# ECOLOGICAL STUDY

# OF

# WHITE LAKE

(Renfrew and Lanark Counties)

1976

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# I N D E X

# ABSTRACT

This study, with its ecological approach, provides a firm foundation for monitoring the status of White Lake. Emphasis is placed on aquatic macrophytes, zooplankton and shoal sampling because of their important functions in regard to the pickerel fishery here.

The pondweeds as a whole, constituted a major portion of the plant types. But milfoil was found to be the most abundant and most frequently encountered species on White Lake.

Both phytoplankton and zooplankton showed good species diversity for the time of year that the samples were taken (late August).

Shoal sample analysis provided the most interesting clue to White Lakes problem with the pickerel fishery. This study indicates that the presence of calcareous benthic blue-green algae on the spawning shoals has reduced the spawning potential of pickerel. The encrustations of these algal mats on the spawning beds are strongly implicated in the drastic decline of the pickerel fishery in this lake.

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# INTRODUCTION

White Lake is defined as "early eutrophic" by the Ministry of the Environments Enrichment Status of White Lake report (Michalski, 1972) using secchi disc and chlorophyll _a_ parameters. The follow-up studies by M.O.E. (Robinson, 1973; Robinson 1974) confirmed their earlier findings using these same indices.

Reviewing the criteria for useful indices of eutrophication:

(1) _Discriminate_ or have the ability to distinguish between changes associated with nutrient levels and other categories of environmental change

(2) _Sensitivity_ to levels of enrichment for anticipatory purposes ie., indicator organisms (present or absent)

(3) _Ubiquitous_ or widespread among aquatic environments but short-lived and sensitive to enrichment levels and

(4) _Simplicity_ to provide easy long-term surveillance and monitoring.

It becomes obvious that few methods or indices used fit the bill. Therefore, it is often necessary to use a combination of methods that best suit a particular lake. When one examines the methods presently used, in view of their limitations, one can best judge the one or combinations best suited for a given lake.

Oxygen budget studies for example lack ubiquity for it is only applicable to deep stratified lakes. White Lake has a mean depth of 3.4 metres and does not stratify. There is no

Transparency or using the secchi disc is limited because it does not discriminate between suspended particles - organic or inorganic material.

Morphometric indicators such as sedimentation or rounding out of a lake as it matures is more or less applicable on a long-term basis and cannot be used for immediate feedback as to a lakes status, especially if accurate historical data of this nature is lacking, as is the case with most lakes, including White Lake. Paleolimnology however, is very promising.

Nutrients and associated ions, such as phosphates and sulphur, as indices are quite ubiquitous measures but lack that important quality of simplicity of application and interpretation.

Biological indicators are good but there are too few ubiquitous species available for use.

Productivity simply measures the rate of carbon fixation. Chlorophyll _a_ is an indirect measure of productivity. But both measures merely reflect one trophic level or primary production. Therefore, its scope as anticipatory or predictive is somewhat limited.

Diversity and stability measures, on the other hand, utilize population distribution and size. It has been found to be both useful and sensitive. It is perhaps the best method for White Lake.

This report is intended to provide a broader baseline point of reference from which to gauge White Lake in regard to diversity, and for future comparisons, stability index for measuring the degree of trophic change due to enrichment of the aquatic environment. This is presented as opposed to secchi disc reading or chlorphyll a data which is provided by M.O.E. and may be used in conjunction with this index. (Appendix I).

Generally speaking, continuing enrichment, ensuing eutrophication, reduces the diversity of the aquatic environment.

In fact one of the reasons for undertaking an aquatic study in this lake was because the pickerel population had drastically declined within the last fifteen or so years, with a concurrent species shift toward largemouth bass and pike (Thomas, 1974).

The age class structure of pickerel now leans heavily toward the older classes and from creel census data when compared with stocking of pickerel eyed-eggs indicate little if any recruitment.

It is thought that such a broad study as is this, might reveal specific causes for the pickerel decline, or at least give direction for remedial action to reinstate the pickerel fishery here, if at all possible. If not, then justification will be apparent for discontinuing pickerel eyed-egg plantin

An attempt is made then, to document for 1976, the degree of diversity encountered on White Lake. Emphasis is placed on aquatic macrophytes and zooplankton in consideratio of their role in the ecology of the aquatic environments, especially in relationship to the pisces fauna. This information, in conjunction with shoal condition monitoring, will assist in predicting whether and when lake conditions again become suitable for pickerel.

## Lake Description

The exact location, physical data, origin of name, fish species present, access and other characteristics of White Lake is contained in an attachment to White Lake Map (Appendix III). This map shows some of the lakes more obvious morphometric parameters.

White Lakes morphometric characteristics namely, shallow basin (90.3% littoral zone), major swamp areas, irregular and rocky shoreline, extent of shoreline (61 miles), high shoreline development factor (5.73), moderately level and thin soiled surrounding land area, only four small permanent inlets and one outlet, all combine to produce a natural low flushing rate. Add to this an efficient dam that maintains contrived water levels year round as well as increasing development (462 cottages; a density of one cottage per 12 surface acres - 1976), and it becomes obvious that the lake has a high susceptibility to cultural eutrophication.

