A STUDY OF LAKES IN RENSSELAER COUNTY, NEW YORK WITH PROPOSALS FOR ENVIRONMENTAL MANAGEMENT

FINAL REPORT

By

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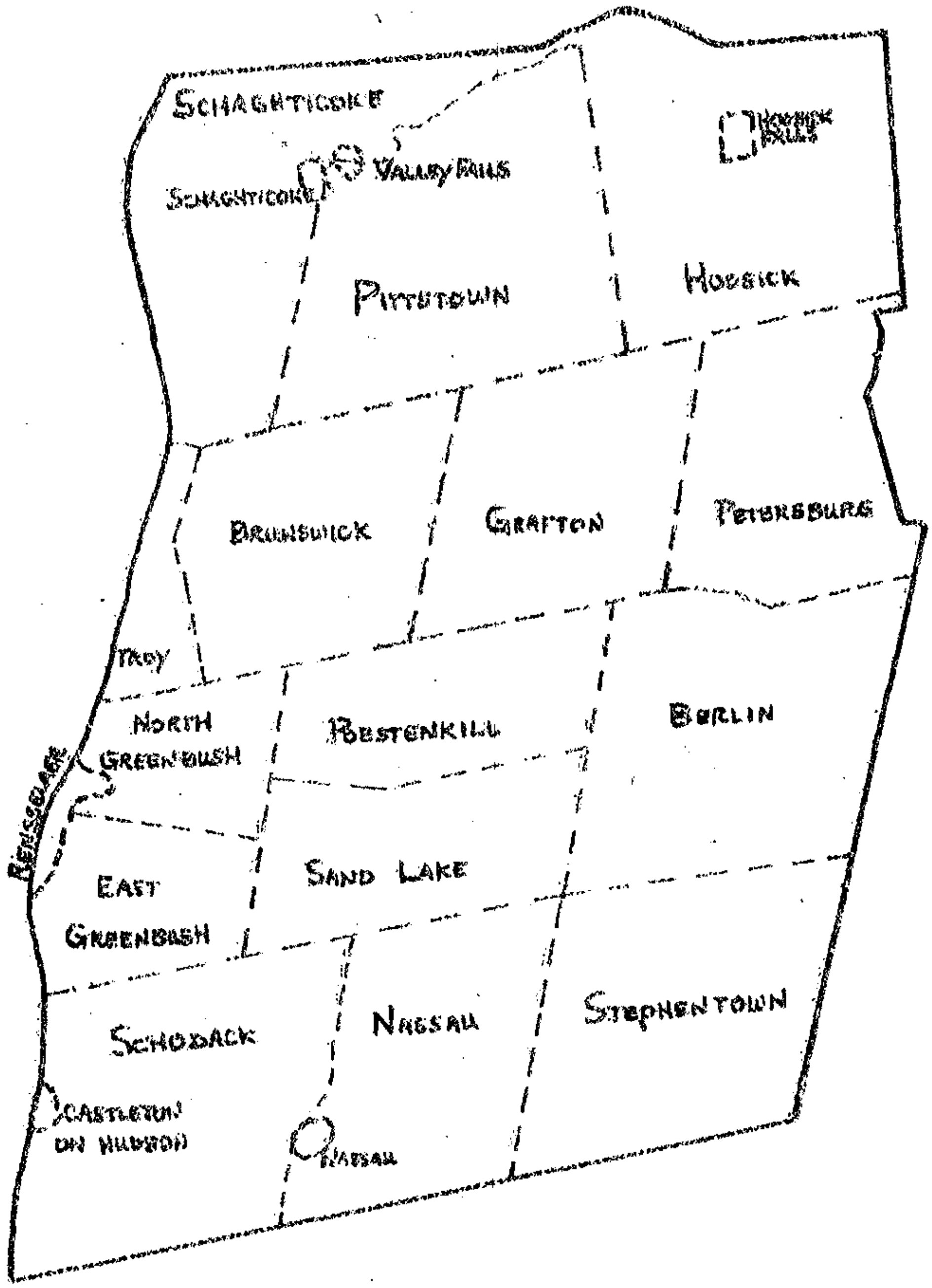
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NORTH GREENBUSH
BERLIN
RENSSELAER
EAST GREENBUSH
SAND LAKE
SCHODACK
NASSAU
STEPHENTOWN
CASTLETON ON HUDSON
NASSAU

TABLE OF CONTENTS

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INTRODUCTION

PURPOSE

The purpose of the study herein reported has been to generate data on certain physical, biological, chemical and geological parameters of twenty representative fresh-water lakes and ponds in Rensselaer County, New York State. The study extended over a period of three months from June 5, 1972 to August 25, 1972. The data generated has been used to characterize the water quality of each lake throughout the summer, to compare the various lakes, and to make general recommendations as to how the present rate of deterioration can be reduced.

The funding for this study was provided through the National Science Foundation Student Originated Studies, Grant Number GY-9611. The study was conducted at, and with the cooperation of, the host institution, Rensselaer Polytechnic Institute.

The study has attempted to fulfill the need for a broad-based survey of the lakes in the county by bringing an integrated, interdisciplinary approach to the investigation. It is hoped that the report will provide a general base line for comparisons with future studies. Further, it is hoped that the data, conclusions, and recommendations provided here will result in direct action taken to improve the lake outlook in this county. Any use of this report for such purposes is eagerly approved.

WHY A LAKE STUDY IN RENSSELAER COUNTY?

A lake is a unique resource for any community. Properly managed, it can greatly benefit the quality of life in the community by offering many domestic, industrial, agricultural and recreational advantages. Of equal importance are the intangible benefits to man's emotional well-being that come from direct contact with the natural environment of a lake.

Rensselaer County is fortunate to contain many small lakes and ponds. These lakes presently are used for recreation primarily although some are used as water supplies. In the future, the water supply status should be good in the urban and suburban areas immediately around the City of Troy. The rural areas of the county are not in such an enviable position. All of the county's present growth is occurring in the rural and outlying suburban areas of the county. Water supply and waste disposal planning will soon be a major concern in these areas and it will be extremely beneficial to have the types of data made available by this study for use as a baseline for planning purposes.

The need for studies of this type was supported by Carl Stefanik, Director of the Division of Environmental Hygiene, Department of Health, Rensselaer County, in the preliminary proposal for this study. His cooperation throughout the study period indicates his continuing interest in the results of this project. Supporting statements were also provided by Edward J. Quinn, Chairman of the Rensselaer County Legislature and Thornton K. Ware, Planning Director, Rensselaer County Department of Planning and Promotion.

The onset of nuisance conditions in certain of the lakes, as evidenced by an increased program of chemical treatment, indicates the changing nature of the lakes. If these lakes are to be of use to Rensselaer County in the future, their present conditions must be examined and the seriousness of their deterioration must be determined.

From a purely academic viewpoint, Rensselaer County offers a unique opportunity for lake studies. The area is dotted with lakes which share some geological and environmental similarities, but with a wide variance in other characteristics that is ideally suited for comparative analyses.

ANALYSIS OBJECTIVES

Sampling twenty lakes and measuring approximately twenty parameters provided a multitude of possible analytical comparisons. There were three basic approaches that were used in preparing this study:

(1) The lakes were compared with each other at certain points in time (six times throughout the study).
(2) The general trend within each lake was investigated as the study continued and each lake was characterized as a separate entity.
(3) The general trends were then compared.

The combined purpose of the above approaches is to determine the quality of each lake and to group the lakes into categories of similar chemical, biological and geological characteristics.

PERSONNEL

In an attempt to provide an integrated, interdisciplinary approach to the problem and to provide the expertise to adequately measure the wide range of parameters investigated, students from six disciplines and four colleges were included on the project team. These included five biology students (with interests ranging from microbiology to botany), four students in environmental engineering, three chemistry students, two students in geology, one physics student, and a political science major. The institutions represented include Rensselaer Polytechnic Institute, State University of New York at Albany, Russell Sage College, and West Virginia Wesleyan College.

METHODOLOGY

SELECTION OF LAKES

Selection of the lakes to be studied was an essential segment of the project. The lakes were selected to be a representative sampling of the county. Certain watersheds were also picked for other specific reasons. The selection of lakes was done by the Steering Committee in conjunction with Mr. Carl Stefanik of the Rensselaer County Health Department and Mr. Russell Fieldhouse, New York State Biologist.

A list of the lakes and reasons for selection follow:

(1) Glass Lake is a large (for this county), deep lake used for recreation.

(2) Crooked Lake is a large, shallow lake also used for recreation.

(3) Burden Lake is large and used for recreation. Also, one of its three sections has recently been studied. This project investigated the remaining two sections.

(4) Snyders Lake was chosen on the basis of its obvious deterioration. Nuisance reports to the County Health Department suggested its worsening condition. Also, an extension of sewer districts has been proposed to include the lake and the lake will be undergoing investigation by the County Health Department. This report will serve as a base line for further studies.

(5) Reichards (Raquet) Lake is located in a residential area. It is close to Snyders Lake, but has a considerably different type of watershed.

(6) Hampton Lake is completely surrounded by a fairly dense residential area and receives drainage from storm sewers in the area.

(7) Crystal Lake is known locally as being "one of the best" lakes in the County. It is reportedly very deep and transparent.

(8) Nassau Lake is in a residential area in the southern part of the County and is used for recreation.

(9) Big and Little Bowman Ponds are very close geographically but represent entirely different watersheds. Big Bowman is a spring-fed lake, while Little Bowman is a man-made mill pond.

(10) Tackawasick (Tsatsawassa) Lake is in the southern end of the County and is used for recreation.

(11) Forest Lake is a small lake with some population on the north shore and little on the south.

(12) Dyken (Dyking) Pond is isolated and the population density in the area is low.

(13) Taconic Lake is a small isolated lake with a watershed in the eastern part of the County.

(14) Long Pond, Second Pond and Shaver Pond are within Grafton State Park. They are primarily recreation lakes although Shaver does receive the discharge from the complex's treatment plant.

(15) Babcock Pond is a spring-fed, deep pond surrounded by summer camps and cottages. It is privately owned and motor boats are prohibited.

(16) Troy Reservoir (Vanderheyden-Brunswick Reservoir) once was a reservoir for supplying water to the City of Troy. It is now a recreation area for the Town of Brunswick.

(17) Tomhannock Reservoir is the largest body of water in Rensselaer County. It is primarily man-made and supplies water to about one quarter of the county.

SELECTION OF PARAMETERS

The selection of parameters to be investigated was made by the Steering Committee after research into previous lake studies and with suggestions from Mr. Carl Stefanik of the Rensselaer County Health Department. A list of the parameters chosen and reasons for selection follow:

Chemical Parameters

(1) Dissolved oxygen measurements are of value in lake studies as they are inherently dependent on most of the chemical, biological and physical characteristics of the lakes. Dissolved oxygen is particularly

useful in determining the effects of increased plant and algal productivity on the lake's ecosystem. Detection of the onset of anaerobic conditions and the institution of proper controls can prevent many lake problems from advancing too far.

(2) Orthophosphate measurements indicate the amounts of phosphorus readily available for use by algae. Many investigators have shown phosphorus can be a limiting nutrient in algal growth (Lund, 1969; Mackereth, 1953; Provasoli, 1969; Fuks, 1971).

The California State Water Quality Board (1967), among others, states that algal blooms may occur at levels of inorganic phosphorus exceeding .015 mg/1 P.

(3) Total phosphorus is a measure of the amount of the nutrient in dissolved and suspended states. This is a better measure of the level of this nutrient (Lund, 1969).

(4) Nitrate-nitrite measurements indicate the amounts of nitrogen readily available to algae. Levels of inorganic nitrogen (NO_3, NO_2, NH_3) exceeding .3 mg/1 N can result in algal blooms (California State Water Quality Board, 1967).

(5) Hydrogen sulfide levels are used as an indicator of anaerobic conditions. As many of the lakes were expected to develop anaerobic conditions in the hypolimnion as the summer progressed; this paramater was included for comparative purposes. Also, odor problems can be expected as levels of this gas rise.

(6) pH measurements can be indicative of certain occurrences within a lake. Decomposition and respiration tend to decrease pH while photosynthesis increases it. Neel (1961) observed that values below 8.0 usually indicate a predominance of decomposition and respiration over photosynthesis. Most fish can tolerate a range of 5.0 to 9.0.

New York standards are 6.5 to 8.5 for water contact recreation and fish and wildlife propogation. Agricultural water supply must be within a range of 6.0 to 9.5. (Water Quality Standards of the United States, 1969).

(7) Total alkalinity measures the ability of the water to accept protons. This ability is imparted by bicarbonate, carbonate and hydroxide components in natural waters. Benoit (1969) has established an alkalinity--productivity relationship. Alkalinity below 40 mg/l is characteristic of low productivity. Between 40-90 mg/l is characteristic of medium productivity. Above 90 mg/l indicates high productivity.

Decomposition and respiration increase alkalinity by increasing bicarbonate concentrations. Photosynthesis decreases alkalinity by decreasing bicarbonates. The hypolimnion may have increased alkalinity due to a predominance of decomposition and respiration over photosynthesis.

(8) Phenolphthalein alkalinity measures the part of the total alkalinity due to the hydroxide ions and half of the carbonate ions (Standard Methods).

(9) Hardness is a measure of the calcium, magnesium and certain other positive ions present.

Biological Parameters

The biological analysis can be divided into three categories--productivity measurements, identification of organisms present and bacterial counts.

The productivity measurements used include the following:

(1) Chlorophyll content of periphyton is measured and used for comparative purposes.

(2) Phytoplankton counts are used for comparative measures of productivity.

Bacterial counts are important in determining the suitability of the water for drinking and recreational purposes.

(3) The Standard Plate Count is a method for determining the bacterial density of the sample.

(4) The Total Coliform Most Probable Number determines if the water meets the bacterial standards set by the United States Public Health Service.

(5) Fecal-Coliform Most Probable Number determines the extent of fecal contribution to the total coliform number.

(6) Determination of fecal-streptococci is used as an indicator of fecal pollution of water. The usual source of these organisms is the intestines of man and animals. This test is of particular value in determining the recreational and drinking quality of a lake. (Standard Methods)

Identification of biological indicators is another useful method of analysis of lake conditions.

(7) Certain species of algae are indicators of high nutrient levels within the lake. Determination of the diversity of species can indicate how unstable the lake's system may be.

(8) Zooplankton are also used as biological indicators. As the productivity of the lake increases, the species of zooplankton may change.

Physical Parameters

(1) Temperature is inherently connected with all the biological and chemical processes within the lake system. Temperature controls anabolic and catabolic rates and nutrient fluxes. In lake studies temperature becomes a very important factor when it causes stratification. (For this study a thermocline was defined as a one degree Centigrade change in temperature per one meter change in depth.)

(2) Secchi disc measurements were taken. This measure of water transparency is often related to productivity. As algal populations increase transparency usually decreases.

Geological Parameters

Investigation of the major geological formations and land use can offer some clues to the causes of natural and cultural eutrophication. Changes in the geological parameters would be expected to occur much more slowly than the other parameters studied. Land use and geological formations are expected to have a profound effect on the nutrient flow into the lakes and subsequent changes in the biology and chemistry of the lake.

(1) Watershed determination reflects the general drainage patterns of the area and indicates the inputs and outputs of each lake. The drainage scheme is primarily determined by the topography of the area.

(2) Bedrock investigations can offer probable sources for certain chemical characteristics of the lake such as pH, alkalinity and the presence of certain elements and compounds. Bedrock is also related to the material

found above it.

(3) Soil and surficial geology indicate the type of material on the surface, its size and distribution. This determines the ground permeability and the drainage rate.

(4) Land use studies provide information on nutrient sources.

These may include agricultural runoff, urban runoff, industrial wastes, septic tank leaching, forest runoff, and erosion due to improper agricultural techniques.

(5) Population density is related to land use. Lakes surrounded by larger populations would be expected to feel greater effects due to cultural eutrophication.

SAMPLING SITES

General

All sampling sites were marked on maps of each lake. When necessary, rough soundings were performed and recorded on the maps. This information provided a means for selecting sampling sites when contour maps of the lake were unavailable.

Tributaries

Stream inlets were sampled when accessible. Care was taken to insure that characteristics of the stream and not the lake were obtained.

Lakes

Sampling sites on the lake proper were chosen on the basis of known contours and rough surroundings. The deepest pools of each lake were selected as stations.

At each station a temperature profile was established to determine the method of sample depth selection. If a thermocline was present, four samples were taken: A surface sample (0.5 meters from the surface), a bottom sample (0.5-1.0 meters from the bottom), and samples from slightly above and slightly below the thermocline. If no thermocline was present, three samples were taken: top, bottom and intermediate (Park, 1972).

Sampling was done with XRB Series Van Doren Water Samplers with Model 106A Hydrographic Messengers.

Microscope slides were fixed on bricks and submerged in the lakes at depths of no more than five meters. The slides were left submerged for no less than two weeks; then retrieved for chlorophyll content of periphyton (Standard Methods).

FIELD MEASUREMENTS

Temperature profiles were established with calibrated Motorola Model FR26.5 thermistors. Readings were taken in intervals of one meter; except within the thermocline where the interval was 0.5 meters.

Errors in temperature measurements were detected at the end of the second round. It was found that equipment calibrations done once a week were not sufficient. For the second round, temperatures of below 1°C were recorded at maximum depth. Macan (1963) states that most temperate lakes never reach temperatures lower than 4°C. This seems to apply to lakes even deeper than those studied here.

It became necessary to recalibrate the thermistors at the end of every sampling day. The day-to-day variations were not excessive, but the weekly change was significant. For this reason, the temperature data for rounds one and two are not considered reliable. Continued testing and calibration after round two indicated an accuracy of ± 1°C for the remaining rounds.

Graphs of temperature against depth are still reliable for locating the thermoclines for these two rounds although the temperature ranges will be slightly different.

Dissolved oxygen tests were performed within three minutes of sampling. The Azide Modification (Standard Methods), as presented by the Hach Chemical Co. Model OX-2P Dissolved Oxygen Test Kit (see Appendix), was used.

Separate containers were used for fixing samples to be tested for hydrogen sulfide. One drop of zinc acetate (1M.) was added to 25 ml. of the sample and then brought into the lab for continued analysis. The procedure followed was that of Standard Methods as adopted by the Hach Chemical Company as described in Colorimetric Procedures and Chemical Lists for Water and Wastewater Analysis (1972).

Transparency measurements were performed with a modified Secchi disc, made of weighted wood, eight inches in diameter with alternate quadrants painted white and black (Coker, 1968). The disc was lowered with a hand line. Maximum depth of visibility was noted for both lowering and raising the disc and the values averaged.

PREPARATION AND STORAGE OF SAMPLES

All samples were held on ice in the field until returned to the lab at the end of each sampling day. Samples saved overnight were kept in storage at 4°C. Maximum shelf-life of any sample was 48 hours.

Each three liter sample was apportioned in the following way:

(1) One quart of unaltered sample was brought in and filtered to remove silt and large organisms. This sample was used for chemical analysis.

(2) One quart of preserved sample was prepared. The first round of samples was preserved with 40 ml/1 of 40% Formalin solution. The remaining rounds of samples were preserved with 36 ml/1 of Merthiolate preservative. These samples were used for algae and zooplankton counts.

(3) One pint of unaltered samples was used for innoculation of cultures in bacteriological tests.

Microscope slides retrieved from submerged periphyton stations were stored in a 40% Formalin solution.

CHEMICAL ANALYSIS TECHNIQUES

The samples were allowed to reach room temperatures at which time pH and hydrogen sulfide tests were run.

The pH of the samples was determined in the laboratory by a Corning Model 5 pH meter with a Calomel reference electrode. Most pH readings were taken within 2-4 hours after sampling with six hours being the maximum time allowed.

Twenty-five ml. samples for hydrogen sulfide determination were preserved with zinc acetate (1 M), in the field. The Merthylene Blue Method (Standard Methods) as adapted by the Hach Chemical Company (Colorimetric Procedures, 1972) was used. The percent transmittance of the solution was measured on a Bausch and Lomb Spectronic 20 at 665 nm. in half-inch Bausch and Lomb test tubes. Blanks of the unpreserved sample were employed where the sample solutions were turbid or colored; deionized water blanks were used when the solutions were clear and colorless. The error limits were determined to be ± .02 ppm.

After the pH was determined, the samples were filtered to remove silt and organisms using Whatman Qualitative filter paper and one liter vacuum flask connected to water aspirators.

The samples were then stored overnight at $4^{o}C$. The next morning the samples were again allowed to warm to room temperature in a water bath. When the temperature of the samples had stabilized at $24^{o}C \pm 1^{o}C$, tests for alkalinity, hardness, orthophosphates, total phosphate and nitrate-nitrite were performed. These tests were all performed using Colorimetric techniques as adapted from Standard Methods by the Hach Chemical Company as described in Colorimetric Procedures (1972).

Phenolphthalein and methyl orange alkalinities were determined in parts per million ($\pm$ 1 ppm) using a Hach Model AL-AP Alkalinity Test Kit.

Hardness was determined in parts per million ($\pm$ 2 ppm below 50 ppm and $\pm$ 7 ppm above 50 ppm) using the Hach Model HA-71A Total Hardness Test Kit.

Total dissolved and suspended orthophosphate and total dissolved and suspended acid-hydrolyzable phosphate were determined by variations of the Standard Methods Stannous Chloride Method. These tests were performed routinely using samples which had been filtered through Whatman Qualitative paper and stored overnight as mentioned above. These results were found to be identical, within our limits of error, with results obtained using unfiltered, unstored samples as required by Standard Methods. This methdd was considered the best for our space and time requirements while still remaining applicable to comparisons with other phosphate measurements performed without the variation. The error limits were + 3 micrograms per liter. As reported in the data, total acid-hydrolyzable values include original orthophosphate levels plus condensed phosphates readily convertible to orthophosphate by acid hydrolysis.

BOTANICAL IDENTIFICATION

The objective was to determine the types of aquatic weeds and algae present in each lake.

Algae were collected from three different types of habitats on each lake. These collection sites were surfaces such as spillway walls and docks, submerged algal colonies from cove bottoms and around aquatic weeds, and floating surface blooms. The collected algae were identified using the keys contained in Algae In Water Supplies by C. Mervin Palmer and Manual of Phycology by Gilbert M. Smith.

Aquatic weeds were identified in the field using Norman C. Farset's Manual of Aquatic Plants.

GEOLOGICAL ANALYSIS

Each lake's watershed was determined by examination of appropriate topographic maps and inflowing and outflowing streams. This area was used as a basis for the following determinations.

Bedrock was determined from the New York State Geologic Survey map.

General soil was taken from a county map done by Dr. Robert LaFleur, Professor of Geology at RPI and by selective grouping of the categories from a 1932 soil map of the county.

Land use was determined by examining the aerial photographs at the Agricultural Stabilization and Conservation Service in Wynantskill, New York and from information supplied by the Rensselaer County Department of Planning and Promotion. Groupings used were woodland, farmland, residential, commercial, public use, public parks and extraction areas.

Population density was partly determined by the above mentioned method and partly from information taken from maps and census information obtained from the County Planning Office.

All of the above maps were presented as overlays on the county-wide watershed map. An integrative analysis was done to correlate all of the geological factors.

BACTERIOLOGICAL ASSAYS

One pint samples brought into the lab on ice were stored at 4°C until assayed. Shelf-time never exceeded forty-eight hours.

Standard Methods for the Examination of Water and Wastewater was the main reference for testing. Numbers appearing in this text refer to sections of the reference.

Water used for dilution of the lake samples was prepared as directed in Media Specification (404C-1a). Tests were performed on undiluted water samples, 1:10 and 1:100 dilutions, in triplicate. All water samples and dilution tubes were shaken 25 times before withdrawing a 1.0 ml sample for inoculation of test media.

Petri dishes were inoculated with 1.0 ml samples of undiluted and diluted water samples and were allowed to stand no longer than 20 minutes before the addition of not less than 10 ml of tryptone-glucose agar (404C-5) kept at 45°C no longer than three hours. The plates were incubated at 35 ± 0.5°C for 24 ± 2 hours. In preparing plates, the amounts of water plated were designed to give from 30 to 300 colonies on two plates. Counting was done with the aid of an American Optical Spencer Forty dissecting scope at 20 power.

The multiple-tube or multiple fermentation tube technique was used for the presumptive and confirmed coliform tests, the confirmed fecal coliform tests and the presumptive and confirmed fecal streptococcal assay. Lactose broth (404C-3) was the test medium for the presumptive coliform assay. The tubes were incubated 48 $\pm$ 3 hours at 35 $\pm$ 0.5°C, at the end of which time the presence or absence of gas formation was recorded. The presence of gas indicated a positive presumptive test.

Positive primary tubes obtained from the first two rounds of sampling had to be stored at 4°C to limit growth of bacteria. There was a delay in the shipment of the confirmed test media. Within three weeks all primary fermentation tubes showing any amount of gas were submitted to the confirmed test on brilliant green lactose bile broth (404C-9). Incubation was at 35 $\pm$ 0.5°C for 48 $\pm$ 3 hours and the presence or absence of gas formation was recorded. The presence of gas constituted a positive test.

The number of coliform bacteria was estimated on the basis of the number of positive tubes per sample. To determine the Most Probable Number per 100 ml, Table 407(5) was used. Those samples exhibiting a confirmed MPN of 150 or greater were submitted to the completed test on EMB plates to obtain qualitative data on the bacteria present.

Colonies considered most likely to consist of organisms of the coliform group were taken from the EMB plates and cultured on nutrient agar slants and lactose fermentation tubes to assure presence of coliform bacteria, incubated at 35 $\pm$ 0.5°C for 48 $\pm$ 3 hours. Gram-stain preparations were done from these agar slants (407A-4).

It became apparent that an inoculant of three loopfuls into the ethyl-violet azide broth for the confirmed fecal streptococcus test was not giving a clear-cut positive or negative result. Therefore, all confirmed tests in rounds V and VI received a 0.5 ml inoculant from the positive presumptive tubes. The result was that a purple precipitate was readily apparent in a positive confirmed tube, removing the indecisive quality the test had previously.

For all tests bacterial density was calculated referring to the Most Probable Number Tables in <u>Standard Methods</u> (407(5)).

PRODUCTIVITY

Phytoplankton: Samples used in the phytoplankton analysis were preserved at the sampling site with a merthiolate-sodium borate solution. One ml. of each sample was placed in a Sedgwick-Rafter counting chamber and the individual plankters counted along strips of the chamber. The total number of plankters was calculated according to:

Number per ml. = actual count x (1 ml/vol. of strips counted). Time prevented any further breakdown than the following categories: Greens and Blue-Greens, Diatoms, Pigmented Flagellates.

Periphyton: Artificial substrates were used to collect periphyton at the sample sites. Three glass, 1" x 3" microscope slides were mounted on bricks faced with wood. Bricks were kept in the lakes for two to three weeks and then returned to the lab in Formalin preservative solution.

The growth from the slides were used to determine the biomass of the periphyton by means of the "Trichromatic Method for Chlorophyll" (Standard Methods pp 746-747).

The merthiolate preservative originally used for preservation of zooplankton samples was developed by C. I. Weber, 1968, as referenced in Standard Methods. He suggested 1.0g merthiolate, 1.5g solium borate, and 1.0 ml saturated Lugol solution dissolved in 1.0 l water. This proved to be ineffective as a fixative and did not stain any organisms for easier identification as the reference claimed.

Instructions accompanying the merthiolate from the Lily Company indicated that merthiolate was incompatible with iodine, a chief ingredient in Lugol solution. The merthiolate was observed coming out of solution within twenty-four hours of preparation of the preservative. Consequently, Lugol solution was eliminated.

Through trial and error a new preservative was developed consisting simply of twice the merthiolate and sodium borate as originally used and no Lugol solution, per 1.0 l of water. This proved to be quite effective.

ZOOPLANKTON ANALYSIS

Preserved samples were strained through a CCM: General Biological Supply Company extra fine, #25 standard, 200 meshes per inch plankton net. Subsequent examination was done under 36 to 37.5 x dissecting microscopes. Those samples with a dissolved oxygen level of less than 1.0 ppm were examined separately and were counted only if they contained at least 75% of the average crustacean population for the rest of the lake. Organisms were keyed using Freshwater Biology by Ward and Whipple. Counts were taken of the cladoceran, cyclopoid, and calanoid copepod crustaceans. Cladocerans were keyed down to genus. Rotifers discernable as such under the magnification used were counted, and several genera easily recognizable and common in the lakes studies were identified. These were *Keratella*, *Kellicottia*, *Polyartha* and *Filinia*. *Asplanchna* was also fairly common but was not counted separately.

