt. At present the dominant species in this stretch of the river is the small-mouthed black bass.

These are the conditions known at present which should suggest the stocking policy at the time of the filling of the lake three years hence. The suggestions are tentative since the interval of time will provide opportunity for more thought upon the matter.

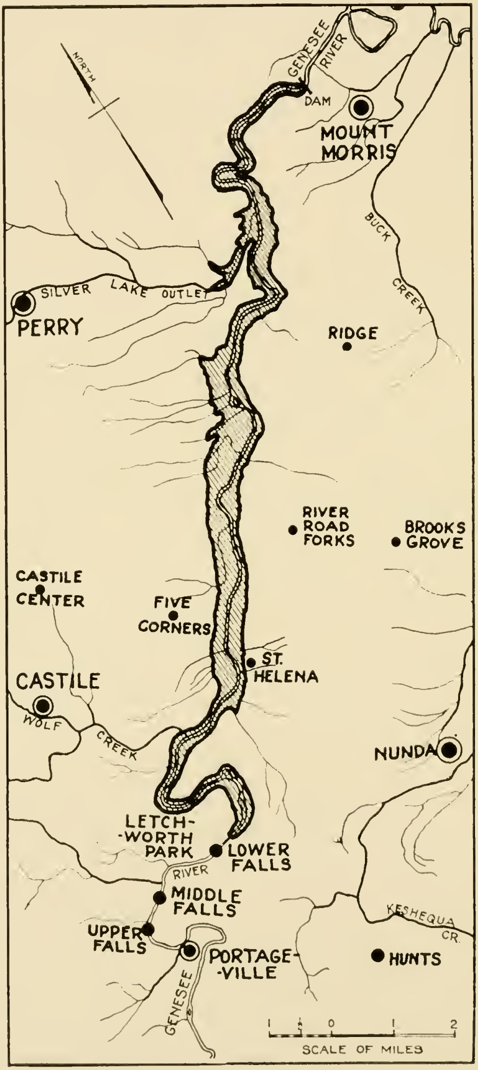


Fig. 2.—Proposed lake in the Genesee River between Mt. Morris and Portage.

As the proposition stands, conditions will call for a generous, annual stocking with fish whose spawning operations will obviously be interfered with by the change of level in fall and spring. The list of species may include the following: the small-mouthed bass and suckers now in the river; the pike-perch whose adaptability to various conditions in the Genesee system has been well established; the yellow perch for game and as a food resource for other fish; and possibly the lake trout and an inland lake cisco (a plankton feeder) as another food resource.

The Caneadea project is of lesser importance as a new lake since operating conditions are likely to introduce to a greater extent the factor of variability in water level, and the possibility of the basin becoming dry. In the headwaters of both are good trout streams but these will not be interfered with. The flowed lands include the lower and unimportant portions of the Caneadea and Rush creeks which are now too warm for trout. Here, if conditions warrant it, shallow, warm water species may be introduced.

Personnel.— The staff in the field consisted of fourteen scientists operating under the direction of the Conservation Department with Emmeline Moore, Investigator in Fish Culture, in charge. The work of the different experts covers the following fields: Dr. Geo. C. Embody, environmental conditions as they relate to the general problem of a stocking policy; Mr. F. E. Wagner, chemist, on problems related to pollution; Dr. P. W. Claassen, biologist, on pollution studies; Mr. J. R. Greeley and Dr. A. H. Wright, ichthyologists; Ellen Edmonson, artist; Dr. W. C. Muenscher, botanist. Assistants on various problems: Dr. D. J. Leffingwell, Messrs. A. L. Hazzard, R. P. Hunter, W. J. Hamilton, Jr., P. E. Hering and F. K. Smith. Especial acknowledgments are due Mr. J. P. Young, who identified the diatoms in polluted and nonpolluted waters, and to the game protectors of the region who gave substantial assistance in the investigation.

Presentation of Data.— The data collected in these several lines of inquiry are presented in the full report of the survey in five sections, dealing with:

(1) Stocking policy for the Genesee river system.

(2) Chemical investigation of the Genesee river system with special reference to pollution.

(3) Biological studies of polluted areas in the Genesee river system.

(4) Fishes of the Genesee region with annotated list.

(5) The vegetation of Silver lake and Conesus lake.

(Plates I to VIII, by Ellen Edmonson)

Additional data of a detailed nature not incorporated in these sections or in the appendices are filed in the office of the Conservation Department where they are accessible on request to all interested in these investigations.

I. Stocking Policy for the Genesee River System

By G. C. Embody,

Professor of Aquiculture, Cornell University

It is desirable to have a well defined stocking policy for each drainage system of the State. One of the chief purposes of the present survey has been the development of such a policy for the Genesee river system.

The Problem.— In the formulation of a stocking policy, answers to two questions have been sought, namely:

1. What kinds of fishes are likely to find conditions suitable for reproduction, normal growth and the escape of enemies?
2. How many should be planted in order to utilize the water to its fullest extent?

With reference to the first it is necessary to know what constitutes suitable conditions for the various species ordinarily planted. Some of the important factors here concerned are the following: water temperature; oxygen, carbon dioxide content, and purity of water; character of bottom in relation to natural spawning; barriers to fish migration; size of stream or lake; current and shelter.

Water Temperature.— This factor has a far reaching effect upon fish life; it governs the rate of all physiological activities — respiration, digestion, ripening of the sex elements, etc.— and is therefore a limiting factor in growth and reproduction.

If a warm water fish, like the large-mouthed black bass or bullhead, is put into a pond fed by cold spring water, it may live there possibly with comfort but it will not grow at the normal rate and probably will not spawn even though other conditions may be favorable. Likewise, a warm pond or stream may constitute an ideal environment for the bass but if brook trout (speckled) are added, they most likely will die from a series of complications induced by the high water temperatures.

In the case of warm water fishes we wish to know whether the temperatures range high enough to enable them to spawn at the normal spawning date and to permit the young to grow to a desirable size before winter. It is hardly necessary to consider, in the latitude of central New York, the possibility of streams and lakes becoming too warm for them. Such species as small-mouthed and large-mouthed bass, bluegill sunfish, bullhead and perch range farther to the south where waters are much warmer than here.

The trout stream, however, presents a different case. Here one ascertains if the water temperatures on the hottest summer days are too high to permit trout to live in them and furnish good sport. Therefore, in order that trout may be placed in a proper environment, one must know the temperature maxima in all streams showing possibilities in this direction.

In the Genesee valley the highest summer air temperatures range from 90 to 96 degrees F., but there are rarely more than a half dozen days during July and August when such are likely to prevail. Nevertheless it is on these very days that the water temperatures may reach the critical point. Where so many streams are concerned, it is not possible to actually cover the ground on the few hot days at one's disposal. Consequently it is frequently necessary to estimate what the maxima will be.

Estimations of this kind are not difficult to make in the case of shaded streams frequently fed by large springs, for here water temperatures are not markedly influenced by the sun's heat. Nor is it so important to have the maximum temperatures of a stream in which trout are observed in abundance. Here one may assume that all conditions are favorable. However, there are many streams which are not abundantly spring fed and whose temperatures must range above what may be considered the optimum for trout but not necessarily up to the critical point. Such of these streams as are well provided with food produce some of our best trout fishing. It is in such cases that the maximum temperatures are so important and at the same time so difficult to estimate.

The estimates in connection with the Genesee survey have resulted from a comparison of the water and corresponding air temperatures obtained in the field on moderately warm days with those recorded in the writer's past experience.

The following table has been the guide in separating brook-trout streams from others in so far as the temperature factor has been concerned. It is based upon experimental evidence obtained in the hatching station of Cornell University and upon observations made in the streams about Ithaca, N. Y. It should apply to the Genesee valley section during the months of June, July and August but not necessarily to others without some modification:

TABLE 1.— COMPARISON OF AIR AND WATER TEMPERATURES IN A BROOK TROUT STREAM

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

The first line gives a series of air temperatures and the second the corresponding water temperatures, which should not be exceeded, if the stream is to be considered suitable for brook trout.

In order to use the table, one must have a record of air and water temperatures taken at the same time and preferably between noon and 5 P. M. Referring to the first and last column, if a stream temperature below 65° happens to have been taken when the air temperature was 80°, one would predict the stream temperature to be about 75°, if the air were 94°. Likewise, the water should not exceed 66.6° on days when the air shows 82° and so on throughout the given range.

One must remember that the temperature of flowing water often lags behind a sudden rise in air temperature, sometimes as much as 24 hours, and that three or four successive days of the same high air temperature followed by warm nights will send the water up a little higher each day. Some judgment has to be exercised in the use of such a table. It has not been possible to extend the range below 80° (for air) because the temperature differences between trout and non-trout streams under such conditions frequently are too small to estimate.

Brown and rainbow trout waters require a different table because these fishes tolerate higher temperatures than brook trout. The following has been used during the present survey. It is based similarly to the one given above.

TABLE 2.— COMPARISON OF AIR AND WATER TEMPERATURES IN A STREAM TOLERATED BY BROWN AND RAINBOW TROUT

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

It is well at this time to mention three important influences tending to hold down the temperatures of our streams.

Cold springs: Size, location and frequency of occurrence.— The larger the spring the more slowly the water warms and consequently the greater the area available for trout. A stream having springs at the source only usually shows three different regions — the upper one suitable for brook trout; the middle, suitable for brown trout, and the lower having only a mixed population of minnows, suckers, etc.

A stream having springs located at frequent intervals throughout its course also has frequent cold pools into which trout may retire on hot days. Practically the entire course of such a stream is available to trout, because on days of average temperature the trout may forage in all sections.

Small unshaded springs in exposed places away from a stream may have little effect upon the stream because the spring water often warms up to the temperature of the stream before it unites with the latter. Such springs and consequently the main stream may be improved by shading their courses.

Stream bed.— Since the temperature of the soil just beneath the surface is much lower than that of the air on warm days, the soil tends to absorb heat from the water flowing over it. The effects are much more noticeable in the spring months than in summer, for as the season advances the soil also becomes warmer. One may thus expect to record higher water temperature in July and August than in May and June, for the same air temperatures.

Shade: Forest cover.— Trees affect the temperature of a stream in the following ways: They keep cool the stratum of air overlying the water; they prevent the stream bed and surrounding ground from warming, both of which have a marked effect upon water temperature; and finally they eliminate the effect of the direct rays of the sun upon the water.

Many a good trout stream has been partly or wholly spoiled on account of the stripping of forest cover.

Oxygen and Carbon Dioxide Content.— In rapid, unpolluted streams these factors need not be considered, because the amount of oxygen contained in the water is in direct relation to the amount of churning the water receives in passing over obstructions. Hence swift waters are generally saturated and thus suitable in this respect for all fishes. Carbon dioxide, if present, is liberated from water that is broken up by riffles and falls and consequently rapid streams show only traces of the gas.

However, in streams polluted by organic wastes, the oxygen may be used up more rapidly than it is dissolved from the air or supplied by plant life. In the process of decomposition, carbon dioxide may become excessive. There is therefore the double danger of insufficient oxygen and too much carbon dioxide which, when critical points are reached, are fatal to fish. Thus a determination of the oxygen and carbon dioxide content of streams receiving organic wastes becomes an important procedure.

In lakes, especially those that might be suitable for lake trout and whitefish, it is important to know something about the gaseous content in depths frequented by these species. To illustrate, let us compare two lakes in the Genesee system: (1) Hemlock lake, which contains lake trout and whitefish in some numbers, and (2) Conesus lake, in which they are known to be practically absent.

By reference to the tables of Birge and Juday (1912)[1] it will be seen that oxygen is lacking in the deeper parts of Conesus lake.

Table 3.— Observation on Gases[1]

Depth in Meters	Temperature	Carbon Dioxide		Oxygen	
		Free	Fixed	Cc. per liter	Per cent of sat.
HEMLOCK LAKE, AUG. 23, 1910					
0	21.7	1.80	12.90	6.77	106.0
5	21.5	1.80	12.90	6.93	108.2
8	21.4	....	....	6.92	107.8
9	19.8	1.30	12.90	7.02	106.5
10	18.0	....	12.90	7.42	108.9
12	15.2	0.38	12.90	7.73	107.4
15	10.9	....	....	5.36	68.2
18	9.8	3.29	....	3.80	47.1
24	9.5	5.06	....	1.37	16.8
27	9.3	7.10	12.90	0.70	8.5
CONESUS LAKE, AUG. 25, 1910					
0	21.8	2.50	23.02	6.16	96.6
5	21.6	....	....	6.12	95.7
8	21.4	2.50	23.02	6.00	93.5
9	20.3	1.77	24.03	1.50	22.9
10	16.4	3.03	25.30	0.11	1.5
11	15.5	....	....	0.05	0.7
12	14.6	3.54	25.80	0.06	0.8
15	13.2	....	26.30	Tr.	....
17.5	12.5	4.04	28.10	0.00	0.0

[1] Birge, E. A., and Juday, C., 1912. A limnological study of the Finger Lakes of New York—Bull. Bur. Fisheries, Vol. 32.

Gardner and Leetham (1914)[1] determined experimentally the asphyxial points for brown trout at various temperatures and published the following data:

TABLE 4.— ASPHYXIAL POINTS FOR BROWN TROUT

Temp. degrees C.	Oxygen c c. per liter
6.4	.79
9.5–10	.81
17.0	1.37
18.0	1.49
24.0	1.97
25.0	2.4

One may reasonably assume that these are not far out of the way for lake trout. It is worthy of note that the asphyxial point varies directly with the water temperature, an indication that the requirements of fishes for oxygen are greater in high than in low temperatures. Consequently the relation between depth and oxygen content assumes greater importance.

In Hemlock lake trout can undoubtedly inhabit regions downward to 18 or 20 meters, showing temperature of about 9.8° C. and oxygen content around 3 c. c. per liter. These are not necessarily the lowermost limits but are undoubtedly close to them.

In Conesus lake the oxygen is practically wanting at a depth of 10 meters (Table 3). Trout could not live here nor at 9 meters, where the asphyxial point is probably reached. In shallower water where the amount of oxygen is sufficient the temperature is probably too high. We could reasonably assume from this that the planting of lake trout in Conesus lake would be a waste of time and energy.

Purity.— The purity of the water in a stream may often be measured by its oxygen and carbon dioxide content. This applies more particularly if decomposible organic substances are entering at certain places. However, if the inpouring of such substances is temporarily stopped, the purity cannot always be determined by chemical tests. In such cases and also in others where the offending substances are inorganic and perhaps poisonous, a census of aquatic organisms will often reveal the true conditions affecting fish life.

It would be useless to stock a stream from which food organisms have vanished, even though the particular kind of pollution did not actually kill the fish. Upper Knight creek is an example in which crude oil from adjacent wells has exterminated nearly everything except certain minnows, crayfish and certain algae.

In Wolf creek, which flows through Castile, the polluting substance is salt. No fresh water fish could stand the degree of

[1] On the Respiratory Exchange in Fresh-Water Fish. Bio-Chemical Journal, Vol. 8, pt. II, 1914.

salinity encountered here. But the fish food is particularly rich therein, consisting of multitudes of salt fly maggots.

Cryder creek, near Whitesville, and Wiscoy creek, near Bliss, are polluted with milk wastes. The degree of pollution is not great enough in either case to destroy brown trout and in the latter case there is some indication that the fish food supply is increased. However, it would be an easy matter to overload each stream, thereby making them unsuitable for stocking.

Size of Water.— Ordinarily the size of a stream bears more directly upon the number and not the kind of fish to be planted. In the case of warm streams, however, the size often determines whether they shall be stocked at all.

Streams that are too warm for trout may be either sluggish or rapid. If sluggish they might be suitable for large-mouthed bass, if rapid, for small-mouthed bass. However, small streams under approximately 30 feet in width seldom furnish good bass fishing. It is not definitely known why this is so. It seems reasonable to believe, however, that the bass multiply to such an extent as to exterminate the larger food animals — minnows, crayfish and larger insect larvae — which leads to a degeneration in size. We then have a stream populated largely with small bass four to seven inches long, and the few that do grow to legal size are easily cleaned out after the first few days of the open season.

Many have assigned inbreeding as the cause of this degeneration in size which is an easy way to avoid saying that we do not know. To produce such a marked decline in size it would have to be very close inbreeding, indeed, a possibility which is inconceivable in wild waters.

However, there is another possible factor operating here. As bass approach legal size there may be a downstream movement into larger waters where the forage is of better quality. If this were true, it would account in a large measure for the scarcity of legal sized bass in many small streams.

Character of Bottom in Relation to Natural Spawning.— Fishes vary widely in the selection of a suitable environment for spawning. The small-mouthed bass prefer a clean gravel bottom where there is a slight current. The large-mouthed bass may select a bottom of sand or mud where such plants as the water lily, cattail and others are rooted. A shallow depression formed upon these roots may constitute the nest. If such an environment is not available the nest will often be excavated in gravel. The habits of the bluegill sunfish are similar to those of the large-mouthed bass. The bullhead nests in the same general type of environment but will take possession of a muskrat hole or excavate its nest.

The northern pike, muskalonge, carp and golden shiner scatter their eggs over vegetation, while the yellow perch lays its egg-string in such a way that it appears to be woven among the stalks of aquatic plants, submerged branches, willow roots and the like. However, these "strings" often lie on a barren bottom or may sometimes float about in a vertical position buoyed up at one end.

Our trout are nest builders, selecting a gravel or rocky bottom and, in many cases, particular localities where water seeps up through the bottom or where springs enter.

The pike-perch, it is supposed, spawn in schools over sand, gravel or bare rock where the water is more or less agitated either in streams or in lakes. (Cobb, 1923.)[1]

Whitefish and lake herring select shoals of gravel or rocks in lakes.

Natural spawning must continue to bear the principal share of the burden of keeping up the yearly crop of young fishes in lakes and larger streams. Stocking with those reared elsewhere must be supplementary. In the smaller heavily fished trout streams, however, it is doubtful if the results of natural spawning can begin to compensate for those taken out by anglers. We must depend to a larger extent here upon the output of hatcheries.

Barriers to Fish Movements.— Dams and natural waterfalls often constitute barriers to the upward movements of fishes. If an impassable falls happens to be located in the right place, it may serve as a barrier to the mixing of two species of trout, brown and speckled trout, in which case the browns are planted below the falls and the speckled above.

Rainbow trout not only may move up stream to the spawning grounds, but return after spawning. The movement is usually over a longer course than is the case with the brook and brown trout. Young rainbows also tend to move down stream until they find larger and more suitable waters in which to grow to maturity. A falls, though not preventing the downward movement may stop them on the return, in which case all rainbows would disappear in the course of two years from the upper waters unless yearly stocking were resorted to.

The upper Genesee river and tributaries constitute a very favorable habitat for the rainbow trout. The only objectionable feature is the dam at Belmont. Although many trout mature above the dam a great many do pass over it, as is proven by the catches of the fisherman at this place. A fish-way correctly installed at this point would undoubtedly do much to improve the fishing above Belmont.

Waters of the Genesee System Worthy of Stocking

The Genesee valley streams fall into six groups, depending upon the species with which they should be stocked:

Brook Trout Waters.— These may be of two classes based principally upon water temperatures: (a) Those in which optimum conditions prevail, temperatures never exceeding about 68, rapid to moderate current, water pure and oxygen above 3 parts per million. (b) Streams showing conditions which are tolerated by brook trout, water temperature ranging upward to possibly

[1] Cobb, Eben W., 1923. Pike-Perch Propagation in Northern Minnesota. Discussion on pp. 101–102, Trans. Am. Fish. Soc., Vol. 53.

75 on the hottest days; rapid current, without pollution, oxygen nearly to the point of saturation at the higher temperatures.

Examples of class (a) streams: Caledonia creek, Upper Trout brook (tributary to Wiscoy), Hovey's brook (Map 3), Fulmer valley brook, Cold brook, and parts of Ford, Orebed and Red Water creeks (Map 5).

Examples of class (b) streams: Dugan's and Macy brooks (Map 2), Canaseraga at source, Bradner, Wiscoy and East Koy (Map 3), Upper Rush creek (Map 4), Upper Dyke, Cryder and Marsh (Map 5).

Brown Trout Waters.— With few exceptions brown trout were found in every stream inhabited by brook trout. However, in the colder brook trout streams, showing temperatures below 65, they were rarely encountered. They reached maximum size and abundance in streams ranging from about 68 to 75° F., and occurred in many others attaining temperatures as high as 80° F.

In Cryder creek (Map 5) they were found below the entry of milk waste at Whitesville, in water the oxygen content of which had dropped from about 6 to 4 parts per million. In the Wiscoy at Bliss (Map 3) they were abundant and of large size, ranging up into water polluted by milk waste.

Thus we found them in streams whose conditions were tolerated by brook trout and in others showing temperatures too high for the latter.

It has been possible to extend the trout fishing range over many miles of streams through the introduction of brown trout. Allen creek from Buttermilk falls to its junction with Caledonia creek probably would not offer trout fishing were it not for the introduction of brown trout. The same is true for the lower sections of Wiscoy and East Koy, Cryder below Whitesville and Dyke below Andover. In Dyke creek and tributaries there are about 11 miles suitable for brooks and 12 miles suitable for browns; in Cryder 4.6 miles for brooks and 9 miles for browns.

In the Genesee system, at least, it is not believed that brown trout have had anything to do with diminishing the number of brook trout in class (a) streams showing optimum conditions for the latter. Consequently, in view of the probability of extending the trout fishing range, we have consistently advocated the planting of brown trout in many streams that now contain brook trout. However, we do not recommend brown trout for streams which have shown throughout their courses conditions favorable for brook trout.

Rainbow Trout Waters.— We have found rainbow trout in warm streams where the temperatures range a little above 80 and also in cold streams showing typical brook trout conditions. They show a tendency to move down a stream to larger waters. This movement takes place sometimes after the fish have reached a length of 6 inches and before they have become sexually mature. Apparently the adults remain in the larger streams and lakes, except in spring, when there is an upstream migration to the smaller streams for the purpose of spawning. In central New York it occurs in late March and early April, and since the season on trout opens the first Saturday in April, many are caught while on the spawning grounds. If there is a barrier, such as a dam, natural falls or polluted condition, preventing this spring migration, the trout will disappear permanently from the headwaters unless yearly plantings are made.

Many small streams have been stocked which do not flow into rivers and lakes suitable for adult rainbows. In such cases the trout have disappeared a year or two after planting. What has become of them is not known. Good fishing for small ones of 6 to 8 inches may have been had, but there must have been a tremendous loss among those that migrated down stream in search of larger waters.

It would seem far better to plant brown trout instead of rainbows in those small streams from which the latter are likely to disappear permanently, and to reserve for rainbows those streams alone to which the adults may return to spawn.

The Genesee river south of the Belmont dam has yielded a few sexually mature rainbows ranging upward of 3 pounds each. This would seem to indicate that this river stops some of them at least on the downstream movement. A few undoubtedly go over the dam, but none, so far as could be determined, have been caught any great distance below. Local fishermen do not report them as far down as Belvidere or Belfast. Consequently those tributaries of the Genesee above the Belmont dam showing temperatures not above 80 may be expected to show good results after stocking, providing the pollution at Wellsville is kept under control. The principal streams in which stocking may be successful are the Genesee river from Belmont to source, Dyke and Cryder creeks, and the inlets to Hemlock and possibly Honeoye lakes.

Small rainbows were found in several streams near Dansville and Wayland, all tributaries of the Canaseraga creek. Since the latter is not a suitable stopping place for the adults, the stocking of these streams must be considered poor policy, more particularly in the case of those suitable for brown or brook trout.

Small-Mouthed Bass Waters.— It is inadvisable to stock a stream or small lake with bass which is entirely suitable for brook or brown trout. However, in the case of certain lakes whose deeper parts are suitable for lake trout, the shallows may often be stocked to advantage with bass.

Small-mouthed bass will tolerate temperatures up to 87° F., and probably higher. Consequently no stream or lake in the Genesee system may be considered too warm for them. They do not seem to thrive in brownish water (Silver lake) nor, as stated before, do we find many of them of legal size in streams under approximately 30 feet in width. It is hardly worth while to stock these smaller streams because they are apparently over populated now with undersized bass. Indeed it would be far better to remove some of them to other waters. We would, therefore, recommend this species for the larger streams and lakes showing warm, clear white water with abundant shoals of clean gravel or rocks.

The principal small-mouthed bass waters are the Genesee river from Belmont to Rochester, Honeoye creek from Honeoye Falls to Rush and Conesus lake.

Large-Mouthed Bass, Bluegill Sunfish, and Catfish Waters.— These three species will be found chiefly in warm streams and lakes showing the following conditions: Brown or white water; very sluggish or totally stagnant; a bottom of mud, silt or sand; and an abundance of vegetation, particularly water lilies, cattails and other emergent types.

The principal waters suitable for these three species are Silver and Honeoye lakes; Black creek with Horseshoe lake, Godfrey's and Byron ponds (Map 1); Round and Long ponds (Map 2); Black creek, Flannagan's pond and Rockville reservoir (Map 4).

Pike-Perch Waters.— Pike-perch apparently thrive in a great variety of situations and have been more or less successfully introduced into different types of lakes and streams. In the Genesee watershed they are found in Conesus lake in depths up to 40 feet on both sand and gravel bottom, where vegetation is dense and where it is absent; in Silver lake, having brownish water, sand bottom and abundant vegetation, in shallow water and in depths up to 30 feet; in the Genesee river below Mt. Morris in shallow water on sand, mud and gravel bottom where vegetation is sparse or absent; associated with small-mouthed bass in the Genesee river and Conesus lake and with large-mouthed bass in Silver lake.

Until something more definite is known about their habitat preferences, it is probably best to limit them to the waters mentioned above.

Two New Lakes.— In the proposed damming of the Genesee river at Mt. Morris and its tributary, the Caneadea creek at Caneadea, two new lakes are to be formed which will increase materially the area available for fishing.

The first lake will extend some sixteen miles up the valley from the proposed dam at Mt. Morris to the lower falls of the Genesee river in Letchworth Park. It will vary in width from one-fourth to one mile and will have a maximum depth of about 192 feet.

The water level will fluctuate widely during the year, due partly to the drawing of water for industrial purposes. This will tend to eliminate all shoal water at certain seasons and should these periods come in late fall and during the spring months as anticipated, the natural spawning of fishes will be seriously interfered with. The principal source of stock fish will have to come from annual plantings of hatchery fish. There may be some natural stocking with small-mouthed bass, due to a downstream movement from the Genesee river above Portageville, but the presence of impassable falls just above the lake will prevent the upward migration of all species from lake to river.

Undoubtedly such species as rainbow and steelhead trout, one of the lake herrings, small-mouthed bass, pike-perch and yellow

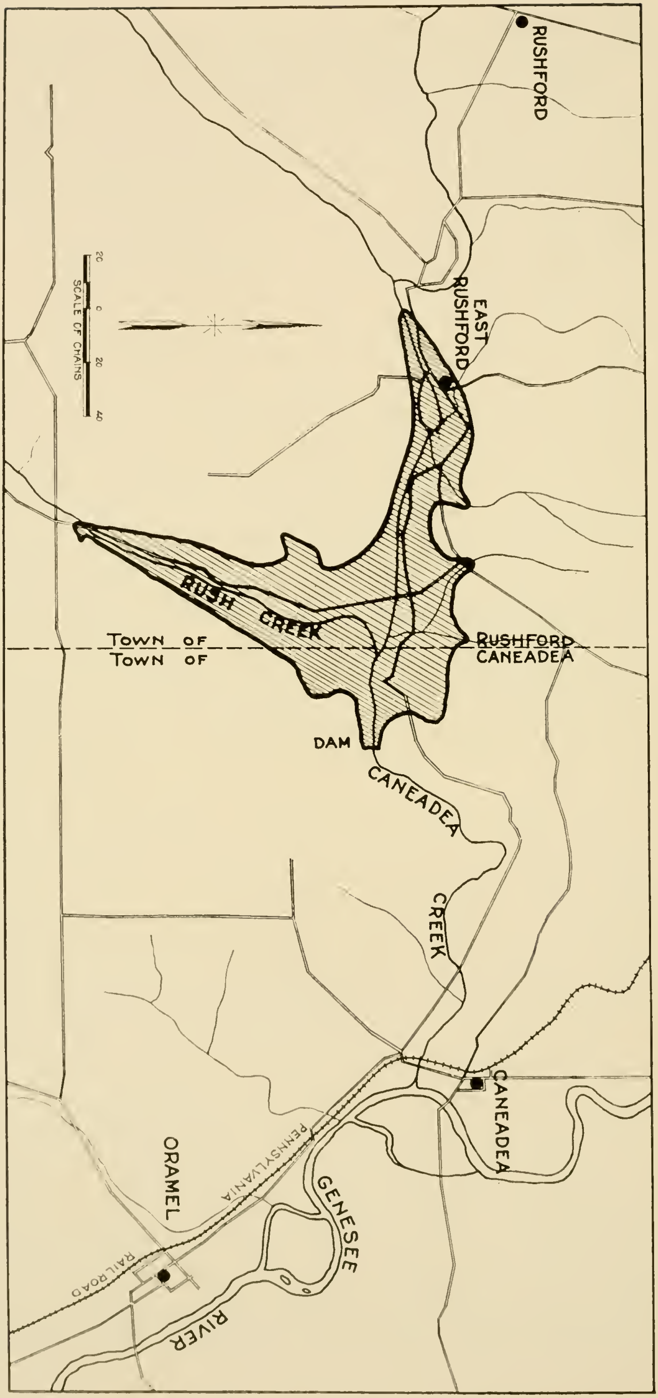


Fig. 3.—Proposed lake in Caneadea project.

perch will find conditions favorable for growth. It is possible that the lake trout also will succeed, however, before introducing them, the conditions as regards temperature, gaseous content and salinity should be carefully determined after the lake is an accomplished fact.