<u>History</u>

The following is an abbreviated history of White Lake in regard to dams, fish introductions, spawning improvements, and biological studies conducted here; commencing in 1921 when pickerel were first introduced into this water.

1921: - 100,000 yellow pickerel eyed-eggs introduced

1924: - 5,000 smallmouth bass fingerlings introduced

1948: - dam at outlet on Waba Creek (originally built in 1845) was rebuilt for logging purposes

1957: - 5,000 largemouth bass fry introduced

1959: - Biological Report on White Lake (Littkemann, 1959)

1968: - 15,000 Maskinonge fry introduced

1969: - Preliminary Lake Inventory (Storr and Beduhn, 1969)

- White Lake Trap Net Study - two weeks (Ellah, 1969)
- Summer Creel Census (Pratt, 1969)

1970: - Department of Lands and Forests - control dam on Waba Creek outlet reconstruction

1972: - Intensive summer creel census (Pratt, 1972)

- Stream improvement on Darling Long Lake Creek (Raycrof Creek)
- Secchi disc and chlorophyll <u>a</u> determination (Michalski 1972)

1973: - Enrichment Status of White Lake (Robinson, 1973) on Bacteriological Examinations, Secchi disc and Cholorophyll <u>a</u> determinations

1974: - Tntensive summer creel census (Thomas, 1974)

- Artificial shoal construction and observations
- Secchi disc and chlorphyll a determinations as part of the - Enrichment Status of Fourteen Lakes in Southeastern Region of Ontario (Robinson, 1974).

Stream improvement took place in 1972. The major inlet, Darling Long Lake Creek, was enhanced for stream spawning by the removal of rubble and debris. The beaver dams on Fish Creek (southwest end of Sector I) were dynamited to produce favourable stream spawning conditions.

The present dam, as noted above, was reconstructed in 1970 to control water levels. The previous dam at this same site on Waba Creek, had been built for the purpose of logging timber downstream. This process was contingent on weather conditions and built up water levels. The stop logs in the dam were released and the logs rushed downstream to the mill with the unrestricted outflow. However, no affect on water fluctuation levels was apparent, as this operation was of short duration (Littkemann, 1959).

The old dam was very inefficient in controlling water levels. But, as with many dams, this one seemed to have been surrounded by controversy. Local residents and tourist operators insisted that the yellow pickerel migrated downstream during the spring spawning and were unable to return to the lake after spawning, due to low water levels in Waba Creek (Ellah, 1969).

There is no record that this creek had ever served as a traditional spawning site. It would seem rather, that as the initial decrease in pickerel numbers was being felt, the dam may have merely provided a focus for blame for the decline of the pickerel population. However, it must not be discounted, in consideration of the relatively recent introduction of pickerel and consequent rapid increase in their numbers, followed by a subsequent rapid decrease, that some loss may have been attributed directly to the dams retarding influence on the spring Waba Creek level, assuming that is, that some fish did attempt to go downstream.

Also it must not be discounted, however ineffient this original dam was or appeared, that adverse affect on the flushing rate of the lake over the long term may have indirectly affected pickerel habitat in the lake. It must be remember that this dam was repaired in 1948 and thus for many years following the pickerel introduction and before this dams deterioration, controlled water levels on the lake.

However, Littkemann in his lake survey of 1959 reported "White Lake with its numerous stony-rocky shores and shoals in different dimensions provide very good spawning grounds for pickerel" and that the spawning shoals were in good shape. There was no indication then, that the shoals were exhibiting any apparent deterioration due to silting or other factors. And in fact the pickerel fishery at this time was so healthy that Littkemann was led to suggest "Even pike cannot favourably compete with large pickerel populations, thus heavier fishing

What a change this represents in contrast to the Thomas trap net study of 1974, in which he states "The data obtained in the present study confirms the rapid species shift which was initially indicated by Ellah in 1969. The 1959 game fish composition of 54.9% yellow pickerel has been reduced to 6.6% in 1964, while the northern pike component has risen from 24.1% to 46.5% and the largemouth bass from .2 to 37.9%". And in reference to spawning shoals, "Observations made during April, 1974 indicate that many of the old spawning shoals were covered with fine particulate matter. This could best be observed when an outboard motor stirred up clouds of this 'silt'".

White Lake has obviously undergone some very drastic changes within a relatively short period of time, changes which have radically altered the fish populations, most notably pickerel, and adversely affected the tourist industry dependent on this resource base.

## METHOD

The method used for the gathering of the aquatic macrophyte data for this report is basically that of the Lake Couchiching Study (Jones and Veal, 1972). The same field procedures, except for a few modifications, were employed in assessing macrophyte abundance and species composition.

No divers were used. Due to the shallow nature of most of the sampling stations and relative clarity of the water, it was felt an adequate assessment could be made from the boat.

When there was doubt concerning a species identification, a specimen was retrieved, preserved, and later keyed out, using Fassett (1969). The nomenclature used here is that of Fassett.