Based on the fact that the filtering rates of the crustacean planktonic, herbivorous filter feeders (Cladocera and calanoid copepods) increases with an increase of size (Burns and Rigler, 1967) and that the size of the standing crop of nannoseston and net phytoplankton is at least partially determined by whether a large or small species of Cladocerans is dominant (Horbacek, 1961 and 1962), a size ratio was set up based on measurements taken with an ocular micrometer during the fifth and sixth rounds. An arbitrary division of 0.75 mm was used. All Cladocerans and Calanoids this size and over were considered large. This number was divided by the total number of Cladocerans and Calanoids to obtain the percentage of large planktonic herbivores in each lake. The lakes were ranked by this means. The lower the percentage, the more eutrophic the lake is.

Another method of ranking used was comparison of the total zooplankton population (Rusakova, 1968).

WEATHER DATA

Weather information was supplied by the New York State Bureau of Air Quality Surveillance. Each month an abstract containing barometric pressure, precipitation, temperature, wind velocity and wind direction was obtained. This data, which appears in the Appendix, was used to a small extent in evaluating the results.

DATA ANALYSIS

Information obtained from the lake water analysis was processed by computer programs and facilities available at RPI.

The computer methods used were quasi-statistical, quantitative analyses. These methods have been used extensively in the development of ecological relationships. They can be used to establish associations of variables representing similar environments (Gevirtz, Park and Friedman, 1971).

Ordination, a method developed by Bray and Curtis (1957), has been used by many investigators of environmental systems (Louchs, 1962; Ream, 1963; Knight, 1964; Beals, 1960; and Hale and Hironaka, 1960). An accurate description of this method can be found in the Journal of Paleontology reprint of an article by Park (1968).

A second method, cluster analysis, has been used by Sokal and Sneath (1963), Valentine and Petticand (1967), Kaisler (1966), Mello and Bugas (1968), and others in ecological studies. An indepth description of the use of cluster analysis, and its relationship to ordination, can be found in the Journal of Paleontology reprint of an article by Gevirtz, Park and Friedman (1971).

Chemical, zoological, bacteriological, algal, Secchi disc and temperature data were analyzed by computer methods. Data was first processed by R-Mode (redundancy) analysis. This procedure prepared similarity matrices for the tests performed. From the similarity matrix, dendrograms were plotted to establish correlations between test categories (see fig. 1). From this test a better understanding of the interdependence of nutrients in the lake ecosystem was obtained.

A second analysis was Q-Mode cluster analysis. This procedure plotted similarity matrices for the entire list of samples for each round. From these matrices, dendrograms were also plotted to establish "clusters" of lakes (see fig. 2). This process led to an ordering of the lakes into general groups.

The third method was ordination. This process converted the samples' similarity matrix to a dissimilarity matrix. From this matrix, graphs were plotted to show relative dissimilarities (see fig. 3). This process allowed a 3-dimensional view of the lake similarities. From these graphs, similar samples (and thus lakes) were clustered and labeled according to data obtained from the Q-Mode analysis.

Overlays were made for the graphs produced by the ordination process. External variables (those not included in the Computer Analysis), such as land use, population, bedrock, algal diversification, population density, and depth were plotted to examine possible trends in the lake similarities due to these external factors (see fig. 4). This provided an indication as to why the lakes were grouped as they were.

An additional program was used to plot the internal variables on this model (see fig. 5). This provided further insight to the reasons for the plotted similarities.

After all the data was collected, programs were run using complete analyses for the summer including the other test variables in various combinations, to produce additional clustering information.

CHEM. R-MODE (REDUNDANCY TEST) — MOUND 1 - EXPANDED RELATIVE UNITS

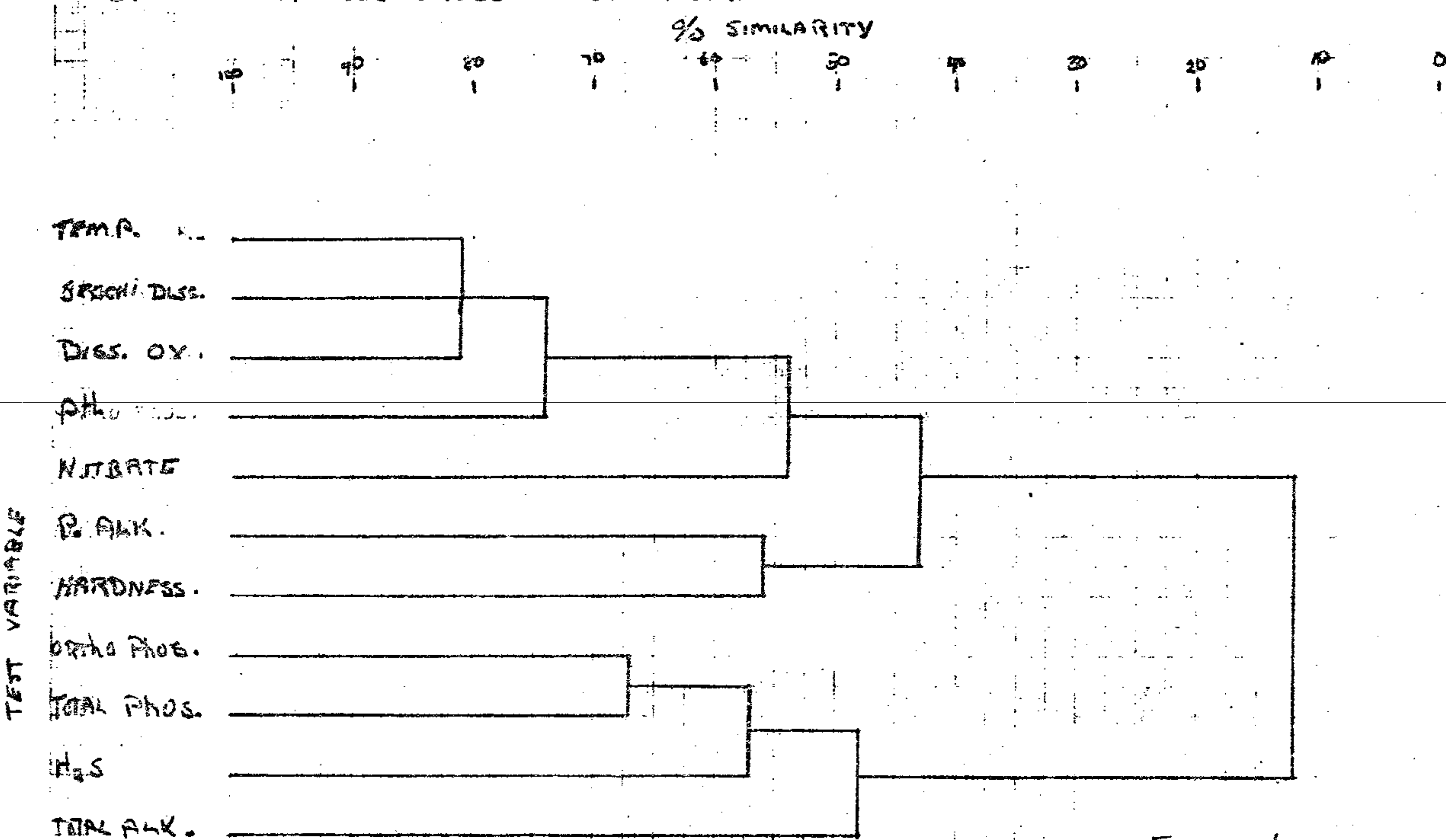


FIGURE 1

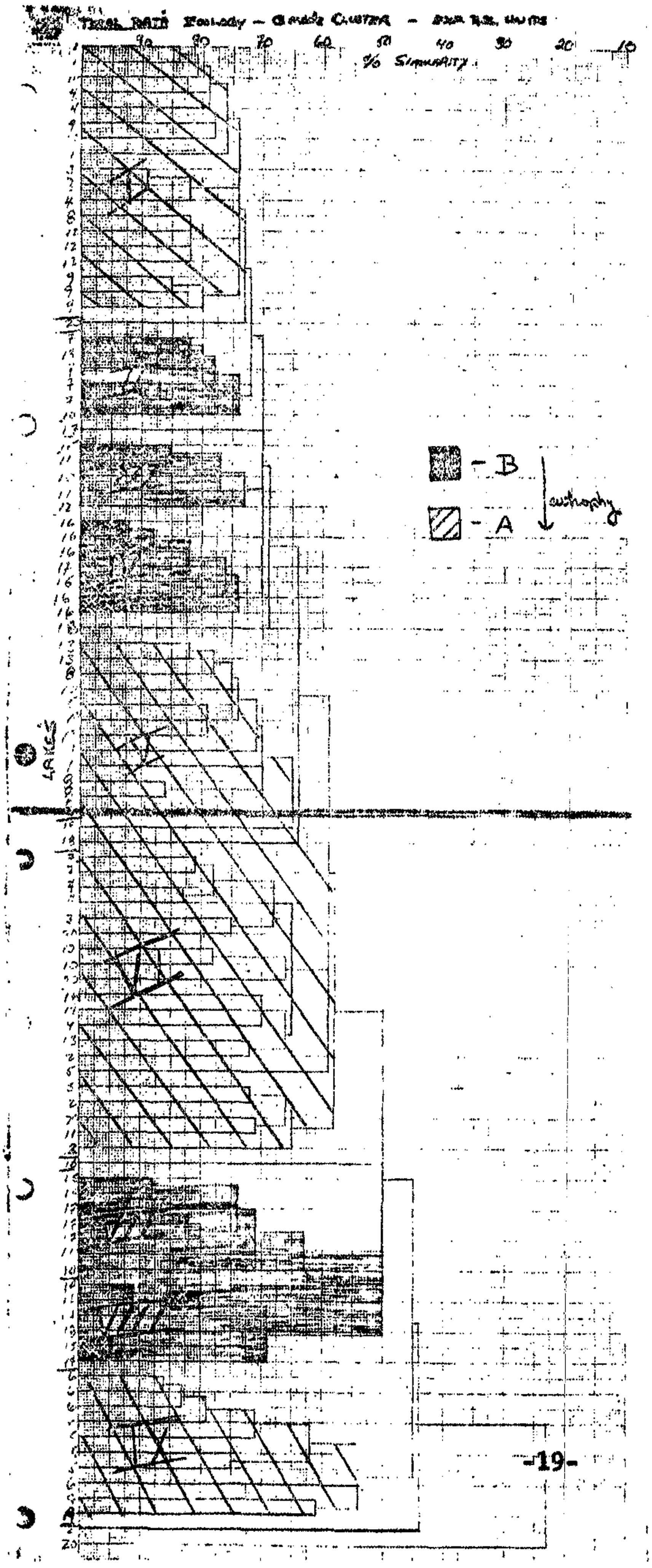


FIGURE 2

RENS COUNTY LAKE STUDY, TOTAL DATA, ZOOLOGY, ORDINATION PLOT OF AXIS 1 VERSUS AXIS 2

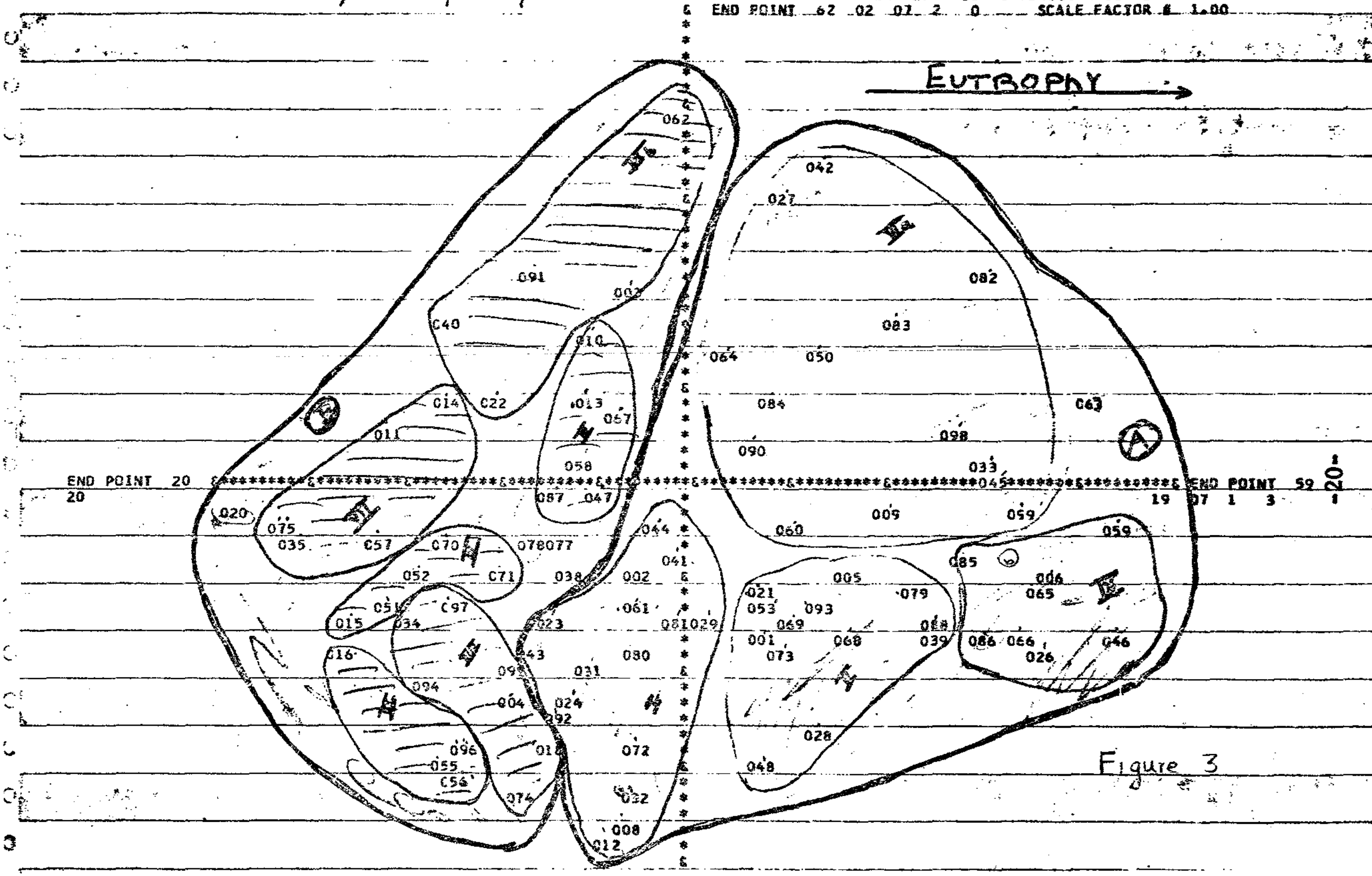


Figure 3

OVERLAY - ROUND IV

Chemistry
ALGAL DIVERSIFICATION

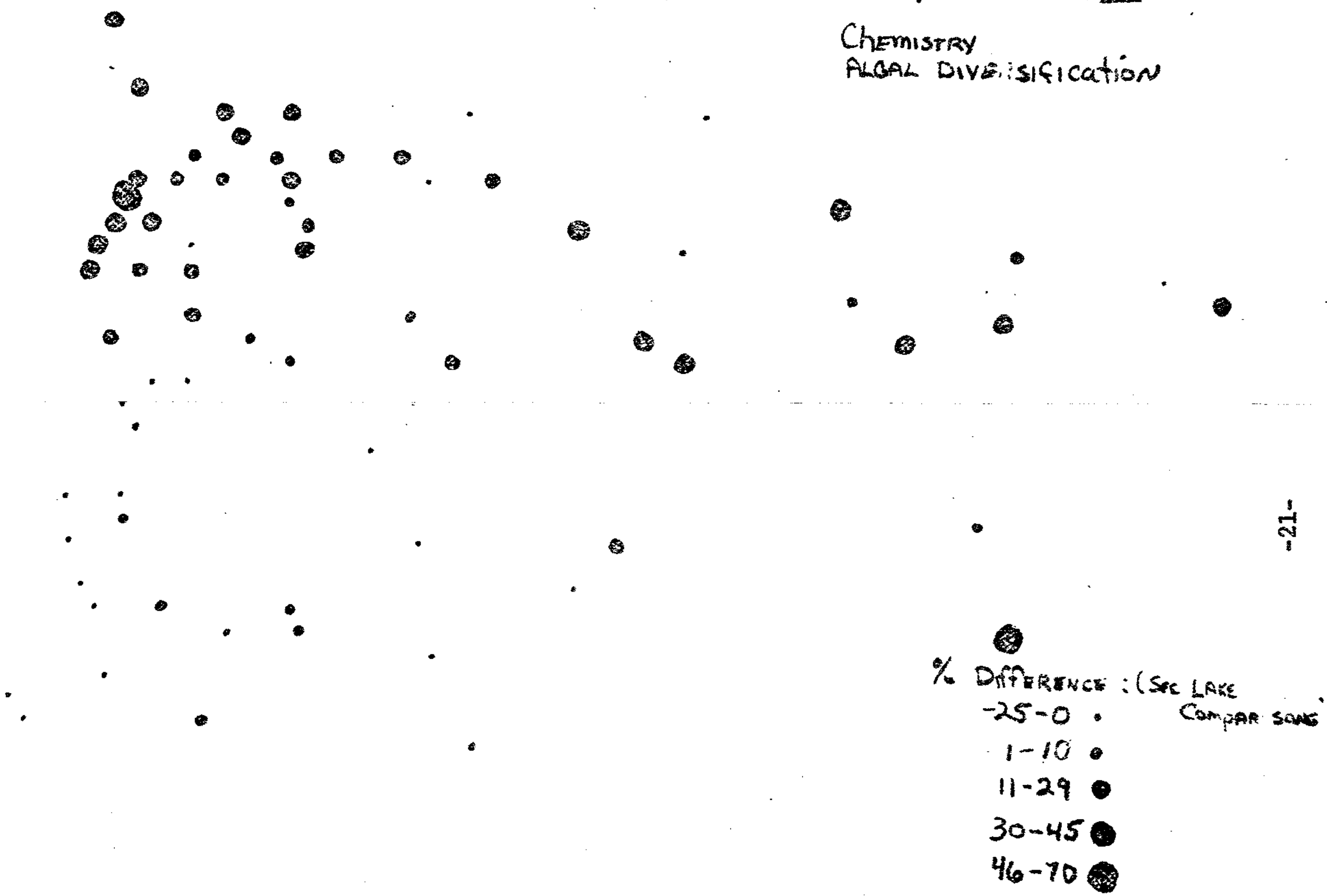


FIGURE 4

ORTHOPHOSPHATE TREND

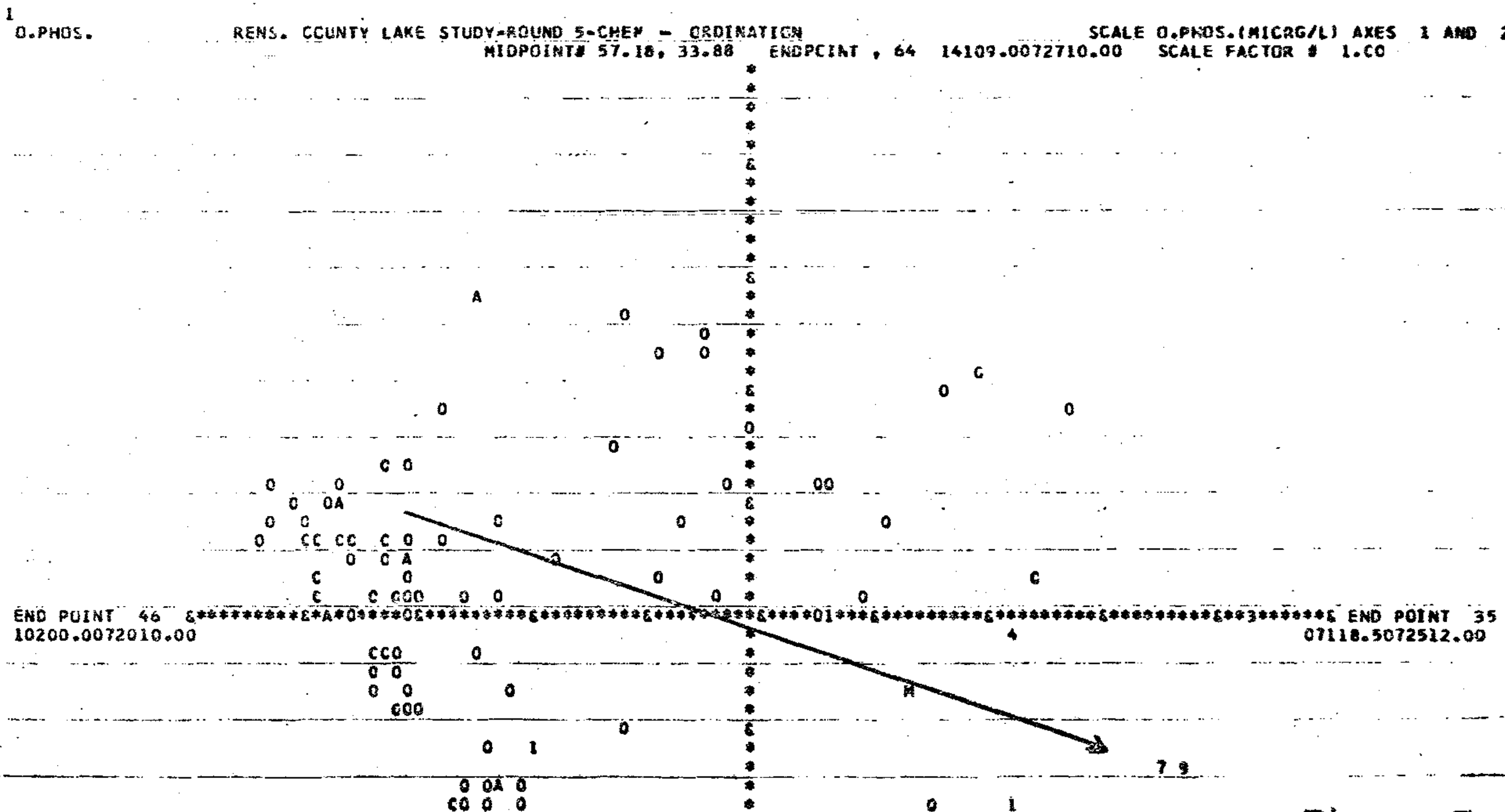


FIGURE 5

RENSSELAER COUNTY*

Topography and Geology

Within Rensselaer County there exist three major topographic divisions. On the east is a succession of parallel ridges composed of shale and schist that trend north and northeast. In the central region is a broad, high plateau underlain by coarse grit or graywacke. On the west is a gently sloping lowland underlain by folded belts of sandstone and shale.

The Taconic Range in the eastern part of the county is made up of parallel ridges much higher than the topographic features to the west. Narrow valleys without flood plains flank the range and in these valleys limestone outcrops come through the shale.

The Rensselaer Plateau is oval, extending from Boyntonville and Pittstown south to East Nassau, and from Poestenkill east to the Berlin-Stephentown valley. The plateau is characterized by nearly uniform levels, many ponds and poorly drained areas.

The western lowland area consists of a low plain that borders the Hudson River and a westward sloping hilly area ranging to 200 feet in height. The plain varies in width from 1/4 to 2 1/2 miles and is composed of beds of sand, silt and clay. During the Pleistocene this area was part of Lake Albany, which later was transformed into the Hudson River. The river cut a trough one mile wide and 200 feet deep. The sloping region extends from the glacial plain to the Rensselaer Plateau. This region is underlain by beds of folded shale and sandstone.

The entire county is situated within the drainage basin of the Hudson River. The Hoosic River drains the northern section, while the rest of the county is drained by such streams as the Poestenkill, Wynantskill, Moordenerkill, Kinderhook Creek and countless smaller streams which empty directly into the Hudson. These streams have relatively low gradients except when they flow from hanging valleys through deep ravines to the low plain bordering the Hudson.

Bedrock

In Rensselaer County there are two groups of consolidated

*The facts in this section were presented in Water Resources in Rensselaer County, Rensselaer County Health Department, 1961; and Water Supply and Sewage Disposal, Rensselaer County Planning Board, 1968.

rocks (see fig. 7). In the east are Rensselaer graywacke (feldspathic chloritic sandstone), Austerlitz phyllite (a schist), Stockbridge limestone and dolomite and Walloomsac slate. The graywacke formation underlies the elevated portions of the central region of the county. The Austerlitz phyllite forms the Taconic Range and the Stockbridge limestone and dolomite are scattered in small districts.

The western part of the county (west of a line connecting Valley Falls and East Nassau) features closely folded belts of green to black shale. The Nassau, Schodack, Normanskill and Snake Hill Formations are all predominantly shale with less prevalent impure sandstones.

The well yields of shale and slate depend on the number of water bearing fractures encountered during drilling.

Rensselaer graywacke, which is postulated to be of Lower Cambrian age and 1,400 feet thick, yields small but reliable water supplies to drilled wells with an average depth of 120 feet. The average yield is five gallons per minute with a small range in yield.

Rowe Schist is also located in the eastern part of the county and is of comparable age with Rensselaer graywacke. This formation is unimportant as a groundwater source due to its location in the county, however, its yield is probably comparable to the Lower Cambrian shales.

Two Lower Cambrian shales from the western part of the county are Schodack (1,000 feet thick) and Nassau (400 feet thick). These produce small but reliable supplies of groundwater to an average drilled well of 125 feet in depth. The average yield is four to five gallons per minute with a large range. The water obtained is moderately hard and contains some iron, but is nevertheless generally satisfactory.

In the eastern part of the county is a Cambrian and Ordivician formation, the Stockbridge limestone, which yields moderate supplies to drilled wells which encounter fractures. The average yield is 17 to 18 gallons per minute. The water has a moderately large concentration of mineral matter and is, therefore, usually hard.

The Walloomsac slate is of Lower Ordivician age and is located in the eastern part of the county. It provides small supplies to drilled wells (average depth is 180 feet). The average yield is seven gallons per minute with a wide range.

The Middle Ordivician Normanskill of the west is about 1,300 feet deep. This provides small but reliable supplies of ground water to drilled wells that average 125 feet in depth. There is a large range with four to five gallons per minute the average yield. The moderately hard water may contain hydrogen sulfide and iron but is generally satisfactory.

The Snake Hill Formation (3,000 feet deep) is of Middle Ordivician age and is found in the western part of the county. It yields small supplies to drilled wells averaging 140 feet in depth with an average yield of two to three gallons per minute. The water is hard and often cloudy, frequently containing hydrogen sulfide.

Some Quaternary deposits that are common are alluvium, stratified sand and gravel, lacustrine and till.

Alluvium is usually between 1-30 feet deep and consists of clay and silt with some sand and gravel. It is relatively unimportant for waterbearing properties because of the small size of the deposits.

Stratified sand and gravel can be up to 120 feet deep. These deposits are interbedded and interlensed sands and gravels, formed by the sorting action of glacial meltwaters. They frequently display crossbedding. This is an important potential source of groundwater.

Till can be 1 to 50 feet deep and consists of a heterogeneous mixture of gravel, sand, clay and boulders with a predominance of clay. It yields small supplies of water to many dug wells for farm and domestic purposes.

Drainage

The Hudson River is the main river in this area. Its valley is one mile wide and 200 feet below the lowest terrace of the clay plain. The channel is 1/4 to 1/2 mile wide.

The Mohawk River is the main tributary but it is not in Rensselaer County. The Hoosic River comes from Southern Vermont and drains into the Hudson two miles above Mechanicville. There are many other rivers such as the Deepkill which originates at Mount Rafinesque and is in the Troy Reservoir watershed. The Poestenkill empties at Troy from the Rensselaer Plateau in the eastern rocky plains.

The Wynantskill drains the lakes at the foot of the plateau, such as Burden, Crooked, Glass, Crystal, Reichards and Snyders. The Moordenerkill empties at Castleton. The Valatie Kill flows from Nassau Lake and empties beyond the Capital District into Kinderhook Creek which flows through Tackawasick Lake as a northern tributary.