The Caneadea project calls for a smaller lake containing some deep water near the lower end but grading into extensive areas of unstable shoals in the upper region. The variation in lake level may even be greater here than in the first project. Were a somewhat constant level to be maintained the conditions would undoubtedly be very favorable for rainbow trout. The deep water in the lower end would tend to prevent further downstream movement of trout while the two tributary streams near the head of the lake, Rush and Caneada creeks, would provide spawning areas for adults and adequate forage grounds for the smaller fish.

The lower Caneadea creek is now well stocked with small-mouthed bass and it is probable that this species will be the principal one to consider in future stocking.

Streams Not to Be Stocked

Streams in which stocking is not advised fall into four categories:

1. Streams which become dry or intermittent during the summer months: Small runs, some of which dry up completely; others normally a little larger which become nothing more than a series of disconnected pools.

2. Streams too warm for trout and too small for bass: Unsuitable for any fishes except the mixed population of minnows and suckers, which they usually contain in great abundance.

3. Cold brooklets too small for angling and tributary to streams not suitable for trout: Ordinarily one stocks a small spring run with the expectation that the trout as they become of legal size will run down into some larger stream. If the larger stream is not suitable there is little reason for stocking the small tributary.

4. Streams too badly polluted: Refuse from oil wells pouring into Upper Knight creek (Map 5) is responsible for the disappearance of nearly all food organisms and all fishes except an occasional minnow.

Wolf creek (Map 3), polluted by salt, is beyond hope of establishing any fresh water food fish. Were it not for this the upper section, at least, would be suitable for trout.

Conesus lake outlet is badly polluted by milk waste. If this were properly taken care of the stream would undoubtedly harbor large-mouthed bass, bluegill sunfish and bullheads.

Number of Fish to Be Planted

In the present state of our knowledge, it is probably not possible to determine with any degree of accuracy the number of fish to be planted in a stream in order to utilize fully its capacity.

The factors are many and their interrelations are complex. However, it seems desirable to attempt some sort of an evaluation of the trout streams in order to avoid the more obvious errors in stocking that have been made in the past. Some of the factors involved may be briefly discussed as follows:

Area of Stream Available for Trout.— It is not an unwarranted assumption to state that, all other things being equal, the productiveness of a stream varies directly with the foraging area, which is practically that part of a stream inhabitable to trout. An approximation of this area was calculated by finding the average width from a series of measurements made in different sections and multiplying this by the length. For convenience in the final calculation, this area was expressed in acres per mile.

Abundance of Primary Food Organisms.— Collections of the principle group of purely aquatic food organisms were made in different sections of the various streams. It was then possible to classify streams as: (1) Rich in food, (2) containing average quantities and (3) poor in food. This does not seem to cover the terrestrial forms which fall into the water, such as worms, grasshoppers, bees, ants and others, sometimes constituting as much as 50 per cent of the food of trout. There is some relation between the width of the stream and the number of insects, etc., falling in and hence this item would be roughly covered in considering the area.

Certain environmental factors were found to be correlated with the abundance of food organisms. They are named as follows in the order of increasing richness:

(1) A bottom of sand or hardpan without vegetation contained very few food animals.

(2) One of coarse to fine gravel was little better.

(3) Muck or silt bottom with much organic debris seemed to be provided with an average amount of food.

(4) Bottom of flat rocks and rubble contained mayflies, stoneflies, caddis worms, crayfish, and many others in great abundance.

(5) A stream margined with watercress or a bottom with frequent and dense clumps of moss, *Fontinalis*, constituted the richest of any environment encountered. Fresh-water shrimps of three genera — *Gammarus*, *Eucrangonyx* and *Hyalella;* Oligochaete worms, midge larvae, mayfly and stonefly nymphs and caddisfly larvae were among the most abundant forms.

Pool Conditions.— In the case of central New York trout streams, it is well known to anglers that those having the largest number of deep pools with suitable shelter, furnish the best fishing, both in point of numbers and size of fishes. Of course, shelter is an important factor in attracting fish, but shelter acting alone could not account for the greater amount of fish flesh produced in those streams. There must be some relation between the abundance or accessibility of food and the type of pool, although it is not known what this is. Nevertheless, we must consider the abundance, frequency and types of pools in making our calculations. The streams have been classified in this respect as follows:

1. Streams showing poorest conditions — pools generally shallow without shelter.

2. Streams showing average conditions in which deep sheltered pools are fairly numerous.

3. Streams showing best conditions in which the pools are large, frequent and well sheltered.

Enemies, Effects of Angling.— Water snakes, green herons and kingfishers are responsible for some of the losses in streams, although we have no means of estimating how large they are. One may be reasonably sure, however, that man is the principal agency in removing the legal size trout.

The few good trout streams of the Genesee watershed are all heavily fished, and if we were to estimate that one-half of the legal sized trout were removed each year, it would probably not be too much.

The relative losses of fingerlings and advanced fry is a matter difficult to analyze. Hatchery experience tells us something about it, but trout reared in a hatchery are subject to many diseases which do not give trouble in wild waters. On the other hand, hatchery trout are protected from the ordinary enemies that operate in wild waters. To some extent one balances the other.

In the calculations of the Genesee system, we have assumed that 95 per cent of the advanced fry and 50 per cent of the fingerlings are lost before the legal size is reached. The number of survivors in the two cases would be in the proportion of one advanced fry to ten fingerlings.

Productivity of a Unit Area.— A series of experiments was undertaken in the Experimental Hatching Station of Cornell University for the purpose of obtaining some definite information in regard to the productiveness of a unit area of running water under varying conditions of food supply. The lowest average production under the condition of food scarcity was equivalent to about 75 pounds of trout per acre; the highest obtained in races in which food animals were very abundant approximated 300 pounds. These have been taken as the extreme and an intermediate value of 187 pounds has been assumed to approximate average conditions.

A trout of 8 inches is not far from the average size occurring in the streams of this section of New York, and according to a series of weight-length measurements a wild trout of 8 inches will average about one-fourth of a pound. An acre of stream should therefore support about 1,200 8-inch trout if rich in food, 750 if average conditions obtain and 300 when poor in food.

We have already estimated that about one-half of the trout are caught by anglers and that about one-half of the fingerlings planted disappear from one cause or another. Therefore, one should plant double the number caught which is equal to the total number supported by the stream.

We have grouped streams into three classes according to the natural food supply, and into three other classes according to the pool conditions, and it is not then difficult to calculate the number of fish to be planted under the different combinations.

The following table has been prepared from these calculations. It indicates the number of fingerlings per mile of stream to be planted in streams of various widths and under the different combinations of food and pool conditions. The letters A, B and C represent the pool conditions in the three classes of streams. The figures after the letters represent the food conditions:

TABLE 5.—STOCKING TABLE FOR TROUT STREAMS IN THE GENESEE SYSTEM

STREAM	NUMBER OF 3-INCH FINGERLINGS PER MILE								
Width Ft.	A 1	A 2	A 3	B 1	B 2	B 3	C 1	C 2	C 3
1	144	117	90	117	90	63	90	63	36
2	288	234	180	234	180	126	180	126	72
3	432	351	270	351	270	189	270	189	108
4	576	468	360	468	360	252	360	252	142
5	720	585	450	585	450	315	450	315	180
6	864	702	540	702	540	378	540	378	216
7	1,008	819	630	819	630	441	630	441	252
8	1,152	936	720	936	720	504	720	504	284
9	1,296	1,053	810	1,053	810	567	810	567	324
10	1,440	1,170	900	1,170	900	630	900	630	360

The values given in the stocking policy lists (Apps. IX–XIII) accompanying the maps refer to 3-inch fingerlings and to advanced fry. In the table above the values refer to 3-inch fingerlings only. In order to apply them to fish of various sizes, multiply the values in the table by the following:

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

These values are tentative and subject to revision as further investigations reveal the true status of the factors concerned.

System of Numbering Streams

Because the number of unnamed streams in the Genesee system is very large, it was necessary at the start to adopt some plan for their identification on the map. The following system of numbering was finally put into use:

1. Named streams directly tributary to the Genesee river were not numbered.

2. Unnamed streams directly tributary to the Genesee river are designated by two letters and a number. The first letter is the initial of the nearest named stream below (down stream) flowing into the Genesee on the same side. The second letter is always G, indicating that it is a direct tributary of the Genesee river. The number indicates that it is the 1st, 2d or 3d, etc., tributary above the named stream.

Thus, on the right the streams labelled R. G. 6 and R. G. 13, respectively (Fig. 4), are the sixth and thirteenth streams flowing into the Genesee above Rush creek and on the same side; the streams labelled W. G. 1, W. G. 2, etc., to W. G. 5, are those flow-

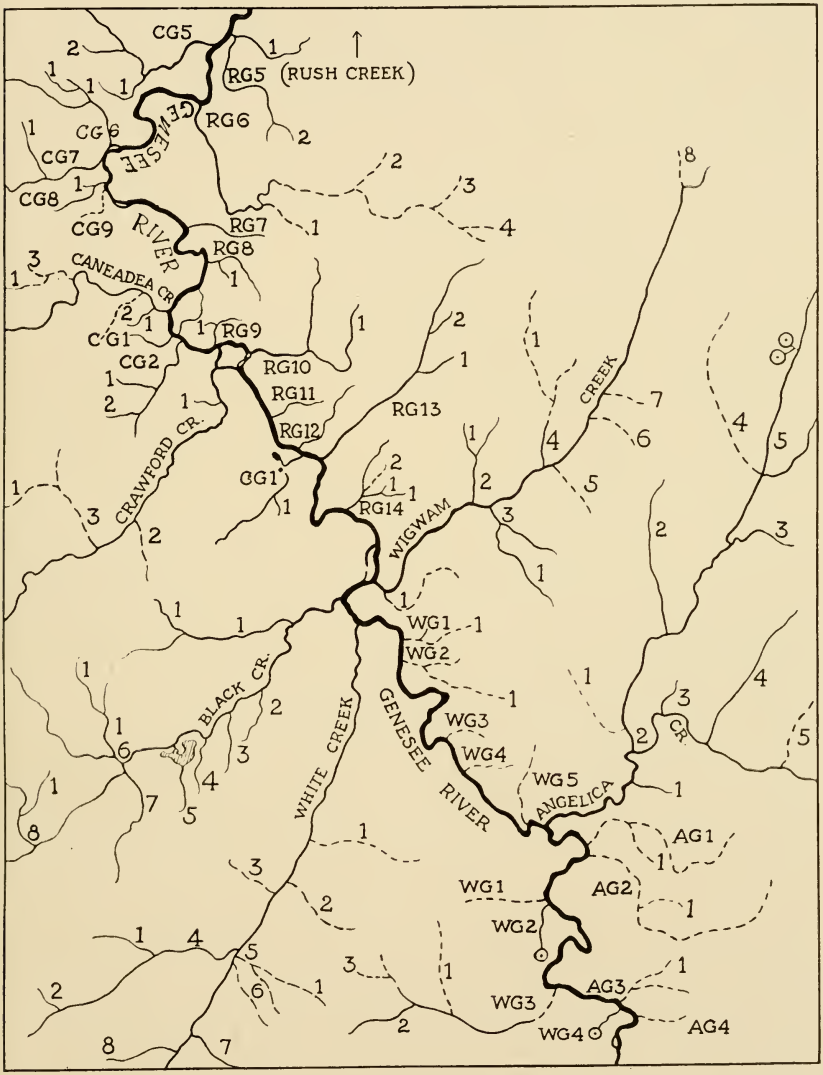


Fig. 4.—Section of Genesee River system (Angelica quadrangle, U. S. G. S.) illustrating the method of numbering the unnamed streams. Dotted lines are streams running dry.

ing into the Genesee above Wigwam creek; A. G. 1 to A. G. 4, those flowing into the Genesee above Angelica creek. Streams on the left and above White creek are W. G. 1 to W. G. 4.

3. All secondary, tertiary, etc., tributaries have been designated by numbers, the one nearest the mouth in each case receiving the number 1, and those following, 2–3–4, etc., in sequence to source. The tributary having the highest number is thus nearest the source. The tributary R. G. 6 (Rush Genesee 6) has 4 tributaries (secondary); Wigwam creek has 8 tributaries (secondary), the second, third and fourth tributaries each has a tertiary tributary numbered 1. The sixth tributary of Black creek has a tertiary and this a quarternary branch and would be referred to as No. 1 of Black creek 6–1.

ABBREVIATIONS AND SYMBOLS USED IN STOCKING LISTS FACING MAPS

S. T.	= Brook trout (speckled) advanced fry.
S. T.+	= Brook trout fingerlings.
B. T.	= Brown trout advanced fry.
B. T.+	= Brown trout fingerlings.
R. T.	= Rainbow trout advanced fry.
R. T.+	= Rainbow trout fingerlings.
Sm. B.	= Small-mouthed bass.
Lm. B.	= Large-mouthed bass.
Y. P.	= Yellow Perch.
Pp.	= Pike-perch.
Bg. S.	= Bluegill sunfish.
G. Sh.	= Golden shiner.
Co.	= Calico bass.
C.	= Catfish or bullhead.
M.	= Maskinongè (Muskalonge).

Legend for maps:

▬ ▬ ▬ ▬ Boundary of watershed.

– – – – – – Dry runs or streams becoming dry.

⊙ Spring.

× Outfall of pollution.

— Dam.

II. Chemical Investigation of the Genesee River System with Especial Reference to Pollution

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Inseparably linked with any policy of fish propagation is a study of water conditions, and the effects of natural influences, as well as those of human creation. One of the first questions which arises is that of pollution, and it is with this that the investigation herein reported has been primarily concerned.

Types of Pollution.— The more noteworthy types of pollution encountered were those chiefly from milk condensaries, cheese factories, oil wells and refineries, paper mills, canning factories, salt refineries, chemical industries, wood products industries, and municipal sewage, with the great variety of contributory elements which the word implies. Naturally these differ in their effects upon fish life, but with all the effects bear a direct relation to the ratio of contaminating material to water receiving it, so that dilution is the great factor.

Gaseous Relations.— Those materials, such as food products, which are subject to decomposition, consume in decomposing the dissolved oxygen in the water which is necessary for the respiration of fish and certain organisms on which they feed.

The solubility of a gas in water depends upon the temperature of the water, and the pressure of the gas upon it. The maximum quantity of oxygen which a water will take up at any particular temperature and barometric pressure is its saturation capacity for those conditions. It follows that when anything occurs within the water, such as respiration or decomposition, tending to deplete the content of oxygen, that the water immediately sets about restoring itself to a condition of saturation, and logically the greater the depletion, the more rapid will be the reabsorption. Neglecting for the moment the effect of oxygen producing aquatic plants, or the influx of highly oxygenated tributary waters, this can only be accomplished by reoxygenation from the air, in two different manners. A quiet body, such as a sluggish stream or pond can restore its oxygen only by surface absorption and gradual distribution from upper to lower strata. The slowness of this restoration can be appreciated by any one who has noted the "flat taste" of recently boiled water. Extremely more rapid reoxygenation takes place when the water is intimately mixed with the air as in a waterfall, natural or artificial, or in the riffles occurring between pools of a rapidly flowing stream. This point is of primary importance in our present investigation because of the nature of the streams, and data will be supplied showing the vast difference between the behavior of a rapid, riffly stream and a sluggish one, both heavily contaminated with decomposible material.

The Genesee river, during the period investigated, summer of 1926, was found to be a comparatively small stream, so shallow, except where ponded by dams, and so abundantly supplied with rapids and riffles throughout at least the upper two-thirds of its length as to be unnavigable to even a small boat. The topography of the region shows an elevation of about 1,500 feet above sea level at Wellsville, compared with approximately 250 feet at Lake Ontario. The intimate mixing of water and air resulting, affords excellent opportunity for replacing the oxygen which may have been consumed, and it would necessitate extensive pollution indeed to lower the content of dissolved oxygen to an alarming degree under such conditions. The foam flecked pools bear witness of the entrainment of air, and the not infrequent values obtained for dissolved oxygen, exceeding the saturation values at the existing temperature, most probably are due to conditions not in equilibrium, and quite possibly indicate colloidal solutions of air in water.

Methods Employed,— Analytical methods employed were in general those recommended by the American Public Health Association, in "Standard Methods of Water Analysis," 6th edition, 1925. In sections of the river of considerable depth, such as north of and immediately south of Rochester, no attempt was made to show the variation in oxygen content between the surface and bed of the stream; some data of this nature are available in Whipple's report of 1913.[1] Rather it was attempted to get a representative sample of the stream at each point investigated, well out into the flowing water, and uniformly well below the surface, that all results might be comparable. In the shallower portions of the river, samples were taken as far distant as possible from the last preceding riffle in order to afford the water the greatest opportunity to reach a condition of equilibrium.

It is desired to call attention to the obvious fact that in a survey covering a river length of slightly less than 150 miles, and extending over a period of three months, the same water could not be followed in its passage to the lake and analyzed at various points to determine just what happens to it during its course. But even such procedure, were it possible, would have to be repeated at successive intervals of time to secure data concerning average conditions as well as fluctuations throughout the season. Conditions are constantly changing; new industries are born and flourishing manufacturing plants cease to exist; production rises to a maximum or drops to a minimum, and with some the nature of the product is changed. All have their effects upon the surroundings directly connected with them.

Conditions Encountered.— Data secured will be found in the accompanying tables,[2] and in some cases graphical representation has been used in the hope that such would convey more readily to the reader a picture of conditions encountered. A profile

[1] Report on the Sewage Disposal System of Rochester, N. Y., Fisher, 1913.
[2] See Appendix III.

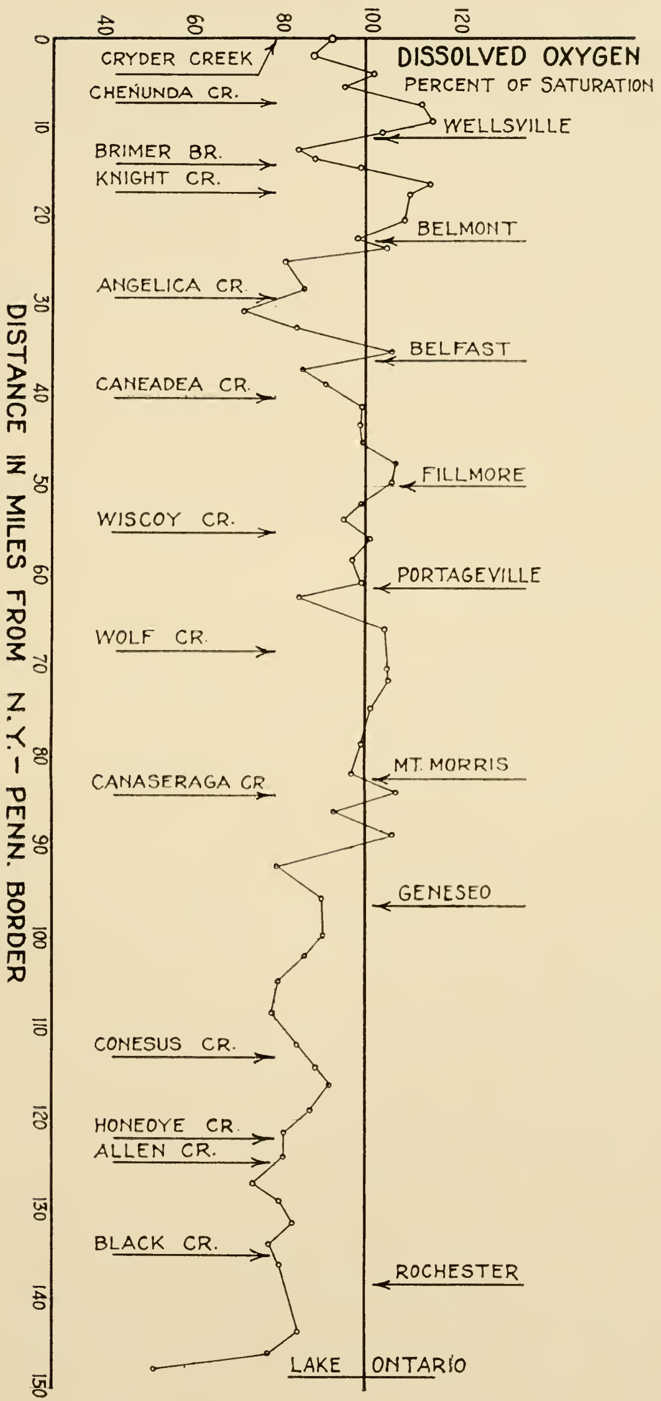

Fig. 5.— Profile showing effects of pollution on dissolved oxygen in the Genesee River.

(Fig. 5) shows the dissolved oxygen content of the Genesee river between the New York-Pennsylvania border and Lake Ontario. Results are expressed as percentage of saturation, based upon the values given by Whipple.[3] This puts upon a common basis variations in temperature, and compensation has been made for the barometric pressure of the regions. As may be seen, entrance of decomposible material into the river is usually marked by a depression in the dissolved oxygen line, and the recovery of the stream is indicated by a corresponding rise in the curve. The data show that beyond a point slightly north of Mt. Morris, the stream never again succeeds in restoring itself to its full saturation capacity.

Figure 6 is a profile of the methyl orange alkalinity of the river, expressed as parts per million of calcium carbonate. Except for that section of its length, where, between Portageville and Mount Morris, the river flows through a gorge approximately twenty miles in length, this profile shows a progressive increase in alkalinity to Rochester, most pronounced where the river's volume is augmented by highly alkaline streams draining regions of limestone. The decrease in alkalinity throughout the length of the gorge is marked, and the entire cause or causes not known with certainty. Part of it might be attributed to dilution of the river water by rains. When we consider tributary streams, we find the only ones of note at this section are the outlet from Silver lake, and Wolf creek. The lake waters are considerably lower in alkalinity (Apps. III, IV) than the river waters which they join. Wolf creek, to be discussed more fully later, is heavily charged with salt refinery wastes. Usually associated in the earth with common salt, sodium chloride, is the chloride of magnesium, which is rejected in the refining of the table product. At elevated temperatures this salt readily hydrolyzes with production of hydrogen ions, the cause of acidity, and the neutralizer of alkalinity. Increase of temperature is chiefly an accelerator of a chemical reaction which takes place more slowly in the cold, so it is not improbable that the drop in the curve may be partly attributable to this cause.

Regarding carbon dioxide it might be mentioned that the same methods which serve for aeration likewise serve for deaeration or degassification in general, so although those processes which consume oxygen also produce carbon dioxide, the turbulent stream conditions previously described do not tend toward an appreciable accumulation of carbon dioxide in water in equilibrium with air, and under its partial pressure which exists in an atmosphere containing normally and at sea level approximately .04 per cent of carbon dioxide, compared with 20.9 per cent of oxygen.

Importance of Character of Stream.— It is hoped that the foregoing will impress the reader with the importance of taking into consideration the nature of a stream and other influencing factors for a proper interpretation of results. A specific instance

[3] Standard Methods of Water Analysis, 62, 1925.

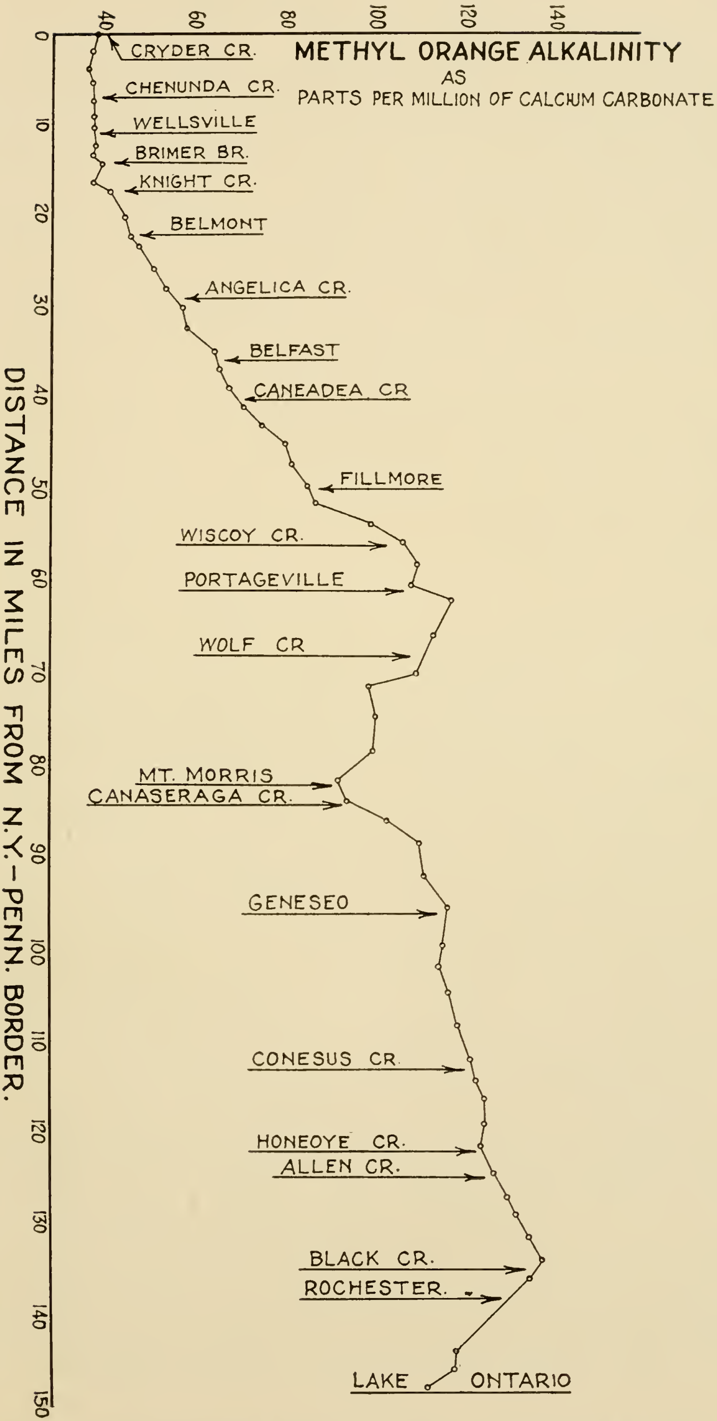

Fig. 6.— Profile showing condition of alkalinity in the Genesee River.

or two may make it clearer. Wolf creek, already referred to, is perhaps one of the most misused streams encountered, and about which considerable interest centered because of its entry into that section of the Genesee which is to be impounded by the proposed dam at Mount Morris. Apart from its use as a carry-off for waste salt from refineries near its source, which made it at the time of investigation virtually a 4 per cent salt solution before dilution by any of its several tributaries, this stream receives a further dosage of sewage from the town of Castile, two and one-half to three miles from its confluence with the Genesee. In spite of this gross contamination which is evident to even the casual observer by virtue of the characteristic yellow foam visible in eddies and in the river about the creek's mouth, the descent to the river is over a bed so steep and rocky that the stream is one continuous riffle, heavily festooned with a dense growth of salt water vegetation, and under these conditions could scarcely be other than as found, supersaturated with oxygen. (App. III, Table III.)

In contrast to this we have the outlet from Conesus lake which receives at Lakeville the effluent from a large milk condensary. Approximately one and one-half miles below there is a dam which

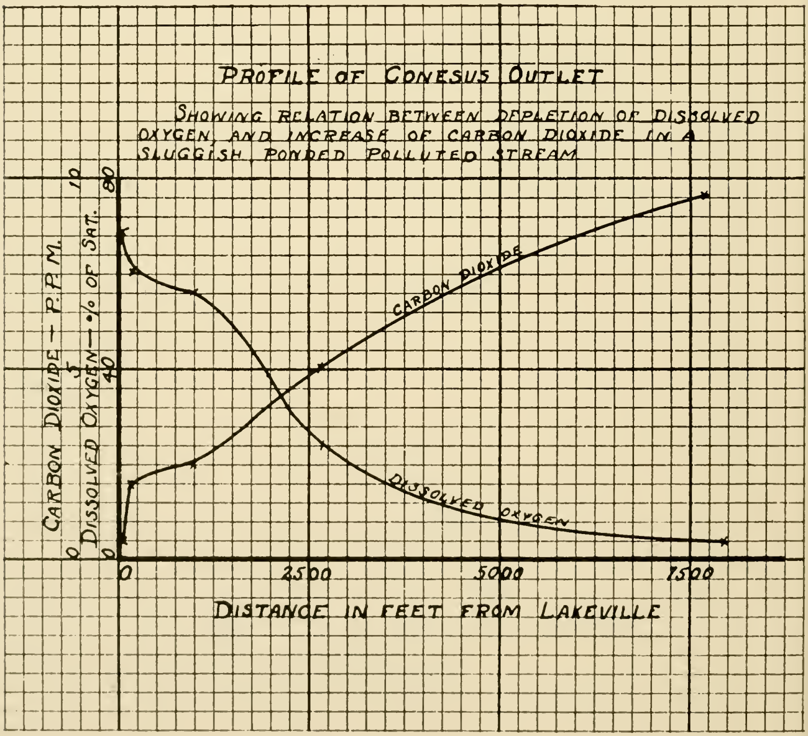

Fig. 7.—Dissolved gases, Conesus Lake Outlet, Aug. 7, 1926.

converts the stream into a long, sluggish pond, lined with vegetation. At the time investigated the contamination was probably close to its maximum, and the content of dissolved oxygen showed a steady decline along the course of the stream, reaching a minimum of 3.9 per cent of saturation at the dam. This and the accompanying rise of carbon dioxide are illustrated in Figure 7.

On a day other than when these chemical determinations were made minnows and other species of fish did not long survive when placed in the water about three-quarters of a mile below the entrance of pollution.*

Apart from streams, a brief investigation was conducted upon the waters of Silver lake. This lake is peculiar in that both inlet and outlet are at the same end and but a short distance apart. As a result the water is more or less stagnant, and at the time of investigation was exuberantly supplied with plankton growth. Samples were taken at regular intervals from top to bottom, and analysis showed a progressive diminution in dissolved oxygen, agreeable with the expectation of decomposing plankton. (Fig. 8.)

