



VOLUME III

Ecology of the Lakes  
of East-Central New York

# LAKES OF NEW YORK STATE

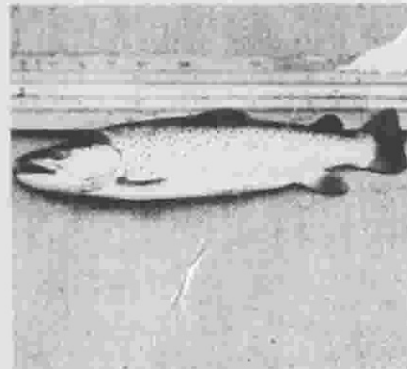
edited by  
Jay A. Bloomfield

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Lakes of  
New York State

**VOLUME III:** Ecology of the Lakes of  
East-Central New York



Four Views of Canadarago Lake, New York. Clockwise from upper left: A dairy farm near Richfield Springs, New York, typical of the agricultural character of the watersheds of lakes in east-central New York. Plaque on the new Richfield Springs Wastewater Treatment Facility. The plant was designed to remove over 90% of the phosphorus in the sewage produced by the Village of Richfield Springs. Construction of this plant in 1973 has subsequently reduced the phosphorus input to Canadarago Lake by about one-half. A brown trout (*Salmo trutta*) collected from Canadarago Lake. Infrared imagery of aquatic macrophyte beds on the southwest shore of Canadarago Lake. (Photos courtesy New York State Department of Environmental Conservation.)

# Lakes of New York State

**VOLUME III**

ECOLOGY OF THE LAKES OF  
EAST-CENTRAL NEW YORK

EDITED BY

***Jay A. Bloomfield***

*New York State Department of Environmental Conservation  
Albany, New York*

1980



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# List of Contributors

*Numbers in parentheses indicate the pages on which the authors' contributions begin.*

SUSAN P. ALLEN (129), Division of Laboratories and Research, New York State Department of Health, Albany, New York 12201

DONALD B. AULENBACH (265), Department of Chemical and Environmental Engineering, Rensselaer Polytechnic Institute, Troy, New York 12181

NICHOLAS L. CLESCERI (265), Fresh Water Institute, Rensselaer Polytechnic Institute, Troy, New York 12181

JAMES J. FERRIS\* (265), Department of Chemical and Environmental Engineering, Rensselaer Polytechnic Institute, Troy, New York 12181

G. WOLFGANG FUHS (129), Division of Laboratories and Research, New York State Department of Health, Albany, New York 12201

DAVID M. GREEN (129), Department of Natural Resources, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca, New York 14850

WILLARD N. HARMAN (1), Biology Department, State University of New York College at Oneonta, Oneonta, New York 13820

THOMAS E. HARR† (129), New York State Department of Environmental Conservation, Albany, New York 12233

LEO J. HETLING\*\* (129), New York State Department of Environmental Conservation, Albany, New York 12233

STEPHEN B. SMITH‡ (129), Department of Natural Resources, Cornell University, Ithaca, New York 14850

LEONARD P. SOHACKI (1), Biology Department, State University of New York College at Oneonta, Oneonta, New York 13820

\*Present address: Environmental Projects, Envirosphere Company, New York, New York 10006

†Deceased.

\*\*Present address: New York State Department of Health, Division of Environmental Health, Governor Nelson A. Rockefeller Empire State Plaza, Albany, New York 12237

‡Present address: U.S. Fish and Wildlife Service, East Central Reservoir Investigations, Ouachita Baptist University, Arkadelphia, Arkansas 71923

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# Foreword

Between 1926 and 1938 the New York State Department of Conservation published a series of biological surveys of the river drainage basins in the State. The studies carried out and the resulting reports must be considered classic biological inventories and, even today, represent the best set of biological information on the surface waters of New York State.

Anyone working in the State quickly realizes their value. Their influence on management of these waters and on the scope and direction of subsequent studies has been and continues to be so prominent that one wonders what would have been done had they not existed. Rarely does a study begin or is a report published on any lake or stream in the State that does not utilize these as basic references.

However, even as the last of the surveys was completed in 1938, the "desirability of up-to-date revisions of former surveys" was recognized. Unfortunately, this has not been done, and an examination of the original surveys reveals this need for updating. Since the original surveys, conditions in some systems have changed, the state of the art of measuring and interpreting data has advanced, and numerous studies provide a wealth of additional information.