There are a great number of extinct lakes and rivers from the glaciers, especially in the eastern hill region. These provide excellent green agricultural oases between the rocky hills. A superb example of this is the Tomhannock Reservoir which was an extinct lake now revived by a dam.

A large number of small brooks that eroded deep ravines into the several hundred feet of soft clays and sands of Lake Albany on both sides of the Hudson reached rock giving very valuable information on the geology.

The courses of smaller brooks are postglacial and not connected with the preglacial drainage pattern; however, the Hudson and the Hoosick Rivers returned to their old valleys. The creeks have for the most part reached bedrock mostly in glacial moraine and postglacial clays and sands of Lake Albany. They follow the surface irregularities in the rather erratic fashion of new drainage.

Surficial Geology

One of the most striking facts about the surficial geology is that the western edge of the county is overwhelmingly lacustrine deposits (see fig. 8). This type of deposit is not found anywhere else in the county in any great supply. Also, in this area are scattered splotches of till and substantial concentrations of outwash. Ice contact deposits are on the eastern edge of the lacustrine. This portion of the county was covered by glacial Lake Albany which accounts for the distribution. In the northwest part of the county around Schaghticoke, there is a large amount of lacustrine, outwash, and sand dunes (another peculiar deposit, again directly attributable to Lake Albany).

The plain directly east from the lacustrine is full of till and ice contact deposits. There are also areas of extensive alluvium andoutwash since it was the site of many extinct lakes and rivers. There is a line of ice contact deposits that goes northwest to Troy from Burden Lake. A parallel line of ice contact goes to Hampton Park.

The plateau is not as varied as the plain and is mostly till and nonglacial with a little outwash and alluvium. One major exception to this is around the Hoosic and Little Hoosic Rivers which are surrounded by substantial alluvium, outwash, till and ice contact material. There are not the extensive drainage patterns on the plateau as found on the plain.

Land Use

The land use map shows a general trend that corresponds to the three topographic divisions discussed previously (see fig. 9). The western and northern parts of the county are most heavily utilized and correspond to the plains. The plateau and the Taconics are not used to any great extent except for the area along a few highways that traverse the expanse. There are several large sections of the plateau devoted to state parks, such as Grafton. Route 22, from the southeastern corner up to the top of the map, follows the main concentration of land use on the plateau. It is mostly residential but some commercial and farming lands are present.

There are few industrial sites in the county. They are primarily located in Rensselaer on the Hudson, in Berlin and in Hoosic Falls. Extraction sites are very common in this county and they seem to be scattered throughout. Schaghticoke has some large extraction sites and farming but not much population. Public use land is also scattered about the county, found in lake areas and on the plateau where many camps are situated.

The commercial areas are, for the most part, near the urban areas or along major highways. Approximately 85% of the population of the county is concentrated in and around Troy and Rensselaer, which represents 26% of the county's area. A rough breakdown of the land use is 80% unused, 11.5% farmland and pasture, 2.7% residential, 1.7% public park, 1.5% public use, 1.3% extraction, 1.1% commercial and .2% industrial.

Population

The most densely populated area of the county is Troy with 10.57 people per acre. Rensselaer follows with 5.67 people per acre and the next three are Hoosic Falls with 4.35, Nassau with 3.31 and Castleton with 3.15 people per acre. According to the 1970 census there are 62,918 people in Troy, 10,136 people in Rensselaer and a total of 720,786 people in the entire county. Troy and Rensselaer are both losing people every year with respective percent population changes of -6.8% and -3.5% from 1960 to 1970. In this period the greatest increase in population by numbers has been in Brunswick, North Greenbush and Schodack; however, by percent, the three towns that have each increased over 30% are Schodack (39.0%), Poestenkill (37.4%) and Pittstown (31.3%).

Water Supply

There are two basic types of water supply systems in Rensselaer County. The cities of Troy and Rensselaer and parts of the towns of East Greenbush and Brunswick are supplied by the public system which draws from Tomhannock Reservoir. These are the more heavily populated urban and suburban areas. The remainder of the suburban areas and the rural areas fall in the second category. These areas use individual systems of water supply. These supply water to 35 percent of the total population of the county. This percentage has risen slightly in the last ten years following a general trend of population from the cities to the rural areas. This migration is occurring at a faster rate than the growth of public water systems.

Three of the lakes in this study are used to supply water during the summer months. These lakes are Babcock Lake, Forest Lake and Taconic Lake. There are no plans to expand these systems beyond their use for summer residents.

Sewage Disposal

Presently only two of the watersheds of the lakes in this study fall within districts having sewer lines. These are Hampton Lake and parts of Troy Reservoir. The remainder of the lakes are within areas using individual septic tank-tile field systems.

Certain other lakes in this study are expected to fall within the expanded Rensselaer County Sewer District No. 1. Completion of the district will relieve Snyders Lake, Reichards Lake, Crystal Lake and the northern ends of Glass and Burden Lakes.

Septic tank systems place a burden on the lakes by allowing nutrients from household functions to return to the lake's watershed. Faulty or overloaded septic tanks are a common enough occurrence to place a strain on the watershed's ability to protect the lake from excessive nutrient output. Sewer systems usually transport the nutrients out of the watershed to a place where their effect may not be as detrimental.

The USDA Soil Conservation Service indicates that most of the county generally will exhibit severe reaction to septic tank systems (see fig. 10). This was significant to this study in that all but one of the lakes investigated are in areas which use septic tank systems. The reasons given for this severe reaction are slow soil permeability, seasonal high water table, shallow depth to bedrock andhardpan or clay within three feet. Any problem that a septic tank owner has with his system means problems for any receiving bodies in the area.

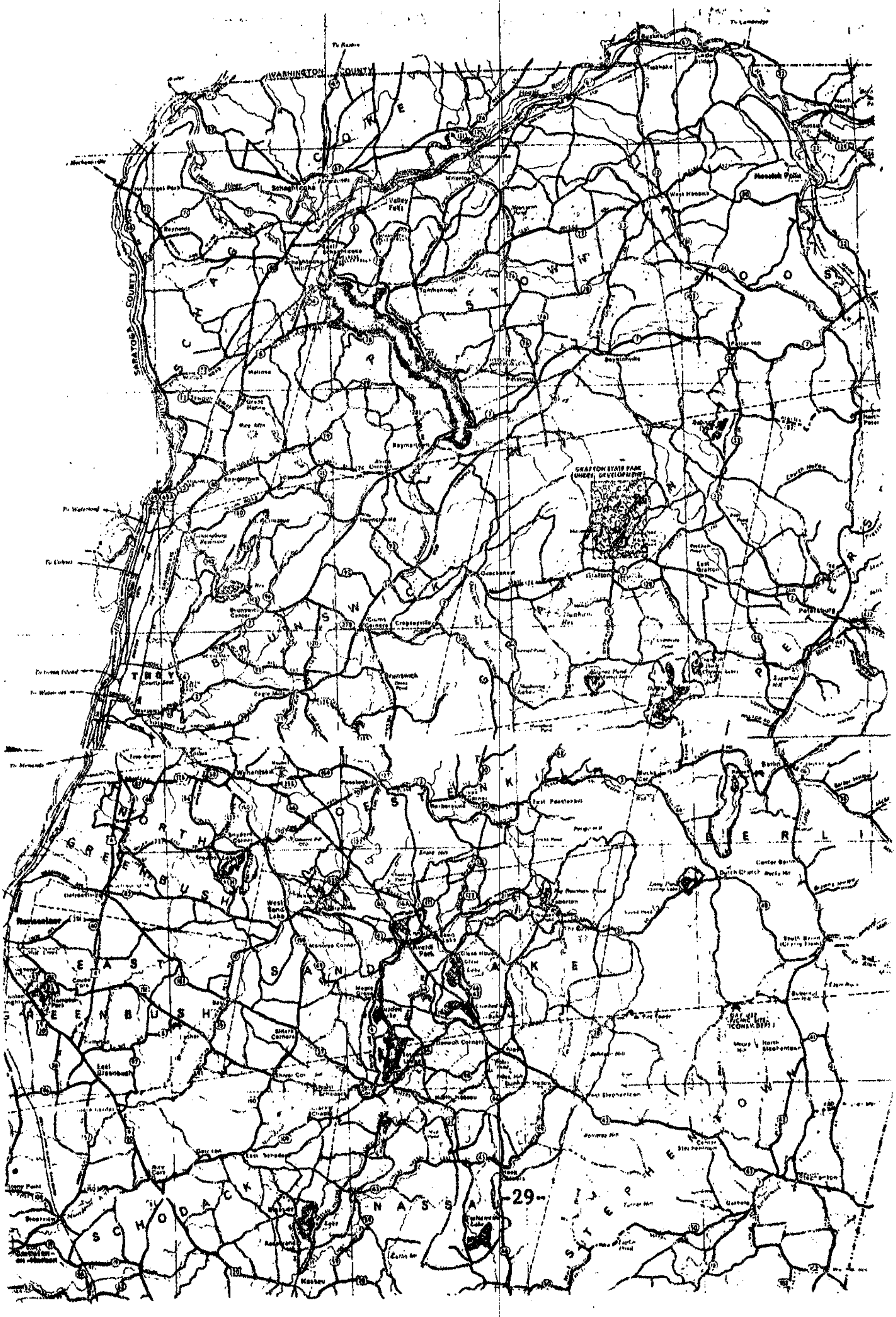

WASHINGTON COUNTY
SARATOGA COUNTY
Schaghticoke
Valley Falls
Hoosick Falls
West Hoosick
GRAFTON STATE PARK (UNDER DEVELOPMENT)
Grafton
Brunswick
TROY
County Seat
Wynantskill
Poestenkill
West Sand Lake
Averill Park
Rensselaer
East Greenbush
Nassau
Berlin
Stephentown

*FIGURE 7
Bedrock

Legend

- Q - glacial + alluvial dep... underlying geology
- Osh - Middle Ordovician - shale
- On - Middle Ordovician - Norm... shale
- Ob - Lower Ordovician + Upper ... carbonates
- OЄ - Lower Ordovician + Lower ...
- Єs - Lower Cambrian - ... Taconic sequence
- Xe - age unknown - Rensse... group

Due to copying difficulties, these Maps could not be duplicated. The original maps will be available with the library copy at Rensselaer Polytechnic Institute.

*Figure 8

Surficial Geology

Legend

- Alluvium
- { Tills
  { Deep + Thin Till
- Outwash
- Ice Contact
  Organic
- Lacustrines

* FIGURE 8

Land Use

Legend

— Farmland or Pasture
— Public Park
·· Public Use
Residential
Commercial

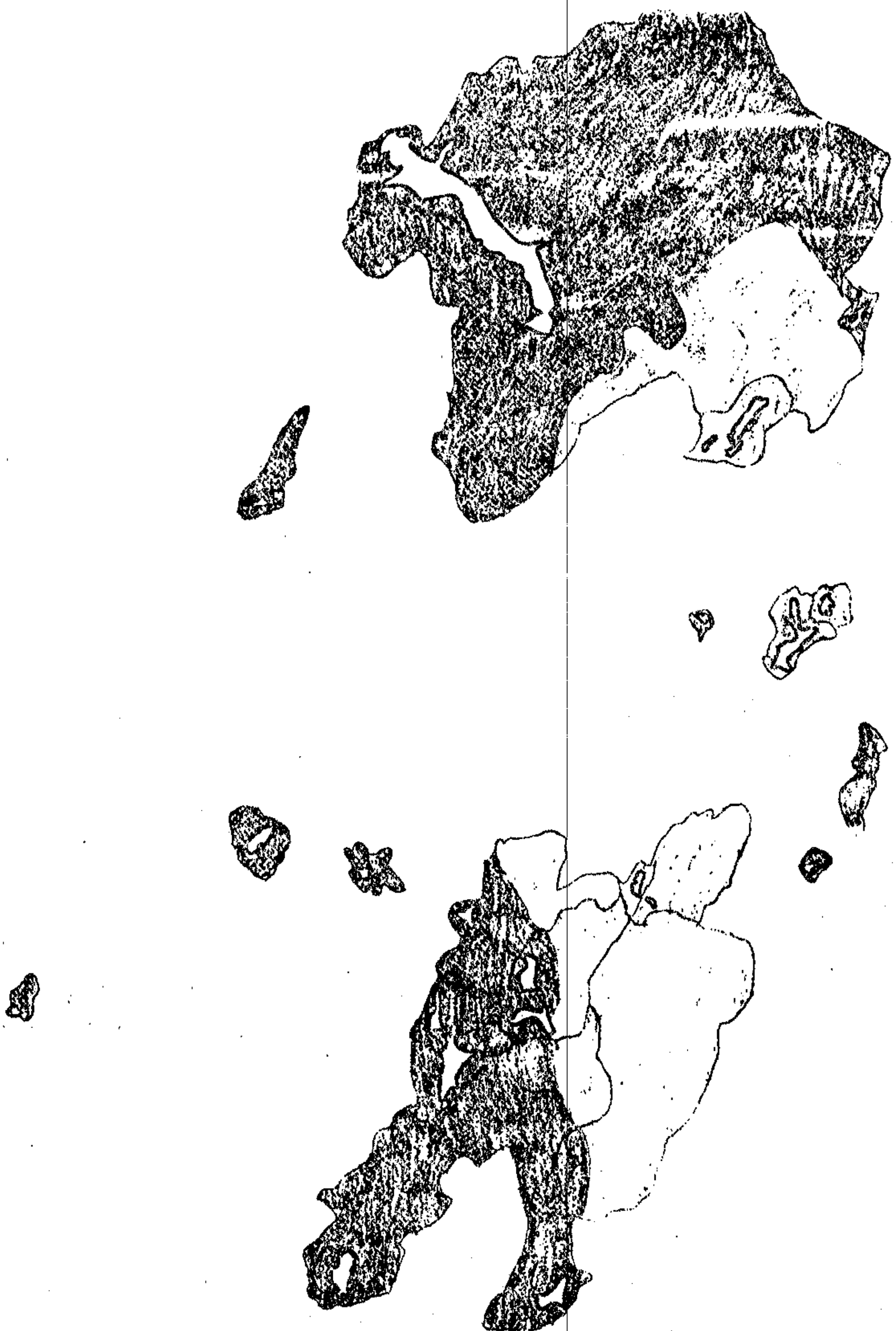


*Figure 10

General Soils

Legend

Troy - Cossayuna - Nassau
Alps - Cilers - Cattaraugus
Hudson Rhinebeck
Nassau
Worth - Empeyville - Westbury
Hoosic

GENERAL CHARACTERISTICS AND FINDINGS

An in-depth investigation of each lake's characteristics will be done later in the report. An overall description of some of the features common to most lakes studied is presented here. Areas covered in this section include morphometric variables found in the county, relationships between algal diversification and chemical composition, trends found in chemical compositions, bacterial content and dissolved oxygen readings.

It is the intent of this section to present the reader with a general feeling for the lakes in Rensselaer County and to clarify some seemingly anomalous results.

(1) Lake quality is generally endangered by one or any combination of three processes. Toxic contaminations, such as oil spills or industrial discharges, are the most readily noticeable threats. Such discharges are often immediately obnoxious and it is usually easy to locate the source. The second threat is bacterial contamination. Often high bacterial counts can be attributed to raw sewage outfalls or a combination of storm and sanitary sewer outfall. In other cases, the sources of such contamination are not as readily identifiable. The third threat can be called nutrient "contamination," although a more inclusive term is cultural eutrophication. The term cultural eutrophication refers to a rate increase in the natural eutrophication, or aging, of the lake due to an expansion of human activity within the area. Expanding human activity often results in nutrients being increasingly supplied to the lake's ecosystem. Changes in the nutrient input can lead to drastic changes in the character and quality of the lake. The sources of these nutrients include sewage plants, leaching from septic tanks, fertilizers, urban street runoff, increased erosion due to construction or poor farming techniques, leaching from land fills and dumps and other sources associated with man's presence.

The primary threat to the lakes and ponds involved in this study is eutrophication. The small size of these lakes makes them extremely susceptible to the products of recent increases in human activities in the more rural areas of the county. Increasing nutrient supplies have resulted in increased algal and plant productivity.

The increased productivity leads to low dissolved oxygen, production of hydrogen sulfide and odors from algae growth that characterize some of the lakes in the study during the summer months.

Eutrophication is a natural aging process which occurs in most lakes. Early in the lake's life it is usually relatively deep with steep walls. During this period of oligotrophy, the productivity of the lake is low; the water is clear; there is little shore vegetation and the plankton are scarce. As the lake ages, the shoreline is eroded, the slope lessens and substantial sediments are accumulated. More of the lake bottom is within reach of sunlight, causing bottom algae and shore vegetation to increase in numbers. As the process continues, the productivity of the lake increases and vegetation and sedimentation result in partially filled areas of the lake. During this period of high productivity, the number of species of plants and animals will decrease as the changing conditions begin to favor one species over others. Although the number of species types will decrease, the total number of organisms within the lake will increase when there is an over abundance of nutrients present.

The nutrient increase begins, originally, with erosion and sedimentation. These nutrients increase the productivity and are generally recycled within the lake system while other nutrients continue to enter the system through runoff and various other means.

Eventually, the productivity of the lake increases to such an extent that it becomes weed-choked. Following this, it is only a matter of time before the lake fills and becomes a bog if no external actions occur.

The lakes in this study are comparatively small and shallow and so they are susceptible to relatively rapid changes stemming from the onset of eutrophication. Any increase in the aging rate of the lakes, due to increased nutrient input, could result in drastic changes in the lakes, even in as short a time span as five years.

(2) Algal diversification (as described in the comparison section of this report) is strongly related to chemical compositions in this study. Overlays of percent difference in algae diversification were made for the chemistry ordination models (see metholology, "Data Analysis" Section). The relationship found follows:

> Algal diversification trends show an inverse correlation with plots of some internal chemistry variables. It is apparent that as phosphate, nitrate, total alkalinity, and hardness increase, the lake conditions as determined by algal diversification approach eutrophy. These relationships seemed consistent throughout the study.

This correlation reinforces the use of both nutrient levels and algal diversification as indices of eutrophication.

(3) Dissolved oxygen concentrations were found to decrease with depth as expected (see Appendix).

(4) Phosphates, both ortho and total acid-hydrolyzable forms, were found in general to increase with depth. Total phosphates in particular tended to concentrate at the bottom of the pools.

(5) Hydrogen sulfide concentrations, in general, increased with depth. Frequently, the concentrations remained essentially the same throughout the lake profile until very deep in the lake where concentrations were extremely high.

(6) Alkalinity and hardness were both observed to increase with depth, generally.
f

(7) Nitrates were observed to vary with depth, but the changes of concentration with depth were dependent in the time of the summer that the profile was taken. In general, in the early part of the summer, the nitrates were concentrated at the bottom of the pools. As the summer progressed, the nitrates became more evenly distributed and finally, by the end of the summer, were concentrated at the surface. This is reminiscent of the cycle of nitrogen in the lake ecosystem.

(8) Dissolved oxygen readings early in the summer were found to be very high--11 to 13 ppm. Readings as high as 15 ppm were also recorded. Although extremely high (saturation being at 8-10 ppm for the range of temperature involved), the results are not anomalous. It has been found that dissolved oxygen readings of this nature are common in lakes of high algal concentration. Photosynthetic processes, during the day, in the epilimnion often cause supersaturation of dissolved oxygen. At night, when respiration replaces photosynthesis, values for dissolved oxygen would have been well below saturation (Kooyoomjia 1972). Unfortunately, night sampling was not undertaken in this study, so substantiation was not readily available.

(9) General relationships and trends in bacteriological content was also observed.

The presence of coliform bacteria was confirmed in all twent lakes studied. Determination of the most probable number per 100 ml was based upon the positive brilliant green lactose bile tubes. All such tubes were subjected to the EMB test. For all the lakes throughout the summer, the presence of coliform was indicated by positive secondary lactose tubes and by observation of gram negative, nonspore forming, rod shaped bacteria. To avoid a cumbersome report of the results of all the EMB cultures, the data sheets were designed to indicate the various combinations of typical and atypical colonies grown on the EMB plates. Occasionally other bacterial colonies were slanted and were discovered not to be coliform upon microscopic examination. Any further mention of these was considered irrelevant.

Since coliform may die rapidly in water, their presence indicates a recent introduction into the lake. If coliform are present at a sampling site over five rounds of sampling, one can infer that there is a continuous contamination of the water with human or animal wastes. A positive test for fecal coliform would only support this conclusion.

Fecal streptococcus is also an indicator of human or animal wastes in the limnological system. A positive test indicates the presence of any of the following species of Group D streptococcus:

- S. faecalis
- S. faecalis var. liquefaciens
- S. faecalis var. zymogenes
- S. durans
- S. faecium
- S. bovis
- S. Equinus

These are some of the bacterial flora normally found in human and animal intestinal tracts. They are resistant to environmental influences and will survive longer than coliform in water. Hence, they do not necessarily indicate a recent contamination of the water.

One should note that the test medium for fecal streptococcus contains 6.5% NaCl, which will not support the growth of Group B., streptococcus, a common agent of mastitis in cows, nor that of pyogenic streptococcus which exhibits beta-hemolytic activity and is associated with diseases of man.

After completion of the bacteriological assays, several of the lakes which were high in fecal coliform or fecal streptococcus were investigated. An attempt was made to trace the contamination in the water and to determine if the source was human sewage or fecal matter of farm animals. Streams entering the lakes were followed to see if they flowed through farm land. It was noted if the lake was heavily populated, if septic tanks were in use and if the waters were used for swimming. Individual reports of the findings are found in the following sections.

One of the major purposes of the computer analysis was to compare two lake variables and determine if there was a relationship between the two. One area where this worked especially well was in the comparison of chemical data and bacteriological data with geological parameters such as population, land use, and bedrock.

(10) One of the most significant trends indicated that the lakes with higher total populations in the watersheds generally had higher nutrient concentrations and higher bacteriological counts--the same correlation existed between population density and nutrient levels although the trend was not as strong.

(11) Another noticeable trend existed for agricultural land use. The lakes with larger amounts of agricultural land in the watershed generally have higher nutrient levels and higher bacteriological counts.

(12) There was also a general correlation with a few exceptions between lake quality and location in the county. The lakes in the eastern region of the county are those with the lower nutrient levels and lower productivity; the lakes in the central region of the county are intermediate in nutrient content and productivity; the lakes in the western section of the county have the highest nutrient levels and productivity. There are obvious reasons for this correlation. Each region of the county has its own characteristics as to population, land use, bedrock and soil trends (see the Rensselaer County section). The eastern region has little population and agriculture, the central region is more heavily populated and has extensive agriculture, the western region has the highest population densities of the county.

(13) Probable Biological Succession in Time for Rensselaer County Lakes

1. Shoreline confined growth of Nymphae and Nupa, Potamogeton, Anacharis

2. Advanced bottom growth of Potamogeton, Microphyllum, Anacharas, Cabomba, Heteranthera

3. Growth of bullrushes, horsetails and ferns along the shore forming swampy land

4. Gradual advancement of swamp, appearance of willows, shrub bushes, water tolerant conifers

5. Growth of pines, oaks, maples and beeches

LAKE CLASSIFICATION

In an effort to characterize the lakes in Rensselaer County, they have been divided into three groups. Characteristics common to the lakes from each group are used to describe a typical lake in each group.

The <u>mesotrophic</u> lakes are usually those lakes better suited for recreation in the county. A typical mesotrophic lake would be located in the forested section, in the eastern portion of the county. It generally has soft water and low nutrient levels; ortho phosphates below 30 ug/l (see figure 12), total acid hydrolyzable phosphates below 65 ug/l, and nitrates below 170 ug/l. The level of productivity is low and algal blooms are uncommon and small (see figures 13 and 14).

This typical lake would have sparse population in its watershed and limited farmland. The surrounding land would most likely slope steeply toward the shoreline.

The aesthetic nature of this type of lake is highly regarded. The area is usually an ideal spot for swimming, boating, and camping.

The typical <u>mildly eutrophic</u> lake would be considered as desirable for recreation as the above lakes; however, its future is endangered by its advancing eutrophic condition. The nutrient levels would be moderate for the lakes studied; orthophosphates below 125 ug/l (figure 12), total acid-hydrolyzable phosphates below 350 ug/l, and nitrates below 330 ug/l; however, in most cases, these would be increasing.

This typical lake would be found in the central plateau region of the county. There would be a fairly large population in its watershed and/or increased farm and pasture land.

This lake would be used extensively for recreation, both public and private. Many cottages and other structures would surround the lake, most having septic tanks.

The typical mildly eutrophic lake would have nuisance bloom during the late-July, mid-August season. The bloom would be large and possibly occur more than once during the season (see figures 13 and 14).

The surrounding land would be moderately sloped and the shoreline more regular than the mesotrophic group.

Aesthetic values of this type lake would have decreased within the past decade. Due to development, the lake has lost its attractiveness because of the increased production of algae.

The typically <u>eutrophic</u> lakes are no longer regarded as desirable recreation areas. The extent of eutrophication has caused a general rejection of the lake for extensive water contact recreation.

The nutrient levels of this typically eutrophic lake would be consistently high throughout the summer: orthophosphates as high as 500 ug/l (figure 12), total acid-hydrolyzable phosphates as high as 600 ug/l, and nitrates as high as 680 ug/l. Hardness is also a common characteristic of these lakes. Hardness, measured as calcium carbonate, could be as high as 110 mg/l.

Algae blooms would be very large and, in many cases, occur all summer (see figures 13 and 14). The blooms would be unsightly and may be accompanied by undesirable odors caused by anaerobic conditions below the thick algal film.

The typically eutrophic lake would be found in the western lowlands of the county and its watershed would be highly populated and/or contain extensive farmlands. A densely populated ring would surround the lake, with many septic tank facilities within the drainage area.

The aesthetic values of the lake have diminished to the extent of rendering the lake undesirable to man.