To facilitate collection and analysis of the data the lake was stratified into four sectors (Appendix III).

The macrophyte communities were assessed in terms of composition and abundance at 98 sampling stations between August 9th and 25th, 1976. The breakdown of stations by sector was as follows; Sector I - 23, Sector II - 24, Sector III - 28 and Sector IV - 23(Appendix III). The stations were arbitrarily chosen on a uniform basis throughout the lake to provide a complete coverage.

Each station was evaluated within a circle of approximately five meters in radius. The stations themselves were spaced at about .5 kilometer intervals.

A density rating was arrived at for each species at each station using the same code as used on Lake Couchiching and is as follows.

I - <u>Heavy growth</u>: plants formed continuous coverage over the sample area with little space between individuals.

II - <u>Moderate growth</u>: plants occurred in dense patches or clumps with large spaces between the clumps.

III - <u>Scattered growth</u>: scattered growth with varying distances between individuals. Perhaps the odd dense clump. More than 15 plants.

IV - <u>Occasional growth</u>: plants not common, usually less than 15 plants.

Plankton samples were collected with a shindler trap and preserved with lugos solution. Sampling took place on August 24th and 25th 1976. Both these days were calm, sunny with no overcast, 24°C.

Eight plankton samples were collected, two from each sector (Appendix III). They were taken between 1300 and 1600 hours at a depth ranging between 1.5 to 5 meters.

Shoal assessment took place between June 28th and August 3rd 1976. Evaluation of the shoals was accomplished by a shoreline cruise for each sector. The dimension of the shoal was first determined. The type of material making up the shoal was noted and the depth of sedimentation as well as the degree and type of biological growth was recorded.

Samples of the shoals were collected and frozen for later analysis of benthic flora and fauna.

Four sediment core samples were taken, one from each sector, on August 16th and 24th 1976. The core sampler took samples ranging from a depth of 3 to 6.25 meters into the sediment, either to the bedrock or maximum compression of sediment within the catch cylinder.

The rough data for this study was collected by two third-year student biologists working for the 'Summer Experience 76' program and under the supervision of the author. Both students were thoroughly framiliarized with the objectives of the study and sampling procedure. An aquatic plant collection of the various specimens to be found here was made. This was used for reference to augment the learning of the species on the lake. Collaboration in species identification and density coding was encouraged to minimize subjective error.

## RESULTS and OBSERVATIONS

All the families, genera and species of aquatic macrophytes found in White Lake in 1976 are listed in Table 1. Included is twenty-five species comprising twenty-one genera from seventeen families.

Some plants were only identified to the genera level (e.g. Utricularia, Scirpus, Eleocharus). The lack of fruiting bodies on these plants precluded further identification.

Table 2 lists the major aquatic macrophytes by their common name, the number of stations where they were found, their frequency of occurrence and abundance values. The means of arriving at these values is explained on the table itself. The plants are listed here in order of decreasing frequency of occurrence for the entire lake and as can be seen, this does not necessarily conform to their abundance.

APPENDIX V: White Lake Core Sampling - 1976

| Date | Sampling Station Location | Sample # | Depth [Metres] | Comments |
|---|---|---|---|---|
| August 16 | Sector I | 1 | 3 | - a rainy overcast day; 15.5$^{\circ}$C<br>- the lake was quite rough |
| | Sector III | 2 | 4 | - the lake was quite rough |
| August 24 | Sector IV | 3 | 6.25 | - a sunny day; 24$^{\circ}$C<br>- the lake was very calm<br>- muck was 1.5 m. compressed into cylinder<br>- sediment was deeper yet, than this |
| | Sector II | 4 | 3.25 | - sediment over rock, core sampler went right to bottom of deposit |

| sion of Shoal | | Deposition | Type of Material | | | | Comments |
|---|---|---|---|---|---|---|---|
| Depth (cm) | Width (m) | Depth (mm) | Rubble | Sand | Silt | Floc | Potential for Rehabilitation |
| 30.5 | .9 | | | | | | – no sample |
| 30.5 | 1.2 | 4mm of growth | X | | | | – growth less heavy |
| 70.0 | 1.5 | 4 | X | | | | – some growth, possibly artificial |
| 45.7 | 1.2 | | | | | | – no sample |
| 43.2 | 1.2 | | | | | | – no sample |
| 70.0 | 4.6 | 4mm of growth | | | | | – possibly artificial<br>– little growth, large, good to cle |
| 40.6 | 1.8 | 13mm of growth | | | | | –heavy growth |
| 30.5 | 1.2 | | | | | | – no sample |
| 76.2 | 3.0 | 12mm of growth heavy | | | | | –possibly artificial |
| 45.7 | 1.5 | | | | | | – no sample |
| 30.5 | .9 | | | | | | –actually quite clean; slight grow |
| 20.3 | 2.1 | 18mm of growth | | | | | – possibly artificial; heavy growt |
| 10.2 | 6.1 | 12mm of growth | | | | | – possible if accessible |
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Date: July 28 - August 3 WHITE LAKE SHOAL SAMPLING- 1976 SECTOR: IV Appendix IV

