REPORT ON WATER QUALITY IN CROWE LAKE

1972

Ontario

Ministry
of the
Environment

REPORT ON WATER QUALITY
in
CROWE LAKE

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PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and it's surrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an even greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970 in order to solve the cottage waste disposal problem in recreational lakes. There are three on-going studies carried out by the Ministry:

1. Evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory;

2. Research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private waste disposal;

3. Evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Crowe Lake is one of a series dealing with the water quality aspects of the recreational lakes studied in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

A study to evaluate the water quality of Crowe Lake was carried out during the summer of 1972.

Crowe Lake is located in the counties of Peterborough and Hastings and in the respective townships of Belmont and Marmara. Its north shore lies within the Precambrian Shield which is characterized by shallow overburden. The southern shore of the lake, which falls within the Trenton Black River geological region, has several feet of overburden covering a limestone bedrock.

The bacteriological water quality was generally good; however, during the June survey there were indications of bacterial inputs along the western shore where there is moderate cottage development.

The waters of the main body of Crowe Lake were of good chemical quality and showed only a small increase in minerals over the content of the inflowing Crowe River probably due to the effect of drainage from the limestone areas to the south. In August, there was present in the deepest protion of the lake, a bottom layer of water almost devoid of oxygen which would render these depths uninhabitable by fish. Phosphorus, chlorophyll _a_ and transparency results indicated the lake water was generally of low fertility.

PURPOSE OF THE SURVEYS

The surveys were designed, and tests selected, in order to evaluate the present conditions in the lakes with respect to:

- concentration of bacteria
- plant nutrients and algae
- water quality with depth
- inventory of shoreline development

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions since most disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant nutrients), mainly nitrogen and phosphorus, support extensive growths of rooted aquatic plants and of microscopic free-floating plants called algae. Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

Aquatic weed beds provide shelter and food for many kinds of fish. Too much growth is undesirable since it can upset the oxygen balance in the lake and can interfere with recreational uses of the lake.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from June 25 to 29, from August 27 to 31 and from September 19 to 23.

A proper estimation of the bacterial population requires several measurements over a period of time which can then be averaged as a geometric mean. Measurements over 5 consecutive days at each station are regarded as the minimum number which will give reliable bacterial data.

Chemical samples collected on the first and last days of the surveys at inlet and outlet stations and at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Twenty bacteriological samples sites were established over the whole lake. Chemical samples were collected at the inlet station, the outlet station and at 2 mid-lake stations. In addition to these surface samples, chemical and bacteriological samples were taken from the bottom water at the mid-lake stations (Figure 1).

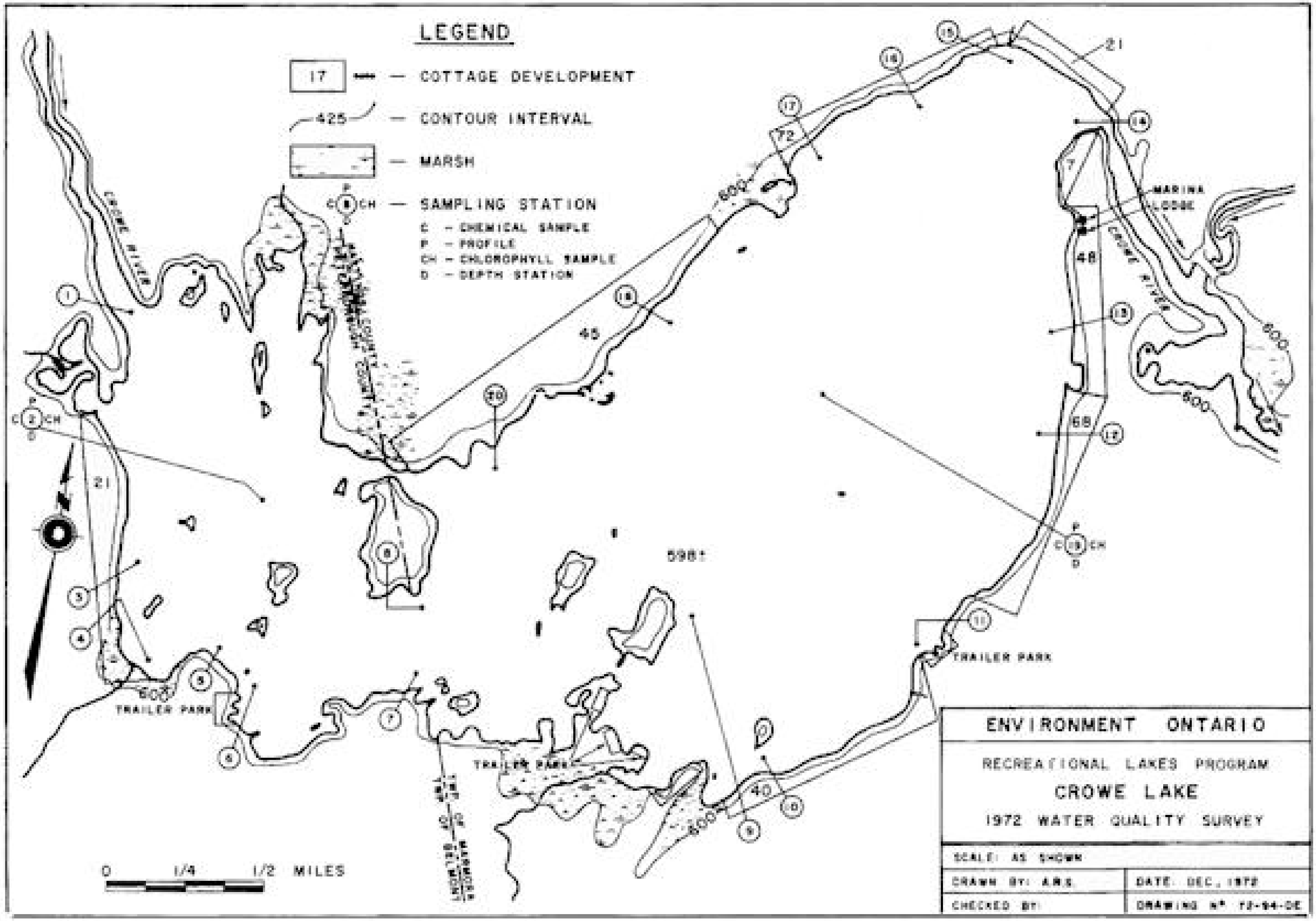

FIGURE 1: Cottage Development and Sampling Stations of Crowe Lake**.**

Field Tests

The variation in temperature and dissolved oxygen values with depth were measured at the three deep water stations witn an electronic probe lowered into the lake and water clarity was measured with a Secchi disc, (Figure 2). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal coliforms and fecal streptococci organisms are all indigenous to man and other warm blooded animals and are found in the colon and feces in tremendous numbers. Hence, these indicator organisms in the water denotes the presence of fecal contamination and hence the risk of disease causing organisms.