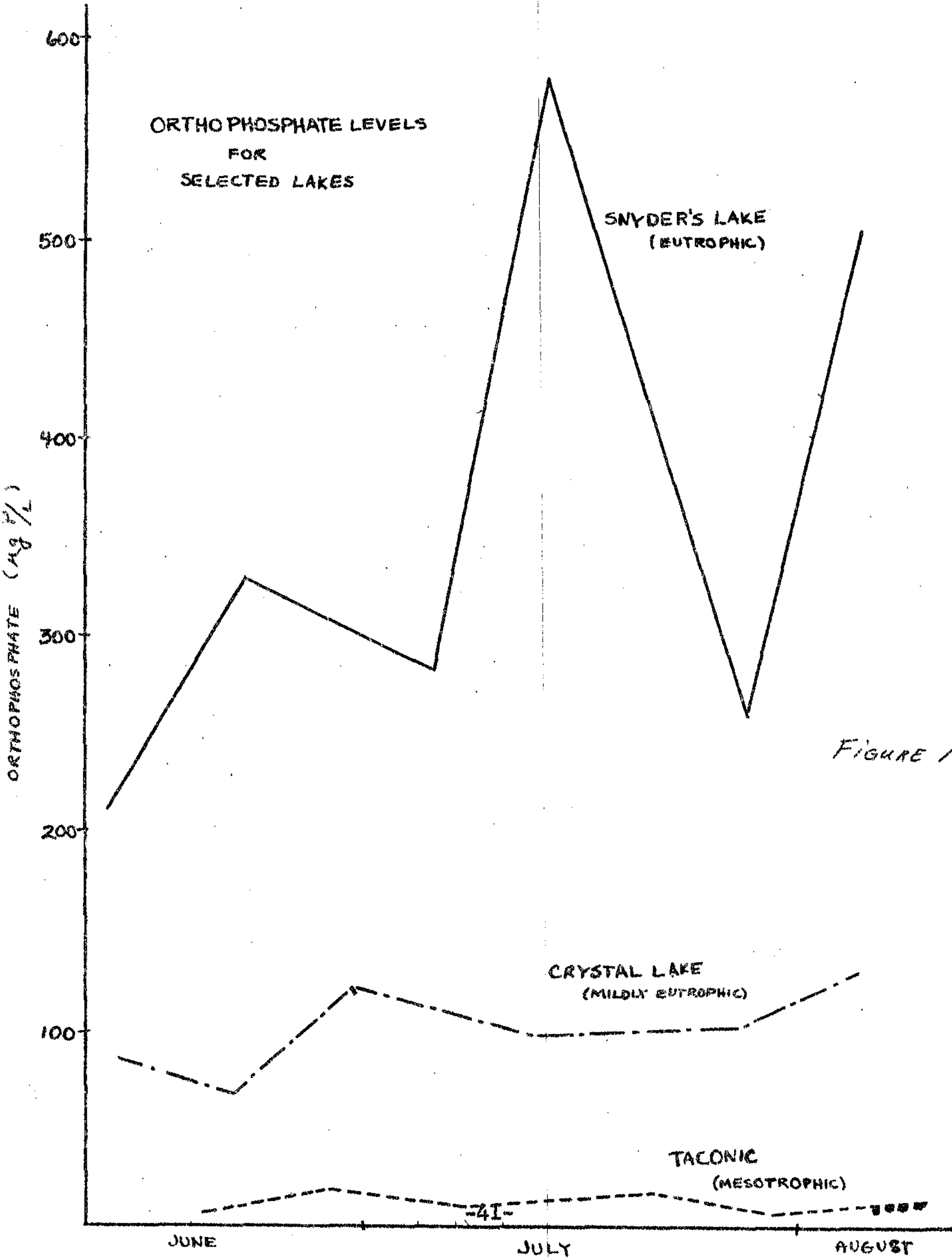

ORTHO PHOSPHATE LEVELS
FOR
SELECTED LAKES
SNYDER'S LAKE
(EUTROPHIC)
CRYSTAL LAKE
(MILDLY EUTROPHIC)
TACONIC
(MESOTROPHIC)
600
500
400
300
200
100
ORTHOPHOSPHATE (µg P/L)
JUNE
JULY
AUGUST

FIGURE 1.

figure 3 TRANSPARENCY (SECCHI DISK)

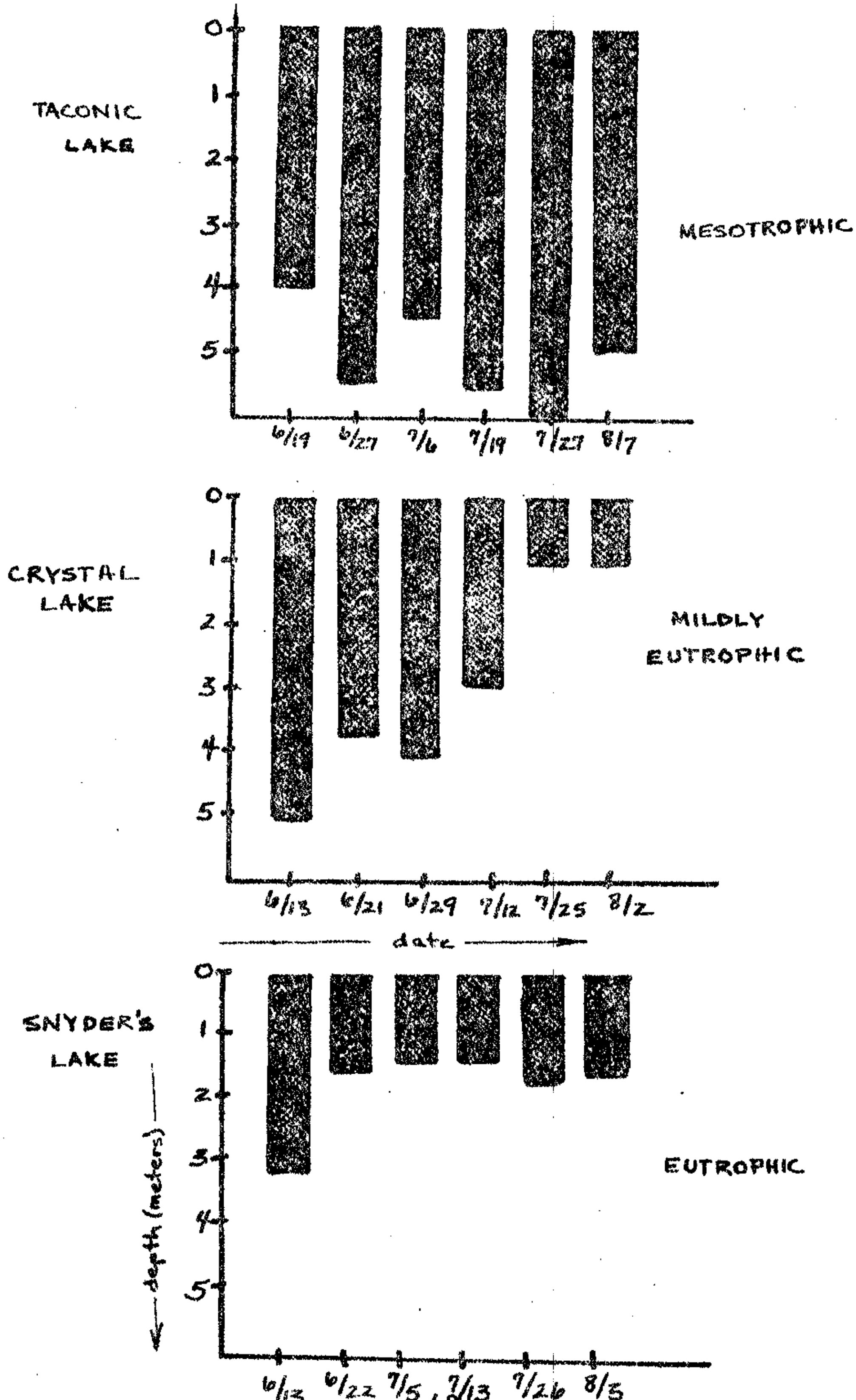
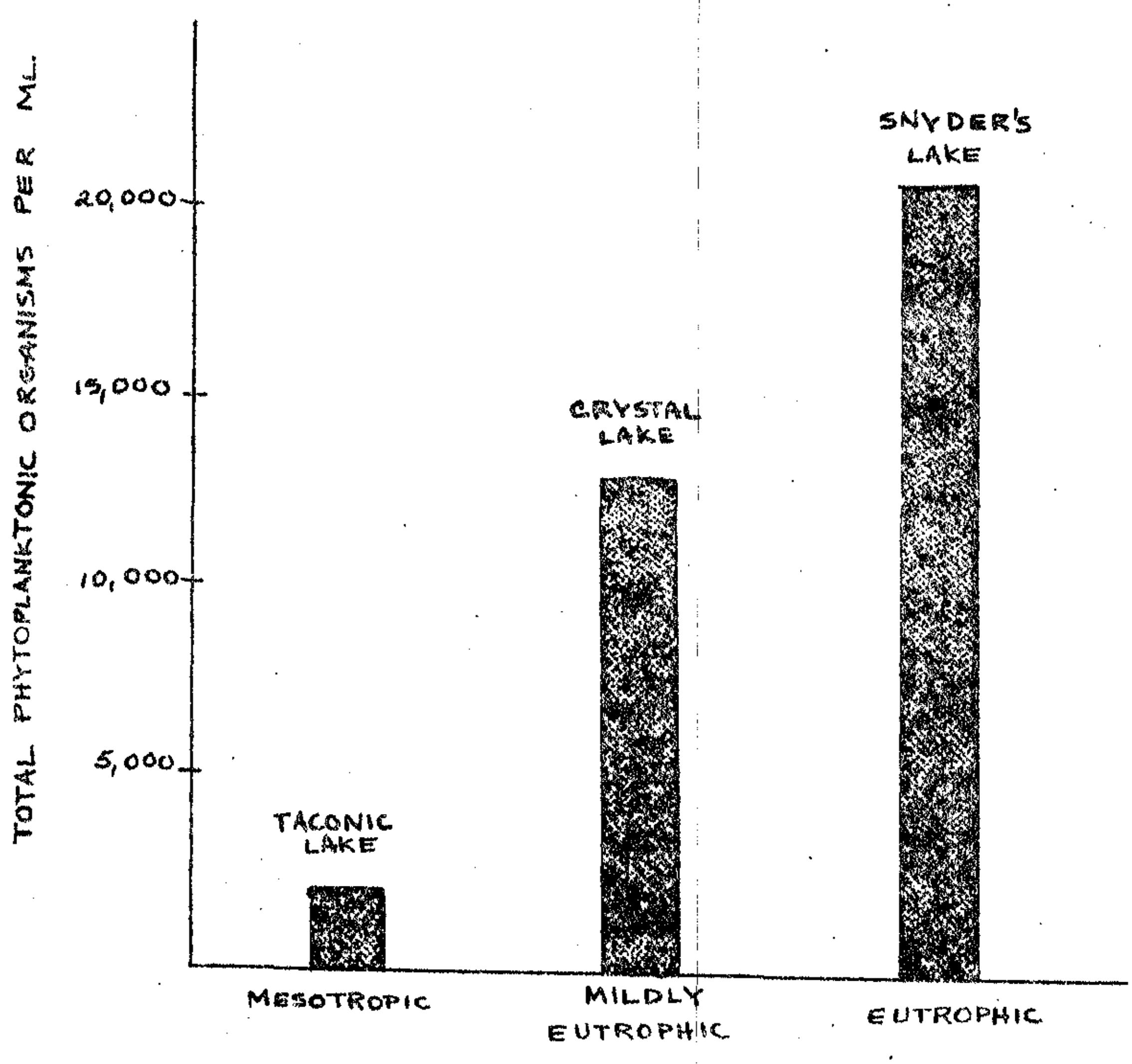


FIGURE 14
PHYTOPLANKTON COUNTS AT SELECTED SITES
FIRST WEEK OF AUGUST, 1972
DEPTH - 0.5 METERS



GLASS LAKE

Physical

In general, Glass Lake is oval-shaped with a regular shoreline and surface area of 102 acres. The two major inlets draining the 3,276 acre watershed are located on the northeastern shore and on the southern shore. Approximately one-sixth of the shoreline is inhabited. The remaining five-sixth of the rocky shoreline is forested. Weed beds extend into the lake in several places. A marsh area exists near the section connecting to Crooked Lake. The slope of the surrounding land is shallow to moderate.

Surface temperatures for Glass Lake ranged from 16.4°C to 27°C throughout the summer, while the bottom temperature at 20 meters was constant at 4°C. The lake evidenced definite stratification. (See the Appendix for thermocline characteristics.)

Below 8.75 meters hypolimnetic dissolved oxygen was recorded at 4 ppm in June and decreased steadily to depletion by late July.

For Secchi disk readings, see the Appendix.

Geological Setting

This lake is located in the hilly area at the foot of the Rensselaer Plateau in the southern central section of the county (500-1,000 feet elevation). The eastern part of the watershed is on the plateau itself which is hilly, mountainous and heavily forested. This part of the area lies within the 1,000-1,500 feet district.

The population is concentrated primarily around the lake with only a few small residential areas to the north. The population count is 513 people according to the census and 738 using houses as the main criteria*, indicating a significant number of summer residents. Additional land use of this watershed shows some farming is done, especially to the north and northeast, but not very extensively. There is an excavation site on Crooked Lake and some commercial land on the northern end of Glass Lake.

The surficial geology here is almost entirely till with small spatterings of alluvium and outwash.

*The population count from counting houses was obtained from maps at the County Planning Service. The number of houses multiplied by 3.1 (average number of persons per household) provided the numbers used here.

The bedrock and soil reflect the division between the Rensselaer Plateau and the foothills to the west. The western portion which includes the lakes themselves is underlain by clastics of the Taconic sequence and is covered by the Alps-Culvers-Cattaraugus Association. This is characterized by upland soils derived from red slate and shale. The eastern portion of the watershed is underlain by Rensselaer graywacke with the Worth-Empeyville-Westbury Association above. This has many stones, boulders and outcrops and has developed on acid glacial till from sandstone.

These lakes are stream fed.

Chemical Composition

Glass Lake is a soft water lake fed by a soft water stream. All sites are relatively low in phosphates, averaging at most sites below 35 ug/l in total acid-hydrolyzable phosphates. Nitrate concentrations are moderate for the lakes studied. The lake does not contain much hydrogen sulfide and the dissolved oxygen readings averaged about 8 ppm.

Photoplankton Counts

Moderate amounts of algal growth were found, approximately 11,000 organisms per milliliter on July 11 and 2,500 organisms per milliliter on August 1. A general decrease in the number of plankters was noted. This trend was most obvious in the diatom classification in which the number of organisms per ml decreased from an average of 78 to an average of 27. The decreases are reflected in a rise in nitrate levels at sample site 2 from 20 to 60 ug/liter as N indicating a decreased nitrate uptake as the numbers of organisms decreased.

Zooplankton Analysis

Glass Lake had a summer average of 163.6 zooplankters per liter. Cladocerans predominated over cyclopoids or calanoids (1:.7:.7). Through most of the summer (sampling rounds 2-5) the dominant cladocerans were Diaphanosoma, Daphnia and Bosmina (1.7:1:1). On August 1 a sharp increase in the number of Bosmina occurred resulting in this organism becoming the dominant Cladoceran in the summer average. Other Cladocerans present include Chydorus, Ceriodaphnia and Holopedium. Rotifers constituted 59% of the zooplankton population, Keratella was the dominant rotifer.

Identification of Flora

Glass Lake was virtually free of weed growth. Algae was confined to rocks along the shore and a spillway wall. Algae from the wall was Chrysophyta and Cyanophyta, but for the majority of the lake the dominant division was Chlorophyta.

Bacteriological Analysis

At sampling site #1, the amount of coliform bacteria fluctuated over the summer as shown by a graph of MPN/100ml as time in days. A graph of the same parameters for fecal coliform showed the same fluctuation, although the ratio of fecal coliform to total coliform was not equal to one at all depths. Surrounding this sampling site are many cottages on the lake shore and a public beach. Septic tanks are in wide use for sewage disposal.

A plot of the amount of coliform vs. depth for each round showed that the number of organisms generally decreased with depth. This is expected and correlates well with a decrease in temperature and dissolved oxygen with depth.

Station #2 exhibited the same fluctuation in coliform over the five rounds of sampling. On one side of the site the lake shore is heavily populated; the other is a recreation area for private use. This is the deepest pool of the lake. There is good correlation between the temperature profile taken here and a graph of coliform vs. depth. Generally the amount of coliform peaks between two and seven meters in depth, along the thermocline.

Site #3 was a stream that dried up after the fourth round of sampling. The data indicates that the stream was a source of coliform bacteria, during June and the first part of July. During this time the maximum amount of fecal coliform running into the lake was 73.3% the amount of total coliform.

The extent of bacteria at site #4 is in keeping with the amount running in from the stream at site #3, which is very close to site #4. Near these sites considerable weed and algal growth was observed, which will support the growth of bacteria that may flow into this narrow region of the lake.

Throughout the summer the amount of fecal streptococcus observed was zero or near zero with two exceptions. An MPN of 230 organisms per 100 ml was obtained for the stream sample of July 11 and an MPN of 930 for station #4 on July 20.

There is evidence of fecal contamination and logical sources present. However, the amount of bacteria measured should not interfere with the recreational use of the lake.

Glass Lake is a mildly eutrophic lake when all characteristics are examined. Some major contributing factors to its trophic state are the relatively high population in the watershed and a large number of septic tank fields surrounding the lake.

If corrective measures are not taken soon the increased productivity may eventually interfere with the aesthetic qualities of this lake, which is used as a recreational area by many people.

CROOKED LAKE

Physical

Crooked Lake is characterized by an odd elongated shape and regular shoreline. The surface area is 115 acres. The 3,276 acre watershed drains into a major inlet on the eastern shore. Although the rocky shoreline is entirely inhabited, much of the foliage remains. There are no extensive weed beds and only one marsh located at the connection with Glass Lake. The slope of the surrounding lake is moderate.

The surface temperature ranged from 16.4°C to 26.8°C, while bottom temperatures at 11.5 meters increased from 3°C to 9.2°C as the summer progressed. The lake showed definite stratification. (See the Appendix for thermocline characteristics.)

Below 8 meters hypolimnetic dissolved oxygen decreased from less than 1 ppm to depletion.

For Secchi disk information refer to the Appendix.

Geological Setting

(See Glass Lake.)

Chemical Composition

Crooked Lake is a soft water lake. Unlike Glass Lake it contains a considerable amount of nutrients. The average total phosphate content reached as high as 150 ug/l. Both the total and ortho-phosphate levels increased throughout the summer. Nitrate concentrations remained fairly constant in a range of 60-80 ug/l. A steady increase of hydrogen sulfide was found in both the stream and the lake pool as the summer progressed. At the bottom of the pool it reached 890 ug/l which was more than insufficient to give the water a rotten odor. Dissolved oxygen in the epilimnion was observed to decrease over the summer.

Phytoplankton Counts

A large increase (from 1,700 to 47,000) was noted in greens and blue-greens at the depth having zero dissolved oxygen readings from July 11 to August 1. The number of diatoms and pigmented flagellates decreased, however, at nearly all depths. Dissolved oxygen decreases from July 11 to July 20 are further evidence of a bloom and the effects of the chemical treatment.

Zooplankton Analysis

Crooked Lake had a summer average of 201.1 zooplankters per liter. Cyclopoids dominated over Cladocerans and calanoids (4.9:1:.4). On June 20 *Chydorus* was the dominant Cladoceran, but *Daphnia* was the sole Cladoceran present in rounds 3-6 (June 25-August 1). Ninety-one percent of Crooked Lake's zooplankton population consisted of rotifers, of which *Keratella* was the dominant genus.

Identification of Flora

Crooked Lake had few aquatic plants except along a swamp-like area on the northern tip. A nearly equal species representation was shown by *Chlorophyta*, *Cyanophyta* and *Chrysophyta*.

Bacteriological Analysis

Fluctuation in the amount of coliform was observed at station #1 on Crooked Lake. The number of organisms peaked on July 20. The graph of fecal coliform MPN vs. time showed a similar change, with a peak on July 20, where the fecal coliform was 100% the total coliform in the water. Also, on July 20 an MPN/100 ml of 150 was recorded for fecal streptococcus. All indicators point to a considerable amount of fecal contamination in the lake on that day. Sample site #1 is surrounded by private homes along the lake shore.

The plot of coliform vs. depth followed the expected pattern of dropping off sharply below the thermocline. The exception to this was the plot for July 20.

Station #2 was at an inlet of a stream, which entered the lake along side of a resort hotel. Before the stream dried up, it was a continuous source of coliform organisms, which were 100% fecal coliform in three out of four rounds of samples. The stream was investigated and found to flow through neither populated areas nor through farmland. However, a drainage pipe from the hotel was observed to cross the stream and go beneath the parking lot, along the lake shore. No definite source of the fecal matter could be determined.

Crooked Lake appears to be more eutrophic than the deeper Glass Lake to which it is connected. The algae productivity of the lake was very high for at least one period of the summer. The nutrient levels are relatively high and further increases in productivity, that will diminish the recreational quality of the lake, should be expected.

The use of septic tanks by the relatively large population around the lake could be a major source of nutrients.

BURDEN LAKE

Physical

Burden Lake has regular shorelines and an irregular shape. The two major inlets are on the north end of First Burden Lake and on the east side of Third Burden Lake. The basin area is 314 acres and the watershed is 5,380 acres. The population forms a ring almost entirely encircling the lake. Few weed beds are in evidence and there are no observable marsh areas. The slope of the surrounding land is steep on the east side and shallow on the west side.

Surface temperature ranged from 22°C to 27.2°C throughout the summer. At 2.7 meters temperatures had a similar range. Stratification was not exhibited.

For Secchi disk records please see the Appendix.

Geological Setting

The topography here is primarily from 500-1,000 feet in elevation since most of the watershed is at the hilly foot of the Rensselaer Plateau. A small portion of the watershed, located to the northeast, is on the plateau which is a hilly, mountainous, heavily forested region. This portion would fall into the 1,000-1,500 foot range.

The population around Burden, the second largest lake studied, is distributed in scattered centers about the lake itself and throughout the remainder of the watershed. By the census, the population was estimated at 1,773 for this area. The estimate from counting houses is 2,335 which seems to indicate a lot of summer residences. The remainder of the watershed is taken up primarily by farmland, with some public use land southeast of the lake, and a bit of commercial area to the southwest.

The surficial geology again shows mostly till with decreasing amounts of alluvium, ice contact and outwash deposits.

The bedrock is mostly clastics with some Rensselaer graywacke to the northeast. The soils are primarily of the Alps-Culvers-Cattaraugus Association--upland soil derived from red shale and slate. The other less prevalent variety is Worth-Empeyville-Westbury which contains many stones, boulders and outcrops mainly developed on acid glacial till from sandstone.

Burden Lake is stream fed.

Chemical Composition

The hardness and total alkalinities were below the levels normally defined as hard and alkaline (40 ppm). Hardness decreased over the summer while alkalinity remained constant. Total phosphate levels remained relatively constant at approximately 30 ug/l. Dissolved oxygen remained constant and hydrogen sulfide decreased. The lakes contain only a moderate amount of nitrates, usually below 150 ug/l. Similar concentrations were found for the stream feeding the lake.

Phytoplankton Counts

A normal range of algal plankton was found on July 12, an average of approximately 7,000 greens and blue-greens, 120 diatoms, and 260 pigmented flagellates per ml. There was, however, a bloom of 30,000 greens and blue greens present on August 2. This information can be correlated with the decrease in the acid-hydrolyzable phosphate concentration at site #3 from 80 to 30 ug/liter and the decrease in nitrate concentration at site #4 from 110 to 30 ug/liter. This indicates an increased nutrient uptake as the bloom progressed.

The lake was chemically treated on August 1 but no indication of the results could be found on August 2, the last time the lake was sampled.

Zooplankton Analysis

Burden Lake had a summer average of 229.9 zooplankters per liter. Cladocerans were the dominant crustacean. Burden Lake showed a sharp rise in the number of *Bosmina** July 25 (from 1.3/liter on July 12 to 410.7/liter). *Bosmina* was the dominant cladoceran. *Daphnia*, *Chydorus* and *Ceriodaphnia* were also present. Fifty-five percent of the zooplankton population was composed of rotifers. *Keratella* was the dominant rotifer.

Identification of Flora

Because Burden Lake was treated with copper sulfate in May, there was little algae growth in June. The rocky shoreline supported sparse weed growth. *Chlorophyta* contributed the greatest number of algae species.

Bacteriological Analysis

Sample Site #3 exhibited a consistent population of coliform bacteria. The amount varied, but generally remained above 100 organisms per 100 ml. At the same time a major part of the total coliform was of fecal origin. In the samples from rounds 4, 5 and 6, there was also a high incidence of fecal streptococcus.

Station #3 is in a cove of the lake, one side of which is heavily populated with summer cottages. The water is shallow and heavily weeded, providing a good environment for bacterial growth. The other side of the cove is heavily wooded and probably the source of soil coliform organisms.

Station #4 was in the middle of an open section of the lake, with homes on all sides. The amount of coliform present was not as high as in station #3, but a consistent introduction into the lake was evident through June and the first part of July. The total coliform count dropped to zero at the time of round #5 and #6 sampling.

The total amount of coliform remained high in site #5, in a narrow end of the lake, dotted with summer homes. A major portion of the organisms present were of fecal origin, the number generally remaining above 100 organisms/100 ml.

The conditions are not unusual for a recreational lake, and the bacterial population is no cause for alarm.

Burden Lake, as studied, is reported as a mildly eutrophic to eutrophic lake. One major contributing factor is the ring of highly populated land around the lake. A result of the dense population and nutrient influx of the lake was the very large algae bloom found in early August.

The First and Second Burden Lakes are shallow with much of the bottom within reach of direct sunlight, which serves to increase the productivity of the lake. Lyons (1971) characterized the deeper Third Burden Lake as "moderately eutrophic" and indicated that the shallower upper lakes would probably be more productive. Comparisons between algae counts and nutrient levels for the two studies indicate this to be true. Further increase in productivity will diminish the recreational qualities of the lakes.

SNYDERS LAKE

Physical

Snyders Lake has a regular shoreline with a basin area of 120 acres, an outlet on the northwestern shore, and an inlet on the southwestern shore. The lake system drains a watershed of 764 acres. The dense population completely surrounds the lake. There are no weed beds and very sparse marshland. The sandy shoreline has slopes varying from shallow to steep.

Surface temperatures ranged from 18.4°C to 26.8°C. At 11 meters temperatures increased from 4°C to 10°C. Definite stratification was evidenced. (See Appendix for thermocline characteristics.)

Below 7.5 meters hypolimnetic dissolved oxygen decreased from 2 ppm to zero at the 8 meter depth and was completely depleted at the 10.5 meter depth throughout the summer.

See the Appendix for Secchi disk information.

Geographical Setting

The lake is surrounded by higher land for the most part, and so even though the lake is in the 0-500 feet range, most of the watershed is 500-1,000 feet in elevation. Gentle to moderately steep hills and drumlins can be found in this area.

The population is quite densely concentrated in the western section of the watershed with some scattered areas in the remaining portion. According to the census figures, there are 755 people, but by houses an estimate is 880, pointing to summer homes. There is some farming in the northern part, some public use land to the south and some commercial areas scattered throughout the watershed.

The surficial geology is mainly till with some alluvium, outwash and ice contact deposits.

The bedrock is mostly clastics with some of the Deepkill, Stuyvesant Falls and Germantown formations to the east. The soil is Troy-Cossayuna-Nassau. This is developed on acid glacial till from shale, slate and sandstone with interspersed chips of shale and slate as well as gravel.

The lake is stream fed.

Chemical Composition

Snyders Lake is highly alkaline and hard. Hardness ranged from 65 to 100 ppm during the summer; alkalinity ranged from 70 to 100 ppm. Phosphates were high on the average but surface concentrations were fairly low. The maximum value for total phosphate was 1,237 ug/1 on August 3 at the stream mouth. Total phosphates at site #1 peaked at approximately 640 ug/1 on July 13 and were observed to be increasing again by the beginning of August. Site #3 did not peak until July 26 and concentrations were still decreasing at the time of the last sample. The nitrates generally decreased over the summer, ranging from 70 to 100 ug/1 and were observed to be relatively evenly distributed throughout the pools. The stream concentations were, in general, constant and reached a maximum at round #5, July 26. The sulfide readings were generally under 50 ug/1 at the surface of the lake and at the stream. However, at the bottom of the pools the hydrogen sulfide concentrations were exceedingly high, with values up to 5,000 ug/1 being reported. These values were more than sufficient for quite strong odors to be observed. In the regions where the sulfides were high the dissolved oxygen was completely depleted. Near the surface and in the stream the dissolved oxygen remained between 8 and 11 ppm.

Phytoplankton Counts

Snyders Lake contained an average amount of surface phytoplankton on July 13. However, a large amount of greens and bluegreens were recorded at the depths having zero dissolved oxygen readings, an indication of an earlier algal bloom. This conclusion is supported by the extremely high levels of phosphates (641 ug/1) found at this time. The largest algal counts of the study were recorded at the bottom of site #3 during this time--221,000 organisms per ml.

High levels of greens and blue greens were found in the surface sample of August 3 (21,000 organisms per ml). This bloom was preceded by a drop in phosphate levels just prior to this time. The algal counts of the upper depths remained at an average of 6,000 organisms per ml.

Zooplankton Analysis

Snyders Lake had a summer average of 152.2 zooplankters per liter. Cladocerans predominate over cyclopoids and calanoids (1:.4:.7), and Daphnia is the dominant Cladoceran. Diaphanosoma, Chydorus and Bosmina are also present. Rotifers comprised 78% of the total zooplankton population and Keratella is the dominant rotifer.

Consistant sightings of large numbers of dead fish on this lake by members of the project tend to indicate that the fish population in Snyders Lake may be well below normal. Since most young fish subsist mainly on zooplankton and many adults are also facultative planktivores they would normally limit the zooplankton population since they selectively prefer large cladocerans over other zooplankton (Berg and Grimaldi, 1965; Brooks, 1968, Luliv, 1961). A decrease in the fish population would probably result in an increase in the population of large zooplankters above what would normally be expected for the trophic level of the lake. This appears to be the condition in Snyders Lake.

Few submerged or floating weeds were noted at Snyders Lake. However, the algae was so dense that the water resembled a thick, green soup. The principal algae were Chysophyta and Cyanophyta.

Bacteriological Analysis

The total coliform count at station #1 fluctuated around 100 organisms per 100 ml at all depths over the summer. Only during one round was a major portion of the coliform of fecal origin.