| Sampling Station # | Dimension of Shoal: Length (m) | Depth (cm) | Width (m) | Deposition: Depth (mm) | Type of Material: Rubble | Sand | Silt | Floc | Comments: Potential for Rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| 12 | 13.7 | 30.5 | 2.4 | | X | | | | - growth present |
| 13a | 60.9 | 40.6 | 2.4 | | X | | | | - a worthwhile spot being so large |
| 13b | 6.1 | 30.5 | .9 | | | | | | - not worthwhile, no sample |
| 14 | 10.7 | 152.4 | 3.0 | | | | | | - no sample<br>- very dirty & very deep but good area |
| 15 | 4.6 | 25.4 | 1.5 | 6 | X | | | | - not worthwhile, very thick growt |
| 16 | 12.2 | 30.5 | 3.0 | 6 | | | X | | - growth present |
| 17a | 13.7 | 25.4 | 1.5 | 3 | | X | | | - actually quite clean |
| 17b | 30.5 | 25.4 | 1.5 | | | | | | - no sample |
| 17c | 24.4 | 25.4 | .9 | | | | | | - no sample |
| 18 | 9.2 | 30.5 | 1.5 | | X | | | | - growth & twigs present<br>- possible area to clean |
| 19 | 36.6 | 15.2 | 2.1 | 8mm of growth | | | | | - heavy growth; also green growth |
| 20a | 15.2 | 45.7 | 1.5 | 6 | X | | | | - snails and growth present |
| 20b | 33.5 | 35.6 | 1.2 | 10mm of growth | | | | | - no sample |
| 21 | 7.6 | 15.2 | 3.0 | 12mm of growth | | | | | - heavy growth |
| 22 | 21.3 | 25.4 | 1.8 | | | | | | - heavy growth |
| 23 | 9.1 | 40.6 | 1.2 | 12mm of growth | | | | | - heavy growth |
| [illegible] | [illegible] | [illegible] | [illegible] | 12mm of growth | | | | | -heavy growth |

Date: July 28 – August 3 WHITE LAKE SHOAL SAMPLING– 1976 SECTOR: IV Appendix IV

| Sampling Station # | Dimension of Shoal: Length (m) | Depth (cm) | Width (m) | Deposition: Depth (mm) | Type of Material: Rubble | Sand | Silt | Floc | Comments: Potential for Rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 9.2 | 30.5 | 1.8 | | | | | | – not worthwhile; growth present |
| 2 | 15.2 | 25.4 | 1.5 | 6 | | X | | | – 5mm growth; good area to clean |
| 3 | 7.6 | 25.4 | 1.8 | 10 | X | | | | – growth present; very dirty |
| 4a | 9.2 | 20.3 | 1.2 | 6 | X | | | | – growth present |
| 4b | 18.3 | 20.3 | 1.2 | | | | | | – no sample |
| 5a | 7.6 | 30.5 | 1.8 | | X | | | | – really dirty<br>– snails and growth present |
| 5b | 12.2 | 45.7 | 3.0 | | | | | | – good area to clean; no sample |
| 6a | a9.2 | 84.6 | 1.8 | | | | | | – excellent spot to clean |
| 6b | 24.4 | 40.6 | 4.5 | | | | | | –excellent spot to clean; no sampl |
| 6c | 18.3 | 30.5 | 1.5 | | | | | | –excellent spot to clean; no sampl |
| 6d | 24.4 | 40.6 | 4.5 | 6 | | | | X | – growth present |
| 6e | 15.2 | 30.5 | 1.5 | | | | | | – no sample |
| 7 | 21.3 | 20.3 | .6 | | | | | | – growth present |
| 8 | 18.3 | 20.3 | .9 | | | | | | – growth present |
| 9 | 9,2 | 30.5 | 1.2 | | | | | | |
| 10 | 33.5 | 20.3 | 1.8 | 10 | | X | | | – good area to clean; quite large |
| [illegible] | [illegible] | [illegible] | 2.1 | | X | | | | –growth present, snails, moss, poss. |

| ...sion of Shoal | | Deposition | Type of Material | | | | Comments |
|---|---|---|---|---|---|---|---|
| Depth (cm) | Width (m) | Depth (mm) | Rubble | Sand | Silt | Floc | Potential for Rehabilitation |
| 35.6 | 1.2 | | | | | | - no sample<br>- growth present; good are a to cle |
| 35.6 | 1.2 | | | | | | - no sample<br>-growth present; good area to clea |
| 30.5 | 1.5 | | | | | | - no sample<br>- growth present; good area to cle |
| 45.7 | 1.5 | 10 | | | X | | - growth present; good area to cle<br>if accessible |
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Date: July 19 - 27    WHITE LAKE SHOAL SAMPLING- 1976    SECTOR: III Appendix IV