Standard plate count (SPC) determinations were made on some mid-lake stations in order to determine densities of some natural water bacteria. The SPC media will only support the growth of those organisms that don't require special nutrients, oxygen requirements and/or incubation temperatures. The SPC is used as a measure of general bacterial activity.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials aid suitability of the lake for various management techniques depend on the mineral content.

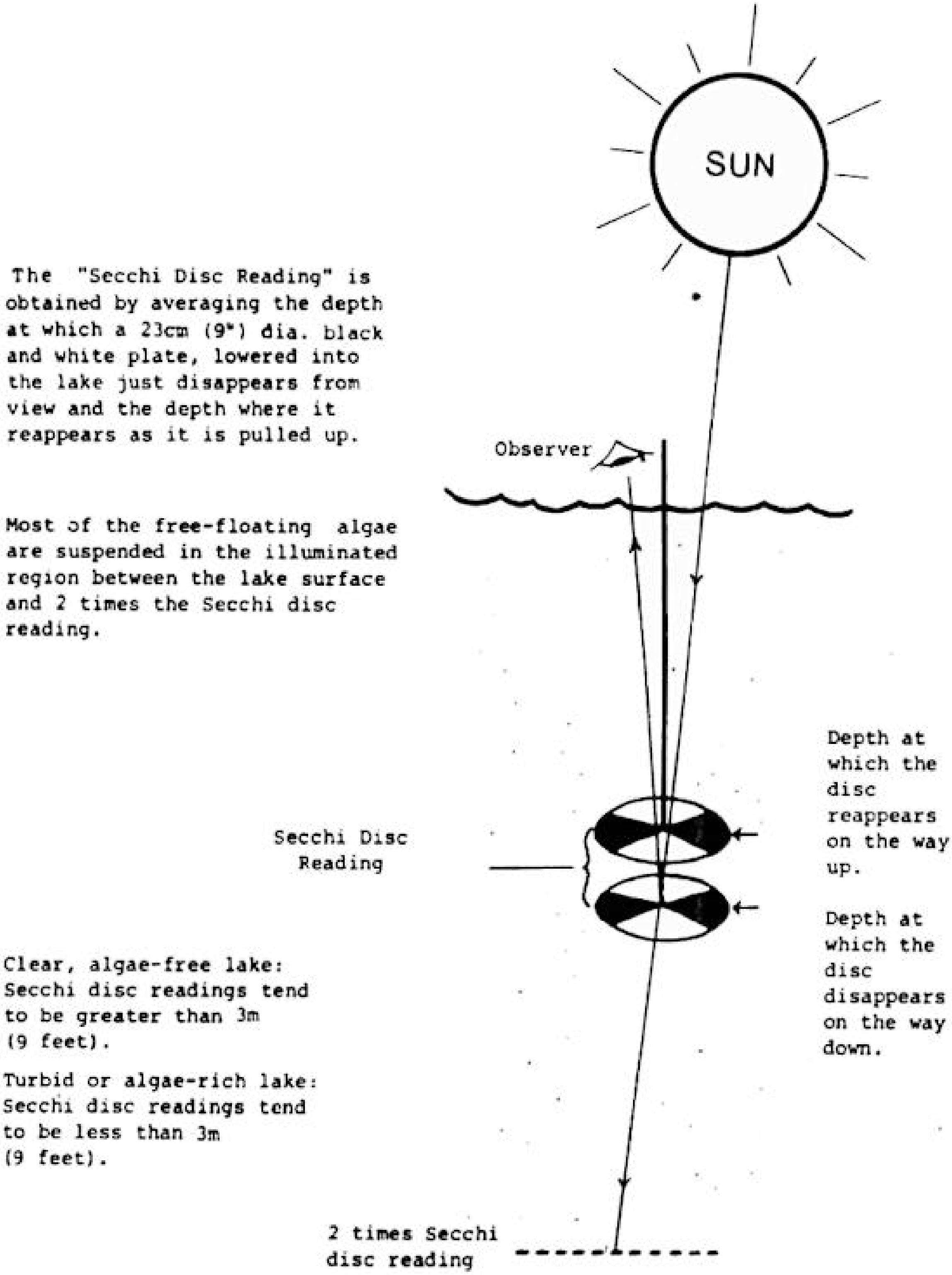

FIGURE 2: Use of the secchi disc to determine water clarity.

Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the mid-lake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the inlet and bottom water samples. They are particularly important in bottom waters since nitrogen may be regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of algae in the water. The live algae are confined mainly to the lighted surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by raising the sample bottle through the depth of this illuminated zone as it filled. The sample was then representative of the average number of algae through the illuminated depth of the surface waters.

DESCRIPTION OF CROWE LAKE AREA

Lake and Soil Characteristics

Crowe Lake is located in the counties of Peterborough and Hastings and in the respective townships of Belmont and Marmora. The Village of Marmora lies two miles to the southeast of the lake.

The entire southern shore of Crowe Lake is dominated by the Farmington Loam soil and the Dummer Loam soil series (Figure 3). The Farmington Loam soil series provides less than half a meter (18 inches) of glacial till over flat areas of limestone bedrock, where drainage capabilities are variable. Dummer Loam is a well-drained, deep mantle loam overlying bedrock.

East of the inflowing Crowe River, the soil type is of the Muck series comprised of decomposed vegetable matter of at least half a meter in depth providing very poor drainage. The Rockland soil series covers a majority of the northern shore. This series is comprised of 50 to 90 per cent rock, thinly covered with a mixture of humus and sand overburden, with small deposits of muck or peat found in the deeper depressions. The northeastern shore of the lake is covered with three types of soil groups, Tioga sandy loam, Granby sandy loam and localized marshland. Tioga sand loam usually has a gently to moderately sloping topography and is made up of a calcareous medium sand. Granby sand loam is usually found to have smooth or depressional topography with poor natural drainage.

The forest cover around the lake is moderate with mixed amounts of coniferous and deciduous trees.