Summary.— To assist in interpreting the tabulated data, a brief summary of conclusions follows:

The pollution of Cryder creek at Whitesville was considerable and marked by a heavy fungus growth. At a point about 4,000 feet below, improvement was noted and corresponded with the return of the less tolerant organisms, but recovery was not complete, and the stream was found to enter the river bearing a cargo of but partially assimilated pollution.

Apart from a seepage of oil from wells and tanks which filmed its surface along the upper part of its course, Brimer brook received the effluent from a cheese factory at Petrolia, evidence of which was appreciable for half a mile below, but recovery practically complete one mile from source of pollution.

Pollution of Chenunda creek by a cheese factory effluent at Hallport was slight and dependent upon weather conditions, inasmuch as a small stream which received the waste directly seeped into the earth during dry seasons.

Black creek, polluted by cheese wastes at Birdsall, was unsatisfactory from the standpoint of volume until supplemented by tributary waters more than a mile below, and here recovery was almost complete.

Investigation of Caneadea creek showed that the tributary stream which under other conditions would have received cheese wastes at West Branch was dry. Similar pollution at Hardy

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* From notes supplied by Emmeline Moore the fish used in the test were: 4 blunt-nosed minnows ($2\frac{3}{8}$–$2\frac{5}{8}$ in.); 1 yellow perch ($2\frac{1}{2}$ in.); 2 common shiners ($3\frac{3}{4}$ and $4\frac{3}{4}$ in.); and 3 common suckers ($4\frac{5}{16}$–$4\frac{3}{4}$ in.). They succumbed in the following order: Blunt-nosed minnows and perch (in 12 min.); common shiners (in 15 and 16 min.); suckers (in 24, 33 and $33\frac{1}{2}$ min.). The time was late afternoon, Aug. 31, 1926; air temperature, 67° Fahr.; water temperature, 74° Fahr.

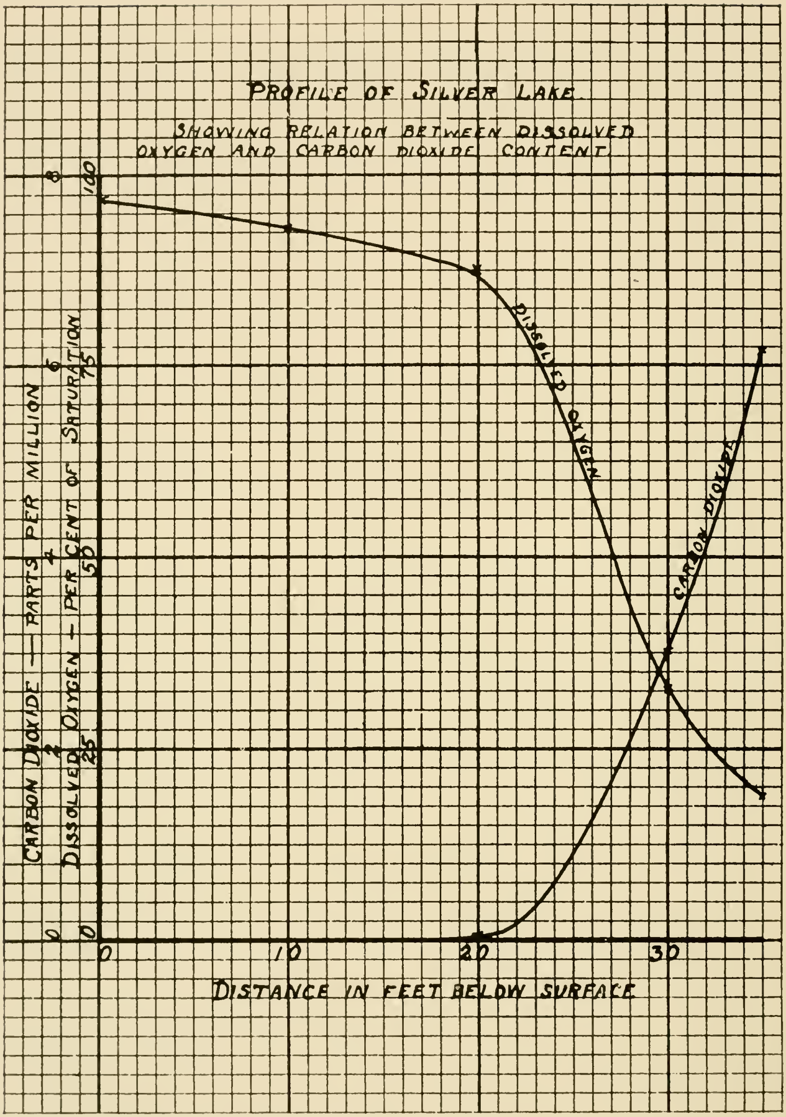

Fig. 8.—Dissolved gases, Silver Lake, Aug. 17, 1926.

Corners was slight and assimilated within a comparatively short distance from its entrance.

Black creek, the recipient of a drain from a milk shipping station at Rockville, was found to be a turbid stream, its already poor condition not being appreciably affected by the slight additional pollution.

The Wiscoy creek receives at Bliss the effluent from a dried milk establishment. Though there is some pollution, the chemically treated effluent was maintained in pretty fair condition. Pollution of a similar nature in connection with its tributary, the East Koy at Gainesville, was also inconsiderable. These are of course potential sources of serious contamination.

A cannery effluent at Hemlock was found to be swarming with rat-tail maggots, and almost totally devoid of dissolved oxygen. This, passing into Hemlock outlet, produced what would have been a worse condition save for the influx of a considerable quantity of fresh water from Rochester's water supply duct. Abundant patches of blue-green algae coincided with the poor conditions found even a mile below. Great improvement was found more than two miles further down stream.

Though a considerable amount of decomposing refuse littered the shores about a cannery at Honeoye Falls, the pollution to Honeoye creek at this point was relatively local, and assimilated within a comparatively short distance. An abundance of clean water fish were found between this source of pollution and the dam in Honeoye Falls, slightly more than a mile below.

Pollution of Mill creek by a paper mill at Dansville was not of such a nature as to appreciably affect the dissolved oxygen content, but manifested itself more by a sludgy deposit on the bed of the stream.

Canaseraga, regardless of the early part of its course, received within about a mile and a half of its mouth the waste from a large canning factory, and poured into the Genesee a load of decomposable material.

Little more need be said of Wolf creek. The chloride content found, when calculated as sodium chloride, and at the rate the stream was then flowing would be equivalent to a discharge of over 500 tons in 24 hours.

Silver lake inlet, at the time of investigation, was receiving a considerable amount of seepage from a pea-vine stack made by a shelling establishment. This imparted a yellow color to the stream which flows into Silver lake, and from which a municipal water supply is obtained. The stream was found to have largely recovered within about two miles of the entrance of pollution, and about one-half mile from the lake.

The bed of Allen creek, receiving the wastes from a paper mill at Scottsville, was heavily carpeted with sludge.

Oatka creek, rapid and riffly below Le Roy, appeared to have assimilated any pollution which it may have received, the outstanding feature being the extremely high pH or hydrogen ion concentration value.

Each stream is a study in itself, and conclusions formed from one can not be applied *per se* to others. Lack of space prevents giving a detailed elaboration of each case investigated, or a detailed correlation of biological and chemical results. In general the reappearance of the more intolerant index organisms below a section of contamination coincided with the return of the stream to conditions approximating those above the entrance of pollution.

III. Biological Studies of Polluted Areas in the Genesee River System

By P. W. Claassen,

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In connection with the stream survey of the Genesee river and its tributaries, considerable attention was given to the study of stream pollution. The object of the investigation was to determine the following: first, the different types of pollution which enter the waters of the Genesee river and its tributaries; second, the exact location of the source of each case of pollution; third, a study of the effect of the pollution substances upon fish and upon all other fresh water animals and plants commonly found associated with fish life; fourth, collecting and determining the plants and animals which occur in polluted waters with a view of establishing a record of the particular types of organisms which occur in waters polluted by different kinds of wastes, in other words, attempting to establish biological indicators which would be of use in determining the condition of the water and its suitability for fish life; fifth, suggestions of remedial measures.

Milk Pollution.— Milk wastes in the form of whey, skim milk, washings, etc., constitute the commonest type of pollution in the Genesee valley. Milk plants are particularly abundant in Allegany county. The waste from these plants when introduced into streams in sufficient quantity constitutes a serious case of pollution. A small amount of milk may serve to fertilize the water and enrich the life of the stream without materially affecting fish life, but in larger quantities milk wastes reduce the oxygen content of the water and become deleterious to fish life. Whey is probably the most detrimental of any of the milk wastes and should, under no consideration, be allowed to enter fish-inhabiting waters. Aside from the question of fish life, milk wastes usually produce an unsightly stream and oftentimes create a public nuisance and possibly a menace to the health of man and beast, in that such foul waters are especially suited for breeding mosquitoes. Furthermore, live stock will not drink water that has become badly polluted.

The typical index organisms found in milk-polluted water include the following: Near the entrance of the milk wastes into the streams, particularly in places where there are rifles in the water, occur abundant growths of sewage fungus (*Thiothrix*, *Leptothrix*, etc.). Within these fungus growths usually are found many protozoa (*Ciliates*) of the foul water types. Generally next in abundance are the snails, *Physa*, *Planorbis* and *Limnea*, air breathers which come to the surface of the water for air, and consequently are well adapted to live in situations where the food supply is rich regardless of the oxygen content of the water. Rat-tail maggots also are able to live in badly polluted waters where the organic contents are high and the oxygen supply very low or entirely absent. Sludge worms (*Tubifex*) likewise thrive in such situations. The presence of any or all of these organisms at once indicates that the water is polluted to the extent of killing or excluding all fish and other fresh water organisms. The presence of blood worms (*Chironomidae*) still indicates considerable pollution, even to the point of danger to fish life, but their presence also indicates that the stream is beginning to recover from the polluting substances, and that there is at least a small amount of oxygen present in the water. Milk-polluted streams often produce a luxuriant growth of green plants, particularly pondweeds (*Potamogetons*), duck weed (*Lemna*) and others. These are of great benefit to the stream for they utilize some of the waste products and help to restore the necessary oxygen of the water. Blue-green algae (*Oscillatoria*) indicate a considerable amount of pollution present and serve as indicators of heavy organic pollution. An account of one or two typical examples of milk pollution in the Genesee valley will serve to illustrate the effect of these wastes upon fresh water streams.

The Merle-Soule plant at Bliss, N. Y., on Wiscoy creek receives more than 50,000 pounds of milk per day and empties its wastes into Wiscoy creek. The milk wastes are first run into concrete vats and are then chemically treated by the lime-precipitation method. In this manner much of the nitrogenous material is precipitated as sludge and kept from going into the stream. The supernatant liquid is then drawn off and run into a filter and from there it is emptied into Wiscoy creek. This treated waste still retains a considerable amount of nitrogenous substances and is, therefore, capable of polluting the water to a considerable degree, especially where there is insufficient stream flow to insure proper dilution.

Wiscoy creek is a cold water stream and represents one of the finest trout streams in the Genesee valley. It was, therefore, of particular interest to determine what the effect of this treated milk waste had upon the stream. Beginning at the point of entrance of this waste into the stream, the stream bed was fairly covered with sewage fungus, a condition which extended downstream a distance of about half a mile. Within the fungus growth were found numerous snails and a very large number of midge larvae (*Chironomidae*). So abundant were they that a sample of 24 cubic centimeters of the fungus growth contained by actual count 333 midge larvae and 3 snails. These midge larvae constitute a choice fish food. Fortunately Wiscoy creek has a rapid and large enough stream flow to dilute the milk wastes. The presence of brown trout and other fish indicated that the stream apparently had not suffered from the milk wastes, and perhaps had been benefited by them to the extent of furnishing considerable food for the organisms upon which the fish feed. It was thus found that by a proper handling and treatment the wastes from milk plants may, under certain conditions, be allowed to enter the stream without apparent deleterious effect upon fish life.

Another example of milk pollution is that of a milk plant at Lakeville which empties its wastes untreated into Conesus lake outlet. This stream, although of considerable size, does not possess sufficient flow to take care of the large amount of raw milk wastes and, therefore, becomes badly polluted. The fungus growth is extremely abundant and for a considerable distance the entire stream bed is literally covered with snails, planarians and blood worms. A dam, about a mile below the outlet of the sewer, backs up the water for a considerable distance and is in part responsible for creating a septic condition in the stream. Numerous tests were made in this stream and in each case the fish died within a very short time after they had been introduced into the polluted water. A chemical analysis showed the water to be almost entirely devoid of oxygen and to contain a high percentage of carbon dioxide. (Fig. 7.)

It is impossible to state the exact effect which milk wastes will have upon a stream for each case has to be studied individually, but in general it would probably be much better if all milk waste could be excluded from those streams which are suitable to the production of food fish. Certain streams which are unsuited to fish life might possibly be utilized for carrying off milk wastes, provided a public nuisance was not thereby created and provided the stream purified itself before it entered a fish stream.

The various types of milk plants in the Genesee river valley pollute, to a lesser or greater degree, a total of some 30 miles of streams.

Domestic Sewage.— Domestic sewage when emptied into streams produces conditions very similar to those created by the introduction of milk wastes. Sewage fungus, snails, sludge worms, blood worms, rat-tail maggots, blue-green algae and other foul water organisms are indicators of this type of pollution and wherever these organisms are found there is sufficient pollution present to endanger fish life. Domestic sewage usually contains other types of wastes, and each case has to be studied individually to determine just what effect it has upon the life in the stream. A typical case of sewage pollution in the Genesee river is that at Wellsville where the city sewer empties directly into the river. Approximately 15 miles of stream become polluted by domestic sewage in the Genesee valley.

Cannery and Vinery Wastes.— The wastes from canning factories and pea vineries find their way into the streams in a number of places and in some instances cause serious cases of pollution. Especially vicious is the seepage from the stacks of the pea vineries. This substance is very rich in nitrogenous matter and is so highly concentrated that a small amount will pollute relatively large streams and endanger all fresh water life therein. Inasmuch as this seepage lasts for only a comparatively short period of time, probably not over two or three weeks, and does not accumulate in very large amounts, it should never be permitted to enter streams of any kind. Provision should be made by the vineries whereby this seepage is spread thinly over gravelly soil or where it can be dumped on land far enough removed from streams to prevent its seeping into fresh waters. Silver lake inlet is one of the streams into which the seepage from a pea vinery stack was allowed to enter. The absence of any fresh water organisms and the presence of foul water plants and animals served to indicate the detrimental effect which this material produced within the stream. Furthermore, it should be noted that this waste entered Silver lake from which the villages of Perry and Mt. Morris obtain their water supply.

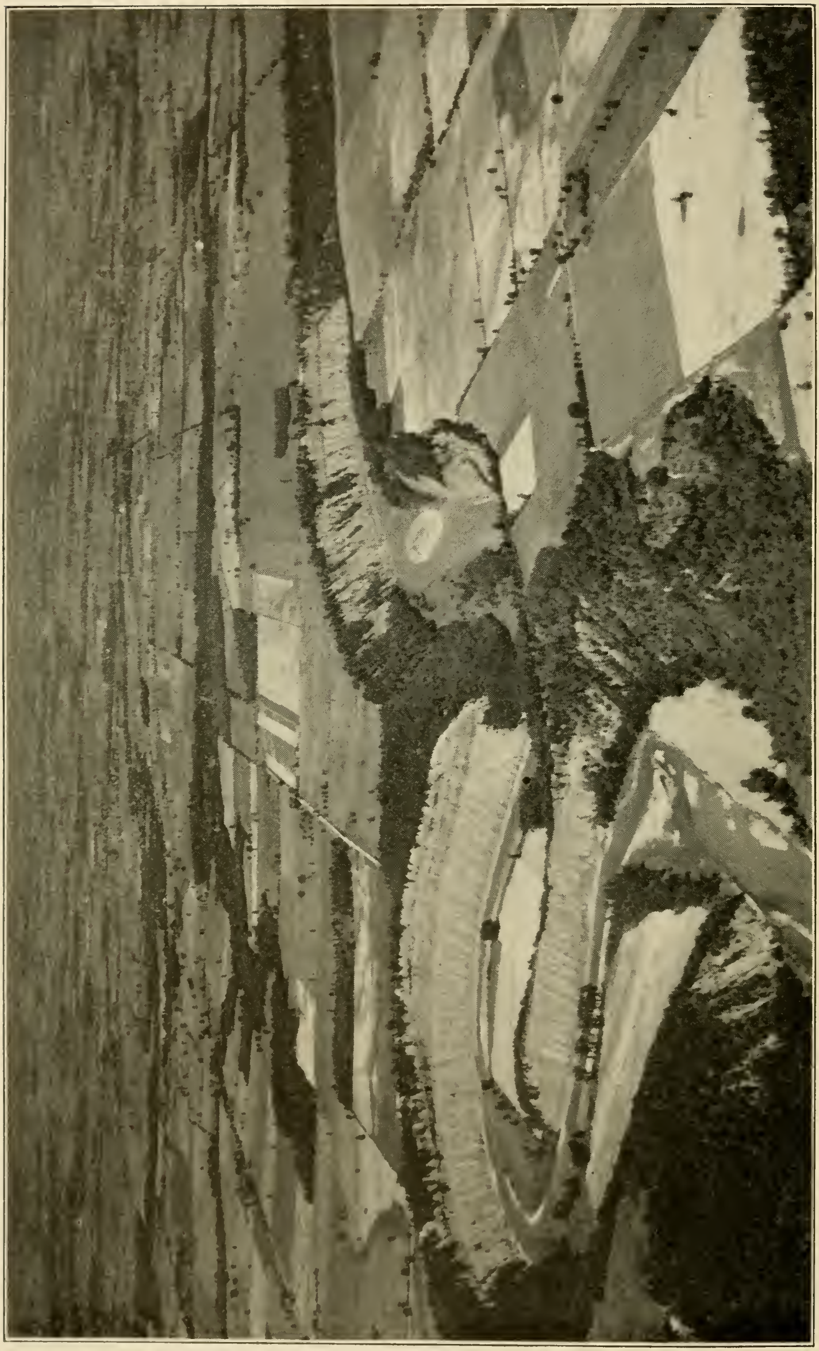
In most canneries attempts are made to separate all solids, permitting only the liquid wastes to enter the streams. There remains, however, sufficient organic material in the wash water to pollute the streams to a considerable extent. The pea cannery at Hemlock pollutes Hemlock lake outlet to the point of killing all fresh water food organisms and endangering fish life. This stream is not a trout stream, nevertheless conditions within the stream showed how detrimental cannery wastes are when they enter fish streams. The case at Honeoye Falls where another cannery is located, polluted Honeoye creek so badly last summer that hundreds of bass were killed at the height of the canning season. This factory empties its waste into a filtering plant, but during the flush season this plant was unable either to retain the wastes for a long enough period of time or else the waste was being discharged into Honeoye creek untreated. At any rate, the stream was being polluted to the extent of killing many fish.

The index organisms found in cannery wastes are very similar to those found in milk wastes. From 13 to 15 miles of streams were found to be polluted by cannery and vinery wastes in the Genesee river valley.

Oil Pollution.—Wastes from oil wells constitute a common source of pollution in Allegany county around Wellsville.

The oil forms a film on the surface of the water and also settles down to the bottom of the stream where it forms an oil film around the stones and other objects. The oil thus kills most fresh water food organisms and although some forms of fish were found to be present in such situations it was at once apparent that they could not thrive where the natural food had been killed by the oil. Most of the stones were found to be thickly coated with a brown plant growth. Samples of this growth showed this to be an almost pure growth of diatoms of which the species *Melosira varians* was particularly abundant.

Approximately 25 miles of stream were found polluted by oil by oil and the greater proportion of this water would, if clean, be ideal trout water.



Aeroplane view of Horse Shoe Gorge, a portion of the natural basin of a proposed lake between Mount Morris and Letchworth Park.

Salt Pollution.— One of the most serious types of pollution found during the summer survey was that of pollution by salt water. Wherever salt water enters a fresh water stream in sufficient amount all fish and other fresh water organisms are killed and an entirely new association of plants and animals becomes established — that is, an association of the marine or salt water type.

The salt works which is located in Silver Springs, N. Y., empties its waste salt water into Wolf creek. About five or six miles farther down Wolf creek empties its waters into the Genesee river within the area of the new lake which will be formed when the proposed dam at Mt. Morris has been built. This lake will thus receive all the waste salt which Wolf creek carries down to the Genesee river.

Wolf creek is a stream which if clean would constitute one of the best trout streams in that section of the country. In fact one of the main tributaries (Tributary 6) of Wolf creek which is not being polluted was found to contain brook trout and possess ideal trout water. Thousands of gallons of salt water are being dumped into Wolf creek daily. A chemical analysis on August 13, 1926, showed that the stream just below Silver Springs contained 3.84 per cent of salt. At the mouth of Wolf creek where it entered the Genesee river the stream showed a flow of 18.1 cubic feet per second and on August 16, 1926, it tested 1.14 per cent salt. A number of tributaries entering Wolf creek below Silver Springs had reduced the concentration from 3.84 per cent to 1.14 per cent. Calculating from the above figures, we find that at the time of observation Wolf creek was carrying salt into the Genesee river at the rate of more than 500 tons per 24 hours. This probably does not represent the average amount for at another date, August 13, 1926, Wolf creek showed a flow of only about 6 cubic feet per second and at that time it was carrying 1 per cent salt. However, even then it was carrying salt into the Genesee river at the rate of more than 150 tons per 24 hours.

A biological examination of Wolf creek disclosed the absence of all fresh water organisms. The stream bed was almost entirely covered by a filamentous green alga (*Enteromorpha intestinalis*), a salt water plant This was the dominant plant present, although diatoms and other plants were also numerous. (App. VIII.) Of animals there were found the following: The salt fly, *Ephydra subopaca* Loew., predominating with the larva of a small midge (*Culicoides varipennis*) next in abundance. Mosquito larvae, rat-tail maggots, oligochaetes, beetle larvae and other forms were present.

What the cumulative effect of this salt will be on the proposed lake is difficult to predict. It certainly can be of no value and may possibly prove in time very injurious to all fish life within the entire lake. Altogether some 13 miles of streams were found to be polluted by salt water.

Paper Mill Wastes.— The wastes from paper mills appear to be of a toxic nature and wherever they were found to enter the streams all fresh water organisms were absent. The paper mill at Dansville pollutes Mill creek badly. Just above the entrance of the waste from the paper mill, Mill creek was found to be in ideal condition for fish food. Fresh water organisms were abundant and trout were present. Below the entrance of waste the stream contained no fresh water organisms and no fish were observed. The effect of this pollution was noticeable down stream to the entrance of Mill creek into Canaseraga creek and continuing therein the depletion of the food organisms for a distance of at least 3 miles. Approximately 11 miles of streams were being polluted by this type of wastes.

Miscellaneous Wastes.— There occur in the Genesee river various kinds of factories whose washes are permitted to enter the river or its tributaries. Especially prevalent are these factories in the city of Rochester. The Genesee river at and below Rochester is being badly polluted, and at present it is difficult to state just which one of the commercial plants is causing the greatest damage.

Summary.— In all a total of nearly 125 miles of streams were noticeably affected by polluting substances. A more extended study would probably reveal an even greater mileage. Some of the most typical trout streams within the Genesee valley have become barren, unsightly streams, due to the introduction of waste products. The following tabulation forms a helpful guide:

Tabulation of Pollution Studies of the Genesee River Survey

Type of pollution	On what quadrangle	Township or post office	On what stream	Effect on stream	Miles of stream affected	Index organisms	Remarks
Milk (cheese)	Belmont	Petrolia	Trib. 2 of Brimer brook	Both oil and milk	2	Fungus, diatoms, etc.	Both oil and milk have killed most of the fresh water forms
Milk (cheese)	Belmont	Allentown	Knight creek	Slight	1	Fungus	Both oil and whey
Milk (cheese)	Belmont	Friendship	Van Campen	Slight	$\frac{1}{4}$	Fungus	Not sufficient to do much harm
Milk plant	Wellsville	Scio	Genesee	None	......	......	......
Milk plant	Wellsville	Wellsville	Genesee	Pollutes badly	2–3	Fungus, blue-green algae, bloodworms, etc.	Both milk and sewage
Cheese	Wellsville	Hallsport	Trib. 8 of Chenunda	Kills all fresh water forms	1	Fungus, tubifex, etc.	Trib. 8 much polluted and affects Chenunda for half mile or so
Milk	Wellsville	Whitesville	Cryder creek	Considerable pollution	6–7	Fungus, etc.	Apparently does not kill fish
Milk (cheese)	Franklinville	Near Rushford	Trib. 1 of Trib. 17 of Caneadea creek	Very little	$\frac{1}{2}$	......	Does not reach a fishing stream
Milk (cheese)	Franklinville	Hardy Corners	Caneadea creek	Slight	$\frac{1}{2}$	Fungus	Does not appear to do any harm
Cheese	Angelica	Centerville	Trib. 14 of Sixtown	None	None	......	......
Cheese	Angelica	East Rushford	Trib. 10 of Caneadea creek	Slight	$\frac{1}{2}$	Fungus	Trib. 10 not a fishing stream
Cheese	Angelica	Rushford	Trib. 11 of Caneadea creek	Pollutes stream badly	1–$1\frac{1}{2}$	Fungus, rat-tail maggots, etc.	This stream not suitable for fish
Milk	Angelica	Caneadea	Caneadea	None	......	......	......
Milk	Angelica	Fillmore	Cold creek	Badly polluted	1	Tubifex, rat-tails, etc.	Old stream bed, which consists of standing water
Milk	Canaseraga	Birdsall	Black creek	Slight	$\frac{1}{2}$	Some fungus	Apparently does not effect water much
Milk	Canaseraga	Canaseraga	Canaseraga	......	......	......	......
Milk	Arcade	Bliss	Wiscoy	Considerable	3	Fungus, midges, etc.	Apparently increases fish life
Milk	Portage	Gainsville	East Koy	Considerable	2–3	Fungus, midges, etc.	Kills fish food and possibly some fish
Milk	Portage	Perry	Silver lake outlet	Slight	1	Fungus, etc.	......
Milk	Portage	Silver Springs	Wolf creek	......	......	......	Both milk and salt water
Milk	Portage	Castile	Wolf creek	......	......	......	......
Milk	Portage	Pike	Wiscoy	Slight	1	......	......
Milk	Honeoye	Lakeville	Conesus lake outlet	Very bad, kills fish	3	Fungus, midges, snails, etc.	Probably the worst case seen
Paper mill	Wayland	Dansville	Mill creek, Trib. 22 of Canaseraga creek	Kills all fresh water forms	7	Fungus and rich growth of diatoms	Mill creek is a good trout stream above paper mill
Paper mill	Caledonia	Mumford	Trib. 4 of Allen creek	Considerable harm to fish food	2	Fungus and rich growth of diatoms	Depletes a good trout stream of fish
Paper mill	Brockport	Scottsville	Allen creek	Very bad; oil scum on water and on stones in stream	2	Fungus and rich growth of diatoms	Kills all fresh water forms

TABULATION OF POLLUTION STUDIES OF THE GENESEE RIVER SURVEY — (Concluded)

Type of pollution	On what quadrangle	Township or post office	On what stream	Effect on stream	Miles of stream affected	Index organisms	Remarks
Sewage	Wellsville	Wellsville	Dyke creek	Badly polluted	3	Fungus, blue-greens, etc.	River badly polluted
Sewage	Nunda	Mt. Morris	Canaseraga	Considerable	2–3	Fungus, etc.	Both sewage and cannery waste
Sewage	Wayland	Dansville	Canaseraga	Slight	1	...	...
Sewage	Portage	Warsaw	Oatka	Medium	3	Blue-greens, etc.	Reported to be killing fish where water is low
Sewage	Portage	Perry	Silver lake outlet	Slight	1	...	Not sufficient to kill fish
Sewage	Portage	Silver Springs	Wolf creek	...	...	...	Both salt and sewage
Sewage	Portage	Castile	Wolf creek	...	...	...	Both salt and sewage
Sewage	Caledonia	Geneseo	Genesee river	Slight	1–2	Blue-greens, etc.	...
Sewage	Caledonia	LeRoy	Oatka	Medium	1–2	Blue-greens, etc.	...
Cannery	Nunda	Mt. Morris	C. G. 1 emptying into Canaseraga	Badly polluted	3–4	Tubifex, rat-tails, fungus, blue-greens, etc.	Promotes development of coarse fish
Pea vinery	Portage	Perry	Silver lake inlet	Badly polluted	2	Fungus, etc.	Could easily be avoided. Now kills all fish
Cannery	Batavia	Wyoming	Trib. 20 of Oatka	Apparently never reaches stream	...	...	...
Cannery	Caledonia	Geneseo	Genesee	Considerable pollution	1	Blue-greens	Probably not sufficient pollution to kill fish
Cannery	Honeoye	Hemlock	Trib. 7 of Hemlock lake inlet	Bad pollution	3	Fungus, blue-greens, snails, rat-tails, etc.	Very bad, but this is not a fishing stream
Cannery	Honeoye	Honeoye Falls	Honeoye creek	Very badly polluted	3	Dead fish, blood worms, snails, fungus, etc.	Worst case of cannery pollution seen
Pea vinery	Albion	Byron	Black creek	...	...	...	Reported to be killing fish. Waste goes into a deep well
Oil	Belmont	Scio	Knight creek	Top and bottom of stones covered with a film of oil. Slimy deposit on bottom. Film of oil on surface. Kills fish food	10	Brown slimy growth, largely made up of diatoms of which Melosira is particularly abundant	Good trout water ruined by oil pollution
Oil	Belmont	Scio	Brimer		5		
Oil	Belmont	Wirt	Trib. 5 of south branch Van Campen		4		
Oil	Belmont	Wirt	Trib. 2 of south branch Van Campen		3	...	...
Oil	Wellsville	Wellsville	Genesee river	...	2	...	...
Salt	Portage	Silver Springs	Wolf creek	Kills all fresh water organisms	8	Prolific growth of salt water plants and animals. Enteromorpha (Alga) Diatoms, Ephydra (salt fly), Culicoides (salt midge), Aedes (mosquito)	Wolf creek would be a fine trout stream if it were not polluted
Salt	Caledonia	Retsof	Allen creek G.18 (A. G. 18)	Kills all fresh water organisms	4		A. G. 18 not a fish stream. Enters G. ¾ miles below
Salt	Caledonia	Piffard	Allen creek G.20 (A. G. 20)	...	1	Oligochaetes (worms) and other miscellaneous forms	A. G. 20 dry except for the salt water

IV. Fishes of the Genesee Region with Annotated List

By J. R. Greeley,

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General Nature of Region.— The entire Genesee valley lies within that part of New York State which was glaciated. In some areas of the region the ice scoured deeply and carved out lakes such as Conesus, Hemlock or Honeoye lakes. Other areas were cut less deeply and have gradually filled in, forming swamps such as Bergen swamp. The ice carried a vast quantity of rock and soil southward and deposited much of this material in the Genesee region.