Because of the demonstrated values of these biological inventories and the increased interest in lake management, the Department of Environmental Conservation commissioned the preparation of this treatise on lakes in New York State. The contributions were to be inventory reports modeled after the original biological surveys, but were to be expanded to cover the physical, chemical, and biological state of the lake and its drainage basins. Preparation of the contribution was not to include carrying out of any special field studies but was to be based on existing data and information. Fortunately, in New York State, for most of the important lakes, a great amount of data has been collected and reported as part of studies directed at one or another aspect of the lake. Additionally, the State has a reservoir of resident limnologists who by virtue of their location and interest were uniquely capable of authoring these articles.

The purpose of these articles may be explicitly stated as follows:

1. To provide in a unified manner an authoritative set of current data from which lake management decisions can be made.

2. To begin to meet the requirements of the 1970 Federal water pollution control legislation which requires "that the State shall prepare an identification and classification according to the trophic condition of all publicly-owned fresh-water lakes in such State."

3. To provide a uniform set of data from which comparative lake studies could be made.

4. To provide a set of uniform baseline data on lakes from which future changes can be measured.

5. To provide for students a set of real data that will bring to life their classroom experience.

6. To determine where gaps in our knowledge of New York State lakes exist, and provide a basis for investment in future studies and research.

In an age when there is an increased awareness of the value of the environment, when environmental laws and regulations are multiplying at an unprecedented rate, when environmental legal proceedings are commonplace, and when environmental impact statements have become a way of life, these volumes should prove useful.

The idea of this treatise series was originally conceived in 1972 and, after many setbacks, the project commenced in 1974. The leadership, assistance, and patience of so many people were instrumental in their completion that space prevents a listing of their names and contributions. However, I feel compelled to mention the commitment of Mr. Eugene Seebald, Director of the Division of Pure Waters, who provided steadfast support for the effort, even when short-term needs suggested utilization of the required resources in other areas.

Leo J. Hetling  
Albany, New York

# Preface

This volume of "The Lakes of New York State" is dedicated to the memory of the late Dr. Thomas E. Harr, a former co-worker of mine, who is the senior author of the chapter on Canadarago Lake. It is difficult for me to believe that five years have passed since Tom and the other contributors to this treatise first discussed the idea behind a series of manuscripts that would synthesize ecological information on thirty or so of the State's significant lakes. I remember Tom for his meticulous writing style which is reminiscent of much of the classical ecological literature of the first half of this century. The irony of a written work to be published after the author's death is at once both a happy and somber occasion. It is sad to recognize that occasionally we do not harvest the fruits of our labors, but this cynicism is tempered by the lasting properties of the written word.

The chapter on Canadarago Lake is a result of studies conducted by the authors between 1967 and 1976 on shallow and culturally enriched Canadarago Lake and its watershed. Like Lake Washington near Seattle, Washington and Shagawa Lake near Ely, Minnesota, Canadarago Lake was the site of a controlled experiment in environmental management. Sewage, receiving only minimal treatment from the village of Richfield Springs had been entering a tributary of the lake, and this discharge represented a sizeable proportion of the annual phosphorus load to the lake. The construction of a new wastewater treatment facility in 1973 reduced the phosphorus contribution by the village of Richfield Springs by about 90%. Monitoring surveys covered all aspects of the lake's condition, including a unique investigation of the behavior of predatory and forage fish populations during and after nutrient control.

About 10 km to the southeast lies Otsego Lake, the Glimmerglass of James Fenimore Cooper's Leatherstocking novels. Otsego Lake is probably most well known for Cooperstown on its southerly shores, the location where Abner Doubleday reportedly invented the game of baseball. Harman and Sohacki's treatment of the lake reflects the profuse amount of data on the lake's plants and animals. The diversity of biological data is unusual considering that Otsego Lake exhibits low productivity and high water clarity that make it the biologically poor sister of Canadarago.