Crowe Lake contains two basins, the small western basin which is shallow and the eastern basin which constitutes three quarters of the lake area. The total surface area of the lake is 11 square kilometers (4 square miles) and its immediate watershed

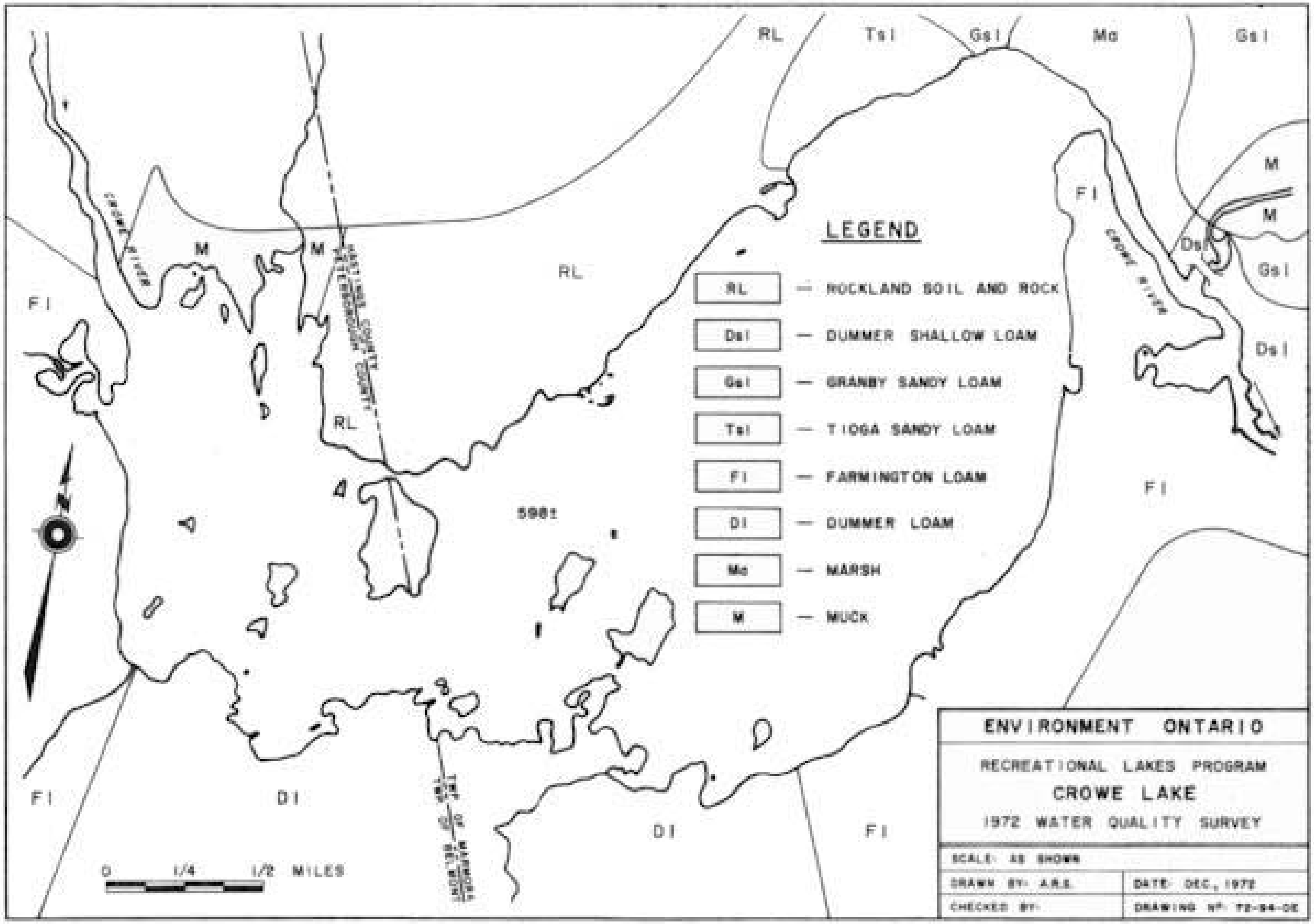

FIGURE 3: Soil Types Near Crowe Lake.

covers 1140 square kilometers (56 square miles). The lake has a shoreline length of 21 kilometers (13 miles), and a maximum depth of 15 meters (50 feet).

Crowe Lake is located in the Crowe River watershed which is a part of the Greater Trent River drainage basin. The headwaters of Crowe Lake originate just north of Paudash. Lake. From here, the Crowe River drains many small lakes and streams including Chandos, Cordova, Kasshabog, Round and Belmont Lakes before flowing into the west end of Crowe Lake. Plato Creek which drains a large marshy area originates just west of the Village of Havelock and enters the west end of Crowe Lake just south of the Crowe River. The sole outlet of the lake is the Crowe River which empties into the Trent River. Beaver Creek whose headwaters originate at Limerick Lake drains the eastern side of the Crowe River watershed and joins the outflowing Crowe River just beyond the east end of Crowe Lake.

Water Usage

Most of the cottagers use the lake as their source of domestic water supply. It is used for recreational purposes such as boating, fishing, water skiing and swimming. According to information available from the Ministry of Natural Resources, the lake offers a sport fishery of northern pike, maskinonge, smallmouth bass, and largemouth bass. Some of the dominant coarse fish in the lake are black bowhead, pumpkinseed, rock bass and white sucker. Plantings of at least 20,000 maskinonge fry per year have been carried on with some regularity since 1959.

At the present time, there are no direct discharges of raw or treated wastes into Crowe Lake from municipal or communal sewage treatment facilities. The area residents are now provided with a municipal refuse disposal site located on Lot 8, Concession V, Township of Marmora. According to information provided by our Waste Management Branch, this site is to be abandoned and will be replaced with an alternate site.

Shoreline Development

The shoreline of Crowe Lake is well-developed with the exception of the north and south shores of the west basin. There are approximately 340 summer cottages, 5 resorts, and 3 trailer camps on the lake (Figure 1). There are no urban communities on the lake but the Village of Marmora is located two miles down the river.

RESULTS AND DISCUSSION

Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the analysis of variance and Barlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas, or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

The water quality of Crowe Lake during the spring, summer and fall surveys was found to be satisfactory and well within the Ministry of the Environment Criteria for total body contact recreational use. (MOE 1973).

During the June survey, the western basin of Crowe Lake had considerably higher means than were encountered in the eastern basin (Figure 4). The western portion (Group A) had a total coliform mean of 156 TC/100 ml and fecal coliform, mean of 2 FC/100 ml while the eastern 'portion (Group B) had a slightly lower total coliform mean of 43 TC/100 ml and fecal coliform mean of 2 FC/100 ml. Fecal streptococcus concentrations were similarly higher in the western basin (Group A, 16 FS/100 ml) than in the eastern basin (Group B, 1 FS/100 ml). Station 3 near an area of moderate cottage development on the western shore had higher fecal coliform means than elsewhere on the lake. This may indicate a minor bacterial pollution source.

Crowe Lake in the month of August had an overall total coliform mean of 12 TC/100 ml with the exception of the centre of the eastern basin and a moderately cottaged area on the south-eastern basin (stations 19 and 11) which had slightly higher counts (Figure 5). The lake was homogeneous and low for fecal coliform and fecal streptococcus with respective means of 1 FC/100 ml and 2 FS/100 ml.