The streams show the influence of glaciation very strongly. The most common type of creek runs over glacial deposits. Such a stream has a hard bottom of rubble, gravel, and perhaps hard-pan clay where the current is strong, but where the current is slow, much of the silt and mud which the water carries settles and the bottom is soft.

Quite a number of the streams course over a bottom of hard bed-rock. Generally this occurs where the deposits of material by the glaciers had caused a change in the course of the stream, as is the case of the Genesee river at Letchworth Park. Some of the rock-bottom streams of the headwaters of the river are believed to flow in their original, preglacial beds, but have cut through a rather thin deposit reaching the shales and other rocks.

A few creeks of the Genesee region show a bottom of black muck which is a deposit caused by the decay of vegetation. A swamp stream such as lower Black creek (Monroe county) is of this type. In places, however, this creek has a rather firm bottom due to the numerous shells of small clams in the muck.

Changes in the Character of the Region.— Originally the region was an unbroken area of forest. Within the memory of many people now living the timber covering has been cut off leaving a greater acreage of cleared fields than of woodland.

These changes which have taken place on the land have affected the waters. Many streams go dry in summer due to lack of forest protection and the great majority of them are open to the sun and become warm in summer. The number of streams cold enough for trout is now comparatively small though an early writer (Turner, 1851, p. 375), referring to the Genesee river above Genesee falls, states that "speckled trout were plenty in the river, and in all the tributary streams."

The Genesee River.— The Genesee river rises in Pennsylvania and flows northward across the State of New York to enter Lake Ontario. Like many rivers, it is shallow and swift in its upper parts and becomes deep and rather sluggish toward its mouth. The bottom is composed of rubble and gravel in the more rapid sections, while in places where the current is slow the prevailing type of bottom is silt and mud. A long stretch of the river near Letchworth Park flows over bedrock.

The greater part of the Genesee river may be considered a warm stream, though the upper waters are rather cold. Rainbow trout are taken as far downstream as Belmont, but below that point they become rare, and warm water fishes, such as the small-mouthed black bass, become common.

A number of falls and dams form barriers to the upward migration of fishes in the river. The Genesee falls at Rochester are an unsurmountable obstacle to Lake Ontario fishes which enter the river. No fish could climb the Portageville falls. Other barriers are: Geneseo dam, Mt. Morris dam, Belmont dam. It is probable, however, that many water-falls are passable to fishes going downstream. At least seven species of fishes are found between the upper and middle falls at Letchworth Park and some of these have probably entered this stretch of water by coming over the upper falls, a drop of 71 feet.

The Genesee river has probably gained a few species of fishes by means of man-made connections with other bodies of water. The Genesee valley canal, for example, which is now abandoned, once connected the Allegany and Genesee rivers; the Erie canal now connects Lakes Erie and Ontario with the Genesee river.

Fishes of the Genesee Region.— Sixty-six species of fishes representing 21 families are listed as occurring in the Genesee region. Of these, at least 5 species (German carp, alewife, brown trout, rainbow trout, muskalonge) were introduced directly by man; 7 species (lake sturgeon, long-nosed gar, spot-tailed minnow, alewife, two-spined stickleback, bowfin, calico bass) are Great Lakes species which enter the Genesee river only below Rochester; 3 species (common eel, white bass, sheepshead) are Great Lakes species which have entered the river above Rochester falls. The remaining species are probably native to the region although man has wrought so many changes that we cannot be certain that some others were not introduced.

Food and Game Fishes.— There are 26 species of food and game fishes. These are: lake sturgeon, common bullhead, black bullhead, common sucker, 2 species of red-horse suckers, German carp, common eel, alewife, whitefish, brown trout, rainbow trout, lake trout, brook trout, chain pickerel, northern pike, muskalonge, calico bass, rock bass, common sunfish, small-mouthed black bass, large-mouthed black bass, pike-perch, yellow perch, cisco, white bass, and sheepshead. Of these 5 species (lake sturgeon, muskalonge, calico bass, white bass and sheepshead) have practically no importance in this stream system due to rarity. The more important fishes of this region as food or game resources are: small-mouthed black bass, brown trout, pike-perch, brook trout, northern pike, large-mouthed black bass, chain pickerel, yellow perch, common bullhead, rainbow trout, rock bass, and 3 species of suckers.

Miscellaneous Other Fishes.— There are 39 species which have practically no direct use to man as food or as game. To this large group belong long-nosed gar, mud-fish, stone cat, tadpole cat, hog sucker, chub sucker, all the minnow family except the carp, barred killifish, brook stickleback, two-spined stickleback, trout perch, 5 species of darters (*Percidae*), and the sculpins.

The great majority of these species, however, have great importance in our waters as food for the larger game fishes. Bass, pikes, pike-perch, and others of our more desirable fishes consume large numbers of minnows and other small fishes. Evermann and Goldsborough (1901) estimate that 80 pounds of muskalonge "represent several tons of minnows, whitefish, and the like."

Fishes as Food for Game Fishes.—An abundant supply of minnows and other small fishes is desirable in the warm water streams and lakes where basses, pikes, or pike-perch are found. The Genesee region is well supplied with food resources for these types of game fishes. Crayfishes and small fish are the chief foods of the larger members of the bass family. Crayfish are abundant in all waters of the region. All streams and lakes have some species of fishes available to basses, pikes, and perches.

In the Genesee river from Belmont to the vicinity of Avon the following are species occurring in sufficient numbers to be considered food resources of game fishes (notably the small-mouthed black bass):

Common shiner (*Notropis cornutus*).
Hog suckers (*Hypentelium nigricans*), young.
Rosy-faced minnow (*Notropis rubrifrons*).
Horned dace (*Semotilus atromaculatus*).
Straw-colored minnow (*Notropis deliciosus*).
Blunt-nosed minnow (*Hyborhynchus notatus*).
Common sucker (*Catostomus commersonnii*), young.
Red horse sucker (*Moxostoma aureolum*), young.
Rock bass (*Ambloplites rupestris*), young.
Satin-fin minnow (*Notropis whipplii*).
Green-sided darter (*Etheostoma blennioides*).
Johnny darter (*Boleosoma nigrum*).
Black-sided darter (*Hadropterus maculatus*).
Log-perch (*Percina caprodes*).
Stone-cat (*Noturus flavus*), young.

In the deeper parts of the river from near Avon to Rochester the shallow-water types of fishes are not abundant and species are fewer in number. As food fishes for the small-mouthed black bass, pike-perch, and northern pike in this area the following occur:

Straw-colored minnow (*Notropis deliciosus*).
Blunt-nosed minnow (*Hyborhynchus notatus*).
Red horse suckers (*Moxostoma aureolum, M. lesueurii*), young.
Common sucker (*Catostomus commersonnii*), young.
River chub (*Nocomis biguttatus*).
Slender minnow (*Notropis atherinoides*).
Rock bass (*Ambloplites rupestris*), young.
Log-perch (*Percina caprodes*).

Below Rochester Lake Ontario fishes enter the river. The more common ones which might be eaten by other fishes here are:

Spot-tailed minnow (*Notropis hudsonius*).
Slender minnow (*Notropis atherinoides*).
Yellow perch (*Perca flavescens*).
Alewife (*Pomolobus pseudo-harengus*).
Common bullhead (*Ameiurus nebulosus*), young.

In the lakes of the Genesee watershed the important foods for predaceous game fishes are:

Yellow perch (*Perca flavescens*), young.
Golden shiner (*Notemigonus crysoleucas*).
Blunt-nosed minnow (*Hyborhynchus notatus*).
Satin-fin minnow (*Notropis whipplii*).
Common sunfish (*Eupomotis gibbosus*), young.
Rock bass (*Ambloplites rupestris*), young.
Common bullhead (*Ameiurus nebulosus*), young.

In a few cases we have evidence from stomach examination that some of these fishes are eaten. Fishes which we have found in bass stomachs include: hog sucker, horned dace, common sunfish, and minnows (unidentifiable). In northern pike and pickerel we have found: golden shiner, yellow perch, log-perch, common sunfish. In wall-eyed pike we have found: yellow perch, sucker, minnows. In rock bass we have found yellow perch.

Bait fishes of the region.— Small fishes of various kinds are useful as bait for game fishes. Desirable qualities of a fish for this use are (1) suitable size, (2) hardiness, (3) easy visibility. light colored baits are preferred by most fishermen.

The more important bait fishes of the region are:

Common shiner (*Notropis cornutus*).
Horned dace (*Semotilus atromaculatus*).
Common suckers (*Catostomus commersonnii*), young.
Blunt-nosed minnow (*Hyborhynchus notatus*).
Stone roller (*Campostoma anomalum*).
Golden shiner (*Notemigonus crysoleucas*).
Yellow perch (*Perca flavescens*).

Many anglers and dealers in bait take their minnows from the streams as they are usually more easily secured there than in the lakes. Most of the warmer streams of the region abound in minnows suitable for use as bait, especially the two species first listed, and no serious depletion of the supply that could be attributed to collecting for this use was found.

Ecology of Fishes.— The numerous kinds of fishes show a remarkable adaptation to their various conditions of environment and it is apparent that a species will thrive best when in that type of environment for which it is adapted. For example, a fish such as our brook trout, which is fitted for life in cold water, usually flourishes in a cold stream but cannot maintain itself in a warm one. Such a fish as the small-mouthed black bass is quite the reverse, being adapted to life in warm waters. This fish does not become well established in cold streams and we have never found it occurring commonly in association with the trout.

Some of the main factors of environment in determining the kinds and numbers of fishes which any given stream might support are: (1) size of stream, (2) current, (3) type of bottom, (4) temperature, (5) chemical and gaseous content of water, (6) type and abundance of food, (7) shelter, (8) spawning grounds. Although these factors are usually inter-related they may be treated separately.

(1) *Size of Stream.*— The black-nosed dace (*Rhinichthys atronasus*) is an example of a species which prefers small streams. Although commonly in nearly all small tributaries of the Genesee, it is rare in the river and large tributaries. Another minnow, the river chub (*Nocomis biguttatus*), was taken only in large streams as the Genesee river and Black creek (Monroe county).

(2) *Current.*—All of our specimens of the stone-cat (*Noturus flavus*) came from rapid water. Another catfish (*Ameiurus nebulosus*) prefers still waters.

(3) *Type of Bottom.*— The fan-tailed darter (*Catonotus flabellaris*) is an example of a fish which prefers a stream with hard bottom, usually rubble or gravel in this region. The common bullhead (*Ameiurus nebulosus*) seems to be most common in waters having a soft mud bottom.

(4) *Temperature.*—As a cold water fish we have already named the brook trout (*Salvelinus fontinalis*). As a warm water fish we might name the small-mouthed black bass (*Micropterus dolomieu*).

(5) *Chemical and Gaseous Content of Water.*—A test made in a milk polluted stream at Lakeville August 31, 1926, showed that fishes representing minnows (*Hyborhynchus notatus, Notropis cornutus, Exoglossum maxillingua*), one species of perch (*Perca flavescens*) and one species of sucker (*Catostomus commersonnii*) died within a few minutes in a stream having a low dissolved oxygen content accompanied by a high carbon dioxide content (Fig. 6). The absence of fishes in a salt water stream (Wolf creek) could be considered evidence of the dislike of fresh water species for a high concentration of this chemical substance.

(6) *Type and Abundance of Food.*— Embody and Gordon (1924) give as the total composition for the ration of the brook trout (based on analysis of the food of wild fishes from 4 to 13 inches in length) the following:

	Per cent
Crude protein	48.73
Fat	15.50
Carbohydrates	
Nitrogen free extract	17.90
Crude fiber	7.97
Ash	9.90
	100.00

These trout had obtained a ration of this composition by taking the following natural foods in the percentages stated:

	Per cent
Fish	2.52
Insects	88.88
Crustacea	8.23
Mollusca	.27
	100.00

The high percentage of insect food is noteworthy. Naturally it would be expected that trout will be most abundant in those parts of the stream which provide the greatest amount of such food. It is not known how diverse fishes are in their protein, fat, and carbohydrate requirements. It is quite apparent, however, that different species differ widely in type of food organism. Pickerel (*Esox*) feed largely upon other fishes; the stone roller (*Campostoma anomalum*) subsists upon a diet of mud and "slime" containing very small plant and animal life.

It is worthy of note here that young fishes differ from adult fishes in type of food. A young bass (*Micropterus dolomieu*) 1 inch long, taken from Caneadea creek (Allegany county) July 6, 1926, had eaten 3 very young mayfly nymphs (*Ephemerida*), a small species of fly (*Diptera*), 2 small midge larvae (*Chironomidae*), and 5 tiny crustacea (*Phyllopoda* and *Copepoda*). Adult fishes of this species feed mainly upon crayfish and small fishes.

(7) *Shelter.*— Certain species of fishes and the young of many other species seem to require weed beds or some type of shelter. A fish such as the golden shiner (*Notemigonus crysoleucas*) is most common among water plants, probably resorting there for both shelter and food. In trout streams, pools affording shelter of logs, roots and the like are usually more productive of fish than are unsheltered pools.

(8) *Spawning Grounds.*— All fishes show certain requirements regarding places to spawn. The optimum type of breeding place for small-mouthed black bass (*Micropterus dolomieu*) is shallow water with gravel bottom. Many other fishes choose similar places, where there is less likelihood of silt and mud "smothering" the eggs than there is in a muddy location.

Comparatively little is known of the factors which influence the presence and abundance of many of our common fishes. This is a fertile field for study.

Fishes and Pollution.— Polluting of streams by man often causes a decrease in fish life. In some cases fishes are poisoned directly by the dumping of a poisonous substance into a body of water. In others fishes are suffocated due to a serious reduction of the oxygen content of the water, caused by the presence of large quantities of milk wastes or other organic substances. In still other cases certain types of food organisms are driven out by pollution, and fishes which require these particular foods cannot exist, even though the condition of the water itself may be good.

The brook trout feeds largely upon aquatic insects, such as mayflies (*Ephemerida*), stoneflies (*Plecoptera*), and caddis flies (*Trichoptera*). These organisms are mostly absent in polluted waters and we have not found the trout in such waters.

Some of the fishes which were found tolerating rather serious organic pollution are: Common sucker (*Catostomus commersonnii*), hog sucker (*Hypentelium nigricans*), red-horse sucker (*Moxostoma aureolum*), stone roller (*Campostoma anomalum*), horned dace (*Semotilus atromaculatus*), common shiner (*Notropis cornutus*), trout perch (*Percopsis omisco-maycus*), black bass (*Micropterus dolomieu*). Most of these species are able to subsist upon algae, and small bottom-living organisms, such as can occur in polluted waters. Young black bass were found feeding upon midge larvae (*Chironomidae*) which were present in water polluted by cannery wastes.

It is dangerous to assume, however, that pollution of a stream is harmless to fish life merely because fishes exist there. The number and kinds of fishes must be taken into account. Also, it should be borne in mind what we do not know, from the existence of individuals (young or old) or a species in the polluted part of a stream, that conditions are favorable for the propagation of that same species there. The environmental requirements of eggs, young stages, and adult fishes may be, and probably are, very different.

Typical Fishes of a Trout Stream.— In cold streams, where brook, brown, or rainbow trout occur there are usually but few species of other fishes. A list of fishes commonly taken associated with trout is as follows:

Black-nosed dace (*Rhinichthys atronasus*).
Horned dace (*Semotilus atromaculatus*).
Common sucker (*Catostomus commersonnii*).
Pearl minnow (*Margariscus margarita*).
Red-sided minnow (*Clinostomus elongatus*).
Common shiner (*Notropis cornutus*).
Sculpin (*Cottus bairdii*).
Fan-tailed darter (*Catonotus flabellaris*).
Brook stickleback (*Eucalia inconstans*).
Stone-roller minnow (*Campostoma anomalum*).

Other species sometimes enter trout waters in limited numbers. These are likely to be found in the lower, warmer waters of the stream. They include the following:

Blunt-nosed minnow (*Hyborhynchus notatus*).
Fat-head minnow (*Pimephales promelas*).
Long-nosed dace (*Rhinichthys cataractae*).
Johnny darter (*Boleosoma nigrum*).

By far the most common trout associates are the black-nosed dace, the horned dace, and the common sucker. All of these occur in the majority of trout streams of the region. The sucker is the least abundant of the three.

Little is known upon the subject of minnows and their relation to trout. It is known, however, that trout eat some minnows and other fishes. A 13-inch brown trout taken on Mill creek (near Patchinsville, N. Y., Steuben county) July 26, 1926, had eaten a young sucker (*Catostomus commersonnii*) and a black-nosed dace (*Rhinichthys atronasus*). These made 40 per cent of the food of this individual. A 7¾-inch brown trout taken on East Koy creek August 29, 1926, had eaten a small minnow. A rainbow trout 8 inches in length taken on the Genesee river at Belmont, N. Y., on June 20, 1926, had likewise taken a small minnow. A 3½-inch brook trout from Browning Spring cove (Allegany county) had a stone-roller minnow (*Campostoma anomalum*) 1 inch long in its mouth when it was captured. Two sticklebacks (*Eucalia inconstans*) made 92 per cent of the food of a 6-inch brook trout taken from Seven Springs pond, near Batavia, N. Y., August 31, 1926. Dr. Juday (1907) found suckers in Colorado specimens of brook trout. Embody and Gordon (1924) found sculpins (*Cottus*) in the stomachs of brook trout from streams of Tompkins county, N. Y.

The fish item of the brook trout is rather small, however, according to Embody and Gordon (1924), who list fishes as 2.52 per cent of the food. That minnows compete with trout for food is apparent from the following data taken from specimens from Mill creek, near Patchinsville, N. Y. (Steuben county), August 1, 1926:

Black-nosed dace (*Rhinichthys atronasus*), 3 specimens, 2¼ to 2½ inches long. Midge larvae and pupae (*Chironomidae*), 98.4 per cent. One water mite (*Hydracarina*), 1.6 per cent.

Horned dace (*Semotilus atromaculatus*), 2 specimens, 2½ to 2¾ inches long. Snails, 25 per cent; land insects, 62.5 per cent; aquatic insects (nymphs of *Ephemerida*), 2.5 per cent; grass seeds, 10 per cent. A third specimen was nearly empty, having eaten only a small mayfly nymph (*Ephemerida*).

Brook trout (*Salvelinus fontinalis*), 3, 4, 8 inches long. Snails, 8.3 per cent; land insects, 42.6 per cent; aquatic insects, 49 per cent (midge larvae, 8 per cent).

Brown trout (*Salmo fario*), 2 specimens, 6½ and 7 inches. Snails, 9 per cent; land insects, 30 per cent; aquatic insects, 59 per cent (midge larvae, 12.5 per cent); grass seeds, 2 per cent.

Rainbow trout (*Salmo irideus*), 4 inches long. Land insects, 66 per cent; water insects, 29 per cent (midge larvae, 3 per cent); grass seeds, 5 per cent.

Note that midge larvae (*Chironomidae*) were taken by black-nosed dace and trout and that horned dace were feeding upon the same type of surface food (insects) that trout were taking. The grass seeds eaten by the fishes were probably mistaken for floating insects.

The German Carp.— The distribution of the German carp in the Genesee region is rather general, occurring in suitable parts of the Genesee river from Wellsville to Lake Ontario. It is established in the lower waters of some of the larger tributaries, such as Dyke's creek (Allegany county), in Black creek (Monroe county) and in the lakes, especially Conesus lake. Below Rochester carp are abundant in the Genesee river during the spawning season in June and at that time run up from Lake Ontario into the marshes near the mouth of the river.

In spite of this wide distribution, carp can hardly be called abundant in the Genesee region. The greater part of the river is not well suited to this fish, which thrives better in sluggish, weedy waters than it does in streams having a swift current. Probably for this reason carp are rare in that part of the river above Letchworth Park. Above this section they have been found in several long, sluggish pools near Belvidere (Allegany county). As the Genesee river becomes larger and less rapid, below Mt. Morris, carp become moderately common. It is often said to be very abundant in Conesus lake, though few have been taken by operators of a licensed carp seine at Lakeville.

There is a natural tendency to over estimate the abundance of the carp. These fishes ''school'' in large numbers, especially at the spawning season, and being in shallow water at that time are often readily visible. The same number of fishes, when scattered over a larger area, would give an observer a different impression of the abundance of the species. The large, coarse-scaled redhorse suckers which are common in the Genesee river are easily confused with carp when seen in the water. Also, it is quite probable, that the widespread agitation throughout the country against carp may lead to exaggeration in particular cases.

The claim, that carp uproot aquatic vegetation and muddy the water, seems to have little importance in this reigon. Carp are bottom feeders and may both loosen the roots of water plants and cause roiliness of the water. L. J. Cole (1904) points out that carp may be nuisances in reservoirs by causing turbidity of the water. The Genesee river is often muddy, as are most rivers flowing through open, cultivated land, whether or not they contain carp. Conesus lake does not show any appreciable amount of carp damage in the matter of roily water or of destruction to plant growth.

Persons sometimes make specific charges that carp eat other fishes, and it is often stated that they destroy spawn and consume food at the expense of better fishes. It is impossible for carp to prey upon other fishes. The mouth is small and without teeth. This point has been well demonstrated by Cole (1904), who states that ''the carp is obviously unadapted by structure for capturing other fish for food.''

Authorities do not deny, however, that carp may take spawn of other fishes when occasion presents. Indeed, Cole found that three stomachs out of thirty-three examined contained whitefish spawn. However, only one egg was present in each of the three stomachs and this author concludes that the amount of whitefish spawn consumed is insignificant.

It is the general opinion of authorities that fishes of the bass family (*Centrarchidae*), which protect their nests, are able to successfully defend them against the carp, which is not a pugnacious fish. Cole (1904) mentions the robbing of a temporarily deserted sunfish nest by a small perch (*Perca flavescens*), a log-perch (*Percina caprodes*) and a minnow (*Notropis whipplii*), but careful study of this question by this worker brought no evidence of this kind against the carp. Carp may occasionally find and devour spawn in searching over the bottom for other food, but the assertion that they extensively seek out and eat spawn remains to be proven.

The most tenable argument against carp in relation to other fishes is that they compete for food. In connection with this point it is important to study the food of both young and adult carp.

The stomachs of twelve* young carp ($1\frac{7}{8}$ to $2\frac{3}{8}$ inches long) taken from Casadaga creek (Chautauqua county, N. Y.) on July 14, 1925, were examined:

Food Item	*No. of Stomachs in which Contained*
Crustacea	9
Ostracoda	7
Cladocera	7
Copepoda	2
Aquatic insects	8
Diptera (adults)	3
Diptera (larvae or pupae)	5
Zygoptera (nymphs)	2
Pupae (unindentified)	1
Snails	4
Rotifera	1
Algae	2
Cladophora	1
Green algae (unidentified)	1

A $4\frac{3}{8}$-inch carp from Cayuga lake (Tompkins county, N. Y.) on October 6, 1926, contained nearly 100 per cent animal food, including snails, midge larvae (*Chironomidae*), plankton crustaceans (*Cladocera, Copepoda*), caddis larvae (*Trichoptera*) and fragments of an unidentified insect. Bits of fine mud and numerous unicellular plants (*diatoms, desmids*) indicated that some food, at least, was from the bottom. Adults of the carp (Forbes and Richardson, 1908) are "omnivorous feeders, taking principally vegetable matter, but insect larvae, crustaceans and mollusks and other small aquatic animals as well." They feed principally at the bottom and sort out small animal life from the mud.

It is probable that both young and adult carp compete for food with our game fishes. In turn, it is quite probable that young carp may serve as food for predaceous game fishes, such as the basses, pikes and the pikeperch.

* Ten of the examinations by Emmeline Moore.

RED-SIDED DACE, *Clinostomus elongatus* (Kirtland)
Breeding colors from male about 3 inches long.

PLATE No. 1.

LONG-NOSED DACE, *Rhinichthys cataractae* (Cuvier and Valenciennes)
Breeding colors from male about 3 inches long.

PLATE No. 2.

PEARL MINNOW, *Margariscus margarita* (Cope)
About 3 inches long.

PLATE No. 3.

SATIN-FIN MINNOW, *Notropis whipplii* (Girard)
Breeding colors from male $4\frac{1}{8}$ inches long.

PLATE No. 4.

RED-FIN SHINER, *Notropis cornutus* (Mitchill)
Breeding colors from male 4⅜ inches long.

PLATE No. 5.

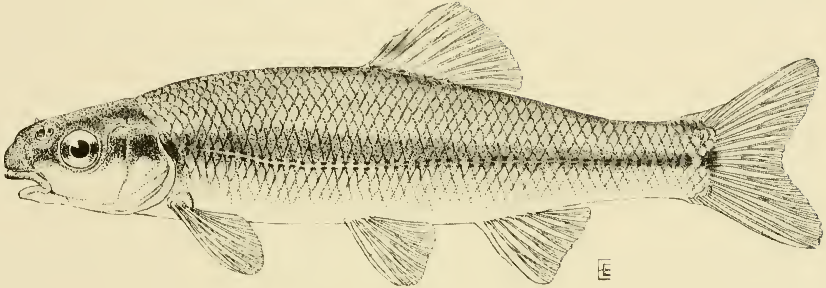
BLACK-NOSED DACE, *Rhinichthys atronasus* (Mitchill)
About 2¾ inches long.

PLATE No. 6.

STONE-ROLLER MINNOW, *Campostoma anomalum* (Rafinesque)
Breeding colors from male $5\frac{1}{3}$ inches long.

PLATE No. 7.

SCULPIN, *Cottus bairdii* Girard
From female 3 inches long.



BLUNT-NOSED MINNOW, *Hyborhynchus notatus* (Rafinesque)
$3\frac{1}{4}$ inches long.

PLATE No. 8.

ANNOTATED LIST OF FISHES OCCURRING IN THE GENESEE RIVER DRAINAGE *

ACIPENSERIDAE *Sturgeons*

Acipenser fulvescens Rafinesque.—Lake Sturgeon. A Great Lakes species. Reported (Mr. Chas. H. O'Donnell of Mumford) to ascend lower Genesee river very rarely. This fish was formerly more common in Lake Ontario (Smith 1890, p. 185).

LEPISOSTEIDAE *Gar Pikes*

Lepisosteus osseus (Linnaeus).—Long-nosed gar pike, billfish. Common in Lake Ontario (Evermann and Kendall, 1901). Doubtless enters the mouth of the Genesee river, though none were seen.

AMIIDAE *Bowfins*

Amia calva Linnaeus.—Bowfin, dogfish, mudfish. Occurs in Lake Ontario (Smith 1890, p. 213). Doubtless enters lower Genesee river in spring at spawning season. None were seen.

AMEIURIDAE *Catfishes*

Ameiurus nebulosus (Le Sueur).—Common bullhead, horned pout. Locally abundant. Lakes, ponds and sluggish streams. Thrives best in warm waters where bottom is mud or muck and weeds are present. An excellent food fish. Natural range has been increased by artificial planting in numerous ponds and reservoirs of the region. August 19. Silver lake, specimens up to 14½ inches (2 lb.) common. Food of 17 from 10–14½ inches was 100% midge larvae (*Chironomus plumosus*), taken from mud on bottom in 15 to 30 feet of water.

Ameiurus melas (Rafinesque).—Black bullhead. Rare. Our two specimens are from warm streams: Genesee river below dam at Belmont; and a tributary of Black creek (Allegany Co.).

Noturus flavus Rafinesque.—Stone-cat. Rare. Warm, shallow streams with hard bottom. Rapids. Genesee river near Pennsylvania boundary; near Belvidere (Allegany Co.); 2 miles north of Mt. Morris; Van Campen creek (Allegany Co.). A good bait for small-mouthed black bass, but rare.

Schilbeodes gyrinus (Mitchill).—Tadpole stone-cat. Recorded from the Genesee river from below Gold (Potter Co.), Pennsylvania (Fowler, 1907). Probably occurs in our limits but is rare and was not taken.

CATOSTOMIDAE *Suckers*

Catostomus commersonnii (Lacépède).—Common sucker, white sucker, mullet. Abundant. Streams and lakes. Warm or cold waters. The only sucker common in trout streams of the region. A common food fish, especially in spring when it is caught on hook baited with angleworm. Flesh good but bony. Small specimens are used as bait for pike and pickerel in the lakes. June 18, Brimer brook (Allegany Co.), 2⅝ inches. Food: mud containing diatoms and filaments of algae. August 4, Honeoye creek, 6 inches. Food: mud containing diatoms and a few midge larvae (*Chironomidae*).