About 100 km to the northeast of this limnological odd couple is Saratoga Lake. In his chapter, Aulenbach has categorized a productive lake exhibiting the classic symptoms of cultural eutrophication: low water clarity, growth of nuisance algae, hypolimnetic oxygen depletion, and the presence of fecal bacteria in the lake water. A popular tourist spot until recently, the lake's change in character has selected for a certain group of humans, the amateur angler. Saratoga Lake now possesses an impressive sports fishery with Walleye (*Stizostedion vitreum vitreum*), Northern pike (*Esox lucius*), black bass (*Micropterus*), and pan fish dominating. Recent sewage diversion efforts in the Saratoga Lake watershed have worried sportsmen, who are concerned that the constant stimulation of the lake's productivity by plant nutrients in sewage was responsible for the outstanding sport fishery. Aulenbach's balanced account of prediversion conditions should provide a solid footing for future ecological studies.

Three North Temperate lakes in areas of extensive agriculture in eastern New York State, all of about the same surface area, are the subject of this volume. Two, Saratoga and Canadarago Lake, are biologically productive, primarily due to man's activities. The other, Otsego Lake, is deep and hence relatively immune to the effects of civilization. This is how they are as of today, but how they will fare in the future is unknown. What is certain is that unlike people, lakes constantly change and rarely does the limnologist outlive the inanimate object of his attentions.

This publication was supported under a United States Environmental Protection Agency Annual Water Pollution Control Program Grant No. M002060033 to the New York State Department of Environmental Conservation.

The contributions have been reviewed by the New York State Department of Environmental Conservation and approved for publication. Approval does not signify that the contents necessarily reflect the views and politics of the Department of Environmental Conservation, nor does mention of trade names or commercial products constitute endorsement or recommendation for their use.

I would like to thank Arlene Crawford, Valerie Weisman, Virginia Capano, Rose Salvo, Patrick Hanley, and Stanley Zelka for their help in preparing the manuscripts for this volume.

Jay A. Bloomfield

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# The Limnology of Otsego Lake (Glimmerglass)

*Willard N. Harman and Leonard P. Sohacki*

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## INTRODUCTION

This chapter has been assembled to provide information for government agencies, planners, and any groups concerned with land use and development in Eastern New York State, and to disseminate accumulated data describing the aquatic resources of New York.

The characteristics that a body of water exhibit are a reflection of local bed-

rock, soils, hydrology, climate, and stream flow. Nutrient cycling, both rates and amounts, is extremely important and is a result of the attributes of the physical factors mentioned in addition to the abundance, diversity, and biotic efficiency of the flora and fauna. In recent years the effects of man on aquatic ecosystems have become more and more apparent; therefore, land use, population distribution, and the socioeconomic characteristics of watersheds are important variables in ascertaining lake quality. For the above reasons, discussions of these factors have been included so that a fuller understanding of the lake is possible.

Otsego Lake fills a depression formed by the overdeepening of the headwaters of the Susquehanna River by Pleistocene glaciation. It is unique; other local lakes of its shape and size drain north via the Oswego River into the St. Lawrence watershed. The fauna and flora are represented by organisms typically found in morphometrically oligotrophic lakes (as indicated by some Finger Lakes), but many associations have been derived from taxa typical of the Atlantic coast drainage and are, therefore, different from their counterparts in the Finger Lakes region.

With a maximum depth of 50.5 m (166 ft), Otsego is one of the deeper lakes in New York State. This characteristic, combined with a preponderance of narrow, precipitous shores, results in a comparatively restricted phototrophic zone. This phenomenon, in turn, is directly responsible for the maintenance of the aesthetic qualities of Otsego despite appreciable nutrient introduction from natural and cultural origin.

## History

In 1612 two Dutch explorers traveled from the junction of the Mohawk and Hudson Rivers westward up the Mohawk, crossed overland to Otsego Lake and then south down the Susquehanna (Cooper, 1920). This link that the lake provides in joining the Mohawk and Susquehanna watersheds has had important effects on Otsego and its utilization throughout recorded history. Cadwallader Colden, the New York State surveyor-general, reported 125 years later (1737),

At 50 miles from Albany, the land carriage from the Mohawk River to a lake (Otsego), from whence the northern branch of the Susquehanna takes its rise, does not exceed 14 miles. Goods may be carried from this lake in battoes or flat-bottomed vessels, through Pennsylvania to Maryland and Virginia, the current of the river running everywhere easy. (Shaw, 1886, p. 6).