| ampling tion # | Dimension of Shoal Length (m) | Depth (cm) | Width (m) | Deposition Depth (mm) | Type of Material Rubble | Sand | Silt | Floc | Comments Potential for Rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| 30 | 18.3 | 22.9 | 1.2 | | X | | | | - growth present; maybe inaccessibl |
| 31 | 21.3 | 30.5 | 2.1 | 6 mm of heavy growth | | | | | - good area to clean & accessible |
| 32 | 36.6 | 30.5 | 3.0 | 6mm of heavy growth | | | | | - if accessible good area to clean |
| 3 | 21.3 | 20.3 | 1.8 | | | | | | - green growth; otherwise very cle |
| 34 | 51.8 | 40.6 | 1.8 | | X | | | | - green growth; otherwise very cle |
| 35 | 10.7 | 30.5 | 1.8 | | | | | | - clean and no sample |
| 36 | 30.5 | 25.4 | 1.8 | 4mm of growth | | | | | |
| 37 | 18.3 | 40.6 | 1.2 | 10 | X | | | | |
| 38a | 67.0 | 45.7 | 1.8 | | | | | | - heavy growth present |
| 38b | 30.5 | | | | | | | | - borderline shoal[rocks too big |
| 38c | 30.5 | 25.4 | 1.2 | 6mm of growth | | | | | - good area to clean maybe] |
| 39a | 9.2 | 66.0 | 1.8 | | | | | | |
| 39b | 4.6 | 20.3 | 1.2 | 8 | | | | X | - growth present; no sample |
| 39c | 24.4 | 38.1 | 3.0 | | | | | | - possibly artificial, no sample |
| 40 | 12.2 | 55.8 | 4.6 | 8mm of heavy growth | | | | | - very diry |

Date: July 19 - 27 WHITE LAKE SHOAL SAMPLING- 1976 SECTOR: III Appendix IV

| Sampling Station # | Dimension of Shoal: Length (m) | Depth (cm) | Width (m) | Deposition: Depth (mm) | Type of Material: Rubble | Sand | Silt | Floc | Comments: Potential for Rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| 17 | 18.3 | 25.4 | 1.8 | 8 of thick growth | | | | | - accessible & should be cleaned |
| 18 | 12.2 | 40.6 | 1.8 | | | | | | - no sample<br>- if accessible should be cleaned |
| 19 | 12.2 | 70.0 | 6.1 | | | | | | - no sample<br>- if accessible should be cleaned |
| 20 | 10.6 | 35.6 | .9 | 4 | X | | | | - too small to clean |
| 21 | 6.1 | 30.5 | 1.2 | 6 | X | | | | - not worthwhile |
| 22 | 9.2 | 30.5 | 3.0 | | | | | | - no sample |
| 23 | 10.6 | 20.3 | 1.5 | 4 | | | X | | - accessible |
| 24 | 15.2 | 30.5 | 1.8 | mm<br>4 of growth | | | | | -no sample |
| 25 | 21.3 | 30.5 | 1.8 | 4 mm of growth | | | | | - good area to clean |
| 26 | 30.5 | 40.6 | 3.0 | 6 mm of growth | | | | | - good area to clean<br>- once was a spawning area-5 yrs. |
| 27 | 33.5 | 45.7 | 1.8 | 6 | X | | | | - good area to clean, growth pres |
| 28 | 42.7 | 38.1 | 3.0 | 4 | X | | | | - good area to clean, growth pres |
| 29a | 54.9 | 40.6 | 1.5 | 3 | | | | X | - |
| 29b | 18.3 | 30.5 | 1.2 | | | | | | - inaccessible and no samples |
| 29c | 9.1 | 30.5 | 1.2 | | | | | | - inaccessible and no samples |
| 29d | 12,2 | 30.5 | 1.2 | | | | | | - inaccessible & no samples |
| | | | | | | | | | - inaccessible & no samples |

Date: July 19 - 27 m    WHITE LAKE SHOAL SAMPLING- 1976    SECTOR: III    Appendix IV

| Sampling Station # | Dimension of Shoal: Length (m) | Depth (cm) | Width (m) | Deposition: Depth (mm) | Type of Material: Rubble | Sand | Silt | Floc | Comments: Potential for Rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 48.7 | 24.5 | 2.1 | 2 | | | | X | - clean close to shore; good area |
| 2 | 57.9 | 35.6 | 1.5 | 1 | | | | | - slimy green growth; otherwise clean |
| 3 | 21.3 | 38.1 | 3.0 | 12 | | X | | | - growth present |
| 4 | 33.5 | 45.7 | 2.1 | 6 | X | | | | - heavy growth present |
| 5 | 6.1 | 22.9 | 3.0 | 6 | | | X | | - heavy growth present |
| 6 | 85.3 | 20.3 | 2.1 | | | | | | - looks artificial, heavy growth |
| 7 | 67.1 | 20.3 | 2.1 | 12 | | | | X | - one-half of this area is very dirty |
| 8 | 42.7 | 25.4 | 1.5 | | | | | | |
| 9 | 9.2 | 22.9 | 3.0 | 5 | | X | | | - growth present |
| 10 | 4.6 | 38.1 | 1.2 | 5 | X | | | | - quite clean |
| 11 | 9.2 | 30.5 | 1.2 | | | | | | - heavy growth [10mm] |
| 12a | 7.6 | 35.6 | 3.0 | 4 | | X | | | - |
| 12b | 12.1 | 20.3 | 1.5 | | | | | | - no sample |
| 13 | 9.2 | 30.5 | 1.2 | 6 | X | | | | - heavey growth |
| 14 | 27.4 | 22.9 | 1.8 | 6 | X | | | | - slight growth |
| 15 | 12.2 | 45.7 | 3.0 | | | | | | - no sample<br>- accessible & should be cleaned |
| 16 | 24.4 | 45.7 | 3.0 | 1 mm of thick growth | | | | | - if accessible should be cleaned |