During the September survey the eastern basin (Group A) had a higher total coliform mean of 555 TC/100 ml while the western basin (Group B) had a mean of 182 TC/100 ml (Figure 6). Fecal coliform showed a geometric mean of 1 FC/100 ml for the lake with the exception of the outflow of the Crowe River and the extreme south shore of the eastern basins (stations 1 and 10), but these were not significantly higher.

Standard Plate Count analysis was performed on the mid-lake areas of both the eastern and western basins (stations 2 and 9) during the three surveys to give indications of overall bacterial populations on the lake. The geometric means of these tests over the survey revealed bacterial levels in the range of 1014/100 ml to 3455/100 ml.

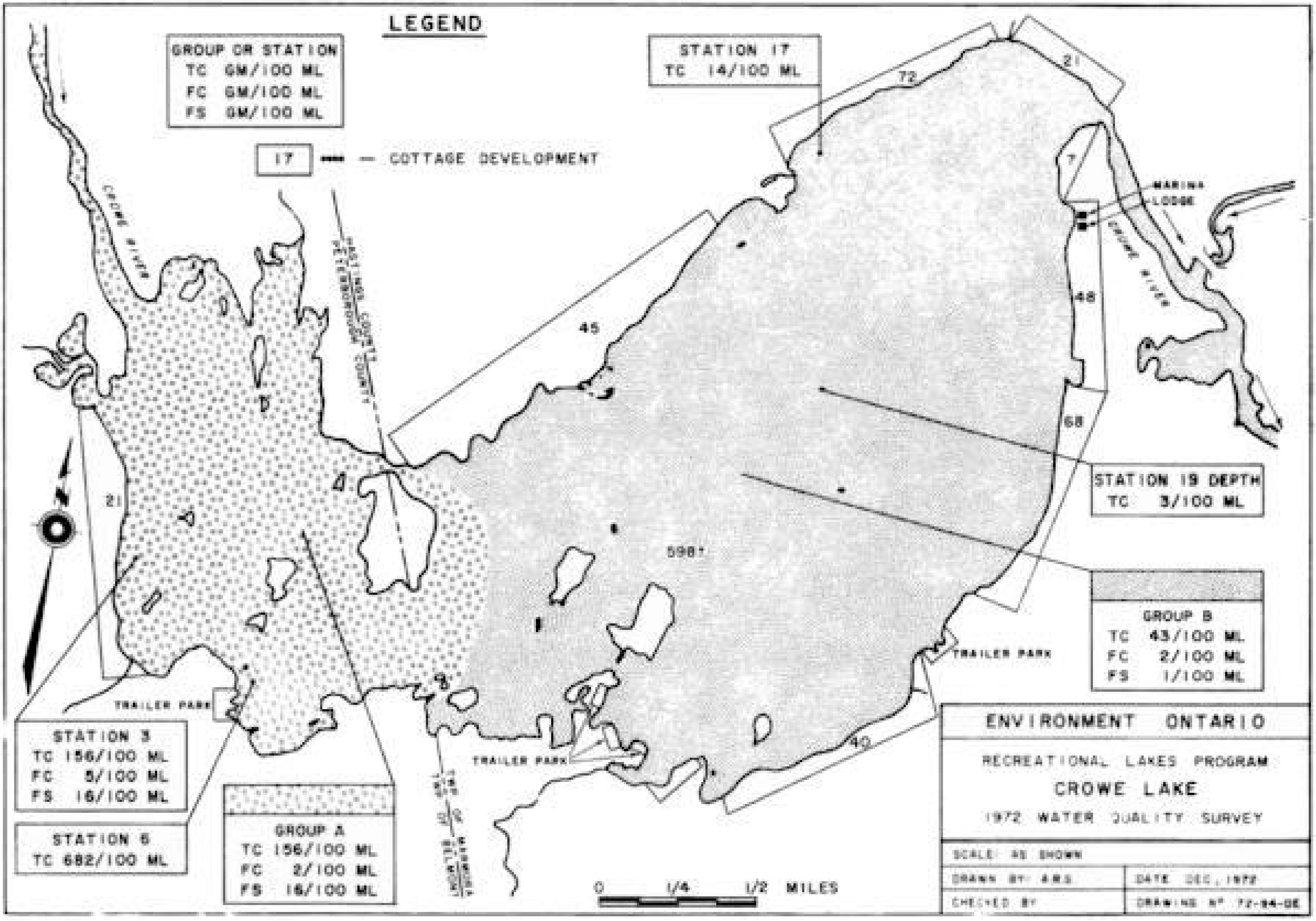

FIGURE 4: Distribution of Bacteria in June.