Hypentelium nigricans (Le Sueur).—Hog sucker, stone-roller sucker, hog molly, black sucker. Abundant. Warm, shallow waters usually with swift current and bottom of rubble or other hard material. Little used as food fish due to small size and numerous bones. Young are good bait fish for small-mouthed bass. July 6, Caneadea Creek, young (⅞ inch). Food: about 40 crustacea (*Chydorinae*) which were 95% of the content. Midge larvae (*Chironomidae*) made up the other 5%. A wheel animalcule (*Rotifera*) and diatoms amounted to a trace. August 4, Honeoye creek, 7¼ inches. Food: a small quantity of mud, containing a few diatoms.

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* In the following annotated list the nomenclature has been largely based upon that given by Professor Carl L. Hubbs in "A Check-List of the Fishes of the Great Lakes and Tributary Waters."

Erimyzon sucetta oblongus (Mitchill).—Mullet, chub sucker. Recorded from the Genesee river at Gold (Potter Co.), Pennsylvania (Fowler, 1907). Also occurs in Lake Ontario tributaries. No specimens taken from the New York State part of the Genesee drainage though it should occur there.

Moxostoma aureolum (Le Sueur).—Red-horse sucker, red-fin mullet. Common. Large warm streams. Usually in pools with moderate to strong current. The largest and most important sucker as food, reaching a weight of about 5 lb. August 4, Honeoye creek, 9 inches. Food: mud containing filaments of algae and many diatoms and the following animal matter: 8 midge larvae (*Chironomidae*), 5 crustacea (*Cyclops*).

Moxostoma lesueurii (Richardson).—Short-headed red-horse sucker, red-fin mullet. Moderately common. Large warm streams, often occurring with the preceding species. As good a food fish as *Moxostoma aureolum*, but not as large.

CYPRINIDAE *Minnows*

Campostoma anomalum (Rafinesque).—Stone-roller, dough-belly. Common in warm, shallow streams. Occasionally present in trout waters but rare there. Commonly used as a bait minnow for the larger game fishes. June 29, Genesee river at Belmont, 3½ inches. Food: mud containing diatoms. July 6, Caneadea Creek, 1⅛ inches. Food: mud containing 2 midge larvae (*Chironomidae*) which were 25% of the food. The mud was very rich in diatoms.

Hybognathus nuchalis Agassiz. Silvery minnow. Rare. One specimen taken in lower Black Creek (Monroe Co.).

Pimephales promelas Rafinesque.—Fathead minnow, blackhead minnow. Rare. Ponds and sluggish streams of warm or rather cold water. Dykes creek (Allegany Co.); Browning Spring Cove (Allegany Co.); Genesee river near Belmont; pond near Pennsylvania line (Allegany Co.). June 22, spawning in the last named locality. A male 2⅞ inches long defended the eggs, attached side by side, to the under side of a stick in water 8 inches deep. Eggs 1/16 inches in diameter, round, opaque. Mass 4″ x 1⅓″; contained approximately 700 eggs. Water temperature 67° F. Air 71° F. Food of one 1 9/16″ specimen from this pond at this date was mud containing diatoms and desmids.

Hyborhynchus notatus (Rafinesque).—Blunt-nosed minnow. Common in warm streams, ponds and lakes. Taken twice in brown trout stream in limited numbers. A good bait minnow for basses and yellow perch. July 1, Rockville reservoir (Allegany Co.) spawning. Male guarded eggs which were in a mass, side by side, on the under side of an old milk can top in shallow water. June 29, Genesee river at Belmont, N. Y. 2⅝ inches. Food: contained a few filaments of algae and some diatoms.

Semotilus atromaculatus (Mitchill).—Horned dace, creek chub, chub. Abundant in small streams. Less common in large, deep waters. Thrives in trout waters and warm streams. Large individuals are easily caught on worm, crawfish or artificial fly and are occasionally used for food. Smaller ones are popular as bait minnows. Food of 7 specimens 1¾ to 8 inches long from streams of Genesee region July, June, August: Aquatic insects 31.4%, land insects 28.4%, crawfish (1 stomach) 14.3%. Snails 7.3%, grass seeds (1 stomach) 2.8%, vegetable debris (2 stomachs) 15.7%.

Clinostomus elongatus (Kirtland).—Red-sided minnow. Locally common. Pools and quiet waters of small, cool streams, avoids both warm and very cold waters. Present in a few brown trout streams. A very active minnow feeding largely at the surface, even rising to artificial flies. Appears to be an attractive bait minnow. June 20, Fulmer Valley stream (Allegany Co.). Food: a large adult fly and fragments of another winged insect. This fish was a female 3¾ inches long, nearly ready to spawn. The patches of red on the sides were very brilliant.

Margariscus margarita (Cope).—Pearl minnow. Locally common, limited to small, cool, or cold streams. Pools of moderate or strong current. Often present in trout waters, occurring in as cold waters as any other minnow of the region. July 19, Wiscoy creek. 2⅞ inches. Food: about 25 midge larvae (*Chironomidae*), 3 adult midges (*Chironomidae*) and a trace of diatoms. September 2, tributary of Black creek (Monroe Co.). 3 inches. Stomach contained only fragments of vegetable debris.

Notemigonus crysoleucas (Mitchill).—Golden shiner, roach. Locally common,—lakes and warm, weedy streams (notably Black creek, Monroe Co.). Prefers sluggish waters where plants are present. A choice bait for fishes of the pike family in the lakes and an important natural food for these fishes. September 2, Black creek (Monroe Co.), 3 9/16 inches. Food: algae (*Spirogira*) to the extent of 95%. The other 5% consisted of one water mite (*Hydracarina*).

Notropis heterolepis Eigenmann and Eigenmann.—Black-nose shiner. Rare. A single specimen from Dykes creek (Allegany Co.), June 21.

Notropis heterodon (Cope.)—Rare. A few small specimens were taken in Black creek (Monroe Co.) among weed beds. Occurs in Lake Ontario (Evermann and Kendall 1901), and could be expected in lower Genesee river. September 2, Black creek (Monroe Co.), 1 3/16 inches. Food: small crustacea (mostly *Chydorinae*).

Notropis deliciosus Girard.—Straw-colored minnow. Common in Genesee river and large, warm tributaries. Strong to moderate current. An important food resource of small-mouthed black bass in the river. June 29, Genesee river at Belmont (below dam) 2¼ inches. Food: mud containing diatoms, and other small algae. July 6, Genesee river near Caneadea (Allegany Co.) 2⅜ inches. Food: diatomaceous mud containing one midge larva (*Chironomidae*) and a few fragments of green and blue-green algae.

Notropis hudsonius (DeWitt Clinton).—Spot-tailed minnow, "smelt." A lake species. Occurs moderately commonly in lower Genesee river below Rochester falls. Used for yellow perch bait near mouth of the river. September 6, Genesee river, ¼ mile from mouth, 1½ inches. Food: plankton crustacea (fragments of about 15 *Cladocera*).

Notropis whipplii (Girard).—Satin-fin minnow, silverfin. Common in Conesus lake. Rather rare in the Genesee river and larger tributaries. Stream specimens were from warm water with moderate current. A good bait minnow though uncommon in the region. August 30, Canaseraga creek 3 1/16 inches. Food: rat-tailed maggot (*Eristalis*) and fragments of an adult insect. This fish was collected from clean water just above entry of cannery wastes.

Notropis gilberti (Jordan and Meek).—Rather rare. Genesee river and larger, warm tributaries. Usually found in moderate to sluggish current over mud or sand bottom. July 22, Canaseraga creek near Dansville, 2 1/16 inches. Food: 2 midge larvae (*Chironomidae*), fragments of 3 small insects (1 *Coleoptera*) and numerous diatoms.

Notropis cornutus (Mitchill).—Common shiner, red-fin. Abundant throughout streams becoming less common in the lower waters of the Genesee where it is replaced by the next species. Warm and sometimes cold waters, being moderately common in some brown trout streams. Takes a small bait readily and large specimens will sometimes rise to an artificial fly. Ranks high as a bait fish. A plentiful food supply for small-mouthed black bass and pike-perch in the river. June 20, Fulmer Valley stream (Allegany Co.), 4⅜ inches. Food: 85% plant matter consisting of green algae, diatoms and blue-green algae; the 15% animal food was made up by a caddis worm (*Trichoptera*) and a small fly (*Diptera*). June 24, Vandermark creek (Allegany Co.). Spawning was witnessed by Dr. G. C. Embody and Mr. W. J. Hamilton, Jr. who took the following notes: Nest 1 foot in diameter, 2 inches deep, composed largely of gravel size of hickory nut and an occasional stone size of an egg. Guarded by brilliantly colored male who spawned with several females. The male wrapped its tail over the caudal peduncle of the female and the two anal openings were close together for a fraction of a second. During this time the eggs were ejected and fertilized. They fell between crevices of the stones and were immediately sought out by black-nosed dace, fantailed darters and red-sided minnows, who "stood on their heads" and wedged down between the stones to reach the eggs. The male opposed this but was unable to keep the numerous fishes away. A larger male shiner drove the original one from the nest and took his place for a few minutes after which the smaller one returned and spawned with several more females. The water at the nest was 8 inches deep and its temperature was 73° F.

Notropis cornutus chrysocephalus (Rafinesque).—A well defined variety of the preceding, having the scales before the dorsal fin much larger. Common in the Genesee river for about 10 miles above Rochester falls and in lower Black creek (Monroe Co). A few specimens were taken at the mouth of the river. All were from warm waters.

Notropis atherinoides Rafinesque.—Emerald minnow, slender minnow. The distribution in the region is similar to that of the preceding species. September 4, Genesee river near Henrietta, N. Y., 2 13/16 inches. Food: finely ground insect remains; at least one insect was an adult midge (*Chironomidae*).

Notropis rubrifrons (Cope).—Rosy-faced minnow. Closely allied to the preceding species but frequents swifter streams. Common in the Genesee river and its larger tributaries. Warm, shallow waters of strong current. An important food resource for small-mouthed black bass in shallow, rapid parts of the river. July 6, Genesee river near Caneadea (Allegany Co.), 2 15/16 inches. Food: 90% animal matter of which 2 young caddis larvae (*Trichoptera*) were 30%, 1 mayfly nymph (*Ephemerida*) was 20%, 2 adult midges (*Chironomidae*) were 20%, one black fly larva (*Simulium*) was 20%. The vegetable matter, amounting to 10%, was green algae (*Spirogira*).

Rhinichthys cataractae (Cuv. and Val.).—Long-nosed dace. Moderately common in shallow, rapid, warm streams. Taken only once in a brown trout stream. Rapids or very swift water. July 2, Genesee river at Belmont, 2⅞ inches. Food: a large quantity of green algae (*Ulothrix*). July 6, Genesee river near Caneadea, N. Y., 3 5/16 inches. Food: 10% insect food consisting of mayfly nymphs (*Ephemerida*), caddis-fly larvae (*Trichoptera*), midge larvae (*Chironomidae*) and a trace of algae (*Spirogira*). July 19, Wiscoy creek (taken in slight milk pollution), 3⅞ inches. Food: 50% pollution worms (*Tubificidae*). Several adult midges made up the other 50%. A few diatoms and fragments of filamentous algae were present.

Rhinichthys atronasus (Mitchill).—Black-nosed dace. Abundant in small creeks. Both warm and cold waters. Nearly always present in trout streams. Avoids large streams and is very rare in the Genesee river even in the more shallow parts. Inhabits rapids or pools with strong current. Sometimes sold as a bait minnow. Brown trout feed to some extent upon this fish. Food of 6 specimens from streams of the Genesee system collected during June, July and August were: midge larvae (*Chironomidae*) 70.8%, mayfly larvae (2 stomachs) 16.6%, adult insects, (2 stomachs) 5%, crustacea (1 stomach) 1.6%, water mites (1 stomach) 0.8%, diatoms and vegetable debris (2 stomachs) 5%.

Nocomis biguttatus (Kirtland).—River chub, hornyhead. Locally rather common. Large warm streams. Moderate current. Genesee river about 10 miles south of Rochester; Black creek (Monroe Co.). Appears to replace the horned dace (*Semotilus atromaculatus*) in the large deep section of the Genesee river from near Avon to Rochester. September 2, Black creek (Monroe Co.), 3½ inches. Food: fragments of about 10 small clams (*Sphaerium*?).

Exoglossum maxillingua (Le Sueur).—Cut-lips minnow, nigger chub. Moderately common in warm streams, preferring a moderate current and a gravel or rubble bottom. June 23, Genesee river near Pennsylvania boundary. Cut-lips was seen on spawning nest. This was a rounded small mound of pebbles 17 inches in diameter and 5 inches deep at the center. A male 4½ inches long guarded the nest, occasionally adding a pebble, which he picked up and brought with his mouth. A few eggs (about a dozen) were found on the upstream slope of the mound, adhering loosely to the gravel. They were 3/32 inches in diameter and opaque and flattened on one side. The water temperature was 69° F. and the air 71° F. The pool where the nest was located was 19 inches deep with moderate current. The bottom was gravel covered by about ½ inch of fine silt. August 4, Honeoye creek (Monroe

Co.). Food: a 3 inch fish contained 3 midge larvae (*Chironómidae*) and a minute quantity of mud. A 5¼ inch individual contained the claw of a small crayfish (*Cambarus*) in its intestine.

Cyprinus carpio Linnaeus.—German carp. An introduced fish. Locally common in deep, sluggish parts of the Genesee river, the lower waters of some of the largest tributaries and in the lakes. Very common in the lower Genesee river in the spring when it runs from Lake Ontario to spawn. Warm waters, especially among weeds. Not regarded by most persons as a good food fish. Many anglers consider it destructive.

ANGUILLIDAE *Eels*

Anguilla rostrata (Le Sueur).—Common eel. Present in Lake Ontario (Evermann and Kendall 1901) and is occasionally taken in the Genesee river near its mouth according to fishermen. Occurs above Rochester falls but is rare. (Mr. Edw. S. Bush of Rochester has taken it about 10 miles south of the city.) Does not occur above Portageville falls. A good food fish though rare in our region.

CLUPEIDAE *Herrings*

Pomolobus pseudo-harengus (Wilson).—Alewife, sawbelly. Abundant in Lake Ontario. Enters the mouth of the Genesee river in spring to spawn in great numbers. Young were found moderately common in the river near its mouth on September 6, 1926. Dr. T. H. Bean (Bean 1884) believes that this fish was unintentionally introduced into Lake Ontario with fry of shad. The alewife was first observed in the lake in 1873 according to this authority. Dr. H. M. Smith (Smith 1892) states that the alewife has little commercial value as a food fish. Young individuals are used as bait in Lake Ontario.

COREGONIDAE *Whitefishes*

Coregonus clupeaformis (Mitchill).—Common whitefish. Present in Hemlock lake; reported to occur in Silver lake. The one specimen from Hemlock lake was taken on September 19, 1926, and is 7¼ inches long. Much larger ones are said to occur here, though they are seldom seen as they inhabit deep waters and do not take a bait readily. An excellent food fish but unimportant here.

Leucichthys artedi (Le Sueur).—A colored plate by S. F. Denton, published with Dr. T. H. Bean's report on the "Food and Game Fishes of New York" (1901), bears the name "Cisco from Hemlock lake (*Argyrosomus artedi* Le Sueur)". Some species of cisco inhabit Hemlock lake according to fishermen of the vicinity and on September 19, 1926, we observed fishes of this type jumping at the surface of the lake but were unable to collect any specimens.

SALMONIDAE *Salmons*

Salmo fario Linnaeus.—Brown trout, German brown trout. An introduced species. Locally common, being well established in nearly all streams suitable for it. Requires cool waters (having a maximum temperature of not over about 80° F.). The most common trout of the region. An excellent food fish and game fish. Food of 10 individuals taken in the Genesee river during June, July and August 1926 was: land insects 43.1%, aquatic insects 37.8%, snails (3 stomachs) 4.2%, suckers (*Catostomus commersonnii*, 1 stomach) 4%, minnows (1 *Rhinichthys atronasus* and 1 unidentifiable, 2 stomachs) 3.4%, crawfish (1 stomach) 1.8%, grass seeds (3 stomachs) 0.7%, unidentified 5%. These trout ranged from 6 to 12 inches in length.

Salmo irideus Gibbons.—Rainbow trout. An introduced species. Locally common. The temperature requirements are about the same as those of the brown trout, though the rainbow will perhaps tolerate slightly warmer water than the latter.

Rainbow trout have been introduced into many of the trout waters of the region but do not mature and reproduce well in a stream unless it is tributary to a large, cool body of water. In this region one of the best rainbow streams is the Genesee river north of Belmont. Fish from this water have the Belmont dam to stop them in their downward migration after the spawning run in the spring.

An excellent game fish though not as good for food as our other two stream trouts. The food of 5 specimens from 5 to 14 inches from the Genesee river taken in June, July and August 1926 was: Aquatic insects 43%, land insects 36%, snails (1 stomach) 11%, minnows (1 stomach) 6%, algae (*Cladophora*, one stomach) 12%, grass seeds (1 stomach) 3%.

Cristivomer namaycush (Walbaum).—Lake trout. One young specimen was taken in Hemlock lake September 19, 1926 where the fish is said to be rather common, occurring in the deep waters where the temperature is low. A lake trout weighing several pounds was caught by a fisherman in Conesus lake in July, 1926, and the head of this fish was seen by Dr. G. C. Embody. They are said to be unusual in this lake. An excellent food fish but unimportant in the region.

Salvelinus fontinalis (Mitchill.)—Brook trout, native trout. Locally common in streams suitable for it (having a maximum temperature of not over about 75° F.). Was formerly abundant throughout the region before cutting off of the forests (Turner 1851, p. 375). It is now practically confined to certain smaller streams, especially at the headwaters, as most large streams are now too warm. Is considered the best of food and game fishes by most anglers. The food of 6 specimens from the Genesee region taken in June, July and August 1926 was: aquatic insects 48%, land insects 46%, snails (1 stomach) 4.1%, grass seeds (2 stomachs) 1.8%.

UMBRIDAE *Mud Minnows*

Umbra limi (Kirtland).—Mud minnow. Locally common. Taken in warm and rather cool tributaries of Black creek (Monroe Co.) September 2, 1926. Prefers sluggish, weedy waters with mud bottom. September 2, Black creek (Monroe Co.)—Food: one 2⅝ inches long had eaten insect larvae and small crustacea. Another 2⅞ inches long had taken a beetle larvae (*Coleoptera*) and crustacea.

ESCIDAE *Pikes*

Esox niger Le Sueur.—Chain pickerel, common pickerel. Locally common. Honeoye, Canadice and Hemlock lakes. Doubtless enters the Genesee river through the outlets of these lakes but is reported rare by fishermen on the river. Thrives best in warm, rather shallow, weedy situations. A good food and game fish. September 19, Hemlock lake. Food: a 15 inch pickerel contained a few small fish vertebrae. One 11½ inches long had eaten a golden shiner (*Notemigonus crysoleucas*) about 2 inches long. A 5¾ inch fish contained a sunfish (*Eupomotis gibbosus*) about ¾ inch in length.

Esox lucius Linnaeus.—Great northern pike, "pickerel." Locally common. Inhabits much the same type of water as the preceding species, Silver lake, Conesus Lake, Genesee river about 10 miles south of Rochester, Black creek (Monroe Co.). Reported by fishermen north of Rochester to run up from Lake Ontario to spawn in marshes along the lower river. "There was no pickerel or pike above Genesee Falls, until 1810 when William Wadsworth and some others caught pickerel in Lake Ontario and other Lake fish and put them into Conesus Lake." (Turner, 1851, p. 375). August 17, Silver lake. Food: a 6½ inch pike had eaten 2 yellow perch (*Perca flavescens*) 1½ inches long and a 12 inch fish contained only a dragon fly nymph (*Anax junius*). September 4, 1926; Genesee river about 10 miles south of Rochester, 10⅝ inches: Food: one log perch (*Percina caprodes*) 4¾ inches in length. An excellent food and game fish but all of the family are destructive of other fishes.

Esox masquinongy (Mitchell).—Muskalonge. An introduced species; has been planted in Honeoye and Conesus lakes. No authentic records of specimens from these lakes are available.

CYPRINODONTIDAE *Killifishes*

Fundulus diaphanus menona Copeland and Jordan.—Barred killifish, fresh-water killy. Common along the shores of Lake Ontario and probably enters the mouth of the river. Specimens obtained only from Black creek (Monroe Co.) a warm, sluggish stream. Used as bait for perch near the mouth of the river. September 2, Black creek (Monroe Co.), 1 5/16 inches. Food: 70% crustacea (mainly *Hyalella knickerbockeri*) and 30% midges (*Chironomidae*).

GASTEROSTEIDAE *Sticklebacks*

Eucalia inconstans (Kirtland).—Brook stickleback. Locally common. Weedy streams or ponds. Warm or cold waters; found sometimes in trout waters if weeds are present. Browning Cove (Allegany Co.); Black creek and tributaries (Monroe Co.). September 2, Black creek (Monroe Co.), 1 9/10 inches. Food: 60% young aquatic insects (*Zygoptera, Chironomidae*), 20% crustacea (*Cyclops, Cladocera, Ostracoda*), 8% water mites (*Hydracarina*), 12% snails (*Mollusca*).

Gasterosteus aculeatus cuvieri (Girard).—Two-spined stickleback. Present in Lake Ontario and enters the mouth of the Genesee river. A small specimen was taken among weed beds near the river mouth on September 6.

PERCOPSIDAE *Trout Perches*

Percopsis omisco-maycus (Walbaum).—Trout-perch. Moderately common in rather large, warm streams. Prefers moderate current and mud or rubble bottom. June 29, Genesee river below Belmont dam, 3¼ inches. Food: Midge larvae (*Chironomidae*). Crustacea (*Cyclops*), and adult fly (*Diptera*), and a black fly larva (*Simulium*).

CENTRARCHIDAE *Sunfishes*

Pomoxis sparoides (Lacépède).—Calico bass, strawberry bass. Recorded from Lake Ontario "especially in bays, ponds, and bayous with grassy shores connected with or adjacent to the lake" (Smith 1890). This author says it "seems to be especially abundant in Irondequoit Bay (Monroe Co)." Probably enters the mouth of the Genesee river in limited numbers.

Ambloplites rupestris (Rafinesque).—Rock bass, goggle-eye. Common in the Genesee river and largest tributaries and in the lakes and some ponds. Usually found in moderate or sluggish current, often among weeds. A good food and game fish of the "pan fish" type. Four of the five specimens examined from this region contained only crawfish. These fish were from 5½ to 10 inches long and were collected in July, August and September, 1926. An 8 inch rock bass from Silver lake August 17, 1926 contained 3 yellow perch (*Perca flavescens*) each about 1½ inches long and had also eaten a fragment of a water plant (*Vallisneria*).

Eupomotis gibbosus (Linnaeus).—Sunfish, "pumpkinseed." Common in the lakes and in many ponds. Present in sluggish parts of the Genesee river and in its largest tributaries but is rather rare in most streams. Common in Black creek (Monroe Co.) in weedy places. Not as useful a food fish as the preceding species due to smaller size. September 2, Black creek (Monroe Co.). 3⅝ inches. Food: 13 midge larvae (*Chironomidae*) and one crustacean (*Hyalella knickerbockeri*).

Micropterus dolomieu Lacépède.—Small-mouthed black bass. The commonest game fish of the region. Common in the Genesee river throughout most of its course. The most southern record for the river was Wellsville (Allegany Co.). No specimens were obtained below Rochester falls. Moderately common in Conesus and Hemlock lakes. Rare in Silver and apparently absent from Honeoye lake. Occurs rather commonly in large, warm tributaries of the Genesee river. One of the gamiest of fishes. Maintains itself well by natural spawning in the river. The food of 13 specimens from the Genesee region taken in July, August and September was: crayfish 56%. aquatic insects 24.2%, minnows (1 stomach) 7.7%, sunfish (1 stomach, *Eupomotis gibbosus*) 7.7%, suckers (1 stomach, *Hypentelium nigricans*) 3% land insects (1 stomach) 1.4%. These bass were from 7½ to 12½ inches long. July 6, Caneadea creek (Allegany Co.). A bass 1 inch long had eaten small mayfly nymphs (*Ephemerida*), midge larvae (*Chironomidae*), a small fly (*Diptera*), and small crustacea (*Phyllopoda, Copepoda*). August 8, Honeoye creek. 4 bass from 2 to 4½ inches taken in water polluted by cannery waste. had eaten numerous midge larvae (*Chironomidae*). June 28, Genesee river near Belfast (Allegany Co.). Several schools of fry were seen. One 12 inch female taken on this date contained eggs which were nearly ripe.

Aplites salmoides (Lacépède).—Large-mouthed black bass. Much less common than the preceding species. Warm waters. Locally common in many weedy ponds. Rather frequent in Honeoye, Hemlock, Conesus, and Silver lakes, especially the first named. Rare in the Genesee river which does not seem to be weedy enough for the fish. Moderately common in Black creek (Monroe Co.). Nearly as fine a fish as the preceding species. July 4, Rockville reservoir (Allegany Co.). One specimen contained crawfish, one contained crawfish and a few minnow vertebrae, and one had eaten a horned dace (*Semotilus atromaculatus*) 3½ or 4 inches long. These bass were about 12 inches in length.

PERCIDAE *Perches*

Stizostedion vitreum (Mitchill).—Pike-perch, pike, wall-eyed pike. Moderately common in the Genesee river from Mt. Morris to Rochester and in some of the lakes. Has been introduced into the Genesee river above Portageville falls and at the Belmont dam but is rare in the river above these falls. Specimens were obtained at Silver lake, Conesus lake, Genesee river 2 miles below Mt. Morris, lower Black creek (Monroe Co.). Occurrence of this fish was reported also in Honeoye lake, in the Genesee Valley Power Co. reservoir on Wiscoy creek and in lower Canaseraga creek. The pike-perch frequents strong or moderate current in the river. It is more common in still waters of lakes, however. Our specimens came from warm waters. It is a voracious fish. Has excellent flesh and is popular with anglers. The food of 7 specimens from 13 to 27 inches long from Conesus lake, Silver lake, and the Genesee river in August was: young yellow perch (*Perca flavescens*) 52.8%, aquatic insects (2 stomachs) 18.8%, suckers (1 stomach) 14.2%, minnows (1 stomach) 14.2%.

Perca flavescens (Mitchell).—Yellow Perch. Common in lakes and many ponds. Absent in most streams except the largest. Warm waters. Specimens were secured in: Silver lake, Conesus lake, Hemlock lake, Honeoye lake, Black creek (Monroe Co.), Genesee river about 10 miles south of Rochester, Genesee river near mouth. A very good food fish and has game qualities. July 24, Hemlock lake, 8 inches. Food: 12 snails (*Physa*), 12 crustaceans (*Hyalella knickerbockeri*), 1 caddis worm (*Trichoptera*), 12 mayfly nymphs (*Ameletus*), and a fragment of vegetable debris. August 19, Silver lake. Four large perch from 10 to 11½ inches long had eaten midge larvae and pupae (*Chironomus plumosus*). These fish had been feeding at the bottom in 15 to 30 feet of water.

Percina caprodes (Agassiz).—Log perch, "stone-roller." Large, warm, streams of swift current and hard bottom, usually being found in the shallow parts. Widely distributed but rare. Dykes creek (Allegany Co.). Van Campen creek (Allegany Co.), Genesee river (Letchworth Park, 2 miles above Mt. Morris, 10 miles above Rochester). September 4, Genesee river about 10 miles south of Rochester. A large specimen 4¾ inches long (taken from the stomach of a northern pike) contained 7 crustaceans (*Gammarus*), 3 caddis larvae (*Trichoptera*), 7 midge larvae (*Chironomidae*), and an unidentified insect pupa.

Hadropterus maculatus (Girard).—Black-sided darter. Widely distributed in the Genesee river but rather rare. Warm waters. Usually found in shallow, swift water where the bottom is rubble or bedrock. Apparently absent in small streams. Genesee river: below Belmont dam, at Belvidere (Allegany Co.), 2 miles above Mt. Morris, ½ mile below Mt. Morris, about 10 miles above Rochester. July 7, near Mt. Morris, 1⅝ inches. Food: 6 midge larvae (*Chironomidae*) and a small mayfly nymph (*Ephemerida*).

Boleosoma nigrum (Rafinesque).—Johnny darter. Moderately common. Warm streams. Inhabits both swift and sluggish current and, unlike most darters, is often taken over a bottom of mud. September 2, Black creek (Monroe Co.). 2⅜ inches. Food: about 30 midge larvae (*Chironomidae*).

Catonotus flabellaris (Rafinesque).—Fan-tailed darter. Common. Rapid, shallow streams of warm or cold waters and hard bottom. Shows a preference for smaller streams but occurs also in the Genesee river, though rare below Portageville Falls. June 18, Brimer brook (Allegany Co.). 2 9/16 inches. Food: 3 small midge larvae (*Chironomidae*). Fan-tailed darters were taken with eggs at several places. June 25, Phillips creek (Allegany Co.). There were about 400 eggs, fastened side by side to the under side of a flat stone in shallow water where the current was moderate. The eggs were spherical, 3/32 inches in diameter and the egg mass formed a round patch on the stone. As the mass and its attachment were lifted from the water some eggs hatched, possibly due to the warmth of the sun. The young were ¼ inch long and had a rather small yolk sac. They were very active and quickly sought shelter under stones. Due to dark spots on the body they were inconspicuous when in the water. A male darter 2¼ inches long, probably the parent, was found under the stone which bore the eggs. The water temperature was 68° F. June 22, Cryder creek (Allegany Co.). Egg mass about 2 days from hatching and male taken under stone in swift, shallow water. Water 66° F. July 9, Angelica Genesee—2 (Allegany Co.). Egg mass (hatching) and male found under stone in shallow water. Water 76° F.