Date: July 6 - 12 WHITE LAKE SHOAL SAMPLING- 1976 SECTOR: II Appendix IV

| ampling ation # | Dimension of Shoal Length (m) | Depth (cm) | Width (m) | Deposition Depth (mm) | Type of Material Rubble | Sand | Silt | Floc | Comments Potential for Rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| 13 | 18.3 | 182.9 | 2.1 | 4 | | | X | | - |
| 14 | 6.1 | 70.0 | 1.2 | 5 | | | | X | - relatively clean |
| 15 | 21.3 | 35.6 | 1.2 | 1 | | | | X | - relatively clean |
| 16 | 3.0 | 30.5 | 1.2 | | | | | | - no sample |
| 17 | 2.1 | 15.2 | 1.5 | | | | | | - crusty growth |
| 18 | 3.0 | 5.1 | .6 | | | | | | - no sample |
| 19 | 5.2 | 25.4 | .9 | 3 | | | | X | - if accessible ,a good spot |
| 20 | 4.6 | 20.3 | .9 | 3 | | | X | | - if accessible, a good spot |
| 21 | 10.6 | 38.1 | 3.0 | 2 | | | | | - crusty growth, snails present |
| 22 | 51.8 | 30.5 | 1.2 | 6 | | | | X | - crusty growth, snails present |
| 23 | 109.8 | 30.5 | 1.2 | 2 | X | | | | - very large area to clean<br>- crusty growth, snails, twigs |

Date: July 6 – 12 WHITE LAKE SHOAL SAMPLING– 1976 SECTOR: II Appendix IV

| ...mpling ...tion # | Dimension of Shoal: Length (m) | Dimension of Shoal: Depth (cm) | Dimension of Shoal: Width (m) | Deposition: Depth (mm) | Type of Material: Rubble | Type of Material: Sand | Type of Material: Silt | Type of Material: Floc | Comments: Potential for Rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 18.3 | 20.3 | .9 | 5 | | X | | | – possible |
| 2 | 3.0 | 20.3 | 1.2 | 2 | X | X | | | – not worthwhile |
| 3a | 36.6 | 35.6 | 1.2 | 3 | X | | | | –possible if accessible |
| b | 21.3 | 30.5 | .9 | 4 | | X | | | – Possible if accessible |
| 3c | 15.2 | 38.1 | 1.8 | 3 | | X | | | – possible if accessible |
| 3d | 15.2 | 38.1 | 1.2 | 5 | | X | | | – possible if accessible |
| 3e | 21.3 | 35.6 | 1.2 | 0 | | | | | – no sample |
| 4 | 16.8 | 25.4 | 3.0 | 15 | | | X | | – |
| 5 | 6.1 | 35.6 | 3.0 | 12 | | X | | | – crusty growth present |
| 6 | 3.0 | 35.6 | 3.0 | 0 | | | | | – very clean |
| 7 | 4.6 | 25.4 | 4.6 | 7 | X | | | | – possible artificial; accessible |
| 8 | 1.8 | 35.6 | 1.2 | 5 | | X | | | – not worthwhile |
| 9 | 3.0 | 33.0 | 1.5 | 7 | | | X | | – |
| 10 | 15.2 | 30.5 | 1.5 | 12 | | | | X | |
| 11 | 12.2 | 30.5 | 1.5 | 12 | | | | X | |
| 12 | 7.6 | 50.8 | 3.0 | 6 | | | | | – artificial skoal; crusty growth |

| Sampling Station # | Dimension of Shoal: Length (m) | Depth (cm) | Width (m) | Deposition: Depth (mm) | Type of Material: Rubble | Sand | Silt | Floc | Comments: Potential for Rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| 27 | 13.7 | 70.0 | 2.4 | 7 | | X | | | - possible |
| 28 | 3.1 | 50.8 | 3.0 | 5 | X | | | | - not worthwhile |
| 29a | 36.6 | 91.4 | 4.6 | 0 | | | | | - scattered growth<br>- actually quite safe |
| 29b | 48.8 | 70.0 | 4.6 1 | 1 | | | | | - very little covering |
| 29c | 21.3 | 55.9 | 3.0 | 12 | | | | | |
| 29d | 48.7 | 70.0 | 6.1 | 6 | X | | | | - twigs present |
| 29e | 106.7 | 40.6 | 3.0 | 5 | | | X | | - moss present |
| 30a | 21.3 | 70.0 | 3.0 | 3 | | | X | | - crusty growth |
| 30b | 9.1 | 45.7 | 3.0 | 10 | X | | | | - possible |
| 30c | 54.9 | 35.6 | 3.0 | 5 | X | | | | - possible if assessible |