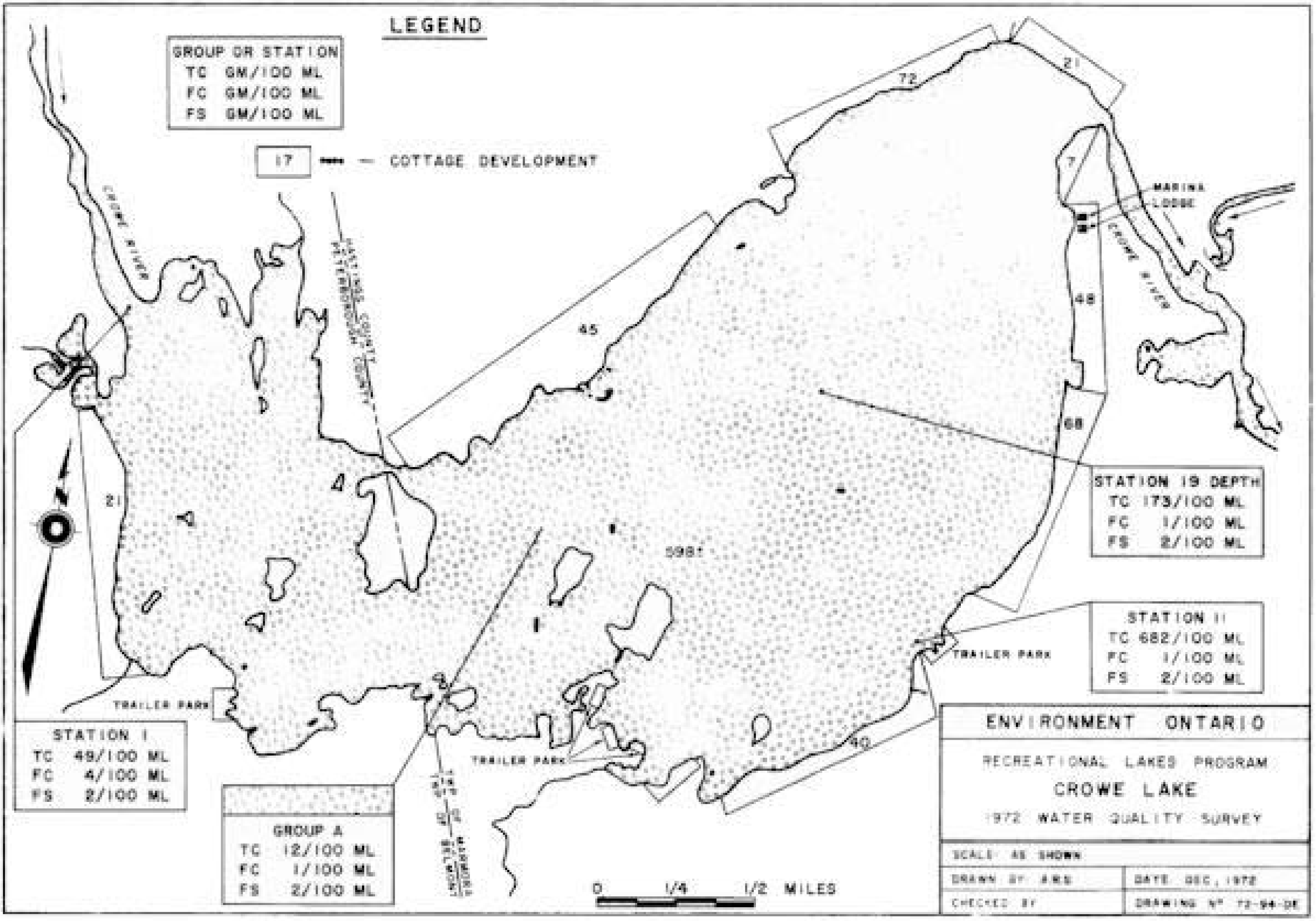

FIGURE 5: Distribution of Bacteria in August.

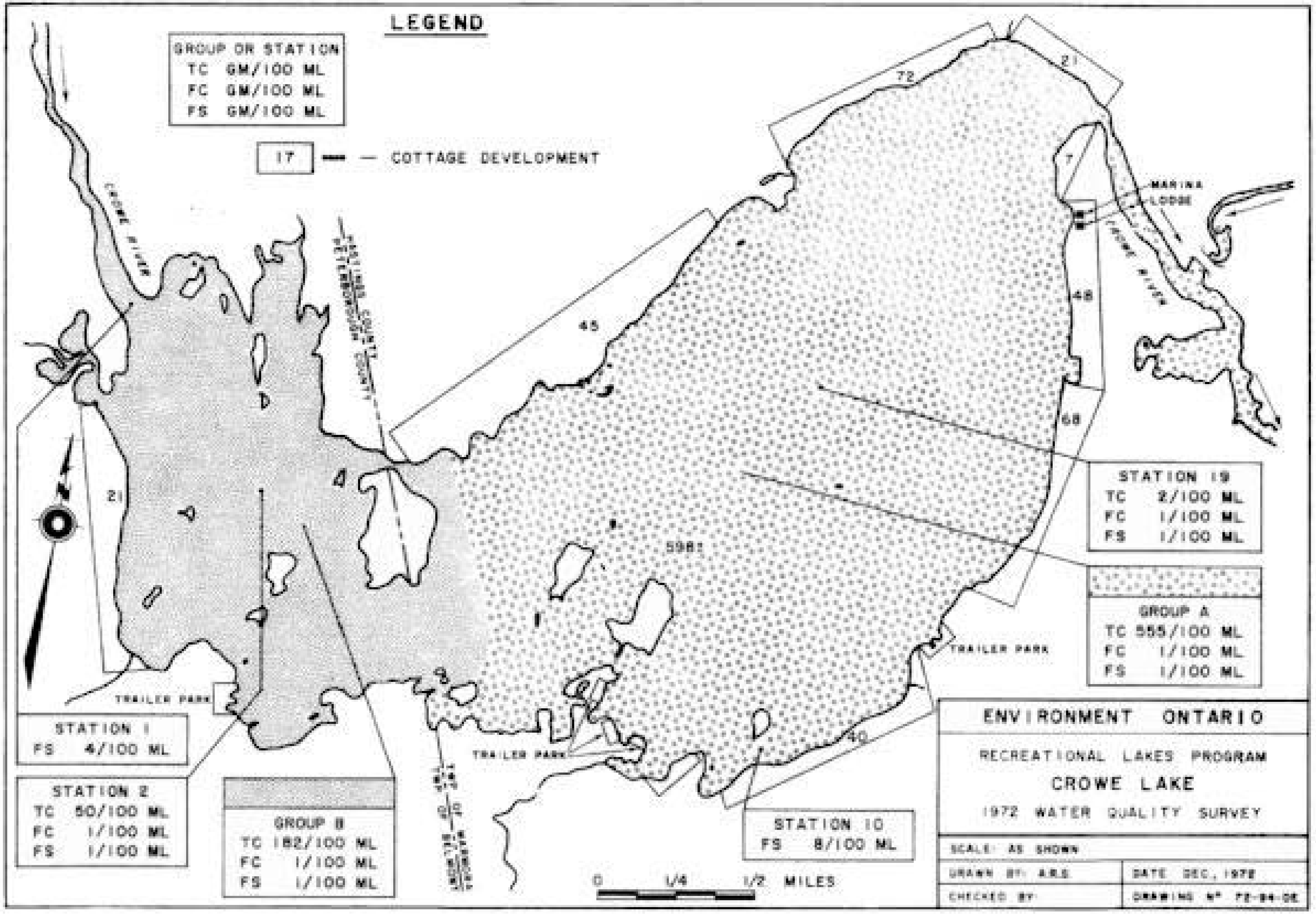

FIGURE 6: Distribution of Bacteria in September.

No rainfall was recorded at the Campbellford meteorological station for the periods prior to and during the August and September surveys. Although some rainfall was noted during the June survey, it had no apparent effect on the bacterial status of the lake.

Secchi Disc and Chlorophyll a Correlation

Chlorophyll a levels were low throughout the entire body of Crowe Lake, never exceeded 4.1 µg/L and averaged 1.7, indicating low fertility probably as a result of the low average total phosphorus content of 16 µg/L .

On a scale of lake enrichment as indicated by chlorophyll a concentrations and water transparency (Figure 7), Crowe Lake is similar to Balsam and Cameron lakes, two relatively clear water lakes and is far removed from such highly enriched waters as the Western Basin of Lake Erie, Lake Scugog and the Bay of Quinte.

Chemistry

The mineral content of Crowe Lake showed small but consistent variations, increasing slightly from June to September, and increasing within the lake in a "downstream" direction as shown in the following table. The June results for the bottom water at Station 19 in the eastern basin depart from this trend by a small margin, and showed the lowest mineral content of any sample. This probably results from the entry of cool dense water flowing from subterranean springs which drain the hard rock area to the north of this section of the lake. On the other hand, the western basin showed high results at the surface in September. This is probably due to an inflow of warm water from Plato Creek, which would have a high basic mineral content derived from the limestone bedrock and soils of the area which this creek drains. This would be increased by the low rainfall and high evaporation rates characteristic of late summer.