Etheostoma blennioides Rafinesque.—Green-sided darter. Genesee river and some of largest tributaries as Black creek (Monroe Co.), Honeoye creek (Monroe Co.). Warm waters. Rapids or swift shallow water with hard bottom. Moderately common in the Genesee river from Belmont to Black creek (Monroe Co.). June 29, Genesee river below Belmont dam. 2 inches. Food: 3 midge larvae (*Chironomidae*) and 1 crustacean (*Ostracoda*). Contained a trace of vegetable matter (diatoms).

SCIAENIDAE *Drum-fishes*

Aplodinotus grunniens (Rafinesque).—Sheepshead, fresh water drum. One specimen was said to have been caught from the dock of the Oak Hill Boat Club (Rochester). It is possible for some Great Lakes species to enter the river via the Erie canal.

COTTIDAE *Sculpins*

Cottus bairdii (Rafinesque).—Sculpin, Miller's Thumb, Blob. Moderately small shallow, swift streams with rubble or rock bottom. Occurs in warm or cold waters but seems to avoid large waters such as the Genesee river. June 18, Brimer brook (Allegany Co.). 1⅝ inches. Food: 2 young caddis worms and their cases (*Trichoptera*), a mayfly nymph (*Ephemerida*), and a small amount of filamentous algae and diatoms. July 6, Tributuary of Caneadea creek (Allegany Co.), 2⅛ inches. Food: 2 mayfly nymphs (*Chirotenetes, Heptagenia*), 3 midge larvae (*Chironomidae*), and a small fragment of algae. June 26, Nigger spring (Allegany Co.) Messrs. F. B. Smith and P. E. Hering found a sculpin with its egg mass. The eggs were spherical, ⅛ inch in diameter and yellow. They were in a grape-like mass of approximately 200 eggs, attached to the under side of a stone. A 3½ inch fish found with them was probably the male parent. The water temperature was 48° F.

Uranidea gracilis viscosa (Haldeman).—Miller's Thumb. Recorded from the Genesee river at Gold (Potter Co.), Pennsylvania, (Fowler 1907). Should occur in the Genesee drainage within New York State though not taken this season. Probably represents the species now known as *Cottus cognatus* Richardson in Hubbs' check-list (Hubbs 1926).

Literature Cited

Bean T. H. 1884. On the occurrence of the branch alewife in certain lakes of New York. The Fisheries and Fishery Industries of the United States. Section 1, Natural History of Aquatic Animals. Washington 1884.

Bean, T. H. 1901. Food and Game Fishes of New York. 7th Annual Report of Forest, Fish and Game Commission, State of New York.

Bean, T. H. 1903. Fishes of New York. N. Y. State Museum Bull. 60. Zoology 9.

Cole, L. J. 1904. The German carp in the United States, Rept. U. S. Fish Com. pp. 525-641.

Embody, G. C. & Gordon, Myron. 1924. A comparative study of natural and artificial foods of brook trout. Transactions of Am. Fish. Soc. pp. 185–200.
Evermann, B. W. & Goldsborough, E. L. 1901. Notes on the fishes and mollusks of Lake Chautauqua, N. Y. U. S. Com. of Fish and Fisheries. Commissioner's Report 1901 (1902). pp. 169-175.
Evermann, B. W. & Kendall, W. C. 1901. Notes on the fishes of Lake Ontario. U. S. Com. of Fish and Fisheries. Commissioner's Report 1901 (1902). pp. 209-216.
Forbes, S. A. 1914. Fresh water fishes and their ecology. Ill. State Lab. Nat. Hist. pp. 1–19.
Forbes, S. A. & Richardson, R. E. 1908. The Fishes of Illinois. Nat. Hist. Survey of Ill. Ill. State Lab. Nat. Hist.
Fowler, H. W. 1907. Records of Pennsylvania fishes. American Naturalist Vol. XLI, No. 481.
Hubbs, C. L. 1926. A check-list of the fishes of the Great Lakes and Tributary waters with nomenclatorial notes and analytical keys. University of Michigan, Museum of Zoology. Miscellaneous Publications No. 15.
Juday, Chancey. 1907. A study of Twin lakes, Colorado, with special reference to the food of the trouts. Bull. Bur. fisheries 26: p. 151-175.
Smith, H. M. 1890. Report on the fisheries of Lake Ontario. Bull. U. S. Fish Com. for 1890. pp. 177-215. Plates XXI-L.
Turner, Orsamus. 1851. Phelps and Gorham Purchase.

V. Vegetation of Silver Lake and Conesus Lake

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The writer and Mr. P. R. Burkholder visited Silver lake in the latter part of August and Conesus lake in early September, 1926, for the purpose of making a study of the plant life of these lakes as a part of the biological survey of the Genesee river system. The time available, about two weeks, was altogether too short to investigate all the problems of plant life that might have a bearing upon the fish population of these lakes. During the time that was spent at these lakes data were obtained respecting (1) the distribution of the larger aquatic plants in both lakes, (2) the distribution of the bottom fauna and flora in both lakes, (3) the quantity and vertical distribution of the plankton in Silver lake, (4) the transparency of the water of Silver lake.

Silver Lake.— Silver lake, in Wyoming county, lies in a shallow valley with very gradual slopes. The surrounding hills rise only a few hundred feet above the lake, which is 1,356 feet above sea level. The lake is about three miles long and about three-fourths of a mile wide in the widest place. Its shores are mostly stony or gravelly, except that at the north and south ends, where swamps occur, the shore and bottom are muddy. The lake is fed by springs. A small inlet and the outlet of Silver lake both occur at the north end.

The lake is shallow and the flat bottom is mostly about 25–35 feet deep. The deepest bottom found in the lake (Fig. 9) was 37 feet. The transparency of the water in Silver lake is low as compared with Conesus lake and may be termed "brown water."

A white disc 10 cm. in diameter lowered into the water at noon, August 26, 1926, disappeared from view 16 feet below the surface. On account of its shallowness and the low transparency of the water, Silver lake shows no stratification in its plankton life. Rooted plants occur only in the shallow water near the shore and at the ends of the lake; none were observed below the 15-foot depth.

Vegetation of Silver Lake.*— The largest beds of water weeds occur at the south end of the lake and at the north end, including the inlet and outlet streams. The vegetation along the east and west shores of the lake is very sparse except for a few beds of "weeds" in the small coves along the west shore. The most common plant in Silver lake is eelgrass (*Vallisneria americana*). Several species of pondweeds (*Potamogeton*) are also abundant and form the bulk of the vegetation in many places. Stonewort (*Chara sp.*) is very common and sometimes occurs in pure stands over extensive areas. The map (Fig. 9) indicates the character of bottom in the vegetation zone and shows the location of the most extensive beds of weeds found in Silver lake.

Plankton.— Quantitative estimations of net plankton and nannoplankton were made at three depths in Silver lake, namely, 1–10, 10–20, and 20–30 foot strata. The usual methods of obtaining and estimating them were employed.

In the net plankton no striking differences were noted in the plants of the different depths (Table 6). The most abundant plants found were diatoms, *Asterionella* sp. predominating. The blue-green algae were well represented. A "bloom" composed of *Rivularia*, *Anabaena*, and *Aphanocapsa* almost completely covered the surface of the lake during the latter part of August. The number of animals found in the net plankton was low. In the case of protozoa, with the exception of Ceratium, the figures probably do not represent a true value because it was not possible to make these counts at the time the plants were counted. The enumeration of undetermined animals, practically all protozoa, at the time shows that there were large numbers of individuals present. By comparison with the net plankton the nannoplankton values are low.

* For a complete list of the larger plants growing in Silver lake and Conesus lake, see Appendix VII.

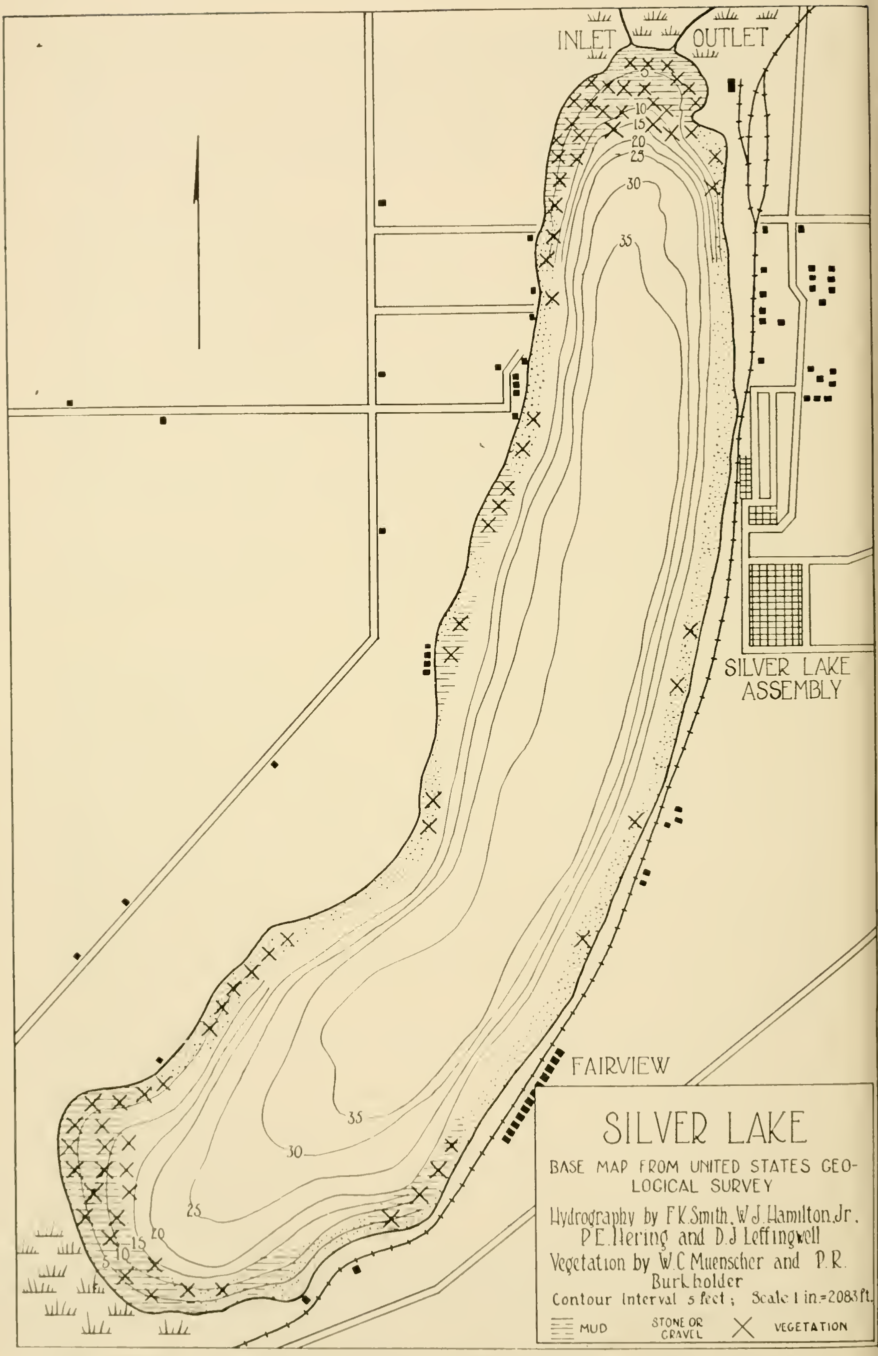


Fig. 9. Map of Silver Lake showing depth, character of shore, and location of the larger weed beds.

Table 6.—Enumeration of Plankton Organisms Obtained from Silver Lake, August 26, 1926

Phytoplankton recorded in number of organisms per litre.
Zooplankton recorded in number of organisms per cubic meter.

	Net Plankton			Nannoplankton		
	1–20 ft. depth	10–20 ft. depth	20–30 ft. depth	1–10 ft. depth	10–20 ft. depth	20–30 ft. depth
Phytoplankton:						
Diatoms (mostly Asterionella).	2,597	880	7,648	115,600	51,000	71,300
Blue-green Algae						
Anabaena	1,240	1,653	1,488	57,800	41,000	43,200
Aphanocapsa	558	558	775	....	....	....
Chroococcus	....	248	....	....	....	....
Coelosphaerium	310	124	341	23,000	40,800	37,000
Gomphosphaeria	279	186	....	....	....	....
Oscillatoria	31	....	62	....	....	....
Green Algae						
Staurastrum	517	556	1,271	34,000	132,000	....
Pediastrum	....	....	31	....	....	....
Unicellular species	279	124	181	17,000	17,000	15,500
Zooplankton:						
Protozoa						
Ceratium	93,000	155,000	372,000	....	....	....
Mallomonas	....	....	....	....	167	....
Undetermined	....	....	....	500	666	....
Rotifera						
Polyarthra	500	500	1,000	....	....	....
Rattulus	167	....	....	....	....	....
Asplanchna	167	500	....	....	....	....
Conochilus	167	....	....	....	....	....
Cladocera						
Bosmina	333	167	333	....	....	....
Daphnia	167	333	667	....	....	....
Copepods						
Cyclops	167	....	....	....	....	....
Nauplii	1,167	333	832	....	....	....
Diaptomus	....	....	167	....	....	....
Undetermined	155,000	248,000	93,000	....	217,000	....

Bottom Fauna.— A number of samples of mud were taken from various depths ranging from 10 to 30 feet deep where it was found that the bullheads were feeding at the time. The samples were taken with a mud sampler from near the north end and also from near the middle of the lake. The mud was washed to ascertain the kinds of macroscopic animals inhabiting the lake bottom.* In the soft mud between the 15 and 30-foot depths the most abundant organisms were midge larvae, *Chironomidae*. *Chironomous plumosus* was the most common species, occurring in largest numbers at the 25-foot depth. *Tanypus* sp. was next in abundance. Some small bivalve clams were also found. One of the Neuroptera, *Sialis* sp., was found but rarely.

Conesus Lake.— Conesus lake, in Livingston county, lies in a shallow, north-south valley which has gradual slopes. The lake is 818 feet above sea level. Its length is about nine miles and its greatest width is about one mile. Near its center two streams,

* The writer is indebted to J. R. Greeley for the identification of these animals.

entering opposite each other, have built out large deltas, Long point and McPherson point, which have nearly divided the lake. The sides of the lake are steep and the bottom fairly flat. A broad, sandy shoal extends into the lake for over one-half mile from the north end. In general the lake is shallow; most of the bottom is probably between 35 and 40 feet deep. The greatest depth observed was 61 feet. The lake is fed by springs and several small streams, the largest of which is Conesus inlet, entering at the southwest corner. It is drained into the Genesee river by Conesus creek which leaves the lake from the northwest corner.

Records from Soundings in Conesus Lake.[1]— Soundings were made along five transects or lines across Conesus lake. The transects are numbered I to V, from north to south, and the stations along each transect are numbered consecutively from west to east (Fig. 10).

With the aid of a bottom sampler and trawl, records were obtained of the depth, nature of bottom, animal life present, and plant life present for each of the 38 stations where soundings were made (App. VI).

The data from the soundings made along transect IV and V illustrate the general condition of the lake bottom. The rooted aquatic plants are limited to the water, which is about 15 feet or less in depth, the most profuse growth appearing in the 6–15 foot depth. The shallow bottom near the shore (1–5 feet) is often very bare of plants. The 15-foot depth is reached but a short distance from the shore, except in some of the coves. As a result, most of the beds of "weeds" are very narrow. The deeper water contains no rooted aquatics but the bottom mud, 30–45 foot depths, is very rich in bloodworms — *Chironomus* and *Sayomya* sp.[2] being very common at the 40-foot depth.

Vegetation of Conesus Lake.— The largest beds of weeds in Conesus lake occur at the south end, especially in and near the inlet and in the coves along the east side (Fig. 10). This is conceded to be one of the best spawning grounds for fish. Most of the weed beds contain several species, among which Potamogetons predominate. Chara and Vallisneria sometimes occur in pure stands over extensive areas.

[1] The present studies on Conesus lake are supplemental to those made by E. A. Birge and Chancey Juday for this lake in 1911–12. See, A Limnological Study of the Finger Lakes of New York. U. S. Bull. of the Bur. of Fisheries, Vol. 32, 1912.

[2] Identifications by A. O. Johannsen.

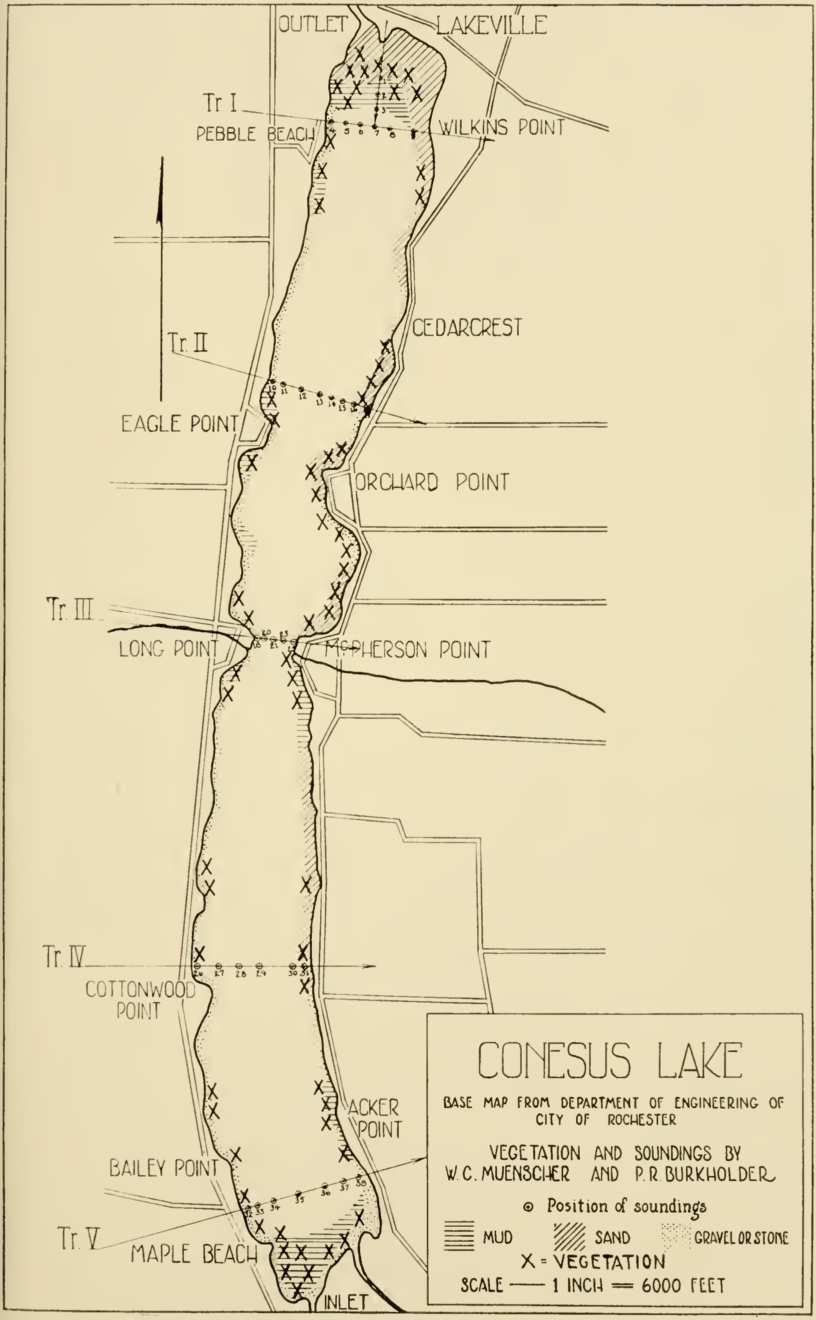


Fig. 10.— Map of Conesus Lake showing character of shore, the location of the larger weed beds, and the places where soundings were made.

Appendix I.— Blank Forms Used in the Field

NEW YORK CONSERVATION DEPARTMENT

STREAM SURVEY

Name..Date..........................

Tributary to..................................Length..........River System..........

Town..........................County..............................Authority..........

REGION	Width	Depth	Flow cu. ft. per second	Temperature Air	Temperature Water	Perma-nency	Color of water	Turbidity	Game fish present
Upper......	---------	---------	---------	--------	--------	---------	---------	---------	-----------
Middle.....	---------	---------	---------	--------	--------	---------	---------	---------	-----------
Lower......	---------	---------	---------	--------	--------	---------	---------	---------	-----------

Bottom: sand, bare rock, hardpan, gravel, rubble, mud, silt, muck..........

Vegetation: water cress, chara, filamentous algae, pondweeds, water lilies, cattails.....

Fish Shelter: logs, overhanging roots and banks, pools, large boulders..........

Shade: low overhanging willows or alders, forest cover..........

Natural Food: mayflies, stoneflies, caddisflies, blackflies, midges, shrimps, misc. Minnows (abundance and species).

Springs: location, temperature, volume, evidences of sulphur, iron, lime..........

Dams and Falls: height, area and depth of pond, type, location..........

Pollution: location, extent, nature, index organisms..........

Character of Region: Open fields, well wooded, wild, cultivated..........

Value as a Fishing Stream: amount of fishing, success..........

Posted Area: length, owner's name, town..........

Planting Places: Permanent spring runs near roads, locate on map..........

Impermanent Runs Not to be Stocked: locate on map..........

Miscellaneous:..........

Stocking Policy:..........

Appendix II

ALLOTMENTS OF FRY AND FINGERLINGS IN THE GENESEE SYSTEM 1917–1925

County and Species	Number	County and Species	Number
Allegany		Monroe	
Brook trout	699,205	Brook trout	68,960
Brown trout	347,475	Brown trout	123,570
Bullheads	1,108	Bullhead	5
Pike-perch	7,585,000	Herring	4,025,000
Rainbow trout	71,950	Large-mouthed bass	63
Small-mouthed bass	16,000	Pike-perch	4,945,000
Yellow perch	66,900	Rainbow trout	18,675
		Small-mouthed bass	12,382
Cattaraugus		Steelhead trout	34,972
Small-mouthed bass	400	Sunfish	10
		Yellow perch	1,022,000
Genesee			
Brook trout	800	Ontario	
Brown trout	8,900	Muskalonge	205,000
Large-mouthed bass	800	Pike-perch	1,975,000
Pike-perch	1,315,800	Small-mouthed bass	900
Rainbow trout	6,000	Whitefish	240,000
Small-mouthed bass	5,600	Yellow perch	3,000
Steelhead trout	5,200		
Yellow perch	7,000	Wyoming	
		Brook trout	78,625
Livingston		Brown trout	70,700
Black spotted trout	715	Bullhead	3,500
Brook trout	247,295	Muskalonge	75,000
Brown trout	102,775	Pike-perch	2,620,000
Muskalonge	1,395,000	Rainbow trout	8,300
Pike-perch	12,390,500	Small-mouthed bass	3,000
Rainbow trout	53,900	Steelhead trout	26,200
Small-mouthed bass	25,700	Yellow perch	2,500
Steelhead trout	16,600		
Yellow perch	18,300	Total	39,951,285

Appendix III

TABLE 1.—CHEMICAL ANALYSES OF GENESEE RIVER

DATE	Sample number	Miles: From preceding sample	Miles: From New York — Pennsylvania border	Temperature, Degrees: Fahr.	Temperature, Degrees: Cent.	Dissolved Oxygen: Parts per million	Dissolved Oxygen: Per cent of saturation	Methyl orange alkalinity p. p. m. calcium carbonate	Carbon dioxide parts per million	pH	Remarks
July 9	1	....	....	77.9	25.5	7.3	92.4	40.1	1.5	7.9	Cryder creek enters.
12	2	2.0	2.0	59.9	15.5	8.5	88.6	39.0	1.7	7.9	
12	3	2.0	4.0	66.2	19.0	9.1	102.0	38.0	1.0	8.0	
12	4	1.6	5.6	63.1	17.3	8.8	95.5	39.0	1.2	8.0	
12	5	1.8	7.4	68.5	20.3	9.8	112.8	39.0	nil	8.1	
12	6	1.8	9.2	70.2	21.2	9.9	115.9	39.0	nil	8.1	Chenunda creek enters.
12	7	1.4	10.6	68.0	20.0	8.9	104.0	39.6	0.5	8.1	
14	8	1.8	12.4	59.0	15.0	7.8	80.5	39.9	3.0	7.6	Wellsville.
14	9	1.0	13.4	60.1	15.6	8.5	88.6	38.9	2.5	7.7	Brimer brook enters.
14	10	1.1	14.5	63.0	17.2	9.2	99.0	40.4	1.0	8.0	
14	11	1.9	16.4	69.4	20.8	9.9	114.6	38.9	nil	8.1	
14	12	1.0	17.4	70.7	21.5	9.4	110.0	43.1	nil	8.2	Knight creek enters.
16	13	2.9	20.3	68.0	20.0	9.6	109.1	46.2	1.0	8.1	
16	14	2.1	22.4	67.3	19.6	8.6	98.2	47.3	1.5	8.0	
16	15	1.2	23.6	73.0	22.8	8.8	105.1	48.3	0.5	8.1	Belmont.
16	16	2.4	26.0	70.2	21.2	7.1	82.6	52.5	2.0	7.7	
16	17	2.3	28.3	71.6	22.0	7.4	87.3	54.9	0.5	8.1	
17	18	2.1	30.4	66.2	19.0	6.6	73.0	58.8	2.5	7.7	Angelica creek enters.
17	19	2.0	32.4	68.0	20.0	7.5	85.0	59.9	2.0	7.8	
17	20	2.6	35.0	73.0	22.8	8.9	106.0	66.0	nil	8.3	
19	21	1.8	36.8	66.2	19.0	7.8	86.6	67.2	1.5	8.1	Belfast.
19	22	2.0	38.8	69.8	21.0	7.9	91.4	69.3	1.0	8.1	
19	23	2.4	41.2	71.6	22.0	8.5	99.8	72.5	nil	8.2	Caneadea creek enters.
19	24	2.0	43.2	73.0	22.8	8.3	99.0	76.7	nil	8.1	
19	25	1.9	45.1	75.2	24.0	8.2	99.9	81.9	nil	8.1	
19	26	2.4	47.5	77.9	25.5	8.6	107.2	83.0	nil	8.3	
19	27	2.3	49.8	80.2	26.8	8.3	106.0	86.6	nil	8.2	
19	28	2.1	51.9	76.6	24.8	8.1	99.6	88.2	nil	8.2	Fillmore.
27	29	1.9	53.8	70.7	21.5	8.2	95.2	100.6	nil	8.1	

27	30	2.0	55.8	72.5	22.5	8.6	101.7	107.8	nil	8.2	Wiscoy creek enters.
27	31	2.4	58.2	74.3	23.5	8.1	97.4	111.0	nil	8.2	
27	32	2.5	60.7	74.1	23.4	8.3	99.6	109.5	nil	8.2	
31	33	1.4	62.1	70.4	21.2	7.4	85.4	118.0	nil	8.3	Portageville.
31	34	3.7	65.8	73.4	23.0	8.9	104.8	114.0	nil	8.4	Falls (Letchworth Park).
31	35	4.4	70.2	73.4	23.0	9.0	105.3	110.0	nil	8.5	Wolf creek enters.
Aug. 9	36	1.3	71.5	71.6	22.0	9.2	105.4	99.3	nil	8.4	
9	37	3.2	74.7	76.1	24.5	8.5	101.8	101.7	nil	8.4	
9	38	3.8	78.5	77.9	25.5	8.2	100.0	100.7	nil	8.3	
30	39	3.3	81.8	74.3	23.5	7.8	91.7	93.0	nil	8.3	
30	40	2.0	83.8	75.2	24.0	9.0	107.0	95.0	nil	8.5	Mount Morris.
30	41	2.2	86.0	74.3	23.5	7.9	92.9	104.0	nil	8.2	Canaseraga creek enters.
30	42	2.6	88.6	74.7	23.7	9.0	106.5	111.1	nil	8.4	
31	43	3.5	92.1	68.9	20.5	7.2	80.4	112.1	1.0	8.0	
31	44	3.3	95.4	69.1	20.6	8.1	90.6	117.2	nil	8.1	
31	45	4.4	99.8	69.4	20.8	8.1	90.9	115.7	nil	8.1	Geneseo.
31	46	2.2	102.0	69.4	20.8	7.7	86.4	115.1	nil	8.1	
Sept. 2	47	2.8	104.8	66.7	19.3	7.5	81.7	117.0	1.0	8.0	
2	48	3.5	108.3	67.3	19.6	7.4	80.6	119.0	1.5	8.0	
2	49	3.5	111.8	69.4	20.8	7.7	86.4	122.0	trace	8.1	
2	50	2.5	114.3	70.5	21.4	8.0	90.7	123.0	trace	8.1	Conesus creek enters.
2	51	1.8	116.1	70.0	21.1	8.3	93.8	125.0	nil	8.1	
2	52	3.0	119.1	70.0	21.1	7.9	89.3	125.0	trace	8.1	
3	53	2.4	121.5	68.4	20.2	7.4	82.2	124.0	1.5	8.0	
3	54	2.8	124.3	68.4	20.2	7.4	82.2	127.0	1.0	8.0	Honeoye creek enters.
3	55	2.6	126.9	68.0	20.0	6.8	75.2	130.0	1.5	8.0	Allen creek enters.
3	56	2.1	129.0	67.5	19.7	7.4	81.4	132.0	1.0	8.0	
3	57	2.5	131.5	67.5	19.7	7.7	84.6	135.0	0.5	8.0	
4	58	2.4	133.9	66.6	19.2	7.2	78.3	138.0	1.0	8.0	
4	59	2.2	136.1	66.9	19.4	7.4	80.9	135.0	0.5	8.1	Black creek enters.
5	60	7.8	143.9	66.9	19.4	7.9	85.2	119.0	1.0	8.0	Rochester.
5	61	2.2	146.1	68.4	20.2	7.2	78.5	119.0	2.0	7.9	
5	62	1.8	147.9	72.5	22.5	4.6	52.7	113.0	5.1	7.6	