Station #2 at the shore appeared to be a prime source of coliform bacteria, generally 100% of fecal origin. The incidence of fecal streptococcus was also high at this point, fluctuating around 1,000 organisms per 100 ml.

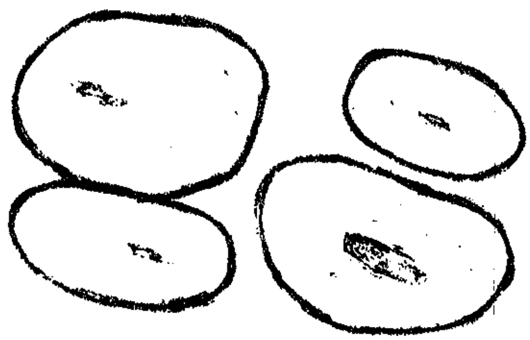
Station #3 was very similar in coliform count to station #1. Here a larger percentage of the coliform was of fecal origin, however.

Several times throughout the summer, masses of photosynthetic purple sulfur bacteria were visible in the sample jars. The masses of bacteria were heavily pigmented--red-purple in color. Upon microscopic examination under oil immersion, sulfur globules were evident in the cells, which were red-purple in color (see fig. 11).

In the samples where sulfur bacteria were found, a large amount of H_2S was found by chemical analysis. The bacteria oxidize the sulfur and elemental sulfur is deposited within the cells.

It appears that Snyders Lake is a eutrophic lake. This is one of the most deteriorated lakes through all the factors studied.

Photosynthetic purple sulfur bacteria



Snyders Lake
Round 4.
Samples:
4-1-7-
4-1-10
4-3-8.5

FIGURE 11

Some of the factors unique in Snyders Lake are the presence of photosynthetic purple sulfur bacteria, extremely high hydrogen sulfide readings in the pool and complete depletion of dissolved oxygen in the hypolimnium throughout the summer.

The Snyders Lake watershed contains the second highest population density of the lakes studied. Septic tank facilities could very easily be one of the major causes of the poor conditions found in the lake.

At the present time the lake is not a desirable recreational site due to the high algae productivity. High algae productivity invariably diminishes the aesthetic quality of any body of water.

REICHARDS LAKE
(Racquet Lake)

Physical

Physically, Reichards Lake is round with irregularities on the northern end. The shoreline is regular and composed of trees, sand beaches and a large marsh which encompasses approximately one-third of the northern periphery. Weed beds exist along the northern area and southeast section. The slope of the surrounding land is one-fourth steep and three-fourths shallow. The area of the watershed is 461 acres and the basin area is 35 acres. The two major water flows are an inlet on the northeastern shore and an outlet on the northwestern shore.

Surface temperatures ranged from 17.2°C to 25.0°C throughout the summer. Bottom temperatures at 7.5 meters fluctuated from 9°C to 12°C and back to 9°C, finally becoming constant at 10.4°C. Stratification was evidenced for all but round #4. (See Appendix for thermocline characteristics.)

For Secchi disk information see the Appendix. Hypolimnetic dissolved oxygen recorded below 5.0 meters decreased from 1 ppm to zero at 5.5 meters and was depleted at 7.0 meters for the duration of the summer.

Geological Setting

The topography here is nearly level plains to steeply sloping hummocky hills with drumlins to the east. The elevation of the watershed ranges between 500 and 1,000 feet.

The population is heavily concentrated on the western half of the lake. According to the census the population is 223 but by houses it is estimated to be 397, indicating summer residences. The land use includes a good deal of farming with some commercial land to the south.

The surficial geology exhibits considerable variety with till, alluvium, ice contact and outwash all present (given in order of decreasing prominence.)

The bedrock is primarily clastics with a portion of Deepkill, Stuyvesant Falls and Germantown Formations to the west. The soil is of the Hoosic Association which is water sorted soil on sand and gravel deposits from shale, slate and sandstone. In the northeast there is a patch of Troy-Cossayuna-Nassau which developed on acid glacial till from shale, slate and sandstone, interspersed with gravel and small chips of shale and slate.

Reichards is stream fed.

Chemical Composition

The water from this lake resembled tea in color. It was found to be hard and alkaline. Both these levels remained constant throughout the summer. Total phosphate and orthophosphate concentrations were consistently moderate, being in the ranges 25 to 60 ug/l and 5 to 25 ug/l respectively. At the same time the dissolved oxygen was observed to decrease, the sulfide levels were found to increase. Hydrogen sulfide concentrations reached a maximum at the end of July. Nitrate concentrations in the stream peaked on July 13 at 680 ug/l. The pool reflected this to a much lesser degree two weeks later.

Phytoplankton Counts

The phytoplankton counts were essentially the same on July 13 and August 3, at an average of 7,000 greens and blue-greens, 50 diatoms and 80 pigmented flagellates. The relatively higher levels of surface algal on August 13 would indicate the predominance of sun-adapted blue-greens.

Zooplankton Analysis

Reichards Lake had a summer average of 359.0 zooplankters per liter. Cladocerans predominated over cyclopoids and calanoids (1:.9:.1). *Ceriodaphnia* was the dominant Cladoceran. *Daphnia*, *Diaphanosoma*, *Bosmina* and *Chydorus* were also present. Rotifers comprised 35% of the zooplankton population with *Keratella* as the dominant genus.

Identification of Flora

In June the lake bottom was a mussine weed bed. By July the lake bottom was clean, except for around the inlet. The most numerous algae were of the division *Chlorophyta*.

Bacteriological Analysis

At station #1 the total coliform count fluctuated around 200 organisms per 100 ml., peaking at 930 on July 26. Analysis showed a major portion to be of fecal origin. On August 3, the incidence of fecal streptococcus was higher than observed in the earlier rounds of samples.

Station #1 is in the middle of a small lake opposite a public beach, which is a logical source of fecal contamination. The number of bacteria at various depths varied so greatly that no correlation with temperature can be made.

Sampling site #2 was at the mouth of a stream which was a source of much fecal contamination over the summer. The total coliform count was generally above 200 organisms per 100 ml, peaking at 24,000 per 100 ml July 13. In three of the five rounds 100% of the total coliform was of fecal origin. The incidence of fecal streptococcus was also high, remaining between 230 and 430 organisms per 100 ml.

The stream runs through marshland and was inaccessible. Consequently, no definite source of the contamination could be determined.

Reichards Lake is apparently a eutrophic lake. The physical nature of the lake indicates a susceptibility to increased weed growth and filling in of the lake. The relatively high nutrient levels are reinforced by an entering stream that contains high nitrate concentrations.

Presently Reichards Lake is plagued with an undesirable tea color. The source of this nuisance was not determined. Further increases in nutrient levels probably will result in increases in the present moderate productivity. The nutrient sources are apparently farmland and septic tanks in the area.

HAMPTON PARK POND

Physical

Hampton Park Pond has a regular shoreline, surface area of 14.4 acres, and drainage basin of 235.6 acres. The main sources of water are 21 culverts from storm drains. Forty percent of the basin is marsh area with a few accompanying weed beds in the remaining sixty percent of the basin. The shallowly sloping shoreline is primarily sand and marshland.

Surface temperatures increased from 21°C to 24.6°C while the bottom temperatures taken at 3 meters increased from 21.0°C to 24.6°C while the bottom temperatures taken at 3 meters increased from 21.0°C to 23.5°C throughout the study. No stratification was observed.

See Appendix for Secchi disk records.

Geological Setting

The topography lies between 0-500 foot elevation. The land is level for the most part with some sloping terraces. There are, however, steep banks from the terrace to the Hudson River.

The population is very heavily concentrated around the lake (839 by census, 846 by houses). Such a close agreement tends to indicate year around residences are the rule. There is some commercial and public use land to the southwest and some extraction to the southeast. A small percentage of the land to the north is devoted to farming.

The surficial geology is half lacustrine (which is not found significantly in any other watershed. Glacial Lake Albany did not extend too far into the county.) The other half is composed of ice contact, outwash and a bit of till--another deviation from the norm of the county.

The bedrock is exclusively shale, the only watershed with this characteristic. The soil is from the Hudson-Rhinebeck Association. This is composed of silty and clayey soils deposited in a glacial lake (i.e., Lake Albany.) There are also acid surface layers with the calcareous substratum with islands of glacial till.

This lake is not stream fed.

Chemical Composition

Hampton Park Pond is the hardest and most alkaline of the lakes studied, although these values decreased somewhat over the testing period. The total phosphate concentrations of under 75 ug/l are considered to be moderate for these lakes. Nitrate concentrations started at about 300 ug/l but decreased from mid-July to the end of the summer to a low of 100 ug/l. Hydrogen sulfide increased from a negligible level to 110 ug/l on August 3. Dissolved oxygen readings remained high.

Phytoplankton Counts

Surface phytoplankton levels were essentially the same on July 13 and August 3 with the exception of the disappearance of pigmented flagellates on August 3. The levels of sub-surface algal dropped on August 3--greens and blue-greens from 50,000 to 16,000, diatoms from 130 to 8, and pigmented flagellates from 33 to 0. The lake was reportedly treated with copper sulfate in mid-June.

Zooplankton

Hampton Park Pond had a summer average of 520.9 zooplankters per liter. Cladocerans predominated over cyclopoids and calanoids (1:.09:.04). Bosmina and Ceriodaphnia were the dominant Cladocerans Diaphanosoma and Daphnia were also present. Rotifers comprised 31% of the zooplankton population and Keratella was the dominant rotifer for most of the summer. However, a rotifer (which, due to distortion from preservation, was unidentifiable) appeared only in the sample taken June 22 in excess of 600 per liter. This may be related to the fact that the lake was treated with copper sulphate several days prior to sampling.

Identification of Flora

Hampton Park Pond supported much shoreline aquatic plant growth. Since the lake was treated with copper sulphate in June, there was little aglae growth. The majority of species were from the Chrysophyta and Cyanophyta divisions.

Bacteriological Analysis

There were two sampling sites on Hampton Park Pond. For station #1 surface sample, coliform was a steady 930 bacteria/100 ml from June 13 to June 22. Fecal coliform incidence was negligible. Fecal coliform appeared in the June 22 sample at 24.7% of total coliform. By mid-July total coliform reached a maximum of 24,000 bacteria/100 ml of which 8.8% was fecal coliform. One possible reason for the appearance of fecal coliform in late June may be that this time coincided with the opening of Hampton Park Pond for public swimming.

For station #2 the coliform population fluctuated over the summer. A maximum of 1,500 bacteria/ml was reached in June. Of this a large percentage was fecal coliform. Mid-July's samples showed increasing coliform with 100% being fecal coliform. Possible sources of fecal coliform are storm water runoff which enters the lake through numerous drainage outfalls and the public beach.

Hampton Park Pond apparently is in the worst trophic state of the lakes studied. Because of the physical surroundings and location, it is extremely sensitive to an influx of nutrients. Nutrient and siltation contributions to the ecosystem from storm drains are cited as the main cause of its deterioration.

Without proper control, the functional and aesthetic values of the pond will continue to decrease rapidly. Increased influx of nutrients and siltation will cause the eventual filling of the lake and will result in a conversion from lake to swamp.

CRYSTAL LAKE

Physical

Crystal Lake has a regular shoreline, irregular shape, a basin of 55 acres and watershed of 287.2 acres. The one outlet is located along the southern tip. There are few weed beds and no marsh areas. Approximately 80% of the periphery is inhabited. The remaining 20% is forested and has a stoney dirt shoreline. One-half of the surrounding land slopes steeply away from the lake, while the other one-half has a shallow slope.

Surface temperatures increased from 17°C to 26.1°C while bottom temperatures at the depth of 19 meters increased from 3.4°C to 5°C throughout the study. Definite stratification was evidenced. (See Appendix for thermocline.)

Hypolimnetic dissolved oxygen decreased rapidly from 1.6 ppm to depletion by mid-July.

See the Appendix for Secchi disk information.

Geological Setting

The topography is hilly due to its position at the foot of the Rensselaer Plateau. The whole watershed falls between 500-1,000 feet in elevation.

The population is concentrated at the north end of the lake with a lesser density in the northeastern portion of the watershed. By the census, the count was 300 people and an estimate of 251 people was obtained by counting houses. There are commercial and public use areas in the southwestern portion of the watershed. Some farm land is evident in the eastern section. This seems to be a good distribution of land use for such a small area.

The surficial geology is almost entirely till with a bit of alluvium to the east.

The bedrock is again clastics of the Taconic sequence and the soil is the Alps-Culvers-Cattaraugus Association--upland soils from red slate and shale.

Crystal Lake is not stream fed.

Chemical Composition

Hardness remained moderate at about 30 ppm. Alkalinity was also moderate and decreased slightly during the summer. The total phosphate levels averaged at about 120 ug/l on June 29 and were always above 60 ug/l. At times the pH levels were below the standards set for recreational waters (Water Quality Standards, 1969). The hydrogen sulfide concentration increased during the summer and the bottom samples had a repugnant odor. The dissolved oxygen in the epilimnion remained constant throughout the testing period.

Photoplankton Counts

In agreement with the Secchi disk readings, the algal counts were larger on August 2 in comparison with the sampling on July 12. The average of the total number of organisms increased from 3,900 to 5,800 per milliliter during this time period. Only the number of diatoms remained constant during the above interval. It should be noted that dispite this increase in algal growth, the level of total acid-hydrolyzable phosphates increased from 110 to 140 ug/liter. This would seem to indicate a large phosphate influx into the lake; such an influx provided more phosphate than the algal plankton could utilize.

Zooplankton Analysis

Crystal Lake had a summer average of 252.1 zooplankters per liter. Cyclopoids predominated over Cladocerans and calanoids (1.2:1:.7). *Bosmina* was the dominant Cladoceran. *Daphnia* was also present. Rotifers composed 49% of the zooplankton population and *Keratella* was the dominant rotifer.

Identification of Flora

Very little aquatic weed growth was noted along Crystal Lake. There were, however, several algae blooms on the northwest side. The most numberous species were from the division *Chlorophyta*.

Bacteriological Analysis

Crystal Lake had only one sampling site in the middle of the lake, and went to a depth of twenty meters. A plot of coliform versus depth showed the expected pattern of the bulk of the organisms along the thermocline, with the number dropping off sharply below it. Over the summer the coliform count remained low, usually below 100 organisms per 100 ml, and only a part of this was of fecal origin. The incidence of fecal streptococcus was negligible.

The lake is in a small town, but its shores are not heavily populated. There is a public beach but it cannot be considered a serious source of fecal contamination.

Crystal Lake is mesotrophic to mildly eutrophic and seems to have the potential for increased deterioration in the near future. Secchi disc readings decreased in an alarming fashion throughout the study. It was also found that at one time during the summer the pH readings were below standards set for safe recreational use.

Presently the lake is in fairly good condition and is set in very good surroundings for a recreational lake. However, it appears that the productivity of the lake is increasing, greatly due to an increase in nutrient flow, probably from septic systems in the area. This increased productivity may diminish the aesthetic quality of the lake and lower its desirability as a recreational site.

NASSAU LAKE

Physical

Nassau Lake has regular shorelines and no unusual formations. The surface area is 153 acres and has two inlets. The major inlet on the southeastern end of the lake drains a 7,500 acre watershed. The lake supports a great deal of weed growth but no marshlands. The shoreline is almost entirely inhabited and composed of stoney sand. The slope of the surrounding lake is very shallow.

Surface temperature increased constantly from 21°C to 26.8°C while at 2.8 meters temperatures increased from 14°C to 19°C. No stratification was evidenced.

See the Appendix for Secchi disk information.

Geological Setting

The topography in this section varies due to a rather large watershed. The lake is in the 0-500 foot district, but the remainder of the watershed is in the 500-1,000 foot elevation range. To the west around the lake, there are nearly level plains to steeply sloping hummocky hills, surrounded by distinctly undulating hills. Further east is the hilly foot of the Rensselaer Plateau as well as the plateau itself, which is hilly to mountainous.

The population is well distributed about the lake with a generous scattering of populace throughout the remainder of the watershed. The census count is 1,081 and by houses it is 2,182, which indicates a large vacation population. Two distinctive concentrations are near Burden and Crooked Lakes. Farmland and public use land are prevalent with area devoted to extraction and commercial purposes.

The surficial geology consists predominantly of till and alluvium. There are more ice contact deposits present than is usual for the county. Outwash is also found.

The bedrock is primarily clastics with some graywacke to the east. The soils can be divided into four categories. Around the lake is Hoosic--water sorted soils on sand and gravel from shale, slate and sandstone. Next is Nassau which developed on glacial till from shale, slate and sandstone. The majority of the watershed is covered by Alps-Culvers-Cattasaugus, upland soils from red shale and slate. The rest is Worth-Empeyville-Westbury which has many stones, boulders and outcrops and is on acid glacial till from shale, slate and sandstone. The majority of the watershed is covered by Alps-Culvers-Cattasaugus upland soils from red shale and slate. The rest is Worth-Empeyville-Westbury which has many stones, boulders and outcrops and is on acid glacial till from sandstone.

The lake is stream fed.

Chemical Composition

This lake exhibited a general increase in hardness but always remained at a moderate level. Alkalinity was also found to be moderate, but remained fairly constant throughout the testing period. Phosphates showed a slight increase as the summer progressed but remained at low levels in the pool; total phosphates remained below 55 ug/l. The lake remained fairly low in nitrates (maximum 100 ug/l) despite the fact that the nitrate concentrations in the stream increased considerably during the summer. Sulfides reached a maximum at the end of June and then decreased. The concentration of sulfide in the stream at site #3 was much greater than that found at the other two sites. Dissolved oxygen was observed to decrease generally throughout the testing period.

Phytoplankton Counts

A moderately large increase in the number of algal plankton occurred during the period between July 12 and August 2. The average total number of organisms per ml increased from 12,000 to 26,000. This algal growth is reflected in the lower secchi disk readings during this time period. The effect of the July 29 chemical treatment remained undetermined.

Zooplankton Analysis

Nassau Lake had a summer average of 156.9 zooplankters per liter. Cladocerans predominated over cyclopoids (1:.3). No calanoids were present. Bosmina and Ceriodaphnia were the dominant Cladocerans. Diaphanosoma, Daphnia, Chydorus and Scapholebris were also present. Rotifers comprised 35% of the zooplankton population and Keratella was the dominant rotifer.

Identification of Flora

Nassau Lake was treated with "Aqua-Kleen" on May 27, 1972 for control of submergent vegetation. In June the lake had a great deal of weed growth. By July, due to the "speed-up" in life cycle, the lake was generally free of weeds. A near equal representation was demonstrated by the divisions Chlorophyta, Chrysophyta and Cyanophyta.

Bacteriological Analysis

This lake is a well populated one in the midst of a small community in the southern part of the county. Sampling station #1 was in the middle of the lake. Here the total amount of coliform varied over the summer at both sampling depths. Usually more than half of the coliform was of fecal origin, fluctuating around 100 organisms per 100 ml.

Site #2 was at the mouth of a stream where the amount of fecal coliform remained high over the summer, above 2,000 organisms per 100 ml in three of the five rounds of samples. The total coliform count was above this figure in all five sampling rounds. In addition, the high incidence of fecal streptococcus over the summer, running above 150 organisms per 100 ml, was yet another indicator of continuous fecal contamination of the lake. It was discovered that the stream flows through farmland before entering the lake. The farm animals are a logical source of contamination, in addition to houses in the vicinity which may have sewage problems.

Site #3 along the shore also exhibited a high amount of coliform over the summer, running above 430 organisms per 100 ml. The major portion of the coliform was of fecal origin. There was also a considerable amount of fecal streptococcus present along the shore all summer long.

Nassau Lake is apparently eutrophic, as evidenced by high algae growth, extremes in the zooplankton population and the presence of submergent vegetation. Factors contributing to its trophic state are heavy population around the lake, high nutrient influx from streams draining farmland, and the shallowness of the lake which allows sunlight to reach every part of the lake bottom, thereby enhancing productivity.

Increased algae blooms, caused by the high nutrient concentrations and the submergent vegetation, detract from the recreational and aesthetic values of the lake. High bacterial contamination, believed to originate in the farming area of the watershed, was found. This will also affect recreation if it is allowed to increase.

BIG BOWMAN POND

Physical

Big Bowman Pond has a regular shoreline and a surface area of 70 acres. The watershed is 220 acres in area. The pond has one major outlet on the northeastern side. There are few weedbeds and no marshlands.

Three-fourths of the rocky shoreline is inhabited and the remaining one-fourth is forested. The encompassing land sloped steeply toward the lake.

Surface temperature increased steadily from 18°C to 25.5°C throughout the summer. At 9.2 meters the temperature increased from 3.5°C to 7.0°C during the summer. Definite stratification was observed. (See Appendix for thermocline information.)

Below 6.0 meters hypolimnetic dissolved oxygen decreased at a steady rate from 2 ppm on June 15 to depletion by August 1.

Please refer to Appendix for Secchi disk information.

Geological Setting

The topography in this area is hilly, mountainous and heavily forested since it is on the Rensselaer Plateau. The elevations are in the 1,000-1,500 foot range.

The population, like the watershed, is relatively small. The residential areas are mostly on the eastern side of the lake, the census count is 20, but by house, 167 -- apparently another seasonal group. The watershed is so small that there is little additional usage barring some public use land.

The surficial geology is basically till. The bedrock is Rensselaer graywacke and the soil is Worth-Empeyville-Westbury with many stones, boulders and outcrops. It developed on acid glacial till from sandstone.

This lake is not stream fed.

Chemical Composition

All parameters measured at Big Bowman decreased during the summer. The hardness tests indicate the water is soft. It is non-alkaline. Dissolved oxygen in the epilimnion showed a general decrease while the hydrogen sulfide increased. Both, however, remained at reasonable levels. Dissolved oxygen was over 6 ppm in the epilimnion and hydrogen sulfide averaged below 50 ug/1. Phosphate concentrations are low at all depths. The total phosphate was below 50 ug/1. Nitrates were constant at about 100 ug/1.

Phytoplankton Counts

The phytoplankton of Big Bowman Pond shows the pattern of a surface algal bloom present July 11 with the subsequent decomposition of these algae on the lake bottom around August 1. Surface counts dropped from 23,000 to 6,000 greens and blue-greens, while bottom counts jumped from 4,000 to 24,000 during this period. Some oxygen depletion is further evidence of this. Also of interest is the fact that the number of diatoms and pigmented flagellates decreased at all depths over this period.

Zooplankton Analysis

Big Bowman Pond had an average of 183.0 zooplankters per liter. Cladocerans predominate over cyclopoids and calaroids (1:.9:.4) with Bosmina as the dominant Cladoceran. Daphnia, Diaphanosoma, and Holopedium are also present. Rotifers comprise 79% of the zooplankton population and Kellicottia is the dominant rotifer.

Identification of Flora

Big Bowman Pond supported a minimum of aquatic weeds. Chlorophyta, especially desmids, contributed the most numerous species.

Bacteriological Analysis

The amount of coliform varied in the lake over the summer, only once going above 1,000 organisms per 100 ml, on July 20. Throughout the summer a large part of the coliform was of fecal origin, and 100% at all depths on July 20. The incidence of fecal streptococcus was almost nil all summer. The pond is somewhat populated on three sides, heavily wooded on the fourth. A possible reason for the rise in coliform is swimming by the residents of the private homes on the lake.

Big Bowman Pond, considered mesotrophic by this study, has the possibility of the occurence of nuisance blooms.

If conditions are continually reviewed and possible sources of increased nutrient contributions are checked, Big Bowman Pond should remain satisfactory for recreational and residential use. It should be remembered that it is a relatively small, shallow lake and is very sensitive to any increase in nutrients.

LITTLE BOWMAN POND

Physical

Little Bowman Pond has a regular, rocky shoreline, with an outlet on the northern tip and one major inlet on the southeastern shore. The surface area of the pond is 19 acres and the watershed area is 1,708 acres. There are many weed beds and a marshland on the southern tip. The eastern shoreline is inhabited and the remaining land is forested. The surrounding slope is shallow.

Surface temperatures ranged from 19.5°C to 25.4°C throughout the summer. Bottom temperatures at 4.0 meters ranged from 8°C to 14.5°C. Although there was a large temperature change from the surface to the bottom, no stratification was observed due to the shallowness.

Bottom dissolved oxygen readings decreased from 6 ppm on June 15 to depletion by July 20.

See Appendix for Secchi disk records.

Geological Setting

Since this lake is located on the Rensselaer Plateau, the land around is hilly, mountainous and heavily forested. It is located right at the transition between the 1,000-1,500 foot and 1,500-2,000 foot elevation ranges (vascillating between the two).

The population is scattered about in the lower quarter of the watershed. By the census, the count is 43, but 124 by houses. The other land use types include a minuscule area of farmland as well as some public use and commercial land.

The surficial geology is till for the most part with alluvium to the south. An area of organic material is present to the east. The bedrock is Rensselaer graywacke and the soil is Worth-Empeyville-Westbury. This means that there are many stones, boulders and outcrops on the surface often developed on acid glacial till from sandstone.

This lake is stream fed.

Chemical Composition

Little Bowman Lake is soft and non-alkaline. Phosphates were consistently low (maximum valve for total phosphate in the pool was 50 ug/l) although the stream showed a slight rise in total phosphate concentrations toward the end of the summer. The concentrations of phosphates did not vary with depth in this lake--a deviation from the norm as observed in the other lakes in the study in which the phosphates tended to concentrate at the lake bottoms. Nitrate concentrations remained at moderate levels (in the range of 80-110 ug/1), however, the finding of a nitrate concentration of 520 ug/1 on August 1 (the last testing date for this lake) indicates that this nitrate level in the lake increased within a short period of time. Hydrogen sulfide concentrations varied between 30 and 50 ug/1 throughout the summer, with one exception. On June 28 the concentration was found to be 120 ug/1. Dissolved oxygen decreased over the course of the summer.

Phytoplankton Counts

A sharp increase in the number of greens and blue-greens was noted during the period from July 11 to August 1 -- the average count for this category increased from 5,000 to 23,000 organisms per ml. Despite this sharp increase in the algal population, the nitrate levels of the lake climbed steeply. This would indicate a large nitrate influx into the lake, an influx too large to be utilized by the phytoplankton bloom.

Zooplankton Analysis

Little Bowman Pond had an average of 185.0 zooplankters per liter. Cyclopoid predominate over Cladoverans and calanoids (4.4:1:1.9). The dominant Cladocerans are *Diaphanosama* and *Bosmina*. *Holopedium*, *Daphnia* and *Ceriodaphnia* are also present. Rotifers comprise 68% of the zooplankton population and *Keratella* is the dominant rotifer.

Identification of Flora

Little Bowman Pond was created as a mill pond. The water was dammed and allowed to back up over fallen trees. As a result, the lake bottom is filled with ideal substrates for growing algae. The majority of species were of the *Chlorophyta* division. Algae also grew among a swamplike patch of aquatic weeds near the dam.

Bacteriological Analysis

The coliform present at sampling site #1 in the open part of the lake exceeded 1,000 organisms per 100 ml only once in the summer, on July 20. On that day 100% of the coliform was of fecal origin; on the other days fecal coliform constituted only a small part of the bacteria present.

Station #2, at the mouth of a stream, had a consistently high amount of coliform, 100% of which was fecal coliform on three sampling days. There was also a small amount of fecal streptococcus present also, indicating fecal contamination of the water.

It is probable the source of contamination is somewhere upstream from the lake, which is small enough for contamination entering the lake to appear at station #1, but in a lesser amount.

Little Bowman Pond is apparently eutrophic. Although nutrient levels are moderate and the soft water is less conducive to productivity, the morphologic features induce the increase in productivity. Because the pond is very small and shallow, the chance of algae blooms and extremes in zooplankton populations are increased. This is primarily due to the ability of sunlight to reach all depths of the body of water.

Given the limiting physical surroundings, the increase in nutrients found during the summer is very hazardous to the recreational and aesthetic qualities of the pond.

FOREST LAKE

Physical

Forest Lake, a small lake with very regular shorelines, has a surface area of 20 acres and one major outlet on the northeastern shore. The watershed is 100.8 acres. Forest supports a large number of weed beds but no marshlands. The surrounding land sloped steeply and was thinly forested and rocky.