The first settlement in the area was constructed by the Rev. J. C. Hartwick in 1761. It was abandoned soon thereafter when he discovered that his patent was located somewhat farther south along the river. A few years later (1770) George Croghan built a home and lived along the lake with his family until the revolution. During that time Indian activity precluded habitation by settlers and the area

was abandoned. Soon after, Generals Sullivan and Clinton were sent into central New York to bring a stop to the activities of the Indians. In 1779 Clinton moved south from Canajoharie overland to Otsego Lake with 200 boats and 1500 troops. His mission was to travel down the Susquehanna and join forces with Sullivan at Tioga. When he found the river waters too low for navigation, he dammed up the flow from the lake, released it, and floated downstream on the crest of the flood (Cooper, 1920).

In 1785 William Cooper arrived at the south end of Otsego Lake and founded the settlement that was to become Cooperstown. The aquatic resources of the region soon became recognized. A few years after settlement a late spring saw 200 families in the village bordering on starvation. In the words of Cooper:

A singular event seemed sent by a good Providence to our relief; it was reported to me that unusual shoals of fish were seen moving in the clear waters of the Susquehanna. I went, and was surprised to find that they were herrings. We made something like a small net, by the interweaving of twigs, and by this rude and simple contrivance we were able to take them in thousands. In less than two days each family had an ample supply. (Lynch, 1965, p. 24).

Commercial fishing soon became an enterprise that is still active on the lake. Seining for Otsego Bass (*Coregonus clupeaformis*) was first recorded in 1789 and continued until 1915 when it was permanently banned. In 1896 the holders of 42 seine licenses recorded catches of 1100 kg of these fish. Gill netting was introduced in the 1850s. Between 1855 and 1867, single hauls containing in excess of 5000 Otsego Bass were recorded taken and a drastic reduction in lake trout (*Salvelinus namaycush*) was attributed to the netting (Birdsall, 1917). Final prohibition occurred in 1915.

In 1870 Elihu Phinney built a hatchery on Three Mile Point, and over the next few years many thousands of fish were stocked. It was at this time that commercial transportation on the lake was developed to facilitate access between rail traffic in the Catskill area and that from Albany to Buffalo via rail and the Erie Canal. Recreational possibilities were also recognized (Bacon, 1902).

The first steamboat on Otsego Lake was launched in 1858. The last commercial steam vessel plied the lake in 1933. During the height of these activities, in 1894, ten steam-powered boats were active on the lake. At least two, the "Natty Bumppo" and the "Cyclone," possessed capacities for more than 300 passengers each (Ketchel, 1963).

In 1935 the New York State (NYS) Conservation Department funded the first biological survey of the Delaware and Susquehanna watershed. Otsego Lake was included in those studies (NYS Conservation Department, 1936). Data were collected concerning water chemistry, physical limnology, plankton, seston (all particulate matter suspended in the free water), benthos, nekton (fish), and aquatic vegetation.

In 1968 access to the lake and lands for a biological field station were acquired

by the SUNY College at Oneonta to initiate the development of a biological research facility. Most of the data included in this work have been accumulated through the activities of that group.

### **Population Distribution**

In 1868 there were 40 dwellings around the shores of Otsego Lake, excluding the village of Cooperstown (Beers, 1868). In 1937 at least 147 buildings could be counted along the shores using aerial photographs (U.S. Department of Agriculture, 1936-1937). Photographs taken in 1969 (U.S. Department of Agriculture, 1969) show 273 dwellings. These, coupled with the access given to thousands (about 7000 on a Sunday with optimal weather) via Glimmerglass State Park, indicate an increase in summer, weekend population pressure of greater than 950% in the last 100 years. These calculations include 600 individuals on the steamboats plying the lake in the middle 1800s and 100 individuals at the public park at Three Mile Point (Ketchel, 1963). A census of boats made on Sunday, August 10, 1975 resulted in a total count of 1070 boats (Otsego County Conservation Association, 1975). More than 50% were small motorcraft. There were 173 seasonal residences in the town of Otsego in 1974, 99 in the town of Springfield, and 73 in the town of Middlefield. About two-thirds of these are on the shores of Otsego Lake (Cornell Institute for Research, 1974).