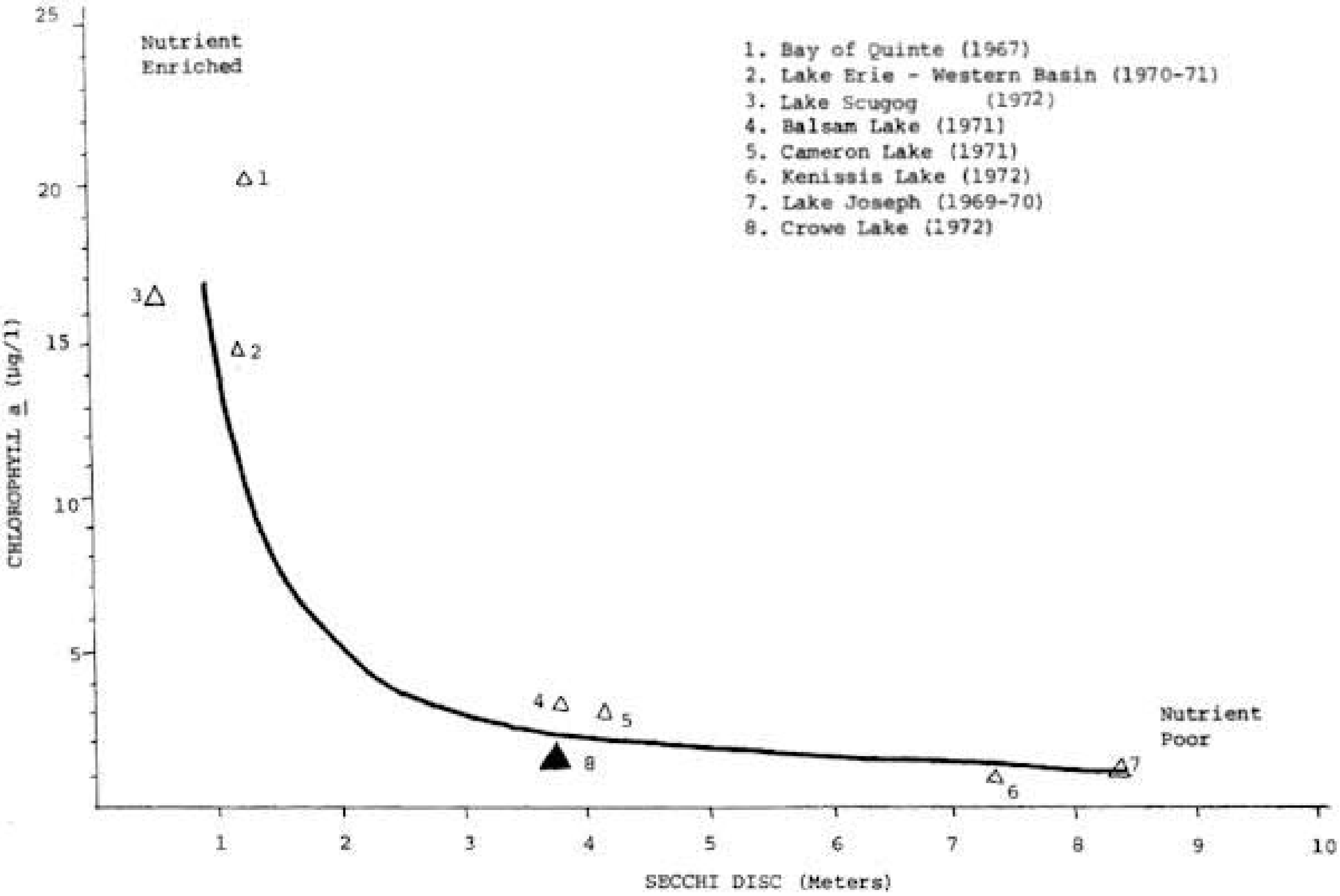

Figure 7: The mean of chlorophyll a and Secchi disc measurements in Crowe Lake relative to a curve describing the chlorophyll a - Secchi disc relationship in many Ontario lakes. Seven other well known lakes are included for comparison with Crowe Lake.

Average Values	Inflowing Crowe River		Western Crowe Lake Station 2 Surface		Eastern Crowe Lake Station 19 Surface		Outflowing Crowe River	
Survey	June	Sept.	June	Sept.	June	Sept.	June	Sept.
Hardness as $CaCO_3$, mg/L	76	76	72	87	76	80 (69- bottom)	79	81
Alkalinity as $CaCO_3$, mg/L	55	60	58	73	58	66 (51- bottom)	57	66
Conductivity µmhos/cm^3	143	159	150	180	147	168 (139- bottom)	147	167

Rivers such as the Crowe which drain Precambrian Shield areas of insoluble hardrock, are usually quite soft and low in mineral content. As they flow into and through limestone areas, such rivers become progressively harder with a higher mineral content since limestone is fairly soluble. In the case of Crowe Lake, the adjacent limestone based drainage area to the south is fairly small, and contributes only a minor increase in minerals to Crowe River as it passes through Crowe Lake.

Chloride content remained relatively constant at all stations, ranging from 3 to 5 mg/L.

The temperature and dissolved oxygen profiles at stations 2 and 19 (Figures 8 and 9) were characteristic of lakes with moderate depth which drain Precambrian watersheds. Temperature stratification was well established by late June, arid bottom dissolved oxygen (DO) levels had been depleted to 4 to 5 mg/l. By late August, the lowest depths were almost devoid of oxygen, with only 0.1 mg/L measurable in the bottom 2 meters at Station 2 and the bottom 5 meters at Station 19. The conversion of the lost dissolved oxygen to carbon dioxide by bacterial decomposition processes was confirmed by decreased pH values at the bottom. In August, pH in surface samples at stations 2 and 19 measured 8.1 and 8.0, while depth samples at the same stations showed pH values of 7.1 and 7.5 respectively. By mid-September the fall overturn (for explanation, see page A-7) had occurred, earlier than in most deeper lakes, temperature was uniform from top to bottom and the DO depletions in the bottom waters had been almost entirely overcome.

The only evidence of nutrient recycling was observed in a sample collected close to the bottom at Station 2 on June 25. Both the total values (iron, phosphorus, and Kjeldahl nitrogen) and the soluble forms of phosphorus and nitrogen were higher than in any other sample from Crowe Lake. A further sample, collected on June 29, at slightly less depth, showed none of the same signs.

While the dissolved oxygen in the deep waters returned by mid-September, it should be noted that two to five meters of the deepest water was rendered un-inhabitable for fish in August. Discharges or organic wastes, or of nutrients which could sponsor additional algae and aquatic plant growth, and thereby additional decomposition of such material once it settled to the bottom, is likely to accentuate the severity and extent of the oxygen depletion in Crowe Lake.