Surface temperatures ranged from 18°C to 25.6°C throughout the summer. At 4.5 meters temperatures ranged from 14°C to 24°C. There was no stratification. Bottom dissolved oxygen remained between 8 and 9 ppm all summer.

Please see Appendix for Secchi disk information.

Geological Setting

The topography again reflects the presence of the Rensselaer Plateau -- hilly, mountainous and heavily forested. The elevations range between 1,500-2,000 feet.

The population is concentrated at the north end of the lake--47 by houses (no census figure). There is a large section of public use land to the east which serves as a boys' camp.

The surficial geology is comprised of till with some organic material. The bedrock is Rensselaer graywacke and the soil Worth-Empeyville-Westbury; hence, the soil has many stones, boulders and outcrops, and developed on acid glacial till from sandstone.

The lake is not stream fed.

Chemical Composition

Forest Lake is soft and non-alkaline. The dissolved oxygen remained high throughout the summer, near saturation. Forest Lake is low in nutrients. The total phosphate concentration averaged between 20-30 ug/l during the summer and the nitrate level decreased from 100 ug/l to about 30 ug/l. Hydrogen sulfide concentrations varied between 10-40 ug/l.

Phytoplankton Counts

The phytoplankton population of Forest Lake remained low with a small reduction in the number greens and blue-greens from July 19 to August 7. The average total number of organisms decreased from 5,800 to 3,200 during this period. No diatoms were found at any depth in the lake.

Zooplankton Analysis

Forest Lake had an average of 54.4 zooplankters per liter. Calanoids predominate over cladocerans and cyclopoids (2:1:.7). The dominant Cladoceran is Bosmina, with Diaphanosoma and Daphnia also present. Rotifers comprise 77 percent of the zooplankton population and Keratella is the dominant rotifer.

Although Forest Lake is mesotrophic according to the size of the total zooplankton population and very low in chemical nutrient levels, with high secchi disc readings, the composition of the zooplankton community is more typical of eutrophic lakes in this study. No information is available concerning the composition of the fish population. This should be checked for the possible presence of an obligatory planktivore.

Identification of Flora

Forest Lake exhibited sparse aquatic weed growth. Algae was confined to the south and northwest shores among weeds, logs and rocks. The greatest algal species representation was from the division Chlorophyta and particularly from the desmid family.

Bacteriological Analysis

Only one sampling site was used for Forest Lake. The amount of bacteria fluctuated over the summer as shown by a graph of MPN/100ml versis time in days. In three of the five rounds 100% of the total coliform was fecal coliform. This fact gives evidence that any contamination present in the lake is of the intestinal origin. However, the degree of this contamination is not severe enough to constitute any immediate problem.

Forest Lake, one of the best lakes studied, is apparently mesotrophic. All data collected from this lake contributed to establishing this trophic state. Very low nutrient levels and the soft water condition limit the productivity.

Land use seems to be the major factor in the conditions found. In this watershed, the lake is relatively unused and contains very little population.

The lake is spring fed, thus confining the nutrient influx to direct runoff from the small watershed and ground water percolation. These two sources appear to contribute fewer nutrients than streams that enter other lakes from large watersheds.

TACKAWASICK LAKE

Physical

The Tackawasick Creek drains a watershed of 1,132 acres into the lake which has a surface area of 134.4 acres.

The lake has a maximum depth of 10.6 meters at site #3 and 4.8 meters at site #1. Site #3 demonstrated stratification. (See Appendix for thermocline characteristics.) The dissolved oxygen in the hypolimnion was 0.4 ppm throughout July disappearing in August. Site #1 had concentrations of 6ppm at the beginning of July which decreased steadily to 0.7 ppm by August.

The ground slope is steep along the south and eastern shores while the remainder has a gentle slope. The shoreline is smooth and sparsely inhabited, with woods coming down to the shore in many places. There is some marshland around the lake and there are many patches of aquatic weeds.

See Appendix for Secchi disk records.

Geological Setting

The topography about the lake at the foot of the Rensselaer Plateau is hilly. On the Plateau itself it is hilly, mountainous and heavily forested. Around the lake the land falls between 500-1,000 feet in elevation with the remainder of the watershed either between 1,000-1,500 feet or 1,500-2,000 feet.

The population is well scattered although there is less density around the lake than in most of the other cases. By an incomplete census count (it didn't include 29 houses), there are 615 people and 977 by houses. This is probably another vacation area. There is not as much farmland proportionately as in the other large watersheds. There are a number of extraction sites and public use areas. Commercial areas are also quite abundant. A large amount of unused land is present in the northern three-fifths of the watershed.

The surficial geology here is mostly till with some alluvium and outwash. There is also some ice contact and organic deposits.

The bedrock in the southern half of the watershed is clastics while in the northern part there is Rensselaer graywacke. The soil in the south is Alps-Culvers-Cattoraugus, upland soils from red shale and slate. The northern soil is Worth-Empeyville-Westbury characterized by many stones, boulders and outcrops.

Chemical Composition

The dissolved oxygen readings of Tackawasick showed decreasing trends in the stream and pool. There was no significant increase in hydrogen sulfide concentrations during the summer. In general, the level of alkalinity for the lake decreased over the summer from a high of 27 ppm to a low of 10 ppm. The hardness remained fairly constant at a low 11 ppm. The total phosphate averaged below 100 ug/l. Nitrates were low throughout the summer averaging under 100 ug/l in the pool.

Phytoplankton Counts

In agreement with the Secchi disk readings, the site #1 phytoplankton counts decreased between July 12 and August 2. The large number of greens and blue-greens at the four meter depth, which appeared July 12 but not August 3 (19,000 to 4,400), were the remains of the bloom which apparently occurred earlier in the summer. At site #3 the depth at which the bulk of the phytoplankton occurred changed from 10 to 8 meters during the period from July 12 to August 3. This would seem to indicate the release of the nutrients from the dead algae of the preceding bloom and the utilization of these nutrients to increase once again the algal population.

Zoological Analysis

Tackawasick Lake had a summer average of 63.5 zooplankters per liter. Cladocerans predominate over cyclopoids and calanoids (1:.4:.0) and the dominant Cladoceran is *Bosmina*. *Daphnia*, *Diaphanosoma*, *Ceriodaphnia* and *Holopedium* are also present. Rotifers comprise 37 percent of the zooplankton population and *Kellicottia* is the dominant rotifer.

Although according to the size of the zooplankton population Tackawasick Lake is mesotrophic and is fairly low in chemical nutrients, the composition of the zooplankton community is more like those of the eutrophic lakes in this study. Supporting this is also the fact that it has an average secchi disc reading of only 2.3 meters.

Identification of Flora

Tackawasick Lake had several large weed beds located along the northwest and southern shores. Algal species representation was nearly equally divided between *Chlorophyta* and *Chrysophyta*.

Bacteriological Analysis

There were three sampling sites on Tackawasick Lake. On sampling site #1, the coliform bacteria was continuously high and a high percentage of this was fecal coliform. A small amount of fecal streptococcus generally appeared.

Site #2 was located at the mouth of a small stream. This site continuously had a high degree of coliform bacteria and nearly all of this was found to be fecal. Fecal streptococcus was recorded as very high, with a peaking point of 430 organisms per 100 ml.

Site #3 had a coliform bacteria count as high as 2,400 organisms per 100 ml. The fecal coliform count was as high as 930 organisms per 100 ml.

After an investigation of the lake, a dairy farm was located approximately one mile upstream from sampling site #2. The dairy farm has a small pond which is part of the stream system of the lake. It was concluded that the cows grazing near the pond are a possible source of the fecal contamination for the lake.

Tackawasick Lake is mildly eutrophic to eutrophic. Indications of eutrophy are fairly high nutrient concentrations and the presence of large algae blooms.

The site of the watershed is probably the reason for high nutrient influxes from the streams. The relatively large size and depth of the lake have prevented these high nutrient influxes from moving the lake into advanced eutrophy.

It must be remembered that although the lake is relatively large compared to the others studied, it is small compared to lakes in other regions. The sensitivity to increased nutrient contributions is still high and should be checked to assure suitability for continued recreation on the lake.

Another lake of concern is the land drained by its major tributary. A large concentration of fecal contamination was found coming from this stream's inlet. The large amount of farmland, especially dairy farms in the watershed, appears to be the source of significant amounts of the nutrients and fecal contamination entering the lake.

DYKEN POND

Physical

A watershed of 667.2 acres drains into the lake which has a surface area of 167.8 acres. The lake has two distinct branches. Sampling site #1, with a depth of 11.7 meters, is in a section sometimes considered a separate pond (South Long Pond). The other section has a depth of 7.0 meters.

There was stratification at site #1 (see Appendix for thermocline characteristics) with the hypolimnetic (below 7 meters) dissolved oxygen being depleted by the beginning of July. Site #2 did not stratify but the dissolved oxygen at the bottom did disappear by the beginning of August.

The ground slope around South Long Pond (site #1) is steep while it is slight around the remainder of the lake. There are a few weeds in some areas. The area around the lake shore is primarily woods with sparse inhabitancy.

See Appendix for Secchi disc information.

Geological Setting

Dyken Pond is another lake on the Rensselaer Plateau so the surrounding land is hilly, mountainous and heavily forested. The topography lies between 1,500-2,000 feet in elevation.

The population is heavily concentrated around the north and south ends of the lake with a count of 291 by houses (no census figure). There is no other land use besides residential. The surficial geology is over half nonglacial with the remainder till except for a little organic deposit.

The bedrock is Rensselaer graywacke and the soil is Worth-Empeyville-Westbury-- many stones, boulders and outcrops developed on acid glacial till from sandstone.

This lake is not stream fed.

Chemical Composition

The dissolved oxygen in the epilimnion in Dyken Pond was generally low and decreased to 4 ppm on August 7. Hydrogen sulfide was very high at greater depths and exhibited a disagreeable odor. The lake was found to be a soft water lake. Total phosphate averaged below 55 ug/1 and decreased during the summer. Nitrate, averaging below 80 ug/1, also decreased with time.

Phytoplankton Counts

At both sites, #1 and #2, there were large green and blue-green counts at the lake bottom in the July 19 samples. The count dropped, however, from an average of 11,000 to an average of 6,000 organisms per ml in the August 7 samples. The upper depth, site #1 samples stayed stable, whereas the site #2 upper depth samples increased from a total organism average of 2,500 to 12,500 organisms per ml during this period. Nitrate at these depths decreased, as would be expected, from 80 to 45 ug/1 from July 19 to August 7.

Zooplankton Analysis

Dyken Pond had a summer average of 258.4 zooplankters per liter. Cladocerans predominate over cyclopoids (1:.7). No calanoids are present. Bosmina is the dominant Cladoceran with Diaphanosoma, Daphnia, Holopedium and Ceriodaphnia also present. Rotifers comprise 78 percent of the total zooplankton population, and Keratella is the dominant rotifer.

Identification of Flora

There were few submerged, floating or attached aquatic plants in Dyken Pond. Algae from the divisions Chlorophyta, Chrysopheyta and Cyanophyta were represented in Dyken Pond. Desmids and other Chlorophyta were in dominance.

Bacteriological Analysis

Dyken Pond had two sampling sites. At station #1, total coliform was measured at 930 bacteria/100 ml with no indication of fecal coliform at the beginning of the summer. Coliform decreased until late July when a rise from 40 bacteria/100 ml to 100 bacteria/ml was noted. Accompanying this increase was the appearance and increase of fecal coliform. The percentage of the coliform increased to 100% and remained at 100% as the total coliform decreased.

Station #2 coliform measurements for the surface showed a decrease from 90 bacteria/100 ml to zero bacteria/100 ml for the beginning of the summer. In late summer, coliform increased to 40 bacteria/100 ml. Depth samples showed increases through the summer, falling off to zero at a depth of 6.5 meters and leveling off at 40 bacteria/100 ml for the depth of 3 meters.

At both stations fecal contamination was insignificant.

Dyken Pond is apparently mesotrophic. Low concentration of nutrients limit the productivity, although a bloom was observed.

Dyken Pond is isolated in the forested, eastern section of the county. It has a large watershed, but with very little population, and no farming; all important factors in the trophic states of the lakes studied.

There is little reason for concern unless the watershed is developed without regard for the lake. As with all bodies of water in this county, an increase in the population in Dyken Pond's watershed could produce a marked deterioration of the ecosystem, if nutrient sources are not controlled.

TACONIC LAKE

Physical

This small lake has a surface area of only 21 acres. The watershed area is 293.6 acres. The deepest observed part of the lake was 10.0 meters.

The lake did stratify (see Appendix) at the sampling site but the dissolved oxygen readings at the bottom never fell below 6ppm.

Taconic Lake is surrounded by woods and cottages. The trees generally extend to the shoreline. There is very little aquatic plant growth in the lake.

The ground slope around the lake is moderate to steep and the shoreline is regular.

For Secchi disc information see Appendix.

Geological Setting

Taconic Lake is on the Rensselaer Plateau and, as such, is in a hilly, mountainous and heavily forested region, with the elevation between 1,500-2,000 feet.

The population is concentrated on the lake perimeter with a count of 143 people by houses (no census figure). There is no other land use besides residential. The surficial geology is all till with a little nonglacial.

The bedrock is Rensselaer graywacke. The soil is Worth-Empeyville-Westbury with many stones, boulders and outcrops developed on acid glacial till from sandstone.

The lake is not stream fed.

Chemical Setting

Taconic Lake is low in all nutrients (maximum values for total phosphates and ortho phosphates were 30 ug/l and 10 ug/l, respectively. Maximum value of the nitrate concentrations was 80 ug/l). The water is soft and is not alkaline. The dissolved oxygen in the epilimnion remained between 8 and 10 ppm for the entire testing period; hydrogen sulfide concentrations remained below 40 ug/l with the exception of one testing date (July 27) when the concentration was determined as 180 ug/l.

Phytoplankton Counts

This lake had relatively low phytoplankton counts, and was reasonably homogeneous from the surface to its nine meter deep bottom. Average total organisms counts were 7,300 per ml on July 19 and 6,800 per ml on August 7. Only the surface count on August 7 with 1,800 total organisms was significantly different from the others. These relatively low figures are a reflection of the consistently low levels of nutrients present in the lake.

Zooplankton Analysis

Taconic Lake had a summer average of 64.0 zooplankters per liter. Calanoids predominate over cladocerans and cyclopoids (5.4:1:.4). Bosmina and Holopedium are the dominant Cladocerans with Daphnia also present. Rotifers comprise 28 percent of the total zooplankton population and Keratella is the dominant rotifer.

Identification of Flora

The surface and shoreline of Taconic Lake were nearly clear of aquatic vegetation. The majority of algae species were of the family desmid and others of the division Chlorophyta.

Bacteriological Analysis

Taconic Lake had only one sampling station. Surface coliform was a maximum at 110 bacteria/100 ml steadily decreasing to zero over the summer. Of this surface coliform only a small percentage was fecal coliform until the counts became very low whereupon it became 100% fecal.

Total coliform at a depth of 1.5 meters decreased from 40 bacteria/100 ml to zero as the summer progressed. There was no incidence of fecal coliform. At the depth of 7 meters coliform dropped steadily from 1,020 bacteria per 100 ml to zero bacteria/100 ml through the summer again with no evidence of fecal coliform.

Taconic Lake, a mesotrophic lake, was the best studied. It has the lowest nutrient concentrations of the lakes in the county, soft water and very little productivity. There were no signs of dangerous bacterial contaminations.

This is a very small but fairly deep lake, located in the forested eastern section of the county. There is very limited population and no farming in the watershed. All of the above factors and the fact that it is primarily spring fed are indicative of oligatrophy. The small size of the lake appears to be the factor resulting in conditions somewhat beyond oligatrophy.

This lake should remain in its relatively desirable state unless increased development in its watershed is uncontrolled. Positive planning of sewage treatment and land use prior to development will insure its preservation.

LONG POND

Physical

The surface area is 102 acres and the watershed area of 1,360 acres is shared with three other lakes in the Grafton State Park. The lake has an outlet at the southeastern end which drains into Second Pond. The deepest point found was 8.0 meters.

Site #1 exhibited no stratification. Site #2 did show some stratification, although the thermocline did run into the lake bottom halfway through the summer. Because the stratification was not extensive the hypolimnion was able to remain at near saturation levels of dissolved oxygen throughout the summer (see Appendix for thermocline characteristics).

The shoreline has a slight to moderate slope to the lake. Generally trees extend to the rocky shore. There is some weed growth along the shore, but there is no marshland present.

For Secchi disc information see Appendix.

Geological Setting

The Grafton Lakes are in the transition zone between the elevation regions of 1,000-1,500 and 1,500-2,000 feet going back and forth between the two. The topography is hilly, mountainous, and heavily forested as this location is on the Rensselaer Plateau.

This area is almost entirely state park so it is not surprising that the only population is on the western border--47 by houses (no census figure). The surficial geology is mostly till and nonglacial except for some small areas of organic and alluvial deposits.

The bedrock is Rensselaer graywacke and the soil is Worth-Empeyville-Westbury. There are many stones, boulders and outcrops with the soil developed on acid glacial till from sandstone.

These lakes are not stream fed.

Chemical Composition

Long Pond is a soft water lake. There is little alkalinity. There is virtually no hydrogen sulfide or phosphates. The total phosphate averaged under 30 ug/1. Nitrates remained under 100 ug/1 for the summer. The dissolved oxygen readings were high and approaching saturation.

Phytoplankton Counts

Algal plankton remained at a moderate level during the sampling period--average total counts were 3,200 per ml on July 18 and 4,200 per ml on July 31. The only major changes in the algal counts occurred at site #7 where the bottom counts were lower on July 31 and at site #2 where the bottom counts sharply increased during the same time period.

Zoological Analysis

Long Pond had a summer average of 47.8 zooplankters per liter. Calanoids predominate over Cladocerans (1.6:1). No cyclopoids are present. The dominant Cladocerans are Bosmina and Holopedium, with Daphnia and Diaphanosoma also present. Rotifers comprise 12 percent of the zooplankton population, and Kellicottia is the dominant rotifer

Identification of Flora

Weed growth on Long Pond was restricted to the southwest shoreline. There were no surface blooms of algae and very little among the weeds. Chrysophyta and Cyanophyta were in dominance.

Bacteriological Analysis

There were two sampling sites on Long Pond, one at each end of the lake. At site #1 the total coliform decreased over the summer from 2,400 organisms per 100 ml to 40 per 100 ml. The greater part of the coliform present was of fecal origin. The amount of fecal streptococcus observed in two of the five rounds of samples was insignificant.

Coliform was present in a larger quantity at Station #2 but showed a similar decline over the summer. Again the coliform was primarily of fecal origin. Since the fecal streptococcus count was also low, no serious contamination of the lake seems to be occurring.

Long Pond, part of the Grafton State Park, is one of the best lakes studied and appears to be mesotrophic.

Low nutrient levels, high dissolved oxygen levels and low productivity are the attributes of the lake which indicate a mesotrophic condition at most.

Being part of the recreational facilities in the State Park, the aesthetic value of Long Pond, as well as the bacteriological content, is very important. Having no major tributaries and very little housing within the watershed, control of the nutrients and bacteriological contamination appears to be relatively easy.

If conditions are controlled so as to prevent misuse of the lake or watershed, there should be no cause for an increase in productivity and consequential reduction of aesthetic values. The lake should serve as a good recreational area for years to come.

Physical

Second Pond has a water surface area of 19 acres and shares a drainage area of 1,360 acres with the three other lakes in the Grafton State Park. Second Pond drains into Mill Pond from the southeastern end. The lake is 7.8 meters at the deepest spot found and is stratified (see Appendix). The hypolimnetic (below 6.5 meters dissolved oxygen decreased from 7 ppm to 2.2 ppm as the summer progressed.

The shoreline is rocky and supports a few higher aquatic plants. There is some marshland around the lake and the ground slope is slight to moderate.

For Secchi disk records see Appendix.

Geological Setting

(See Long Pond)

Chemical Composition

The dissolved oxygen in the epilimnion decreased slightly over the summer at Second Pond, but remained above 6.5 ppm. It is a soft water lake. Total phosphate concentrations remained below 50 ug/1 and nitrate levels were under 100 ug/1. Hydrogen sulfide readings are below 30 ug/1.

Phytoplankton Counts

Algal counts remained at a moderate level during the sampling period. The average total number of organisms per ml were 4,300 on July 18 and 7,900 on July 31. This increase in numbers occurred in all classifications and at nearly all depths. The increase can be attributed to the increase in nutrients found in the pond between these sampling dates.

Zoological Analysis

Second Pond had a summer average of 27.3 zooplankters per liter. Cyclopoids predominate over Cladocerans and calanoids (3.2:1:1.8). The dominant Cladoceran is Daphnia; Holopedium, Bosmina and Ceriodaphnia are also present. Rotifers comprise 32 percent of the zooplankton population and Polyartha is the dominant rotifer.

Identification of Flora

Second Pond supported very few aquatic weeds. The majority of algae species were Chlorophyta, particularly desmids, with Chrysophyta and Cyanophyta in a significant minority.

Bacteriological Analysis

Second Pond had only one sampling site. Total coliform generally decreased throughout the summer from a peak of 24,000 organisms per 100 ml on June 19. In subsequent samples, 100% of the coliform present was of fecal origin. Only traces of fecal streptococcus were observed in the water samples.

Houses along the south shore may be the source of the contamination, but there is no serious threat to the lake.

Second Pond, part of the Grafton State Park, appears to be a mesotrophic lake.

There are low nutrient levels and dissolved oxygen present in all sections of the lake, due mainly to the absence of populated land in its watershed. The main source of water is a stream inlet from Long Pond.

Aesthetic value is important in this lake. An influx of nutrients could cause an increase in algae growth, resulting in an unsightly bloom. Conditions conducive to increased nutrient concentrations are not present in the watershed now and if care is taken in the future development of the area, there should be few problems with the lake's quality for recreational purposes.

SHAVER POND

Physical

Shaver Pond has a surface area of 32 acres and shares a watershed area of 1,360 acres with three other lakes in the Grafton State Park. The lake is 16 meters deep and is stratified (for thermocline characteristics see Appendix). The hypolimnetic (below 8 meters) dissolved oxygen decreased from 5 ppm to 1 ppm as the summer progressed.

The shoreline has a steep slope down to the rocky, weed infested shoreline. One-fifth of the encircling shore is marshland. The area immediately around the lake is heavily wooded.

For Secchi disk records see Appendix.

Geological Setting

(See Long Pond)

Chemical Composition

Dissolved oxygen in the epilimnion was observed to decrease slightly (from 8.7 to 6.3 ppm) as the summer progressed. Sulfides never reached a significant level, remaining below 40 ug/l. The pond is a soft water pond. Nutrient levels, in general, were low. Total phosphates remained below 55 ug/l. Nitrate concentrations were observed to be increasing slightly toward the end of the summer, but the maximum value was only 125 ug/l.

Phytoplankton Counts

When Shaver Pond was sampled for phytoplankton for the first time on July 18, it appeared to be near the end of an algal bloom. The large amount of algal at the three meter depth (26,000 organisms per ml) on this date was no longer there on July 31. It had nearly all sunk to the lake bottom to decompose--this change resulted in the great improvement in the Secchi disk reading in round #6. Nitrate levels began to increase during this period of reduced algal growth.

Zooplankton Analysis

Shaver Pond had a summer average of 58.4 zooplankters per liter. Calanoids predominate over Cladocerans and cyclopoids (4.7:1:.6). The dominant Cladoceran is _Bosmina_, with _Daphnia_, _Diaphanosoma_ and _Holopedium_ also present. Rotifers comprise 45 percent of the total zooplankton community and _Kellicottia_ is the dominant rotifer.

Identification of Flora

There were many weed beds located along the shoreline of Shaver Pond. No surface algae blooms were noted. Chrysophyta, Chlorophyta and Cyanophyta were in nearly equal species representation.

Bacteriological Analysis

The amount of coliform at the one sampling site chosen fluctuated around 100 organisms per 100 ml, with a peak of 1,500 on July 18. The bacteria were predominantly from fecal matter being introduced into the lake, but the amount is no cause for alarm.

A plot of total coliform versus depth exhibited the expected pattern. The number of organisms was greatest above the thermocline, where it dropped proportionately with depth.

Shaver Pond, part of the Grafton State Park, is mesotrophic to mildly eutrophic. This increased eutrophication is evidenced by higher nutrient levels and higher productivity displayed as an algae bloom in mid-July.

Shaver Pond was found to contain higher levels of nutrients than Long and Second Ponds, also of the Grafton State Park. This could be attributed to the presence of a sewage treatment plant for the state park complex with the effluent being discharged into the lake during the summer months.

The presence of the treatment plant has had obvious effects. A closer watch and control of the treatment plant effluent is suggested.

The effects of the fish stocking of this lake were not determined. It is probable that there is some effect on the ecosystem of the lake and may, in part, explain the differences in algae and zooplankton productivity between this pond and the others in the area.

BABCOCK LAKE

Physical

Babcock Lake has a surface area of 51 acres which drains a watershed area of 317.6 acres. There is a small outlet at the southwestern end of the lake. The lake has a maximum depth of 11 meters and exhibits definite stratification (see Appendix). The hypolimnion (below 8.25 meters) was essentially depleted of dissolved oxygen throughout the entire study.

The sharply sloping shoreline is surrounded by small camps, cottages and many trees. There are few aquatic weeds along the smooth shoreline.

For Secchi disc readings see Appendix.

Geological Setting

The southern two-thirds of the watershed is on the Rensselaer Plateau and, therefore, hilly, mountainous and heavily forested. The northernmost third of the watershed has rolling hills with gentle to moderately steep slopes. The elevations fall between 1,000-1,500 feet.

The population in this area is heavy on all but the north end of the lake--332 by houses (no census figures). There is no other land use.

The surficial geology is all till and the bedrock is unknown since it is covered with glacial and alluvial deposits. The soil is divided Worth-Empeyville-Westbury and Troy-Cossayuna-Nassau. The former is characterized by many stones, boulders and outcrops developed on acid glacial till from shale, slate and sandstone interspersed with gravel and chips of shale and slate.

This lake is not stream fed.

Chemical Composition

Over the summer, the alkalinity decreased from a high of 55 ppm to a low of 30 ppm. The hardness averaged about 20 ppm. The phosphate levels were fairly low and were almost completely depleted at the surface by August. The nitrates steadily decreased from 150 to 35 ug/l. The average hydrogen sulfide values were moderate, averaging from 20-90 ug/l. However, there was a maximum of 190 ug/l on July 27. Dissolved oxygen only slightly decreased over the summer in the epilimnion.

Phytoplankton Counts

A large algal bloom was discovered in Babcock Pond August 7. The average total number of organisms per ml increased from 3,500 on July 19 to 38,000 on August 7. This increase did not coincide with any discernible change in phosphates or nitrates.

Zooplankton Analysis

Babcock Lake had a summer average of 189.0 zooplankters per liter. Calanoids predominate over Cladocerans and cyclopoids (2.4:1:.9). The dominant Cladocerans are Daphnia and Holopedium. Bosmina and Chydorus are also present. The summer average of rotifers would indicate that they comprise 72 percent of the total zooplankton population; however, the sharp rise in total organisms per liter from 94.1 on July 27 to 533.7 on August 7 is caused almost entirely by an increase in the number of rotifers.

Identification of Flora

Vegetation in Babcock Lake was limited to a few submerged plants located along the shoreline. The most numerous algal species representation was by Chlorophyta, especially desmids.

Bacteriological Analysis

At the one sampling site in the lake, the coliform count remained consistently under 1,000 organisms per 100 ml, with only a small part being of fecal origin. The number of bacteria present generally decreased with depth as expected.

Babcock is well-populated in the summer; private homes surround the lake. However, they seem to present no threat of contamination to the water.

Babcock Pond, apparently a mesotrophic lake, had a low nutrient level but an absence of dissolved oxygen in its deeper waters.

This lake is an example of what can happen to a small body of water with a populated area around it. Although the nutrients (probably from septic tank fields, as there are no stream inlets) were not excessive, an algae bloom was detected. As the size and depth of a lake decreases, its sensitivity to nutrient flows increases, thus making increases in productivity more possible than for larger, deeper lakes.