Date: ~~July 5 – 6~~ WHITE LAKE SHOAL SAMPLING– 1976 SECTOR: I Appendix IV

| Sampling Station # | Dimension of Shoal: Length (m) | Depth (cm) | Width (m) | Deposition: Depth (mm) | Type of Material: Rubble | Sand | Silt | Floc | Comments: Potential for Rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| 17b | 33.5 | 35.6 | 1.2 | 3 | | X | | | |
| 17c | 15.2 | 68.6 | 1.2 | 7 | | X | | | |
| 18a | 12.2 | 25.4 | 1.5 | 6 | | X | | | – snails present |
| 18b | 9.2 | 25.4 | 1.5 | 2 | | X | | | – good spot to clean |
| 18c | 9.2 | 43.2 | 1.5 | 2 | X | | | | – good spot to clean |
| 19 | 12.2 | 58.4 | 3.0 | 4 | X | | | | – twigs present |
| 20 | 10.6 | 50.8 | .9 | 10 | | X | | | – good spot to clean |
| 21 | 6.1 | 48.3 | 6.1 | 7 | X | | | | – growth present but comes off easy |
| 22 | 12.2 | 45.7 | 1.5 | 2 | | | X | | – possible potential; little coverin |
| 23 | 7.5 | 38.1 | 1.2 | 1 | | | | | – mossy growth; otherwise very clea |
| 24 | 24.4 | 30.5 | .9 | 0 | | | | | – snails present; sample missing |
| 25a | 6.2 | 33.0 | .9 | 2 | X | | | | – snails present; sample missing |
| 25b | 12.2 | 30.5 | .9 | 2 | | | | | – mossy covering |
| 26a | 91.0 | 55.9 | 1.8 | 2 | | | | | – mossy covering; also snails & twig |
| 26b | 36.6 | 45.7 | 1.5 | 20 | | | | | – very dirty; twigs & dead snails |
| 26c | 4.6 | 30.5 | 1.8 | 12 | | | | X | – not worthwhile |

28–July 6, 1976 | 1976 | Appendix

| ...sion of Shoal | | Deposition | Type of Material | | | | Comments |
|---|---|---|---|---|---|---|---|
| Depth (cm) | Width (m) | Depth (mm) | Rubble | Sand | Silt | Floc | Potential for Rehabilitation |
| 40.6 | 1.2 | 12 | | | X | | – cedar sheltered shore |
| 25.4 | 1.2 | 4 | | | | | – snails present; very little covering |
| 30.5 | 1.5 | 4 | | | | | – very little covering |
| 30.5 | .9 | 4 | | | | | – very little covering |
| 30.5 | .9 | | | X | | | – snails present |
| 38.1 | .9 | | X | | | | – snails present |
| 55.8 | 1.2 | | | | | | – no sample |
| 38.1 | 1.5 | | | | | | – cedar overhang<br>– snails and twigs present |
| 55.8 | 1.2 | | | | | | – no sample; mossy covering |
| 70.0 | .9 | | | | | | – snails present |
| 70.0 | .9 | | | | | | – snails present |
| 45.7 | .9 | | | | | | – slimy covering; hard to remove |
| 45.7 | 1.2 | | | | | | – rust coloured growth covering |
| 70.0 | .9 | | | | X | | |
| 45.7 | 6.1 | 4 | X | | | | – crusty growth |
| 22.9 | 3,0 | 1 | X | | | | – snails present |
| 38.1 | 1.5 | 4 | | X | | | – crusty growth |

Apr dix IV
White Lake shoal and core
sampling - 1976.

Ministry of Natural Resources
Ontario

# WHITE LAKE

Counties of Renfrew and Lanark — Bagot, McNab, Darling and Pakenhan Townships

**PHYSICAL DATA**

| | | | |
|---|---|---|---|
| LATITUDE | 45° 18′ | LONGITUDE | 76° 31′ |
| SURFACE AREA | 5,608 acres | VOLUME | 60,953 acre feet |
| HEIGH ABOVE SEA LEVEL | 530 feet | PERIMETER | 60.8 miles |
| MAXIMUM DEPTH | 30 feet | MEAN DEPTH | 11 feet |

**ORIGIN OF NAME**
In 1862 this lake was recorded as Waba Lake. In the Johnston Royal Atlas dated 1860 it was shown as Wabak or White Lake. The origin of these names is unknown.

**LAKE CHARACTERISTICS**
This lake is relatively shallow with the result that thermal stratification does not usually occur. The water temperature varied from 78°F at the surface to 70°F at the bottom at the time of the survey. Dissolved oxygen at the surface was 8 parts per million. The water is neutral with a pH of 7.6.

The total dissolved solids reading was moderately high at a value of 130 parts per million. This value along with a large area of shallow water and numerous aquatic plants indicates a productive lake.