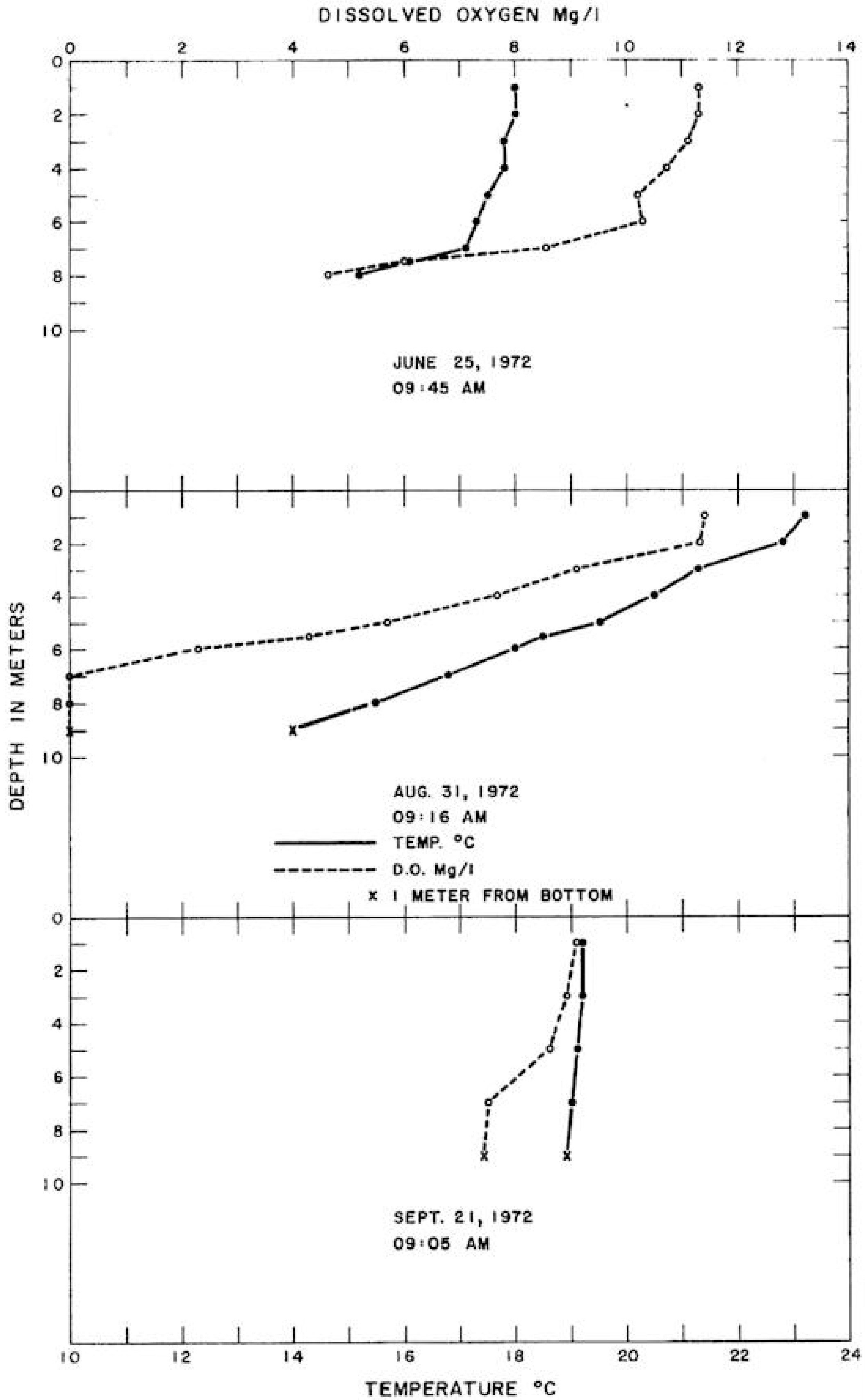

FIGURE 8: Dissolved Oxygen And Temperature Profiles At Station 2, Crowe Lake**.**