The current permanent population in the watershed is estimated at 4475. The population in the town of Springfield and the portions of Herkimer County within the drainage area is 1620. In the town of Otsego there are 299, and in Middlefield the permanent population within the watershed is less than 10. The population of Cooperstown at the south end (outlet) of the lake is 2456 (Cornell Institute for Research, 1974).

Sewage and effluent discharges are almost entirely derived from septic tank leach fields with the exception of Glimmerglass State Park, which discharges secondary treated sewage into glacial tills and lacustrine soils near the mouth of Shadow Brook. There is no known industrial discharge.

The location of Cooperstown at the outlet of the lake is fortunate. The effluents originating there do not reach the lake (with the exception of Willow Brook drainage) but enter directly into the Susquehanna River. Potential eutrophication caused by the towns of Otsego and Middlefield is not considered severe, assuming that future development takes place according to the prerequisites of good land-use planning. Problems lie in the town of Springfield and in Herkimer County, where comparatively high population densities, combined with soils naturally rich in nutrients and intensive areas devoted to agriculture, result in drainage via Cripple Creek, Hayden Creek, and Shadow Brook that undoubtedly contributes significantly to lake eutrophication. According to the U.S. Environmental Protection Agency (1974d), extremely high nutrient export (significantly

higher than urban runoff) occurs in regions with basic agricultural soils, high domestic animal densities, and rapid runoff due to lack of natural vegetation along water courses.

### Socioeconomic Characteristics

In the three towns surrounding Otsego Lake, the average family income is \$9,270.00 (Otsego County Planning Department, 1974). Percentages of family incomes in selected categories are presented in the tabulation below:

Income (\$)	Percentage
0-2,999	9.5
3,000-4,999	11.7
5,000-6,999	18.5
7,000-9,999	18.0
10,000-14,999	25.1
15,000-24,999	15.1
25,000-over	2.1

The percentage of employed population 16 years old and over by occupation is given below:

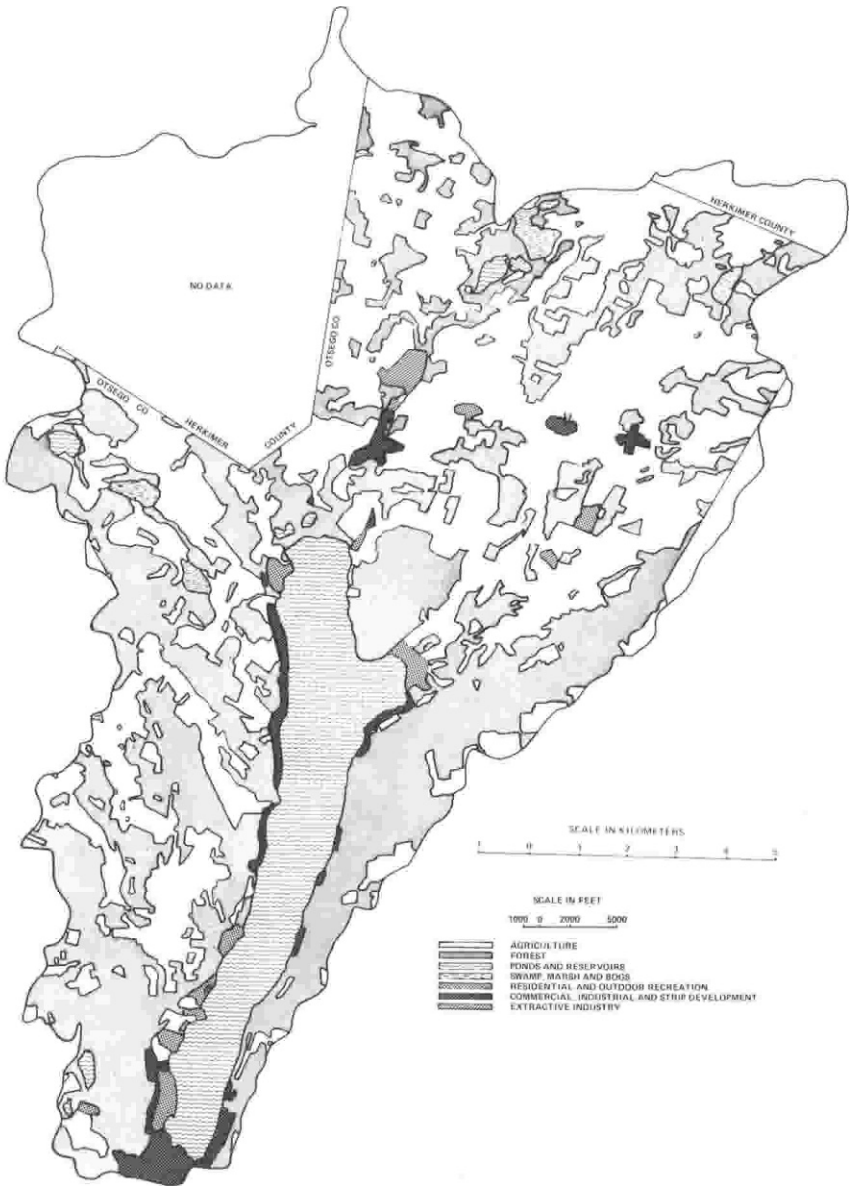
Occupation	Percentage
Professional, technical, managers, and administrators	22.6
Sales, clerical, and kindred workers	20.2
Craftsmen, foremen, and operatives, except transport	16.2
Transport equipment operatives	2.9
Laborers, except farm	6.2
Farmers, farm managers, farm laborers, and farm foremen	10.6
Service workers including private household workers	22.2