TROY RESERVOIR

(Brunswick-Vanderheyden Reservoir)

Physical

A watershed of 856.8 acres drains into the lake. The lake surface area is 61.6 acres. The watershed is drained by a stream which flows into the northwestern tip of the lake. This inlet was still flowing in the middle of August. The lake has an outlet at the southwestern end. A causeway divides the reservoir into two separated sections.

Site #1 has a depth of 3.5 meters. Site #3 had a maximum depth of 5 meters. The lake did not exhibit any extensive stratification (see Appendix). The dissolved oxygen at the bottom did become depleted at site #3 while site #1 remained near saturation throughout the summer.

The shoreline has a moderate slope with a few steeper areas. The area around the lake contains trees and a public park. The shoreline is fairly smooth with some aquatic weeds present.

For Secchi disc information see Appendix.

Geological Setting

The land around Troy Reservoir is in a rolling hilly section of the county. Drumlins are also present. The hillsides are gently sloping to moderately steep. The land surface is generally between 500-1,000 feet in elevation.

There are some residential areas south of the lake and scattered to the north. The census count is 431, but 351 by houses. Of the part of the watershed that is in use, residential area is the most abundant, with some additional farming.

The surficial geology of the watershed above the lake is almost entirely till with a section of alluvium; nevertheless, around the lake the most common deposit is ice contact with some outwash to the east and west. There is very little till around the water.

The bedrock is more varied than in most of the other cases with most of the watershed underlain by clastics. There is also a strip of Deepkill, Stuyvesand Falls and Germantown Formations and a touch of Normanskill interbedded graywacke and shale.

The soil is Troy-Cossayuna-Nassau, developed on acid glacial till from shale, slate and sandstone interspersed with gravel and small chips of slate and shale.

One part of the reservoir is stream fed.

Chemical Composition

Troy Reservoir is a hard and alkaline lake in the pools and inlet. Phosphate concentrations are generally moderate but they peaked on July 13, with a total phosphate average of 125 ug/l. Other than that, they were generally below 20 ug/l. The stream also showed a maximum of 145 ug/l on July 13. The nitrates decreased from 400 to 70 ug/l with the maximum reading on June 24. The hydrogen sulfide readings were moderate. The stream contained very little sulfide. The dissolved oxygen in the epilimnion averaged near saturation.

Phytoplankton Counts

Despite the fact that the reservoir was treated with copper sulfate on June 20, there were large amounts of algal growth by the time it was sampled on July 13. There was an average of 16,500 phytoplankton per ml at site #3 at this time. By the time the lake was sampled on August 3, there was a very large algal bloom in progress. The average total number of organisms per ml had jumped to 20,200. During this time period the nitrate content of the water dropped from 225 to 70 ug/l and the acid-hydrolyzable phosphate content dropped from 100 to 40 ug/l. The reservoir seems to be following the classic "boom and crash" pattern of algal bloom formation and subsequent nutrient depletion and death.

Zooplankton Analysis

Troy Reservoir had a summer average of 444.5 zooplankters per liter. Cladocerans predominate over cyclopoids and calanoids (1:3:.04). The dominant calanoids are *Bosmina* and *Ceriodaphnia*, *Daphnia*, *Chydorus* and *Diaphanosoma* are also present. Rotifers comprise 42 percent of the total zooplankton population, and Polyartha is the dominant rotifer.

Identification of Flora

The swimming side of Troy Reservoir supported no weed growth. The nonswimming side supported several scattered weed beds of mixed species and dense colonies of algae. *Chlorophyta* was in slight algal species dominance.

Bacteriological Analysis

There were three sampling sites in Troy Reservoir. Station #1 had a total coliform count under 2,300 organisms per 100 ml throughou the summer. It generally varied around 200 organisms per 100 ml, and was 100% fecal in nature. There were slightly fewer organisms at 3 meters, but they were primarily of fecal origin, also. Twice during the study small amount of fecal streptococcus were noted.

Total coliform at site #2, a stream inlet, fluctuated around 10,000 bacteria per 100 ml throughout the summer. In four rounds of samples fecal coliform was the major constituent of the organisms present. Fecal streptococcus present in the water varied in amount around 430 organisms per 100 ml, peaking at 2,400 on August 3, corresponding to a peak of 11,000 per fecal coliform on that day.

The amount of coliform at station #3 fluctuated around 200 organisms per 100 ml as in station #1. For all depths, the coliform fluctuated throughout the study, with fecal coliform comprising the majority of coliform present. Only small amounts of fecal streptococcus were noted.

Station #2 was at the mouth of a stream which was a source of fecal contamination. The stream does run through farm and pastureland. Opposite station #3 is a public swimming area which is probably another source of fecal contamination. On two days samples were taken; the number of fecal coliform present at site #3 was 1,500/100 ml.

This is a considerable amount of coliform for a recreational area, although it is acceptable by legal standards. Because of the two sources of contamination, the lake bears close watching.

The Troy Reservoir is apparently eutrophic. This lake was consistently grouped with Snyders, Hampton Park and Reichards Lakes in regard to chemical composition and productivity.

Increased productivity, evident in a large algae bloom detected, is enhanced by the high alkalinity of the water (Benoit, 1969). Troy Reservoir had the second highest total alkalinity readings in the county. High nutrient levels were also a factor in the advanced productivity.

The Reservoir, used presently for recreation, had evidences of fecal contaminations from streams draining farm and pasturelands in the watershed. An increase in bacterial contamination could present problems with standards provided for water contact recreation, although there is no serious danger at the present time.

Of major concern is the proposed housing development in this watershed. If development precedes an extension of sewer districts to this area, it is probable that the nutrient levels will increase due to the poor conditions for septic tank drainage in the surrounding soils (USDA, 1966). The increased nutrient levels will most likely result in increased algae blooms which diminish the aesthetic values of the lake. Also, the decaying algae would provide substantial medium for bacterial growth.

Physical

The watershed of 41,804 acres is the largest in the county and is drained by nine streams. Five of these streams were dry by the middle of August. The largest inlets are the Sankauissia Creek, Otter Creek and Tomhannock, the latter of which was dammed to form the reservoir. The water movement is generally south to north.

The lake surface area is 1,750 acres. The deepest point investigated was in the north end near the outlet, having a depth of 16 meters. The north end of the lake (sampling site #2) was stratified throughout the summer and the characteristics of the thermocline are shown in Appendix. The surface temperature across the lake generally increased from 20°C to 25°C as the summer progressed.

In the stratified section the hypolimnetic (below 12 meters) dissolved oxygen was one ppm at the end of June. It was totally depleted a month later and remained that way the remainder of the project.

This lake is a flooded stream valley and is long and narrow. The shoreline is indented with many small coves. Most of the shore has a moderate slope into the lake. Generally, the shoreline is characterized by trees and rocks. A small marsh is present at the southern end of the reservoir.

The Secchi disc readings (see Appendix) in the northern end of the lake varied between 3.2 and 4.5 (site #2). Site #3 in the middle of the lake varied from 3.0 to 5.8. Site #5 had a reading of 4.0 on June 26 which fell to 1.6 on July 10. This indicates a fairly extensive bloom at this site. The readings then increased as the summer progressed.

Geological Setting

Since this watershed is so large it is not surprising that a wide diversity of conditions exist. The topography varies from 0-500 feet in elevation around the lake to 1,500-2,000 feet in the south near Grafton. The majority of the watershed is rolling hills but as progressing east the foot of the Rensselaer Plateau and the plateau itself appear--from long hillsides to steeper hills to mountains.

The population is scattered all throughout the watershed except for an unused portion to the south. An incomplete census count is 2,754 (18 houses not included) with a count of 2,167 by the house method. The land use also consists of extensive farming and pastureland. Extraction sites, public use land and commercial areas are widespread. There is another large public park above Grafton.

The surficial geology is mostly till with a lot of alluvium and outwash present. Ice contact, organic and lacustrine deposits are also found. The bedrock here covers quite a spectrum and in order of decreasing abundance they are: clastics of the Taconic sequence; Rensselaer graywacke; Normanskill graywacke and shale; glacial and alluvial deposits with unknown geology underneath; Deepkill, Stuyvesant Falls and Germantown formations; Snake Hill shale; and Lower Ordivician and Upper Cambrian carbonates.

The soils are not as varied and can be broken up into three categories (going eastward); Troy-Cossayuna-Nassau, Alps-Culvers-Cattoraugus, and Worth-Empeyville-Westbury. The first is on acid glacial till from shale, slate and sandstone with gravel and chips of shale and slate mixed in. The second is from red shale and slate. The third has many stones, boulders and outcrops and is developed on acid glacial till from sandstone. These correspond to the changes in topography approaching the plateau.

The reservoir is stream fed.

Chemical Composition

The Tomhannock Reservoir is moderate to hard and slightly alkaline. Dissolved oxygen in the epilimnion decreased as the summer progressed. Orthophosphate remained consistently low but the total phosphate concentration reached a maximum of 350 ug/l on July 17. Maximum nitrate concentrations of above 300 ug/l occurred on June 26 and July 17. Hydrogen sulfide concentrations remained below 50 ug/l throughout the summer.

The streams at sites #1 and #4 were considerably more alkaline and hard than the pools or other streams of the lake. Nutrient levels in the streams were considerably higher than in the lake. Nutrient levels at stream #1 increased with time. Streams #6 and #7 show decrease in the levels, with site #6 having exceptionally high concentrations of nitrates.

Phytoplankton Counts

The algal population of the Tomhannock increased at all sample sites to a rather high level. Total organism counts per ml increased from 7,100 on July 18 to 24,500 on July 31. At site #2 the counts increased only moderately during this time period. The situation was different, however, at the other two non-stream sample sites. At site #3 the average total counts increased from 2,500 to 9,500. This increase coincides with a drop in nitrate and phosphate levels in the lake. The situation at site #5 was even more dramatic. The total average increase was from 8,300 to 46,800 organisms per ml. This was accompanied by a drop in the total acid-hydrolyzable phosphate content of the water from 350 to 40 ug/1. Three days prior to this later sampling the reservoir had been chemically treated with copper sulphate. The results of this treatment had not made any visible effect on the phytoplankton counts at the last sampling.

Zooplankton Analysis

Tomhannock Reservoir had a summer average of 96.0 zooplankters per liter. Cladocerans predominate over cyclopoids and calanoids (1:.5:.9). Daphnia is the dominant cladoceran, with Bosmina, Chydorus, Ceriodaphnia and Alona also present. Rotifers comprise 90 percent of the total zooplankton population, and Polyartha is the dominant rotifer.

Identification of Flora

Tomhannock Reservoir is a large man-made lake. The only aquatic weeds were located along the shoreline of small coves. These weeds supported few algae colonies or mats. The most numerous algal species were of the division Chrysophyta.

Bacteriological Analysis

At station #1, the incidence of coliform was high for four rounds, over 10,000 organisms per 100 ml in three rounds. The major portion of the coliform was of fecal origin. There was also a considerable amount of fecal streptococcus present in the water over the summer.

Before the stream dried up, a high amount of fecal contamination was entering the reservoir at site #4. Beside a considerable amount of streptococcus, more than 2,000 organisms per 100 ml were fecal coliform.

One hundred percent of the coliform present at station #6, a stream inlet, was of fecal origin. In two rounds the fecal streptococcus had an MPN of 430 organisms per 100 ml, a further indication of fecal contamination flowing into the reservoir.

There were more than 2,000 fecal coliform per 100 ml at sampling site #7, a stream inlet. These organisms constituted 100% of the coliform present in the water. There was also a small amount of fecal streptococcus observed.

Analysis of sampling site #8, a stream inlet, showed more fecal contamination of the reservoir water. There were more than 1,500 organisms per 100 ml of fecal coliform present in all rounds of sampling. In two rounds, the presence of fecal streptococcus was a second indicator of contamination.

The reservoir is surrounded by farmland. The five sampling sites just described were all taken from streams entering the reservoir, which first flow through such land as cow pastures. Hence the major source of fecal contamination in the reservoir is probably the farm animals around the body of water.

At station #2 on the Tomhannock, the number of coliform did not exceed 100 organims per 100 ml. What was measured was all of fecal origin. No incidence of fecal streptococcus was noted.

At the third lake sample, the fecal coliform observed did not exceed 50 organisms per 100 ml. Some fecal streptococcus was observed, not exceeding 100 organisms per 100 ml with one exception.

On June 26 at statione #5, an MPN of organisms per 100 ml of fecal coliform was measured. The other samples in the summer contained fewer than 100 organisms per 100 ml. An insignificant amount of fecal streptococcus was noted in only two separate samples over the summer at this site.

The data indicates that there are five sources of fecal contamination at the Tomhannock Reservoir. This fecal matter appeared to a lesser extent in the samples from the central parts of the lake. Since fecal coliform indicate recent contamination of the water and pasturelands are near the reservoir, one can infer that the introduction of fecal matter is a daily event.

The Tomhannock Reservoir, the drinking water supply for most of the county, is a mildly eutrophic lake. Conditions indicating this trophic level are high phosphorus and nitrogen readings. Large algae blooms, also an indicator of eutrophication, were recorded during the study.

Some of the highest nutrient concentrations of the study were traced to streams draining extensive farmland, which included dairy farms, in the watershed. Run-off from manured and fertilized land and from livestock excretions may be a significant nutrient source (Biggar and Corey, 1969).

Of greater concern, for the drinking water, is the bacterial contamination found in the reservoir. Very high fecal coliform counts were found in most large stream inlets. A possible source of the bacterial growth is the farm animals found near the incoming streams.

If the conditions in the reservoir's watershed remain uncontrolled, it may become necessary to increase the extent of chlorinatic needed to control the bacteria of the water which will increase costs and decrease the aesthetic nature of the drinking water.

Presently, the City of Troy has had problems in the filtration treatment of the water due to increased algae productivity. The lake is treated often with copper sulfate to control the algae growth.

Continued problems with the treatment process should be expected if nutrient flows into the lake are not diminished.

LAKE COMPARISONS

This section deals with the comparisons made among the twenty lakes investigated in this study. The extent of eutrophication of the lakes, established on the basis of algal diversification and zooplankton population, was compared with groupings derived from chemical data. A scheme was devised to compare the separate groupings with other variables such as bacteriological content, productivity and morphological features, in an effort to establish an overall ordering of the lakes.

An eutrophication ranking of the lakes was developed through the use of algal indicator species. This particular ranking is based upon the percentages of total species within each of three divisions of phytoplankton. The divisions used are *Chlorophyta*, *Chrysophyta* and *Cyanrophyta*. The principle used is one developed by G. E. Hutchinson (1957). In general, species dominance by *Chlorophyta* indicates oligotrophic to mesotrophic conditions, while species dominance by *Chrysophyta* and *Cyanophyta* indicates increasing eutrophication. The method developed here required the difference between the percent of total species that are *Chlorophyta* and that of *Chrysophyta* and *Cyanophyta*. The continuum developed follows in figure 15. It is important to keep in mind that when only one indicator is used to characterize the complex system within a lake there will be significant distortion. The ranking that was developed cannot stand alone in relating the lakes but was used in conjunction with other data to establish a final scale of eutrophication.

(For further justification of the principles used refer to T. T. Macan (1970), G. E. Fogg (1965), L. Provasoli, 1969.)

Zooplankton identification led to an ordering of the lakes according to percent large herbivorous filter feeders of the total herbivorous filter feeder population. (See Methodology)

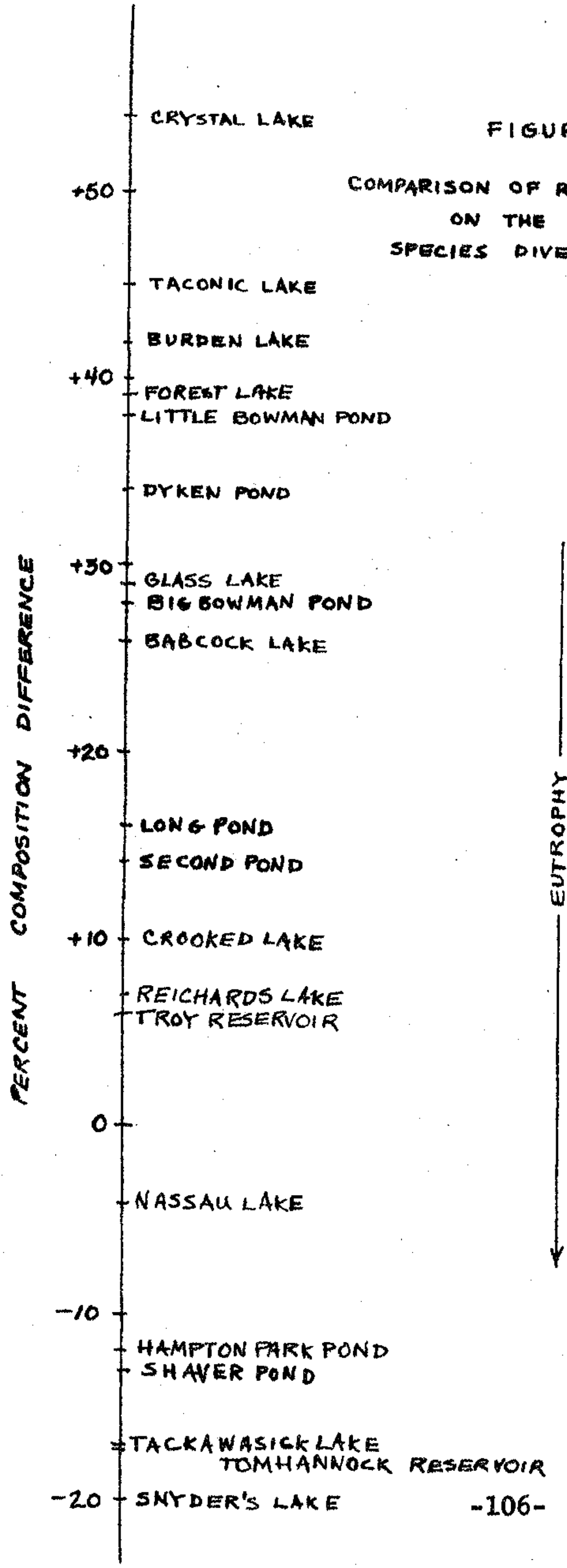
Figure 16 shows the relative ordering of the lakes according to this parameter, with several exceptions (notably Snyders and Forest Lakes) discussed in the section on the individual lakes. This index shows a fairly good correlation with the average Secchi disc readings for the summer.

A second comparison was made with regard to the percent rotifers population of the total population (see figure 17).

When the rotifer percentage of the zooplankton population was determined, it was found that, in general, those lakes classified by the previous method as mesotrophic had very low (12-45) percentages of rotifers. These were Tackawasick, Taconic, Long, Second and Shaver Ponds. The exception to this was Forest Lake,

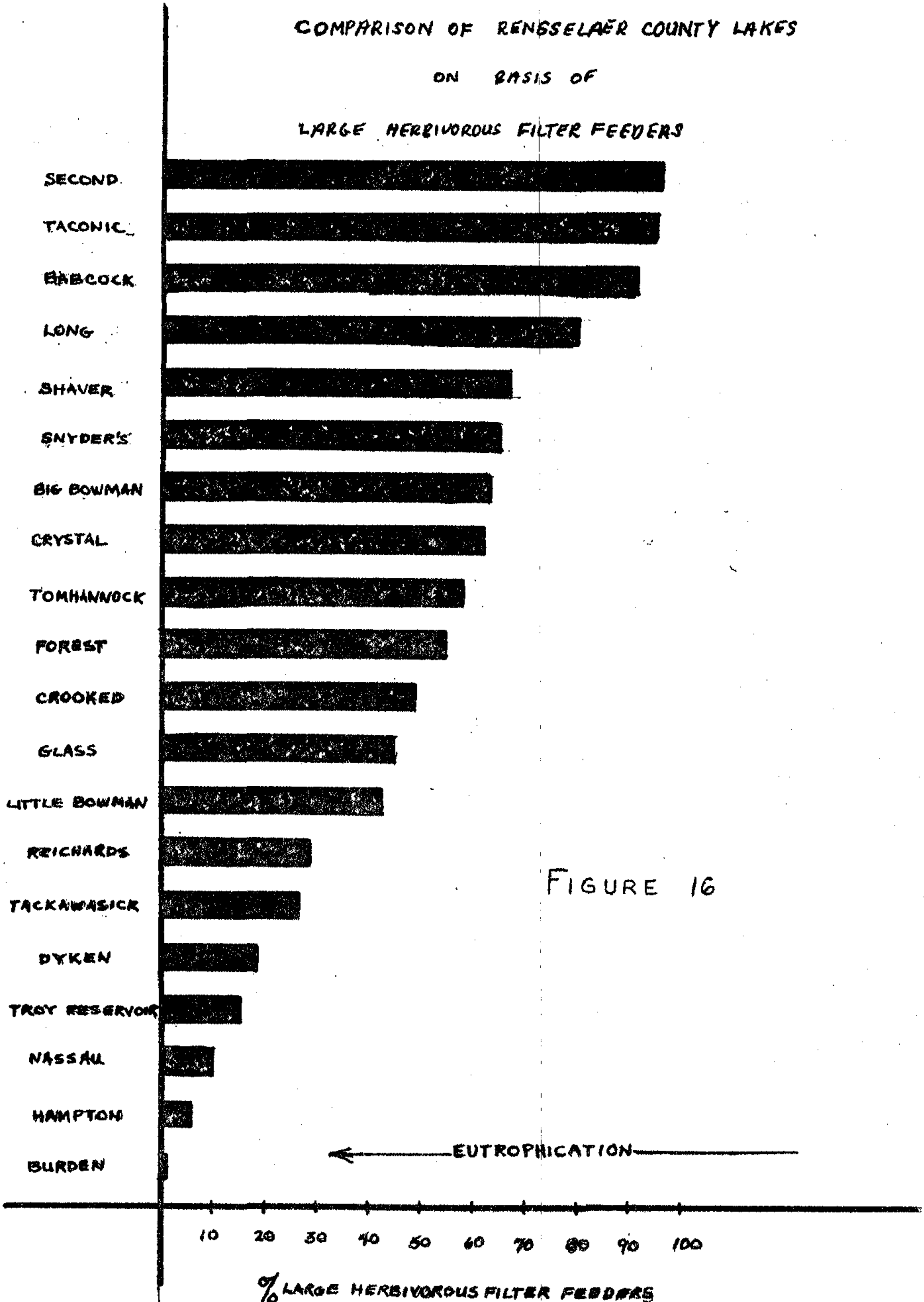
FIGURE 15

COMPARISON OF RENSSELAER COUNTY LAKES
ON THE BASIS OF
SPECIES DIVERSIFICATION ANALYSIS



LAKE	DESMID	OTHER CHLOROPHYTA	CYANOPHYTA	CHRYSOPHYTA	% DIFFERENCE
Crystal	06	66	06	12	+54
Taconic	42	25	07	15	+45
Burden	--	62	0.48	19	+42
Forest	27	48	04	32	+39
Little Bowman	33	25	0.8	19	+38
Dyken	30	32	02	26	+34
Glass	20	44	02.8	32	+29
Big Bowman	16	41	13	16	+28
Babcock	26	28	08	20	+26
Long	25	30	06	33	+16
Second	20	33	15	24	+14
Crooked	10	40	15	25	+10
Reichards	0.6	43	20	17	+07
Troy Reservoir	05	47	11	35	+06
Nassau	15	35	19	35	-04
Hampton	04	40	12	44	-12
Shaver	05	35	15	38	-13
Tackawasick	0.4	35	13	39	-17
Tomhannock	05	33	08	47	-17
Snyders	05	33	25	33	-20

As the percent difference decreases the extent of eutrophication, as determined by algae species diversification, increases.



COMPARISON OF RENSSELAER COUNTY LAKES
ON BASIS OF
LARGE HERBIVOROUS FILTER FEEDERS
SECOND
TACONIC
BABCOCK
LONG
SHAVER
SNYDER'S
BIG BOWMAN
CRYSTAL
TOMHANNOCK
FOREST
CROOKED
GLASS
LITTLE BOWMAN
REICHARDS
TACKAWASICK
DYKEN
TROY RESERVOIR
NASSAU
HAMPTON
BURDEN
EUTROPHICATION
10
20
30
40
50
60
70
80
90
100
% LARGE HERBIVOROUS FILTER FEEDERS

FIGURE 16

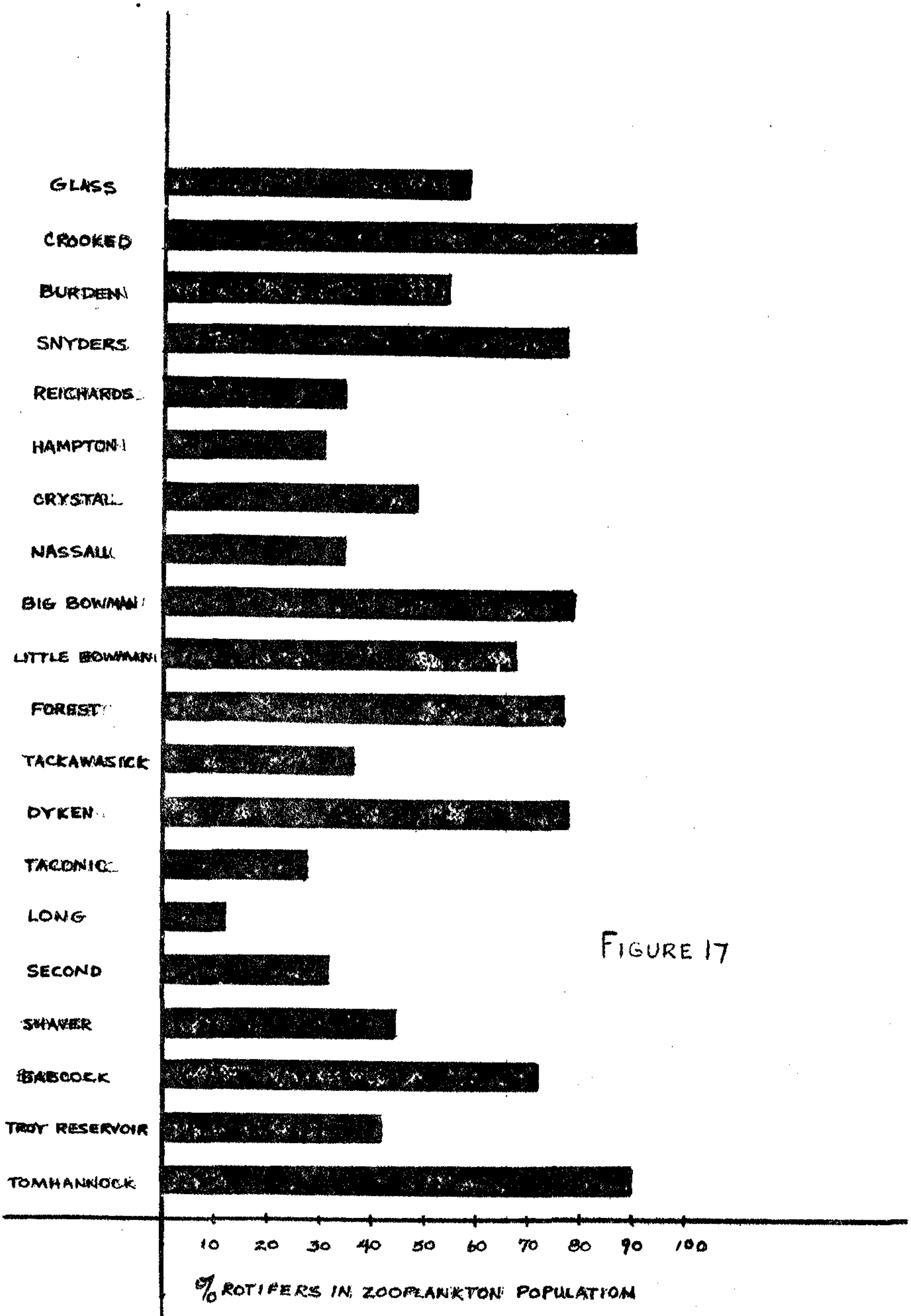

GLASS
CROOKED
BURDEN
SNYDERS
REICHARDS
HAMPTON
CRYSTAL
NASSAU
BIG BOWMAN
LITTLE BOWMAN
FOREST
TACKAWASICK
DYKEN
TACONIC
LONG
SECOND
SHAVER
BABCOCK
TROY RESERVOIR
TOMHANNOCK
10 20 30 40 50 60 70 80 90 100
% ROTIFERS IN ZOOPLANKTON POPULATION

FIGURE 17

1.