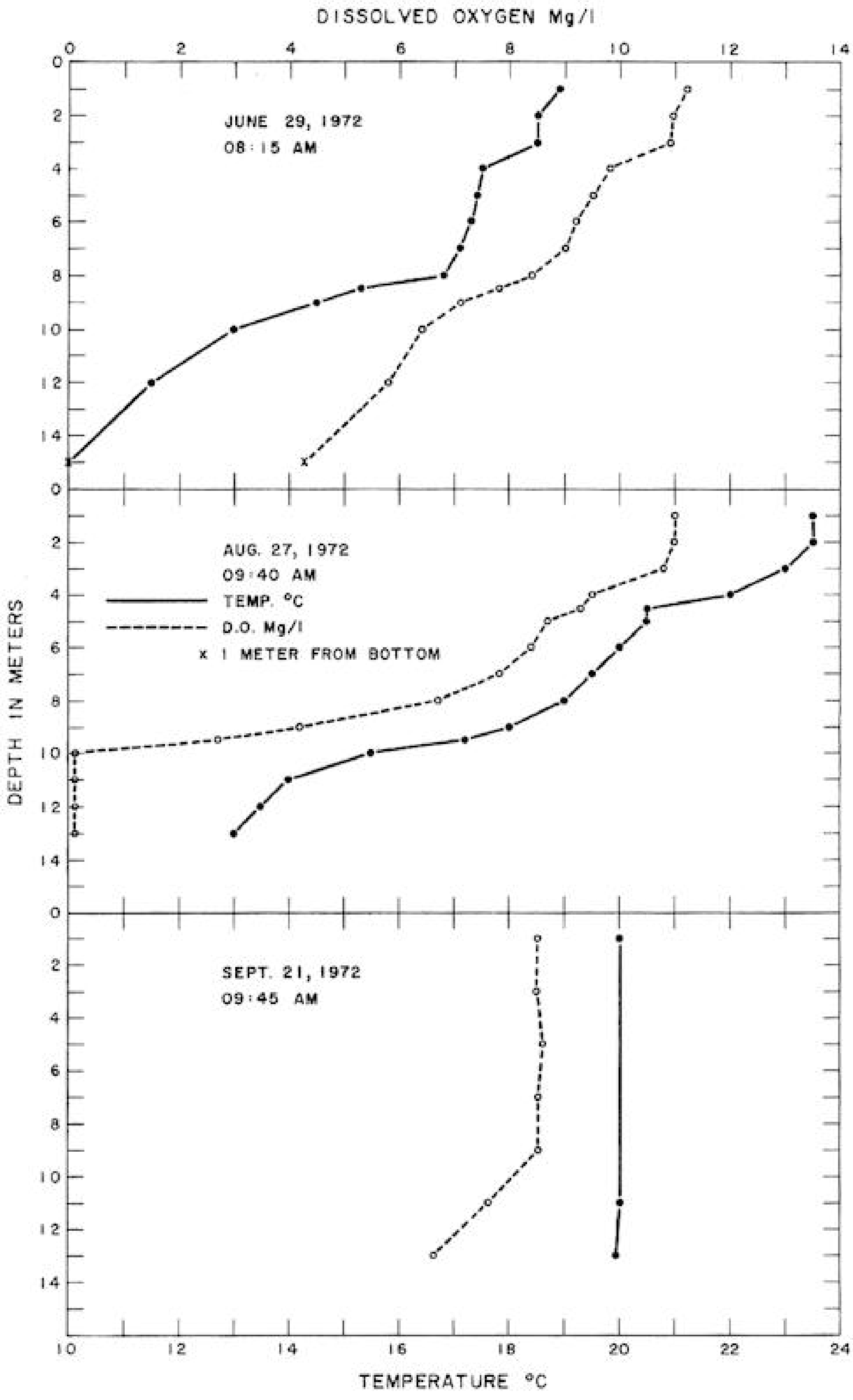

FIGURE 9: Dissolved Oxygen And Temperature Profiles At Station 19, Crowe Lake.

INFORMATION OF GENERAL INTEREST TO COTTAGERS

MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria does not change the appearance of the water but pose an immediate public health hazard if the water is used fro drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborne infections such as typhoid fever, polio or hepatitis, but he may catch less infections of gastroenteritis (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These viral infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic matter in the lake will be used as food by these organisms and will give rise, in turn to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amounts of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems, can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling
Boil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5 ¼% Available Chlorine
Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination
For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment
Well water can be disinfected using a household bleach (assuming strength at 5% available chlorine) if the depth of water and diameter of the well are known.

	CHLORINE BLEACH per 10 ft depth of water	
Diameter of Well Casing (in Inches)	One to Ten Coliforms	More than Ten Coliforms
4	0.5 oz.	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water. Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites) . Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful, Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

- 50 feet to any well, lake, stream or pond.
- 5 feet to any building.
- 10 feet to any property boundary

The tile field should not be closer than:

- 100 feet to the nearest dug well.
- 50 feet to a drilled well which has a casing to 25 feet below ground.
- 25 feet to a building
- 10 feet to a property boundary.
- 50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment arc capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,
5. in the case of storage devices, be equipped with the necessary pipes and fittings

conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1½ inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. Fuel hoses must be in good condition and all connections tight.
4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.
5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".
7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscriminate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form.

The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with boating and swimming and ultimately diminish shoreline property values.

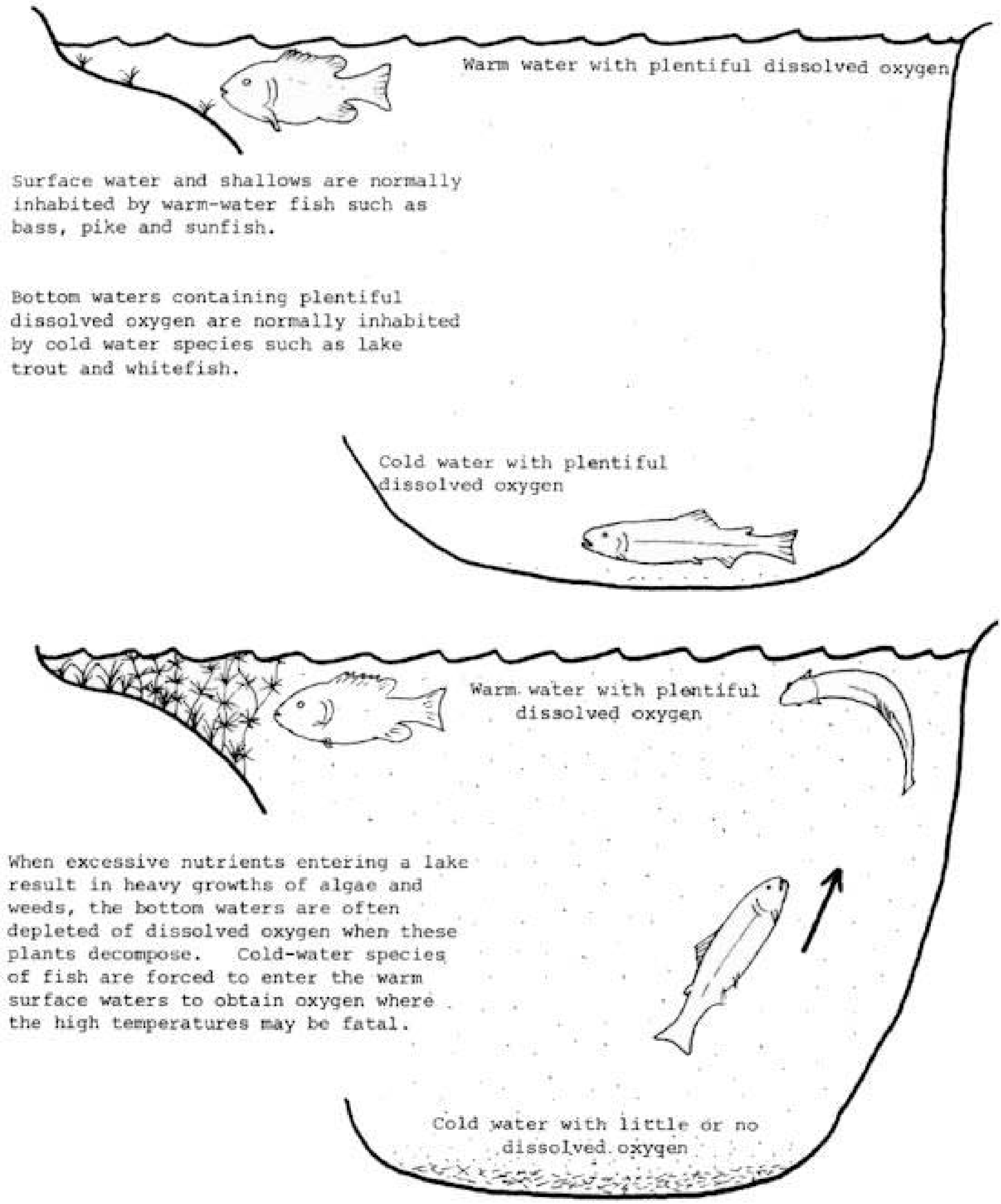

FIGURE A-1: Decomposition of plant matter at the lake bottom can lead to death of deep-water fish species.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation.

Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of' liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater-treatment plants by December 31, 1973, in the most critically affected areas of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975.

The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extremely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.