TABLE 2.—CHEMICAL ANALYSES OF POLLUTED GENESEE TRIBUTARIES

REMARKS	Date	Distance from pollution	Temperature of Water, Degrees		Dissolved Oxygen		Methyl orange alkalinity p. p. m. calcium carbonate	Carbon dioxide parts per million	pH
			Fahr.	Cent.	Parts per million	Per cent of saturation			
Stream:— Cryder	July 5	150 ft. above	66.2	19.0	9.3	104.0	31.7	nil	......
Pollution:— milk cond. at Whitesville	5	150 ft. below	66.2	19.0	5.3	59.4	105.5	nil	......
	5	1000 ft. below	66.2	19.0	4.8	53.8	99.2	nil	......
(Organisms reappearing)	5	4000 ft. below	67.1	19.5	6.0	67.8	35.9	3.0	......
(Organisms scarce)	9	At mouth	74.8	23.8	5.6	66.7	47.7	4.0	......
Stream:— Brimer	July 6	150 ft. above	62.6	17.0	8.2	88.3	54.9	1.0	......
Pollution:— oil and cheese at Petrolia	6	150 ft. below	65.3	18.5	7.2	80.0	54.3	3.0	......
(Stream oily)	7	1000 ft. below	65.7	18.7	7.0	78.1	55.9	4.0	......
	7	2000 ft. below	65.1	18.4	5.9	64.9	58.0	5.0	......
	7	5000 ft. below	72.5	22.5	7.5	89.8	55.9	2.0	......
Stream:— Chenunda	July 6	150 ft. above	78.8	26.0	7.1	90.6	89.7	nil	......
Pollution:— cheese at Hallport, indirectly	6	150 ft. below	77.9	25.5	7.0	88.6	82.3	2.0	......
	6	1000 ft. below	76.1	24.5	6.8	84.4	79.1	1.5	......
	6	2000 ft. below	74.3	23.5	6.4	78.0	78.6	2.5	......
United with Fulmer Valley stream)	9	3 mi. below	68.7	20.4	8.3	95.7	64.4	2.0	......
	9	At mouth	75.2	24.0	8.7	107.0	63.3	nil	......
Stream:— Knight Pollution:— oil	July 14	At mouth	68.0	20.0	8.8	100.4	59.9	nil	......
Stream:— Black creek	July 20	100 ft. above	73.4	23.0	4.3	51.3	78.8	9.1	7.2
Pollution:— cheese at Birdsall	20	100 ft. below	73.4	23.0	4.2	50.1	78.8	10.1	7.1
	20	2500 ft. below	64.4	18.0	3.3	35.3	72.5	8.6	7.2
	20	1.5 mi. below	81.5	27.5	7.7	99.6	86.1	1.5	8.0
At junction with Angelica creek	20	......	81.7	27.6	6.7	86.6	61.4	nil	8.4
Stream:— Angelica	July 20	At mouth	79.7	26.5	7.3	92.7	98.7	2.0	7.9
Stream:— Caneadea	July 21	150 ft. above	76.1	24.5	8.6	105.2	117.6	nil	8.1
Pollution:— cheese at Hardy Corners	21	150 ft. below	77.4	25.2	7.6	94.2	119.7	2.5	7.9
	21	5000 ft. below	80.6	27.0	8.6	110.0	121.8	nil	8.1
(Stream from Rushford enters, possibly polluted)	21	150 ft. above	85.1	29.5	7.9	106.1	124.4	nil	8.3
	21	150 ft. below	84.2	29.0	7.8	103.8	123.9	nil	8.3
	21	At mouth	81.5	27.5	7.3	94.5	116.6	nil	8.3

Stream:— White creek: upper end, scene of cheese pollution practically dry	July 22	At mouth	74.5	23.6	6.0	72.3	110.3	3.5	7.6
Stream:— Black creek	July 22	150 ft. above	75.2	24.0	6.5	78.9	105.0	1.0	8.0
Pollution:— milk at Rockville	22	150 ft. below	77.0	25.0	6.6	80.8	109.2	1.5	8.0
	22	2500 ft. below	80.6	27.0	7.0	89.7	119.7	1.0	8.1
(Stream enters reservoir)	22	2500 ft. below	77.0	25.0	7.6	93.8	114.5	nil	8.2
	22	At mouth	80.2	26.8	7.2	92.0	125.0	nil	8.1
Stream:— North branch of Wiscoy	July 29	100 ft. above	59.0	15.0	8.9	92.8	120.0	nil	8.3
Pollution:— milk cond. at Bliss	29	150 ft. below	64.0	17.8	8.6	94.5	119.0	nil	8.3
	29	1000 ft. below	68.9	20.5	8.2	95.0	117.0	nil	8.3
Wiscoy proper at junc	29	1500 ft. below	70.3	21.3	8.6	101.1	117.0	nil	8.4
	29	1 mi. below	73.8	23.2	8.5	103.4	113.0	nil	8.5
Stream:— East Koy	29	100 ft. above	70.7	21.5	8.9	104.6	102.0	nil	8.6
Pollution:— milk cond. at Gainesville	29	500 ft. below	70.5	21.4	8.8	103.7	101.0	nil	8.6
Wiscoy proper	27	At mouth	73.8	23.2	7.8	93.3	124.4	nil	8.1
Stream:— Hemlock outlet. Pollution:— Cannery at Hemlock, effluent filled with rat-tail maggots.	Aug. 2	200 ft. above	83.3	28.5	13.9	182.0	167.0	nil	8.6
Cannery effluent	2		90.5	32.5	0.2	2.8	310.0	53.5	6.7
Influx of fresh water	2	100 ft. below	73.4	23.0	5.8	68.7	74.0	3.5	7.5
Blue-green algae	2	1 mi. below	81.5	27.5	3.9	50.4	89.0	5.6	7.3
Recovered appearance	3	3.5 mi. below	82.0	27.8	6.9	88.9	107.0	nil	8.5
Stream:— Honeoye creek. Pollution:—Cannery at Honeoye Falls Turbid, turbulent water	Aug. 2	1000 ft. above	78.8	26.0	8.0	99.9	113.5	nil	8.6
	2	1000 ft. below	78.8	26.0	7.0	87.3	115.5	nil	8.3
Dam in Honeoye Falls	2	1.2 mi. below	83.8	28.8	11.3	148.4	109.0	nil	8.7
At Sibleyville	2	3.5 mi. below	84.2	29.0	9.4	124.0	117.0	nil	8.7
Stream:— Mill creek Pollution:— Paper mill at Dansville Turbulent stream	Aug. 4	100 ft. above	71.6	22.0	7.9	91.2	166.0	nil	8.5
	4	100 ft. below	75.2	24.0	8.0	95.6	152.0	nil	8.5
	4	4000 ft. below	76.1	24.5	7.2	86.7	150.6	nil	8.5
Stream:— Canaseraga creek. Pollution:—Mill creek	Aug. 4	1.0 mi. above	80.6	27.0	7.2	90.8	151.6	nil	8.3
	4	0.5 mi. below	79.3	26.3	7.2	89.6	154.5	nil	8.4
	4	1.5 mi. below	78.8	26.0	7.3	90.4	156.5	nil	8.3
Pollution:— Cannery at Mount Morris.	5	150 ft. above	75.7	24.3	7.0	84.0	157.0	nil	8.1
	5	150 ft. below	76.1	24.5	7.0	84.1	156.5	nil	8.1
	5	0.5 mi. below	75.6	24.2	6.3	75.5	157.5	1.0	7.9
At mouth	5	1.5 mi. below	76.1	24.5	4.8	57.7	157.5	1.5	7.9

NOTE.— The designation " at mouth " refers to the confluence of the stream with the Genesee river.

TABLE 2.— CHEMICAL ANALYSES OF POLLUTED GENESEE TRIBUTARIES — (*Continued*)

REMARKS	Date	Distance from pollution	Temperature of Water, Degrees		Dissolved Oxygen		Methyl orange alkalinity p. p. m. calcium carbonate	Carbon dioxide parts per million	pH
			Fahr.	Cent.	Parts per million	Per cent of saturation			
Stream:— Conesus outlet.									
Pollution:—Milk condensary at Lakeville.	Aug. 7	100 ft. above	70.7	21.5	6.0	69.0	101.7	0.5	8.0
	7	150 ft. below	75.2	24.0	5.1	61.2	102.7	2.0	7.9
	7	1000 ft. below	76.1	24.5	4.7	56.9	104.6	2.5	7.8
Entering marshy pond	7	0.5 mi. below	73.0	22.8	2.1	24.6	102.7	5.1	7.5
At dam (morning)	7	1.5 mi. below	73.4	23.0	0.3	3.9	99.8	9.6	7.2
At dam (afternoon)	Sept. 8	1.5 mi. below	72.0	22.2	6.8	79.6	110.0	1.0	8.0
	8	3.5 mi. below	69.4	20.8	8.6	98.2	108.0	nil	8.3
	8	At mouth	73.9	23.3	9.9	117.3	154.0	nil	8.4
Stream:— Silver lake inlet.									
Pollution:—Pea shelling plant (vine stack).	Aug. 20	200 ft. above	62.2	16.8	9.3	96.2	121.0	nil	8.1
Water colored yellow	20	500 ft. below	61.7	16.5	7.2	74.0	128.0	3.5	7.8
Fungi abundant	20	1000 ft. below	63.5	17.5	4.9	51.5	129.0	5.1	7.6
	20	0.5 mi. below	64.4	18.0	6.5	69.0	133.0	3.5	7.8
Small fry appearing	20	2.0 mi. below	63.1	17.3	8.6	90.0	122.5	4.0	7.8
Stream:— Allen creek.									
Pollution:— Paper mill at Scottsville.									
Odor indicative of compounds of sulphur	Aug. 27	500 ft. above	68.9	20.5	9.8	109.4	176.0	nil	8.2
	27	500 ft. below	67.6	19.8	9.7	106.6	180.0	nil	8.2
Stream:— Oatka creek.									
Pollution:— Sewage and industries of Le Roy.									
Entering Le Roy	Aug. 28		71.2	21.8	9.7	110.8	119.0	nil	8.6
Leaving Le Roy	28		77.0	25.0	11.0	131.1	118.5	nil	*9.0
Crest of But'milk fall	28	1 mi. below	79.7	26.5	9.3	115.7	98.0	nil	*9.2

NOTE.— The designation " at mouth " refers to the confluence of the stream with the Genesee river.
* Estimated.

TABLE 3.—CHEMICAL ANALYSES OF WOLF CREEK WATERS

Pollution:— Salt at Silver Springs; Sewage at Castile.

(A) Investigation of dissolved oxygen, etc. Remarks Date:— July 30	Temperature of Water, Degrees		Dissolved Oxygen		Methyl orange alkalinity p.p.m. calcium carbonate	Carbon dioxide parts per million	pH.
	Fahr.	Cent.	Parts per million	Per cent of saturation			
Entering Silver Springs......	55.4	13.0	6.8	67.0	161.0	5.6	7.5
Lv. Silver Springs and salt lake	74.3	23.5	6.5	79.0	76.5	nil	8.6
Tributary stream No. 6, largest tributary............	59.0	15.0	8.6	88.5	148.0	2.0	7.9
After confluence with No. 6, 1 mile from S. P..........	70.9	21.6	9.4	111.0	115.0	nil	8.6
In Castile..................	69.4	20.8	8.2	93.6	96.0	nil	8.8
Leaving Castile.............	71.8	22.1	4.1	47.4	104.0	10.1	7.3
Steep slope, 1 m. from Genesee	69.8	21.0	9.9	113.6	114.0	nil	8.9

(B) Investigation of salt content. Remarks	Date	Temperature of Water, Degrees		Chloride parts per million	Salt	
		Fahr.	Cent.		Parts per million	Approx. per cent
Entering Silver Springs...........	Aug. 13	60.8	16.0	17.2	28.3	....
Lv. Silver Springs, (salt lake effluent)	Aug. 13	79.2	26.2	23,300	38,360	3.84
Analysis of tributary No. 6........	Aug. 13	65.3	18.5	1.0	1.6	....
After confluence with No. 6, 1 mile from S. P.....................	Aug. 13	72.5	22.5	8,840	14,570	1.45
In Castile.......................	Aug. 13	77.0	25.0	7,158	11,800	1.18
Leaving Castile.................	Aug. 13	74.3	23.5	7,024	11,576	1.16
At confluence with Genesee river...	Aug. 13	69.8	21.0	5,896	9,716	0.97
Genesee above entrance of Wolf creek	Aug. 13	77.0	25.0	4.6	7.6	....
Genesee below entrance of Wolf creek	Aug. 13	77.4	25.2	463.4	763.7	....
Wolf at confluence with Genesee River*......................	Aug. 16	68.9	20.5	6,903	11,376	1.14
Genesee above entrance of Wolf creek	Aug. 16	68.9	20.5	3.0	5.0	....
Genesee below entrance of Wolf creek	Aug. 16	70.2	21.2	159	262	....

* At *time of sampling*, Wolf was flowing at the rate of about 18.1 cubic feet per second. At the indicated salt content, this is *equivalent* to a discharge of over *500 tons* in twenty-four hours.

TABLE 4.—DEPTH SAMPLES OF SILVER LAKE

SAMPLE NO.	Distance below surface in feet	Temperature of Water, Degrees		Dissolved Oxygen		Methyl orange alkalinity p.p.m. calcium carbonate	Carbon dioxide parts per million	pH
		Fahr.	Cent.	Parts per million	Per cent of saturation			
1.............	0	72.5	22.5	8.4	97.1	78.7	nil	8.6
2.............	10	72.5	22.5	8.1	93.6	78.7	nil	8.4
3.............	20	72.5	22.5	7.6	87.9	78.7	nil	8.4
4.............	30	70.7	21.5	2.9	33.0	82.2	3.0	7.7
5.............	35 (Bottom)	70.3	21.3	1.7	18.9	82.2	6.1	7.3

Date:— August 17.
Temp. of air:— 24°C.
Had there been sunshine, lake would probably have exhibited greater variation in temperature. Water was filled with a "bloom" of Rivularia, decomposition of which was doubtless largely responsible for the diminution in dissolved oxygen content of lower strata.

TABLE 5.—CHEMICAL ANALYSES OF CALEDONIA HATCHERY WATERS

Remarks	Date	Temp. of Water, Degrees		Dissolved Oxygen		Methyl orange alkalinity p.p.m. calcium carbonate	Carbon dioxide parts per million	pH
		Fahr.	Cent.	Parts per million	Per cent of saturation			
At source, point A (see below)	Sept. 8	49.5	9.7	2.7	23.9	204.0	12.1	7.4
At source, point B (see below	Sept. 8	49.5	9.7	2.0	17.7	196.0	12.6	7.4
Water entering hatchery flume	Aug. 25	49.1	9.5	4.4	38.9	196.0	10.1	7.5
Water in trough (indoors)	Aug. 25	49.6	9.8	6.0	53.4	196.0	8.1	7.7
At exit from entire hatchery	Aug. 25	49.6	9.8	7.0	62.3	196.0	8.1	7.7

The water supplying Caledonia hatchery comes chiefly from large springs about one mile away. Two streams leave the scene of the springs, uniting before reaching the hatchery. The smaller of these, designated B, is probably entirely spring-fed, whereas the larger, designated A, receives a certain amount of surface drainage.

Appendix IV

PLANTS AND ANIMALS FOUND IN VARIOUS TYPES OF POLLUTION *

PLANTS (other than diatoms)	Milk wastes	Cannery wastes	Sewage	Paper mill wastes	Oil	Salt
Elodea canadensis	X	......	X	......	......	....
Potamogeton pectinatus	X	......	X	......	......	....
Potamogeton richardsonii	X	......	......	......	......	....
Potamogeton natans	X	......	......	......	......	....
Najas flexilus	X	......	......	......	......	....
Vallisneria americana	X	......	......	......	......	....
Heteranthera dubia	X	......	......	......	......	....
Sagittaria latifolia	X	......	......	......	......	....
Oscillatoria sp	X	X	X	X	......	....
Cladophora sp	......	X	......	......	......	....
Spirogyra sp	......	X	X	......	......	....
Scenedesmus sp	......	X	......	X	......	....
Pediastrum	......	......	......	X	......	....
Ulothrix	......	......	......	X	......	....
Enteromorpha intestinalis	......	......	......	......	......	X
Enteromorpha prolifera	......	......	......	......	......	X
Ruppia maritima	......	......	......	......	......	X
Actinastrum hentzchii	......	......	......	......	......	X
Spirulina subsalsa	......	......	......	......	......	X
Chaetomorpha?	......	......	......	......	......	X
Fungus	X	X	X	X	......	....

* The identifications of plants were made by Dr. W. C. Muenscher; diptera, by Dr. O. A. Johannsen; coleoptera by Mr. F. C. Fletcher; Molluscs by the Philadelphia Academy of Natural Sciences.

Appendix IV — Continued

ANIMALS	Milk wastes	Cannery wastes	Sewage	Paper mill wastes	Oil	Salt
Chironomus plumosus (flies)	X	......	......	......	......	....
Eristalis aeneus (flies)	......	......	......	......	......	X
Eristalis arbustorum (flies)	X	X	......	......	......	....
Orthocladius sp (flies)	X	......	......	......	......	....
Chironomus cristatus (flies)	......	X	......	......	......	....
Tanypus sp (flies)	......	X	......	......	......	....
Chironomus sp (flies)	X	X	X	......	......	....
Tropisternus glaber Hbst. (beetles)	X	......	......	......	......	X
Enochrus cinctus Say (beetles)	......	X	......	......	......	....
Hydrobius fuscipes L. (beetles)	......	X	......	......	......	X
Gyrinus lecontei Fall. (beetles)	......	X	......	......	......	....
Heleophorus lineatus Say (beetles)	......	X	......	......	......	....
Enochrus ochraeus Melsh. (beetles)	......	X	......	......	......	....
Anacaena infuscata Mols. (beetles)	......	X	......	......	......	....
Illybius biguttulus Germ. (beetles)	......	......	......	......	......	X
Illybius sp. (beetles)	......	......	......	......	......	X
Rhantus tostus Lec. (beetles)	......	......	......	......	......	X
Enochrus perplexus (Lec.) (beetles)	......	......	......	......	......	X
Enochrus hamiltoni (Horn) (beetles)	......	......	......	......	......	X
Helophorus lineatus Say (beetles)	......	......	......	......	......	X
Paracymus subcupreus Say (beetles)	......	......	......	......	......	X
Culicoides varipennis Coq. (flies)	......	......	......	......	......	X
Ephydra subopaca Lw. (flies)	......	......	......	......	......	X
Odontomyia sp (flies)	......	......	......	......	......	X
Aedes dorsalis (flies)	......	......	......	......	......	X
Saldula sp. (bug)	......	......	......	......	......	X
Oniscus sp. (crustacean)	......	......	......	......	......	X
Oligochaetae (worms)	X	X	X	......	......	X
Planaria (worms)	X	......	X	......	......	X
Polita cellaria Müll. (snails)	......	......	......	......	......	X
Physa integra Hald. (snails)	X	X	......	......	......	....
Physa heterostropha Say (snails)	......	X	......	......	......	....
Physa gyrina Say (snails)	......	X	......	......	......	....
(Goniobasis) Elimia livescens Mke (snl.)	......	X	......	......	......	....
Planorbis trivolis Say (snails)	X	X	......	......	......	....
Sphaerium sulcatum Lam. (snails)	......	X	......	......	......	....
Campeloma decisum Say (snails)	......	X	......	......	......	....
Lymnaea humilis modicella Say (snails)	......	X	......	......	......	....
Planorbis parvus Say (snails)	X	......	......	......	......	....
Lymnaea palustris Müll. (snails)	X	......	......	......	......	....
Viviparus contectoides Binney (snails)	X	......	......	......	......	....

Appendix V

TABULATION OF DIATOMS COLLECTED FROM POLLUTED AND NON-POLLUTED WATERS

Identifications by J. P. Young, Ithaca, N. Y.

1 = found in one sample.
2 = found in two samples from same stream.
3 = found in three samples from same stream.

DIATOMS	KIND OF POLLUTION							
	PAPER MILL WASTE		PEA CANNERY WASTE	OIL	SALT		NONE	
	Canaseraga creek, Dansville (2 samples)	Scottsville (2 samples)	Mount Morris (2 samples)	Knight creek (1 sample)	Wolf creek, (3 samples)	Piffard (1 sample)	Spring creek (1 sample)	Seven Springs pond (1 sample)
Achnanthes exilis	1	....	....	....	....	....	....	....
Achnanthidium flexellum	1	....	....	....	....	....	....	1
Amphora ovalis	1	2	....	1	3	....	....	1
Cocconeis pediculus	2	2	1	....	....	....	1	....
Cyclotella antiqua	....	....	....	....	....	....	....	1
Cyclotella kutzingii	....	....	....	....	....	....	....	1
Cycotella menegheinana	....	1	....	....	....	....	....	....
Cymatopleura elliptica	....	1	....	....	....	....	....	....
Cymatopleura solea	2	1	2	....	....	....	1	....
Cymbella cymbiformis	1	....	....	....	....	....	....	1
Cymbella ehrenbergii	1	....	....	....	....	....	....	....
Cymbella laevis	....	....	....	....	....	....	....	1
Cymbella mexicana	....	1	....	....	....	....	....	....

Cymbella ventricosa	2	2	2	1	1	1	1	1
Diatoma vulgare	2	2	2	1			1	
Epithemia sorex			1					
Eunotia arcus								1
Fragilaria harrisonii	1							
Fragilaria virescens		2						
Gomphonema augur			1					
Gomphonema constrictum		1					1	
Gomphonema herculaneum	1	1		1		1		
Gomphonema intricatum	1							
Gyrosigma kutzingii		2	1					
Melosira crenulata	1							
Melosira distans		1						
Melosira varians				2				
Meridion circulare					2	1	1	
Navicula anglica					1	1		
Navicula cryptocephala	2	1			2	1		
Navicula cuspidata			1					
Navicula iridis			1					
Navicula radiosa	2	2	1	1		1	1	1
Navicula rhymcocephala			1					
Nitzschia apiculata	1							
Nitzschia linearis			2					
Nitzschia palea					1			
Nitzschia sigmoidea					1			
Nitzschia vermicularis	1							
Pinnularia viridis			1					
Surirella molleriana		1		1				
Surirella ovata	1	1			1			
Surirella splendida			1					
Synedra acus				1	3			
Synedra ulna	2	2	1	1		1	1	

Appendix VI

DATA FROM SOUNDINGS IN CONESUS LAKE, N. Y., SEPTEMBER 1-3, 1926

Transect number	Station number	Depth found (ft.)	Nature of bottom	Animal life observed	Rooted aquatic plants observed
North end..	1	10	No mud obtained in 2 trials.	....	Profuse bed of Chara sp.
North end..	2	12	" "	....	Profuse growth of Chara sp. Myriophyllum sp. (many) Potamogeton compressus (few)
North end..	3	18	Mud and sand..	....	Sparse growth of Chara sp. Ceratophyllum demersum Potamogeton compressus
I..........	4	1-3	Stony..........	....	None
	4a	3-10	"	....	Chara
I..........	5	20	Mud...........	Many bloodworms (Chironomus sp.)	Potamogeton compressus P. Richardsonii Najas flexilis Elodea canadaensis Ceratophyllum demersum Chara sp.
I..........	6	25	Mud and fine ooze	" "	None
I..........	7	30	" "	" "	"
I..........	8	25	Mud...........	" "	"
I..........	9	15	Mud and sand...	....	Chara Najas flexilis Ceratophyllum demersum
II..........	10	1-3	Stony..........	....	Chara, very much (Rocks covered with Scytonema sp.) Vallisneria americana (small plants)
	......	10	"	....	Chara
	......	15	"	....	None
II..........	11	25	Mud...........	....	None
II..........	12	30	Mud and fine ooze	Many bloodworms (Chironomus sp.)	"
II..........	13	35	" "	" "	"
II..........	14	35	" "	" "	"
II..........	15	30	" "	" "	"
II..........	16	20	Shallow mud and much grit and shells	....	Potamogeton compressus Vallisneria americana Myriophyllum sp. Chara (few plants) Elodea " "
II..........	17	1-3	Stony..........	....	Chara sp. Vallisneria americana Potamogeton sp.
III.........	18	8-10	Gravelly........	....	Potamogeton pectinatus P. Richardsonii P. compressus P. epihydrus P. crispus (small)
III.........	19	10-15	Edge of sloping shelf	....	Vegetation very profuse consisting of same species as "18" Potamogeton compressus P. Richardsonii Vallisneria americana (P. compressus in flower and many winter buds.)
III.........	20	20	Mud...........	Many bloodworms (Chironomus sp.)	None
III.........	21	35	"	" "	"
III.........	22	48	"	" "	"
III.........	23	40	"	" "	"
III.........	24	30	"	" "	"
III.........	25	15	Sandy...........	....	Elodea canadensis
III.........	25a	10	Stony...........	....	Elodea canadensis, dominant Potamogeton Richardsonii Vallisneria americana (Cladophora sp. very common on rocks near shore of McPherson Pt.)

Appendix VI — Continued

Transect number	Station number	Depth found (ft.)	Nature of bottom	Animal life observed	Rooted aquatic plants observed
IV.........	26	Shore	Stony..........	....	Vegetation scarce
		6–10	Sandy-stony.....	....	Elodea canadensis—few
	......	......	....	....	Potamogeton compressus
	.....	......	....	....	Vallisneria americana
					Chara sp.
					Potamogeton (small species) near shore
IV.........	27	45	Mud..........	Many bloodworms (Chironomus sp.	None
IV.........	28	50	Mud and ooze...	....	"
IV.........	29	61	" ...	....	"
IV.........	30	40	" ...	Bloodworms (Chironomus sp.)	"
IV.	31	10–15	Sandy–gravelly..	....	Elodea canadensis
					Myriophyllum spicatum
					Potamogeton compressus
					P. amplifolius
V..........	31a	Near Shore	"	....	Chara sp. Scirpus occidentalis
V..........	32	30	Mud and ooze...	Many bloodworms (Chironomus sp.)	None
V..........	33	40	" ...	Bloodworms (Chironomus sp.) and Sayomya	"
V..........	34	40	" ...	Bloodworms (Chironomus sp.)	"
V..........	35	40	" ...	" "	"
V..........	36	40	" ...	Many bloodworms (Chironomus sp.) and Sayomya	"
V..........	37	30	" ...	" "	"
V..........	38	15	Mud and sand...	....	Ceratophyllum demersum
V..........	38a	5–10	Gravelly.......	....	Vallisneria americana (fruiting)
					Potamogeton Richardsonii
					P. crispus
					P. compressus, dominant
					P. pectinatus
					P. amplifolius
	......	10–15	"	....	Nitella sp.
					Elodea canadensis
					Ceratophyllum demersum
					Najas flexilis
					Myriophyllum exalbescens

Appendix VII

LIST OF THE LARGER PLANTS IN SILVER LAKE AND CONESUS LAKE, N. Y.

S = observed in Silver Lake.
C = observed Conesus Lake.
* = predominating species.

S C *Chara sp. — Stonewort.
C Nitella sp.— " Grass."
S C Fontinalis Lescurii Sulliv.— Moss.
C Equisetum limosum L.— Swamp Horsetail.
S C Typha angustifolia L.— Narrow-leaved Cat-tail.
C Typha latifolia L.— Broad-leaved Cat-tail.
S C Sparganium eurocarpum Engelm.— Bur-reed.
C Sparganium chlorocarpum Rydb.— Bur-reed.
C Potamogeton americanus C. and S. var. novaeboracensis (Morong) Benn.— Pondweed.
S C *Potamogeton amplifolius Tuckerm.
S C *Potamogeton compressus L. (P. zosterifolius Schum.)
S C *Potamogeton crispus L.
S C Potamogeton epihydrus Raf. var. cayugensis (Wiegand) Benn.
S C Potamogeton foliosus Raf.
S C Potamogeton gramineus L. var. graminifolius Fries.
C Potamogeton natans L.
S C *Potamogeton pectinatus L.
S C *Potamogeton Richardsonii (Benn.) Rydb.
S C *Najas flexilis (Willd.) Rostk. and Schmidt.— Naiad.
S C Sagittaria latifolia Willd.— Arrow-head.
S C Sagittaria heterophylla Pursh.— Arrow-head.
S C *Elodea canadensis Michx.— Water-weed.
S C *Vallisneria americana Michx — Eel-grass.
S C Scirpus americanus Pers.— Rush.
S C Scirpus occidentalis (Wats.) Chase — Bulrush.
C Scirpus validus Vahl.— Bulrush.
C Peltandra virginica (L.) Kunth.
S C Lemna minor L.— Duckweed.
C Lemna trisulca L.— Duckweed.
S C Spirodela polyrhiza (L.) Schleid.— Duckweed.
C Pontederia cordata L.— Pickerel Weed.
S C *Heteranthera dubia (Jacq.) MacM.— Mud Plantain.
S C *Ceratophyllum demersum L.— Hornwort.
S C Nymphozanthus variegatus (Engelm.) Fernald (Nymphaea variegata) — Yellow Water-lily.
S C Nymphaea odorata Ait. (Castalia odorata) — White Water-lily.
S C *Myriophyllum exalbescens Fernald (M. spicatum) Water Milfoil.
C Utricularia vulgaris L. var. americana — Bladderwort.
S C Bidens Beckii Torr.— Water Marigold.

NOTE: Specimens of these plants are preserved in the herbarium at Cornell University.