Of the population 25 years old and over, 24.8% have completed only elementary school; 48.1% have completed from 1 to 4 years of high school; and 12.4% have attended 1 to 3 years of college. Four years of college or more have been completed by 14.7% of this group.

## DRAINAGE BASIN

### Land Use

Figure 1 indicates the land-use patterns in the Otsego Lake watershed in Otsego County (Shelton *et al.*, 1968). Calculations are based on the assumption



**Fig. 1.** Land-use patterns in the Otsego Lake watershed, based on hydrological characteristics. Derived from Shelton *et al.* (1968).

that land use in the portion of Herkimer County falling within the watershed is roughly equivalent to that in the northern portion of the town of Springfield.

The total catchment area of Otsego Lake is 17,699 ha (68.2 square miles). Forty-nine percent of the watershed is utilized for some type of agriculture, and 36% is forest dominated by second-growth hardwoods (birch, beech, maple), white pine, and eastern hemlock. Areas of red oak, American ash, hickory, and their associates occur in areas of less relief in the northern portions of the watershed.

Residential, industrial, and commercial use and transportation each cover less than 0.01% of the available land area. The lands utilized most intensively for agriculture are those derived from local limestones. Nutrient runoff inherent in those soils is greatly enhanced by this type of use.

## Geology

Otsego Lake lies in the glacially overdeepened headwaters of the Susquehanna River in Otsego County, New York (42°40'N–70°00'W) within the northern portions of the Appalachian plateau. It is oriented, with its main axis north to south, in a glacially overdeepened valley at an elevation of between 364.2 and 364.5 m. The lake is enclosed on the east and west by truncated slopes rising to the divide at a height of about 610 m. The lake is bounded on the northern end by the Richfield Springs drumlin field and on the south by an end moraine and outwash plain that dammed the valley and impounded the waters trapped therein.

The parent rocks in the watershed were deposited as marine sands, silts, clays, and carbonates in the Appalachian geosynclinal sea during the Lower and Middle Devonian Period. Although most of the Susquehanna watershed lies on acid sandstones and shales (in this region the Hamilton–Panther Mountain and Marcellus formations, roughly 100 m in thickness) low in calcium and other compounds important in organic metabolism, the north end of Otsego Lake and the greatest portion of its watershed lie on the southern exposure of the Onondaga limestone formation (ca. 30 m thick) and drain areas of the older (Lower Devonian) Helderberg limestones to the north. This results in naturally productive waters, appearing incongruous when viewed between unproductive hills of arenaceous shales and siltstones. Glacial outwash, till, and alluvial sediments have partially filled the valleys to the south to depths as great as 75 m, increasing from roughly 15 m in areas north of the lake.

## Soils

The soils derived from the above-mentioned formations, and Adirondack-derived materials carried south by the Pleistocene glaciers, are extremely diverse, dominated by poorly drained, acid, shallow soils in the south and by