Hampton Park Pond
Snyders Lake
Reichards Lake
Troy Reservoir

2.

Nassau Lake
Crooked Lake
Little Bowman Pond
Burden Lake
Crystal Lake
Glass Lake
Big Bowman Pond
Babcock Pond

3.

Tackawasick Lake
Tomhannock Reservoir
Shaver Pond
Dyken Pond
Second Pond
Forest Lake
Long Pond
Taconic Lake

EUTROPHY

An overall ranking was the final result of all the comparisons that were made. The eutrophication ranges developed from chemical data, algal diversification and zooplankton counts were used along with productivity data, morphological characteristics and computer ordinations to arrive at this final composite scale of eutrophication.

The purpose for developing this scale was to show the relative quality of each lake in comparison to the others in terms of eutrophication.

The inclusion of this number of parameters in the analysis helped to alleviate some of the distortion inherent in describing a complex system in a simplified manner. The ranking itself was fairly objective in that the computer's analysis and groupings were as accurate as the data allowed. The characterization of each group which although mesotrophic, had a zooplankton population, 77% of which was composed of rotifers.

Of the eutrophic lakes, the "less eutrophic" ones (according to the above method) tended to have higher percentages of rotifers in the zooplankton population than the "more eutrophic" lakes. The exception to this were Crystal and Glass Lakes, both of which were going through extreme changes, according to Secchi disc readings, and which had very similar curves for fluctuation of their total populations. Snyders Lake also deviated, probably for the same reason, as it did on all the other zoological indices, as previously discussed.

Holopedium gibberum is a cladoceran typical of soft water lakes (Thienem, 1926). It was present in all the lakes that had hardness (measured as values of 20 ppm or less, calcium carbonate), with the exception of Forest Lake.

This relationship should be more thoroughly explored in future studies, especially to determine why this cladoceran was absent in Forest Lake.

The mesotrophic lakes and Glass Lake had fluctuations totaling less than 200 organisms per liter for rounds #2 through 5 of sampling.

Computer analysis of zoological data collected for the entire summer displays the same basic trends found in the size dependent analysis previously discussed. A two-dimensional array of the lakes and the eutrophic trend is shown in figure 18.

Clusters, established by computer analysis based on chemistry data for each round of sampling, were compared and compiled to construct a system of three lake groups.

Computer analysis could result only in the establishment of the clusters. Rankings within each individual cluster were done by inspection of the more general characteristics. The three groups follow:

Comparison of Rensselaer County Lakes on the Basis of Zooplankton Population

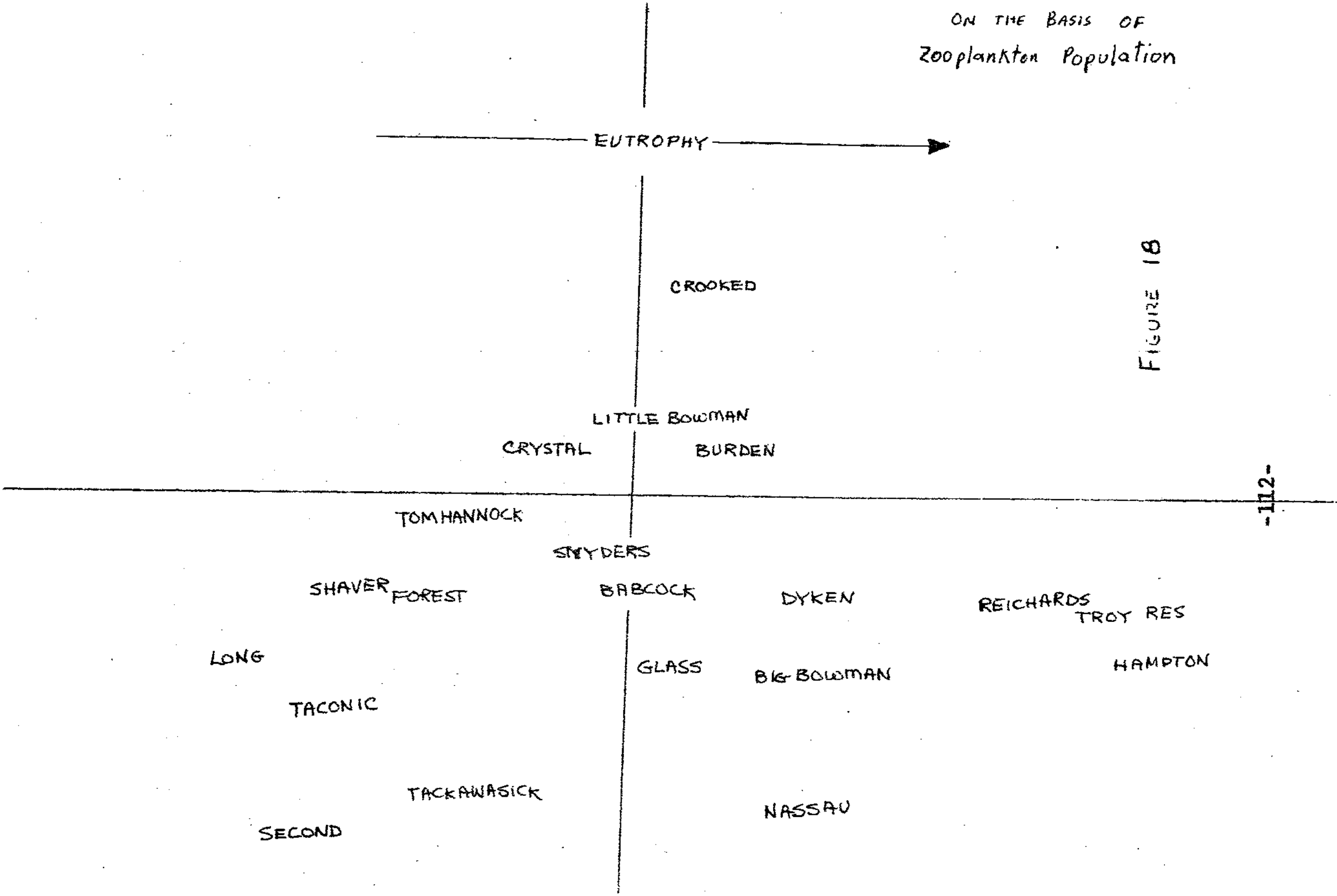


FIGURE 18

POSSIBLE NUTRIENT SOURCES

This study did not attempt to perform any of the investigations necessary for a nutrient budget. Until such a budget is done for each lake, definite statements concerning the largest sources of nutrients cannot be made. It is possible to enumerate some of the probable nutrient sources along with some conclusions drawn from investigations in other areas. Explanations of some possible sources follow.

(1) Septic Tanks

Septic tank-leaching field systems in areas where the ground conditions are acceptable can be assumed to prevent most of the phosphorus in sewage from reaching receiving bodies. Inorganic phosphates are insoluble and form precipitates which adsorb to the soil. This limits the ability of percolating groundwater to transport phosphorus. The same is not true for nitrogen. Inorganic forms of nitrogen such as nitrates and ammonia are very soluble. Percolating groundwater can easily transport them and it can be assumed that they will eventually reach the receiving body. (Biggar and Corey, 1968; Hetling and Sykes, 1971).

The problems with septic tanks as a phosphorus source arise from improperly installed and untended systems, tanks that discharge directly into the lake rather than into leaching fields, and unsuitability of the ground for septic tank installation. As previously noted, a USDA Soil and Conservation Service study points out that most of the ground in the county will exhibit severe reactions to septic tank systems due to seasonal highwater table, shallow depth to bedrock, and hardpan or clay within three feet.

Another problem arises from direct discharges into the lake. Hetling and Sykes (1971) reveal that, in 1969, 24 percent of the septic tanks in the Canadarago Lake area had some sort of direct discharge into the lake.

Considering the extent of septic tank use in the county and the unsuitability of the ground for this type of disposal it is probable that septic tanks contribute significant amounts of nutrients to many of the lakes studied.

(2) Drainage from Agricultural Land

Agricultural drainage will contain nutrients from direct animal excretion, barnyard leakage, land erosion and fertilizers

Hetling and Sykes (1971) found direct animal excretion to be the probable source of about 50% of the total phosphorus from runoff into Canadarago Lake. They suggest that exclusion of animals from stream flood plains and areas of direct lake drainage could significantly reduce nutrients from this source.

Biggar and Corey (1968) show a correlation between manure and nitrates in runoff. They also state that careful disposal of manure could significantly reduce nitrogen and phosphorus inputs. Manure disposal on frozen ground will result in large nutrient loads upon the receiving body when thawing and subsequent precipitation occur. They also presented the following information which is of interest to this study. (See Table 1-4.)

Mixed farmland, which was defined as including dairy and barnyard wastes, gave the highest phosphate concentrations and the second highest nitrogen concentrations of the areas studied. In most cases the improved farming methods did not reduce the nutrient runoff. This may be due to increased fertility and susceptibility of this surface fertility to erosion.

Rainfall is an important factor in considering land drainage no matter what the use of the land. Periods of increased rainfall will increase runoff and erosion and will result in significantly higher nutrient flows to receiving bodies.

Robbins et al. (1972) indicate that land spreading of animal wastes in their study proved preferable to direct discharge into streams and to the use of anaerobic lagoons for nutrient depletion. However, their data do show that land spreading of animal wastes can be a significant source of nutrients. They stated that the nutrient contents of all land runoff samples were well in excess of that needed for algal growth. Nitrate was the only nutrient that did not correlate with runoff data. This indicated probable nitrate contamination of groundwater and further strengthens the evidence that nitrates move primarily by groundwater while phosphates are transported by surface runoff. Some of their suggestions for reducing nutrient flow from land spreading include selecting disposal areas with low erosion potentials, no application of wastes on grassed waterways or other drainage paths, locating dry lots away from streams and hillsides leading directly to streams, and exclusion of pasture animals from streams and drainage paths.

TABLE 1

Constituent Loads in Runoff Under Improved and Prevailing Agricultural Practices[a]

Agricultural Practice	Constituent[b]		
	Suspended Solids	PO_4 as P	Total N
None (rainfall only)	4.5	0.03	0.58
1.5-acre field			
Improved	8.8	0.03	0.81
Prevailing practice	19.5	0.02	0.85
7.5-acre field			
Improved	21.0	0.02	0.19
Prevailing practice	0.94	0.01	0.16
Mixed farm	165	0.07	0.83
Orchard, improved	12.6	0.02	0.48

[a]Source: Weibel et al. (1966).
[b]Data are expressed in pounds of constituent per acre per day of rainfall.

TABLE 2

Nutrient Losses from Agricultural Land

Nutrient	Losses (lb per acre)		
	Croplands and Pasture	Woodlands	Manured Lands
Soluble inorganic N	0.06	0.03	3.0
Soluble inorganic P	0.04	0.003	1.0

TABLE 3

Sources and Estimates of Available Nitrogen and Phosphorus Derived from These Sources in Cultivated Wisconsin Soils

Source	Nitrogen (lb/acre)	Phosphorus (lb/acre)
Fertilizer	10	8
Legumes	12	-
Precipitation	8	-
Organic matter decomposition	45	5
Manure	42	12

10/17/72
ea

TABLE 4

Nutrient Source and Percentage of Total Nutrients Entering Lake Mendota

Nutrient Source	Total Nutrients Entering Lake (%)	
	Nitrogen	Phosphorus
Precipitation	17	2
Groundwater	45	2
N fixation	14	-
Runoff		
Rural lands (not manured)	1	12
Rural lands (manured)	8	30
Urban area	5	17
Waste waters (municipal and industrial)	8	36

10/17/72
ea

(3) Miscellaneous Land Runoff and Erosion

Phosphorus and nitrogen are usually low in drainage from forestlands (Cooper, 1968), although it does increase somewhat after extensive cutting. Lakes in this study, in areas of considerable woodlands with few residential areas, generally showed lower concentrations of nutrients than lakes in agricultural areas with few residential areas. Forested lands are probably not a significant source of nutrients in the watersheds studied.

Land erosion, including that from agricultural areas, can serve to transport nutrients to a receiving body. Phosphorus contributions from erosion may be more significant than nitrogen contributions. Placing phosphorus fertilizers below the soil may avoid immediate loss by erosion but eventually it will be exposed to runoff and erosion (Biggar and Corey, 1968).

(4) Urban Drainage

This is a source of nutrients for only one lake in this study, Hampton Park Pond. This watershed has the highest population density of any studied. The area is completely served by sanitary sewers which transport sanitary wastes out of the watershed; however, the area is also served by a separate storm sewer system which drains into the lake. From the condition of the lake, it is probable that this source supplies considerable nutrients to the lake.

Weibel (1968) reports that it is possible to get nutrient levels above the threshold values for algal blooms from storm water from residential and light commercial areas. The lake ultimately becomes the recipient of drainage from residues from vehicle wear, vehicle drippage, garbage, animal droppings, construction job silt, runoff from generously treated gardens and lawns, and dustfall.

(5) Sediment Regeneration

Another "source" of available nutrients for growth in the lake is the regeneration of nutrients from the sediments. These nutrients are already a part of the lake system. However, unless they are regenerated into the water, they are unavailable for use by phytoplankton.

At low concentrations of oxygen in the hypolimnion (bottom level of stratification) certain ionic exchanges take place between the sediments and water which tend to considerably raise the concentrations of phosphorus in the lower levels. When fall turnover occurs, the phosphorus re-enters the lake food chain and can set off an algal bloom.

as eutrophic, mildly eutrophic, or mesotrophic was admittedly somewhat arbitrary. The prime tool used to accomplish this was comparison with data from other lake studies and conclusions about the trophic state of these lakes. A primary consideration was the high level of algal productivity on all the lakes. The ranking was as follows.

SUMMARY AND CONCLUSIONS

(1) Twenty representative lakes in Rensselaer County were investigated as to the conditions of the following parameters:

a. lake chemistry
b. identification of algae
c. phytoplankton counts
d. zooplankton identification and counts
e. bacteriological counts
f. higher aquatic vegetation
g. physical and geological characteristics

Each lake was examined in light of the above information and a continuum of lakes was established, based upon the determined extent of eutrophication. The established continuum follows with Taconic Lake being the "best" lake studied and Hampton Park Pond and Snyders being the "worst."

MESOTROPHIC	MILDLY EUTROPHIC	EUTROPHIC
Taconic Lake (Crandal Pond)	Shaver Pond	Little Bowman Pond
Forest Lake (Hayner Pond)	Crystal Lake	Troy Revervoir
		Vanderh[illegible]
Long Pond	Glass Lake	Crooked Lake
Second Pond	Tomhannock Reservoir	Reichards Lake (Raquet Lake)
Babcock Pond	Tackawasick Lake (Tsatsawassa Lake)	Nassau Lake
Dyken Pond (Dyking Pond)	Burden Lake (First and Second Lakes)	Snyders Lake
Big Bowman Pond		Hampton Park Pond

(2) A distinct correlation exists between algal productivity and level of nutrients (phosphorus and nitrogen) in the lake. The lakes that exhibited higher plankton counts generally were those with the highest nutrient levels.

(3) Relationships between higher nutrient levels and both total population in the watershed and population density (people per acre) were established. The lakes with population stresses upon them were found to be in the mildly eutrophic to eutrophic range.

The lakes with the largest population stresses upon them are Hampton Park Pond, Snyders Lake, Nassau Lake, Reichards Lake, Crooked Lake, Burden Lake, Glass Lake and Crystal Lake.

(4) Although a nutrient balance was not performed, it appears that the major cause of the stress on the lakes in populated areas is the extensive use of septic tank systems for houshold

waste disposal. Rensselaer County's geology indicates that the soil will generally exhibit severe reactions to septic tank systems, thus further compounding the problem.

(5) Hampton Park Pond is the only lake studied which has a sanitary sewer system completely covering its watershed. The population stress is not alleviated, however, due to storm sewer outfalls which result in a stress upon the lake that appears to be as severe as that due to the use of septic tank systems.

(6) The lakes with higher nutrient levels were generally those with large amounts of agricultural land use in their watersheds. The lakes with this agricultural stress upon them were found to be in the mildly eutrophic to eutrophic range. The lakes with the largest amount of agricultural land in their watersheds are Tomhannock Reservoir, Nassau Lake, Burden Lake and Tackawasic Lake.

(7) The lakes with high bacterial counts were generally those with large amounts of agrictural land use in their watersheds. This indicates a correlation between farming and the amount of bacteria which contaminates a lake area. None of the lakes studied were found to be dangerously contaminated.

(8) The major streams flowing into the Tomhannock Reservoir consistently contained among the highest nutrient concentrations and bacterial counts found in the study. This indicates a high nutrient loading from the agricultural land surrounding the reservoir. Problems due to increasing algal productivity and bacterial counts should be expected for the Tomhannock Reservoir.

(9) The lakes with the lowest nutrient levels were generally those found in the eastern part of the county. These lakes are similar in that they all have very little population, almost no agricultural land use within their drainage basins, and appear to be primarily spring fed. These lakes are Taconic Lake, Forest Lake, Long Pond, Second Pond, Big Bowman and Dyken Pond.

RECOMMENDATIONS

Local government in Rensselaer County is divided into fourteen townships, five villages and two city governments. Local zoning ordinances have been established by six of the fourteen townships, two of the five villages, and by both city governments.

These ordinances provide for land use planning, which concern itself with two major purposes: (1) maintaining environmental status quo, and (2) providing communities with essential quality services, at the lowest possible cost.

The best method of establishing a well-planned community is through local zoning ordinances. However, with only six of the fourteen townships and two of the five villages having viable ordinances, it is difficult to coordinate future plans throughout the county.

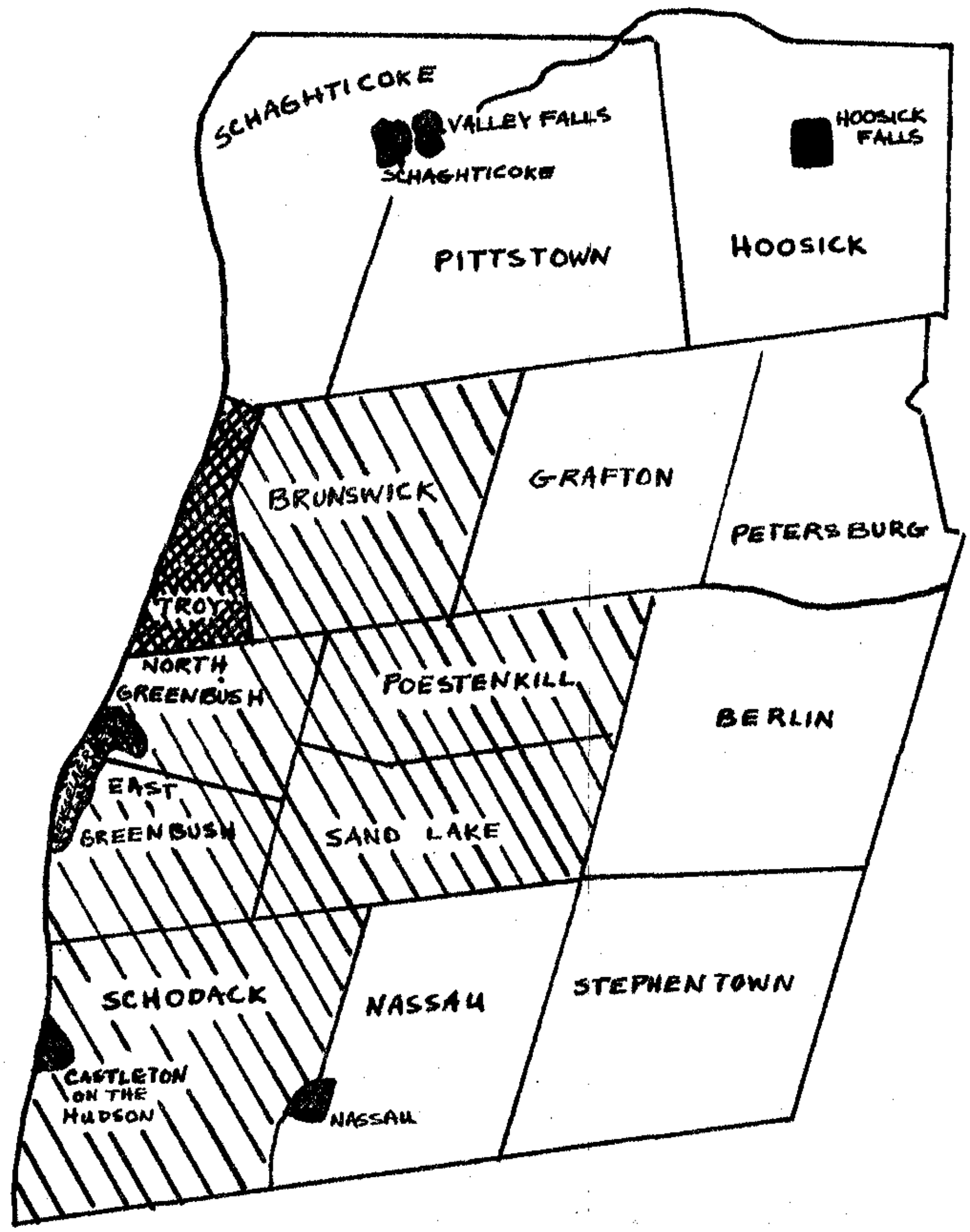
The accompanying diagram (figure 25) illustrates that only 35% of the total county land area has land use controls. Approximately 86% of the county's total population inhabits this area.

With the market for shoreline land booming and the development of environmental controls lagging, several problems have arisen in unzoned or weakly zoned areas. In many places, rings of developments that are not professionally planned form around the lake. These developments bring with them such problems as the destruction of wildlife habitats and unsightly man-made structures. Another problem is private septic tanks which, when built near a lake, are frequently inefficient since geological conditions may inhibit complete retention of waste materials, allowing for the seepage of nutrients into the water source.

Lake ownership is divided into two categories, private and public. When the property owners around the lake own a lake bed, then the lake is classified as private. A public lake is one held in trust by the state for public use; i.e., the state owns the lake bed. In order for a public lake to be usable by the public, the state must also own a parcel of land which gives the public access to the lake. The people have a right to use the public lakes and to expect these lakes to be clean. Lack of proper zoning control for lakefront property violates the people's right to have the quality of the water protected, since controls placed on the use of land for septic tanks and other sources of water contamination, are often ineffective.

The creation of shoreline regulations must not be a haphazard,

LAND USE CONTROLS IN RENSSELAER COUNTY



MUNICIPALITIES WITH CONTROLS

Townships

Cities

Villages

Figure 25

politically motivated set of unenforceable rules. There is a need for a solid record of research work. Close teamwork among lawyer, limnologist, biologist, soil specialist, fish and game specialist, engineer, and land use planner is imperative to ensure the development of viable environmental quality controls.

Programs must be flexible to allow for those cases in which reliable data is lacking and "danger indicators" must be employed.

Wisconsin's Shoreland Protection Program provides an excellent illustration of the difficulties in establishing effective water quality controls. Prior to 1966, Wisconsin's "water pollution control" consisted only of abatement of waste discharging. Enforcement left to existing local agencies of sanitation control, subdivision control and zoning. The results were very unsatisfactory since such agencies could not handle the great number of problems inherent in environmental quality control.

A fulfillment of the need for controls was provided by Douglas Yanggen, Extension Land Use Planning Specialist, Department of Agricultural Economics, University of Wisconsin, (Beuscher, 1969). Yanggen's proposal was a unique legislative package, encompassing:

(1) Zoning controls for setbacks from the lake, lot size and land use
(2) Regulations for the creation and plotting of subdivision lots for sale and building development
(3) Private sewage disposal system controls
(4) Lake shore tree cutting restrictions
(5) Rules governing the filling, grading and creation of artificial waterways

Although problems have arisen from a shortage of technical personnel and "educated" administrators, this system has thus far proven to be both equitable and enforceable. Many advantages have accrued in that the laws are flexible enough to deal with the problems of thousands of different lakes and strong enough to make water quality control a reality.

For water quality control to be effective, several general needs must be met. It has become necessary to establish coordinated environmental programs, a liaison between government officials and environmental investigators, and uniform, comprehensive, flexible, enforceable zoning regulations for lakefront property. If these needs are fulfilled, as in Wisconsin, the public may be assured of clean water in the future.

(1) Zoning, as described above, is what is needed to improve and preserve the water quality of the lakes in this county. Many of the lakes studied have conditions favorable for recreation and housing development. Uncontrolled development of these relatively natural surroundings will result in the undesirable conditions found in the more densely populated lakes of the county.

The inevitability of this occurrence is displayed in the similarity of the morphological settings of the lakes. The only major variance in the lakes is land use. Most other conditions are essentially constant throughout the county. It is apparent that a lake presently in a desirable condition (as are many of the lakes in the county) could deteriorate rapidly if subjected to the same stresses that have resulted in extreme deterioration of certain lakes studied.

Regulations similar to the Wisconsin Shoreline Protection Program would give the state and local givernments a fighting chance to protect badly exploited lakes and shorelines.

The Rensselaer County Legislature is the source from which this type of control must come on a local level. Inevitably, the ultimate responsibility for showing the need for such controls to the legislature rests with the concerned citizens of Rensselaer County.

(2) The expansion of sewer districts to include all the populated areas of the county will ultimately serve the best interests of the county in many ways. For the benefit of a viable water management program in the county, the expansion should be completed as soon as possible. This will relieve the nutrient stresses on the lakes to some extent, thus decreasing the rate of deterioration of lake quality in the county.

(3) Storm drainage systems (such as entering Hampton Park Pond) are very large contributors to the eutrophication process. As the population density increases, the contributions to the lake system from the storm drains increase. It is recommended that steps be taken to find an alternative for the present system. Two alternatives are presently seen. Diversion of the storm drains from the lake basin to the Hudson River drainage system is one possibility. A second alternative, one most desirable from an environmental standpoint, is treatment of the storm drainage effluent. This process is, however, quite taxing financially.

(4) To reduce the amount of nutrients entering waterways from direct animal excretion, livestock should be prevented from entering stream flood plains and areas with high runoff or erosion potential.

(5) A careful review of agricultural land use, agricultural waste disposal methods, manure spreading and fertilization should be undertaken to determine the extent of nutrient loss from these sources.

(6) One of the largest nuisances in the county is algal blooms. There are many methods available for dealing with these nuisances, both chemical and mechanical.

Chemical methods are mainly used in this county. Although chemicals used for nuisance blooms do solve the immediate problem, that of eliminating the overgrowth, far reaching effects are usually overlooked. Chemicals used to kill or "speed up" the life cycle of weeds or algae do not eliminate the nutrients locked in the aquatic vegetation. Bacterial decomposition releases the organic nutrients to inorganic forms, which return the nutrients to the food chain.

Mechanical removal of algae and the higher aquatics not only solve the immediate problem but also take the nutrients from the ecosystem entirely. Mechanical removal is recommended over chemical treatment for the algal problems in the county, because the future condition of the lakes should be regarded at least as highly as the immediate problem.

(7) The impact of a study of this nature is realized most when compared to a similar, previous study. Since this type of comprehensive survey has not been completed since 1934, and even then the study was not comparable because of variations in methodology and standards, follow-up studies are recommended. In this way the temporal variations of the lake conditions will be studied on a level more condusive to investigation of the annual improvement or deterioration of the lakes.

Follow-up studies can be of similar structure to this one or an arrangement of continual monitorings can be established. Because of the expense involved and the nature of the ecological variations, a series of studies, similar in nature and time span to this study, are recommended. Of course, the addition of more elaborate tests and contemporary studies are encouraged.

Public interest is the first step in the interwoven cycle of environmental policy development. This step has been initiated through public interest groups, the news media and academia. The second step, investigation, was begun with this study. Information regarding present conditions, possible dangers, and areas of concern have been sought out and reported. The third step, legislation, is now upon us. Public interest will most assuredly continue, further investigations have been recommended, but legislation must begin soon. Without laws to protect man's environment, man, himself, will continue to unknowingly destroy his own habitat.

We urge legislation regarding environmental management of the waters of Rensselaer County, using the above conclusions and recommendations as guides.

The expediency of these problems is obvious. The sooner regulations are established and enforced, the sooner the county's lakes will be relieved of the stresses presently on them.

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