Appendix VIII

SALT PLANTS OF WOLF CREEK

BY W. C. MUENSCHER

Due to the waste from the Remington Salt Factory at Silver Springs, the vegetation of Wolf creek and the marshy ground near its shores contains several species of plants which are characteristic of the salt marshes and ponds along the Atlantic coast. The salt waste enters Wolf creek at Silver Springs, and its effect upon the vegetation is noticeable for several miles, at least to below Castile. The following salt plants were observed August 30, 1926:

1. *Ruppia maritima* L. This plant was found growing in Wolf creek in several places between Silver Springs and Castile.

2. *Juncus gerardii* Loisel. The black grass of the Atlantic coast covered extensive areas which had been soaked with salt water. It was especially common along the edge of a pond and on some swampy ground just below the salt factory.

3. *Spartina patens* (Ait.) Muhl. This grass, which with the preceding species, forms the bulk of the "wild hay" of the salt marshes of the Atlantic coast, apparently has never been reported so far inland. The only records for this species in New York State are from the shores of Long Island and the vicinity of New York City. It was found on the low, swampy ground below the salt factory at Silver Springs, where it formed dense mats over considerable areas. In some places it produced a pure stand, but around the edges of the dense mats it was also associated with *Juncus gerardii.*

4. *Salicornia europaea* L. Was found growing in several places about the margin of salt water pools and along the low ground, which is sometimes covered by the water from Wolf creek, just below the salt factory. On several small mud bars this species was the only plant present.

5. *Chenopodium glaucum* L. This species is not restricted to saline habitats, but it was common about the salt factory at Silver Springs. It was growing in profusion in one locality between the salt factory and a pond where the soil was so salty that its surface was almost covered with crystals of sodium chloride. Except for the presence of this species the ground was bare.

6. *Polygonum aviculare* L. This widely distributed species, which is usually not associated with a saline habitat was found in situations similar to the one in which *Chenopodium glaucum* was growing. In several places it was the only plant growing in soil which was apparently soaked with salt water.

7. *Enteromorpha intestinalis* (L.) Grev., was the only macroscopic marine alga observed in Wolf creek. This species was very abundant in a number of places, some of which were over three miles from the source where the salt water enters Wolf creek.

Actinastrum hantzschii Lagerh. Green alga in salt water about salt factory.

Spirulina subsalsa Oersted. Blue-green alga among *Oscillatoria* sp. in Mill pond, Wolf creek.

Appendix IX

STOCKING LIST TO ACCOMPANY MAP 1

Albion, Brockport and Rochester quadrangles

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River	23	Sm. B., Pp.
Ontario-East-G. 1–4	Dry or small	None.
Red creek and tributaries	Warm	None.
Red creek G. 1–3	Small	None.
Ontario-West-G. 1–12	Dry or small	None.
Little Black creek and tributaries	Warm, dry or small	None.
Black creek	21 (lower)	Lm. B., Bg. S., C., Y. P.
Byron pond	6–7 acres	Lm. B., Bg. S., C., Y. P.
1–3	Small or warm	None.
4	0.2 mile (below Blue pond)	540 B. T. +
1–2	Dry	None.
Blue pond	18 acres (posted)	(S. T., B. T.) None.
1 (inlet)	5 miles	300 S. T.+
5–27	Dry, warm or small	None.
28 (Spring creek)	6 miles	300 B. T.+
1–5	Dry or small	None.
6	0.3 mile	200 B. T.+
Fuller's pond	1 acre	1,000 S. T.+
1 (inlet)	1.5 miles	200 S. T.+
7–9	Dry or small	None.
29	Small	None.
30 (Bigelow creek)	Warm	None.
1	Small	None.
Godfrey's pond	4 acres	Lm. B., Y. P., Bg. S., Co. B.
Horseshoe lake	6–7 acres	Lm. B., Bg. S., Y. P., C., Co. B.
31–33	Small	None.
Black creek G. 1–2	Dry	None.
Allen creek (lower Oatka)	2.5 miles, Scottsville to Garbutts	2,000 B. T.+
	2 miles, Wheatland to Twin Bridges	1,500 B. T.+
	6 miles, Mumford to Fort Hill	1,000 B. T.+
1–2	Small	None.
6	Small	None.
8 (Oatka creek)	Warm	None.
9	Small	None.

Appendix X

STOCKING LIST TO ACCOMPANY MAP 2

Batavia, Caledonia, Honeoye and Canandaigua quadrangles

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River	38 miles	Sm. B.
Red creek G. 4	Dry	None.
Honeoye creek	5 miles, Rush to mouth	Pp.
	7 miles, Honeoye Falls to Rush	Sm. B.
1–23	Warm, dry or small	None.
Mud pond	0.75 acre	Bg. S.
Round pond	3 acres	Lm. B., Bg. S., C.
Long pond	2 acres	Lm. B., Bg. S., C.
24–27	Dry	None.
28 (Gates creek)	5 miles	250 B. T.+
1–8	Dry or warm	None.
29–34 (Hemlock outlet)	Dry or warm	None.
Canadice outlet	Warm	None.
Hemlock lake	1 square mile	Municipal water supply—no stocking desired.
1–9	Dry	None.
35–46	Dry or warm	None.
47 (Mill creek)	4 miles (lower)	270 B. T.+
1–15	Dry	None.
48–49	Dry	None.
Honeoye lake	2.5 square miles	Lm. B., Bg. S., Y. P.
1–6 and 11–17	Dry	None.
Honeoye G. 1–5	Small	None.
Conesus creek	Polluted, small	None.
1–5	Warm	None.
Conesus lake	3 square miles	Pp., Sm. B., Y. P.
1–20	Dry	None.
Conesus G. 1–4	Dry or small	None.
Fall brook	Dry	None.
Fall brook G. 1–4	Dry	None.
Tributaries of Genesee West:		
Seven Springs pond	2.5 acres (posted)	(S. T.) None.
Black creek		
34–45	Dry, warm or small	None.
Allen creek	2 miles	1,000 B. T.+
3	0.3 mile (r. r. bridge to mouth)	300 B. T.+
4 (Caledonia creek)	3.5 miles (posted)	None.
5–7 (Mud creek)	Small or warm	None.
8 (Oatka creek)	4 miles, LeRoy to Roanoke	Lm. B., Bg. S.
	9 miles, Roanoke to Pearl creek	Sm. B.
1–11	Dry or small	None.
12 (Pearl creek)	3 miles	400 B. T.+
1–6	Dry	None.
13–48	Dry, warm or small	None.

Appendix X — Continued

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River—(Cont'd)		
Allen creek G. 1 (Dugan's brook)	4 miles	400 S. T.+
1	Dry	None.
Spring run	0.25 mile	1,500 S. T.
2–3	Dry or small	None.
4	1.5 miles	1,500 S. T.
Marl pond	15 acres	Lm. B., Bg. S.
Allen creek G. 2–4	Dry or small	None.
Allen creek G. 5 (Macy brook)	3 miles	300 S. T.+
1 (Yopp brook)	2.5 miles	200 S. T.+
Allen creek G. 6	2.5 miles	1,000 B. T.
Allen creek G. 7–21	Warm or small	None.
Beards creek and tributaries	Warm or dry	None.
Silver lake inlet	Warm	None.

Appendix XI

Stocking List to Accompany Map 3.

Arcade, Portage, Nunda, Wayland and Naples quadrangles

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River	31 miles	Pp., natural spawning of Sm. B. adequate.
Honeoye creek		
46 (Mill creek or Berby Hollow)	2 miles	270 B. T.+
16–17	Small	None.
Honeoye lake	Data to be supplied	
1–2; 7–8	Dry	None.
9	2 miles	700 S. T.
1–3	Dry	None.
10 (Honeoye inlet)	7 miles	400 R. T.+
1–16	Dry or warm	None.
17	1.5 miles	600 R. T.
18–20	Small	None.
11	Dry	None.
Canadice outlet	Warm	None.
5–6	Dry	None.
Canadice lake	Municipal water supply, Rochester	Stocking not desired.
1–4	Small or dry	None.
5 (Canadice inlet)	Small	None.
1–3	Dry	None.
Hemlock lake	Municipal water supply, Rochester	Stocking not desired.
7 (Springwater creek) (Hemlock inlet)	6 miles	360 R. T.+
1 (Reynolds gulf)	1.5 miles	630 R. T.+
1	Dry	None.
2	Upper, dry; lower, 1 mile	700 R. T.
Spring run	0.5 mile	350 R. T.
1	1 mile	350 R. T.
2–3	Small or dry	None.
4	4.5 miles	135 R. T.+
1–5	Dry	None.
5–9	Dry, small or warm	None.
10	2 miles	600 R. T.
1–2	Dry	None.
11 (Pokamoonshine) (Gulf brook)	1 mile (lower)	360 S. T.+
12–13	Warm and small	None.
Conesus lake	1.5 square miles	Sm. B., Pp., Bg. S., C.
9	Dry	None.
10 (Conesus inlet)	Warm and small	None.
1–8; 11–13	Dry	None.
Canaseraga creek	3 miles (Rosses to source, remainder warm)	540 S. T.+
1 (Buck creek)–2	Dry	None.
3 (Keshaqua) and tributaries	Warm	None.
4–8	Small or dry	None.

Appendix XI — Continued

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River—(Cont'd)		
Canaseraga creek—(Cont'd)		
9 Bradner creek	2 miles, above dam	360 S. T.+
	2 acres, Bradner creek pond	None.
	6 miles, below dam	300 B. T.+
1–7	Dry	None.
10–17	Dry	None.
18 Mud Run	Mostly dry	None.
1	2 miles	180 B. T.+
1	2 miles	500 B. T.
1	0.2 mile	250 B. T.
2–3	Dry	None.
2–11	Dry	None.
19–21	Dry	None.
22 Mill creek	5 miles, below dam at Patchinville	350 B. T.+
	2 miles, above dam at Patchinville	350 S. T.+
1 Carney Hollow brook	4.5 miles	500 S. T.+
1	Dry	None.
2	2 miles	150 S. T.+
1–3	Small, dry or warm	None.
3	1 mile	700 S. T.
1	Dry	None.
Spring run	150 yards	Natural spawning adequate.
4	Dry	None.
2	0.75 mile	450 B. T.
1–2	Small	None.
3	Dry	None.
4	0.75 mile	450 B. T.
1	Small	None.
5–6	Dry	None.
7	1 mile	250 B. T.
8–12	Small or dry	None.
13	0.75 mile	200 S. T.+
14 (Spring pond)	3.5 acres	1,000 S. T.+
23–24 and tributaries	Dry	None.
25 Stony brook	2 miles	100 B. T.+
1	Dry	None.
2	2 miles	100 B. T.+
3	2 miles	100 B. T.+
1	0.5 mile	100 B. T.
2	0.5 mile	100 B. T.
1	0.5 mile	100 B. T.
3	0.5 mile	100 B. T.
1	0.25 mile	100 B. T.
26–27	Warm	None.
28 Sugar creek	8 miles	135 B. T.+
1–9	Dry or warm	None.

Appendix XI — Continued

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River—(Cont'd)		
Canaseraga creek—(Cont'd)		
41 (Hovey's brook)	2 miles (upper)	200 S. T.+
3	0.25 mile	900 S. T.
4–5	0.5	900 S. T.
6	Small	None.
44–51	Dry, small or warm	None.
Canaseraga G. 15	Dry or small	None.
Oatka (upper)	Warm, Warsaw to source	None.
47–48	Dry or warm	None.
49 (Stony or Mill creek)	5 miles	310 B. T.+
1–3	Small, dry or warm	None.
50–51	Dry or small	None.
52 (Relyea creek)	4 miles	250 B. T.+
1–2	Small or dry	None.
3	1 mile	700 B. T.
53	1.5 miles	150 B. T.+
54–56	Dry	None.
57	5 miles	400 B. T.
58	1.5 miles	500 B. T.
59–61	Small or dry	None.
62 (Warner creek)	4 miles	250 B. T.+
1–4	Dry	None.
63–64	Dry or warm	None.
65–68	Small or warm	None.
Silver lake outlet	1 mile (upper)	Bg. S., Lm. B., C.
1–6	Small or dry	None.
Silver lake	1.5 square miles	Lm. B., C., Y. P., Pp., Bg. S.
Silver lake inlet	0.75 mile, near lake	Bg. S., Lm. B., C.
1–5	Small	None.
S. L. O. G. 1—Eastover broo—4	Small or dry	None.
Wolf creek 1–6	Polluted	None.
7	2 miles	500 S. T.+
1–4	0.25 mile, each	1,500 S. T., each.
Wolf creek G. 1–7	Small or dry	None.
Wolf creek G. 8	3 miles	135 R. T.
1	Small	None.
W. creek G. 9–10	Dry	None.
Wiscoy creek	2 miles, mouth to Mill's Mills	Sm. B.
	11 miles, Mill's Mills to Bliss	3,000 B. T.+
	4 miles, Bliss to source	1,000 S. T.+
1–2	Dry	None.
3 (East Koy)	13 miles, mouth to Hermitage	2,500 B. T.+
	5 miles, Hermitage to source	2,000 S. T.+

Appendix XI — Continued

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River—(Cont'd)		
Wiscoy creek—(Cont'd)		
1	0.5 mile	500 B. T.
2	0.5 mile	500 B. T.
1	Small	None.
3–6	Small	None.
7	2 miles	750 B. T.
1–3	Small or dry	None.
Spring run	0.5 mile (300 yards above No. 7)	900 B. T.
Spring run	0.2 mile (600 yards above No. 7)	900 B. T.
Spring run	0.3 mile (¾ mile above No. 7)	900 B. T.
Spring run	0.2 mile (1 mile above No. 7)	900 B. T.
Spring run	0.2 mile (below dam at Lamont)	900 B. T.
8	Dry	None.
9	1 mile	1,200 B. T.
1	Warm	None.
Spring run	0.3 mile (1.5 mile above Lamont)	900 B. T.
10–11	Dry at mouth	None.
12	1.5 miles	540 B. T.+
1	1 mile	900 B. T.
2	0.25 mile	900 B. T.
13	2.5 miles	400 B. T.+
14 (Smith creek)	3 miles	360 S. T.+
1	0.5 mile	1,300 S. T.
2	Warm	None.
3	0.5 mile	900 S. T.
4	0.5 mile	900 S. T.
15	1.5 miles (upper, dry)	2,000 S. T.
1–2	Dry	None.
16	Dry	None.
17	1 mile	900 S. T.
18–19	Small	None.
4 (Spencer brook)	3 miles	270 B. T.+
5 (Emery brook)	Dry	None.
6 (Bush Brook)	1 mile	1,300 B. T.
1–2	Small	None.
7 (Spring brook)	1.5 miles	200 S. T.+
1	0.25 mile	700 S. T.
8 (Trout brook)	5 miles	1,200 S. T.+
1	1 mile	360 S. T.+
2	1.5 miles	360 S. T.+
1	Warm	None.
3	0.75 mile	900 S. T.
4	2.5 miles	375 S. T.+
1	0.5 mile	270 S. T.+
5–6	Dry	None.

Appendix XI — Continued

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River—(Concluded)		
Wiscoy creek—(concluded)		
9–10	Dry	None.
11	0.5 mile	180 S. T.
12	4 miles	900 S. T.+
1	Dry	None.
2	0.5 mile	360 S. T.+
3–5	Small	None.
13–15	Small	None.
16	3 miles	180 S. T.+
1	1 mile	1,400 S. T.
1	0.5 mile	700 S. T.
2	Small	None.
17	2 miles	170 S. T.+
18–19	Small	None.
20	0.5 (posted)	None at present (500 S.T.)
Cold creek	2 miles (upper)	600 B. T.+
6 (Elm creek)	2 miles	370 S. T.+
7 (Spring lake outlet)	Warm	None.
8–11	Dry	None.

Appendix XII

STOCKING LIST TO ACCOMPANY MAP 4

Franklinville, Angelica, Canaseraga and Hornell quadrangles

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River	29 miles	Sm. B.
Canaseraga creek	2 miles, above Swain	Lm. B., Bg. S.
	3 miles, below Swain	1,000 B. T.+
	Canaseraga to Dansville — too warm	No stocking.
22 (Mill creek)	Upper 3 miles, dry	None.
15–16	Dry	None.
25 (Stony brook)	4 miles (middle and upper)	135 B. T.+
2	2 miles	100 B. T.+
4 (Healy brook)	Warm and small	None.
1–6	Small or dry	None.
5	2 miles	180 S. T.+
6	1.5 miles	500 B. T.+
1	1 mile	170 B. T.+
2	Small	None.
7–9	Dry	None.
28 (Sugar creek)	1.5 miles (lower)	135 B. T.+
29	Small	None.
30	Small	None.
31 (Stader creek) and tributaries	Warm, small or dry	None.
32 (Bennett creek)	Warm or dry	None.
33–37	Dry	None.
38 and tributaries	Warm or small	None.
39–40	Small or dry	None.
41 (Hovey's brook)	3 miles	375 S. T.+
1	1 mile	900 S. T.
1	Small	None.
2	1 mile	900 S. T.
42 (Ewart creek)–43	Warm and small	None.
Canaseraga G. 16–25	Dry or warm	None.
Rush creek	Upper, 3 miles	180 S. T.+
	Lower, 5 miles	235 B. T.+
1–18	Dry or warm	None.
Rush G. 1–14	Dry or warm	None.
Wigwam creek and tributaries	Warm or dry	None.
Wigwam G. 1–5	Dry	None.
Angelica creek and tributaries	Warm or dry	None.
9 (Black creek)	5 miles	5,000 Lm. B., 2,000 C., 2,000 Bg. S.
1–9	Dry or warm	None.
10–15	Dry	None.
Angelica G. 1–4	Dry or warm	None.
Phillip's creek and tributaries	Warm or dry	None.
Wiscoy G. 1–2	Dry, small or warm	None.
Cold creek	3 miles	600 B. T.+
1–2 (Sixtown)–5	Dry or small	None.
7 (Spring lake outlet)	Warm	None.
Spring lake (Flanagan's pond)	120 acres	Lm. B., Bg. S., Y. P., C.

Appendix XII — Continued

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River—(Cont'd)		
Cold creek G. 1–6	Dry or small	None.
Cold creek G. 7 (Trout run)	1 mile	150 S. T.+
Cold creek G. 8	Small	None.
Lily pond	25 acres	Lm. B., Bg. S., C., G. Sh.
Cold creek G. 9	Dry	None.
Caneadea creek	Upper 3 miles	640 B. T.+
	Remainder warm	None.
1–3	Dry or small	None.
4 (Rush creek)	5 miles (posted)	500 B. T.+
1–3	Small or dry	None.
4 (Trout brook)	1 mile (posted)	2,000 S. T.
Spring run at McGrawville	0.5 mile (posted)	1,900 S. T.
5–7	Dry or small	None.
8	1 mile (posted)	2,000 S. T.
9	Small	None.
10	0.5 mile (posted)	1,400 B. T.
11	0.5 mile (posted)	1,400 B. T.
5–6	Dry	None.
7	1 mile (posted)	375 S. T.+
1	Small	None.
8–21	Warm, dry or small	None.
22	1.5 miles	200 B. T.+
23	Dry	None.
Caneadea G. 1–2	Small	None.
Crawford creek and tributaries	Warm, small or dry	None.
Crawford G. 1	Small and warm	None.
Black creek and 1–18	Warm or small	None.
Rockville reservoir	75 acres	Lm. B., Bg. S., C., Co. B
White creek and tributaries	Warm, small or dry	None.
White G. 1–3	Dry or small	None.
White G. 4	0.75 mile	950 B. T.+

Appendix XIII

STOCKING LIST TO ACCOMPANY MAP 5

Belmont, Wellsville and Greenwood quadrangles

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River North of Belmont	Too warm for trout	Stock with Sm. B.
Genesee River South of Belmont	26	1,000 B. T.+ and 1,000 R. T.+
Angelica G. 5	Dry	None.
Phillips creek and tributaries	Dry or warm	None.
Plumbottom brook	Dry	None.
Plumbottom G. 1	0.25 mile	1,000 S. T.+
Dry creek	Dry	None.
Vandermark creek and tributaries	Dry	Stocking not advised.
Vandermark G. 1	Dry	None.
Browning's Spring run	0.75 mile	Natural spawning, B. T. Stocking unnecessary at this date.
Nigger Spring run	Isolated	Stocking not advised.
Vandermark G. 2–3	Dry	None.
Dyke creek	3.2 miles (above Andover)	300 S. T.+
	9 miles (below Andover)	300 B. T.+ and 300 R. T.+
1 (Trapping brook)	Warm or dry	Stocking not advised.
2 (Smith Hollow brook)	Dry	Stocking not advised.
3 (Whiteman Hollow brook)	Dry	None.
4 (Duffy Hollow brook)	Dry	None.
5 (Elm Valley brook)–11	Dry	None.
12 (Railroad brook) and Marsh creek	Warm or dry	Stocking not advised.
13	Dry	None.
14 (Best Hollow brook)	2 miles	300 S. T.+
1	Small and warm	Stocking not advised.
2–3	0.4 mile	200 S. T.
15 (Shovel Hollow brook)	3 miles	700 B. T.
1–3	Dry	None.
16 (Quig Hollow brook) and tributaries	Warm	Stocking not advised.
17	Dry	None.
18	2.5 miles	500 S. T.
1	1 mile	250 S. T.
2	Warm and small	Stocking not advised.
19	1.5 miles	250 S. T.
20	Dry	None.
Dyke G. 1 (Cold brook)	1 mile	350 S. T.+
1	Dry	None.

Appendix XIII — Continued

Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River—(Cont'd)		
Chenunda creek	3 miles	200 B. T.+
1–4	Dry	None.
5 (Fulmer Valley brook)	4 miles	270 S. T.+
1–4	Dry	None.
5	3 miles	270 S. T.+
1	1 mile	1,000 S. T.
6	2.8 miles	200 S. T.+
1	Dry	None.
2	1.2 miles	200 S. T.+
1	Dry	None.
3	0.6 mile	200 S. T.+
1	0.25 mile	250 S. T.
6–7	Dry	None.
8 (Hallport branch)	2 miles (above Hallport)	100 S. T.
1	0.6 mile	100 S. T.
2–3	Dry	None.
9–10	Dry	None.
11	2 miles	150 S. T.
1–2	0.8 mile, each	100 S. T., each.
12	Dry	None.
13	0.4 mile	100 S. T.
Chenunda G. 1–8	Dry	None.
Cryder creek	7 miles (below Whitesville)	500 B. T.+
	4 miles (above Whitesville)	500 S. T.+
1	Small and warm	Stocking not advised.
2	0.4 mile	1,000 B. T.
3–4	Dry	None.
5	1.6 miles	2,000 B. T.
6–10	Dry	None.
11 (Rose brook)	4 miles	300 R. T.+
1	Small and warm	Stocking not advised.
2 (Spring Mills brook)	3.2 miles	250 R. T.+
1	1.5 miles	150 R. T.+
2	1.25 miles	140 R. T.+
3	1.5 miles	150 R. T.+
3	Small	None.
4	3 miles	300 R. T.+
1	1 mile	200 R. T.+
1	Small	None.
2	0.5 mile	150 R. T.
5	Dry	None.
6	1 mile	200 R. T.+
7	1 mile	270 R. T.+
12	Dry	None.
13 (Saltpeter brook)	2.5 miles	200 R. T.+
1	Small	None.
14–18	Dry	None.
19	0.4 mile	500 S. T.
1	0.2 mile	250 S. T.

Appendix XIII — Continued

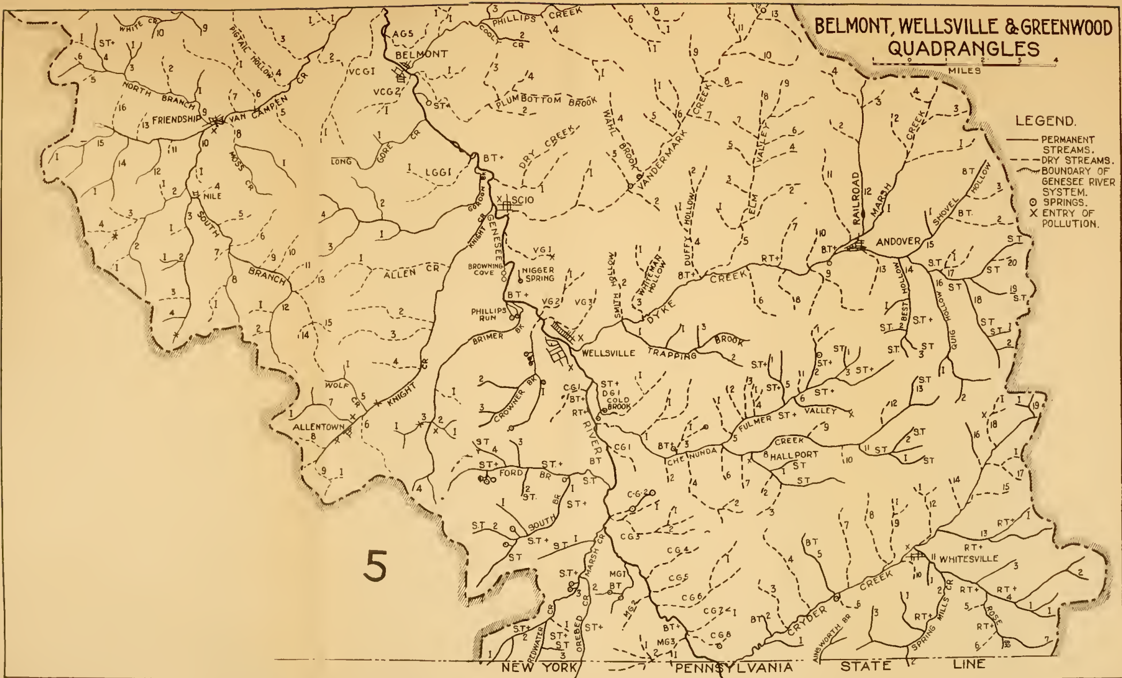
Stream and tributary number	Mileage available for stocking	Stocking policy per mile
Genesee River—(Cont'd)		
Van Campen creek and tributaries	Warm or dry	None.
9 (North branch)	Warm	None.
1–3	Small or dry	None.
4	1.25 miles	300 S. T.+
1	Dry	None.
5–6	Dry	None.
10 (South branch)	Warm, dry or small	None.
Van Campen G. 1–2	Dry	None.
Long Gore creek	Intermittent	None.
1	Small	None.
Long Gore G. 1	Dry	None.
Gordon brook 1–4	Warm	Stocking not advised.
Knight creek	Polluted	Stocking not advised at present.
1 (Allen brook)–4	Dry	None.
5 Spring Hollow brook (Wolf run)	Small	Stocking not advised.
6–9	Warm or dry	None.
Phillip's Spring run	0.75 mile	700 S. T.
Brimer brook and tributaries	Polluted, warm or dry	Stocking not advised.
Crowner brook	Warm	Stocking not advised.
Crowner G. 1	Dry	None.
Ford brook	4.8 miles	1,500 S. T.+
1 (South branch)	4 miles	700 S. T.+
1	1.6 miles	270 S. T.+
2	0.8 mile	500 S. T.
2	0.8 mile	300 S. T.
3	Dry	None.
4	1.2 miles	500 S. T.
Marsh creek	2 miles	800 S. T.+
1	1.2 miles	150 S. T.
2 (Orebed creek)	0.2 miles	400 S. T.+
3 (Redwater creek)	2.8 miles	500 S. T.+
1	Dry	None.
2	1.6 miles	250 S. T.+
1	0.4 mile	1,000 S. T.
3	0.4 mile	800 S. T.
Marsh G. 1	1.6 miles	500 B. T.
1	0.4 mile	300 B. T.
Marsh G. 2–3	Dry	None.

MAP 1.— ALBION, BROCKPORT AND ROCHESTER QUADRANGLES.

MAP 2.— BATAVIA, CALEDONIA, HONEOYE AND CANANDAIGUA QUADRANGLES.

MAP 3.—ARCADE, PORTAGE, NUNDA, WAYLAND AND NAPLES QUADRANGLES.

MAP 4.—FRANKLINVILLE, ANGELICA, CANASERAGA AND HORNELL QUADRANGLES.



MAP 5.—BELMONT, WELLSVILLE AND GREENWOOD QUADRANGLES.

CONSERVATION DEPARTMENT SURVEYS AND STUDIES (BIOLOGICAL)

Reprints and Supplementary Reports

1916: Fish Planting in Public Waters, by Tarleton H. Bean.

1917: Working Plans for Increasing Fish Production in the Streams of Oneida County, by Wilbert A. Clemens. (Out of print.)

1919: Stream Pollution in New York State, by Henry B. Ward.

1921: Limitations of Black Bass Culture, by J. W. Titcomb.

1922: Report Upon a Study of the Fish Producing Waters of Tompkins County, N. Y., by G. C. Embody.

1922: A Biological Survey of Lake George, N. Y., by Jas. G. Needham, Chancey Juday, Emmeline Moore, Chas. K. Sibley and John W. Titcomb. (Out of print.)

1922: Stream Pollution Studies, by Russell Suter and Emmeline Moore, and Studies in Oyster Culture, by Wm. Firth Wells.

1922: Problems in Oyster Culture, by Wm. Firth Wells; Diseases of Fish in State Hatcheries, by Emmeline Moore. In: Report of Bureau of Prevention of Stream Pollution.

1923: Report on Investigation of the Pollution of Streams, by Russell Suter.

1923: Results of Shellfish Investigations, by Wm. Firth Wells; Diseases of Fish in State Waters, by Emmeline Moore. In: Report of Bureau of Prevention of Stream Pollution.

1924: Fish Diseases, by Emmeline Moore.

1924: Oyster Investigations, by Wm. Firth Wells.

1925: Problems in Fresh Water Fisheries, by Emmeline Moore.

1925: A New Chapter in Shellfish Culture, by Wm. Firth Wells.

1925: Proper Methods of Fish Planting, by Sumner N. Cowden.

1926: Biological Survey of the Genesee River System.