The water is light green with a Secchi disc reading of 10 feet.

**FISH SPECIES PRESENT**
Northern pike, yellow pickerel, smallmouth bass, largemouth bass, maskinonge (stocked for the first time in 1968), rock bass, white sucker, bluntnose minnow, creek chub, brown bullhead, yellow perch, pumpkinseed, golden shiner, banded killifish, bluegill, common shiner, blacknose shiner, American eel, fathead minnow, northern redbelly dace, brook stickleback.

**FISHING**
Angling success for yellow pickerel and northern pike is fair. Largemouth bass fishing is considered good. Panfish angling is excellent.

**ACCESS AND FACILITIES**
Hotel, motel and camping facilities are available in and around Perth.

White Lake is one of the larger lakes in Lanark County, located on the northern boundary of it. To reach the lake leave Highway No. 7 at Perth and turn onto County Road No. 1. Follow this road north to Highway No. 511, then travel north again on Nighway No. 511 to a road that turns east to White Lake. The distance from Perth to the turn-off to the lake is approximately 30 miles and the access road is indicated by a sign which states "White Lake 2 Miles." There is a public boat launching ramp at this access point.

SURVEY DATE
July 21 – August 6, 1969.

THE ABOVE INFORMATION IS VALID AS OF AUGUST 1969.
CONDITIONS ARE SUBJECT TO CHANGE.

COPIES OF THIS MAP ARE AVAILABLE AT LOCAL MINISTRY OF NATURAL RESOURCES OFFICES.

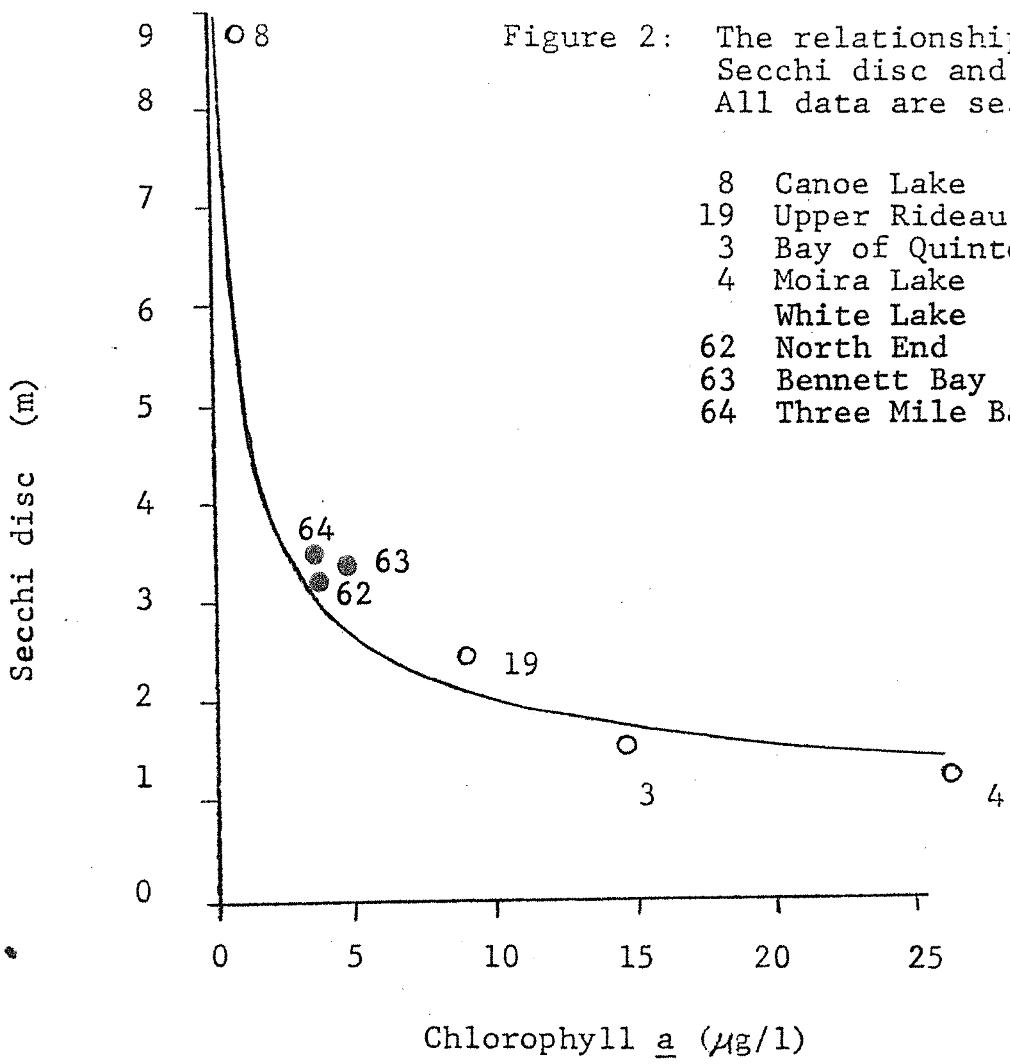
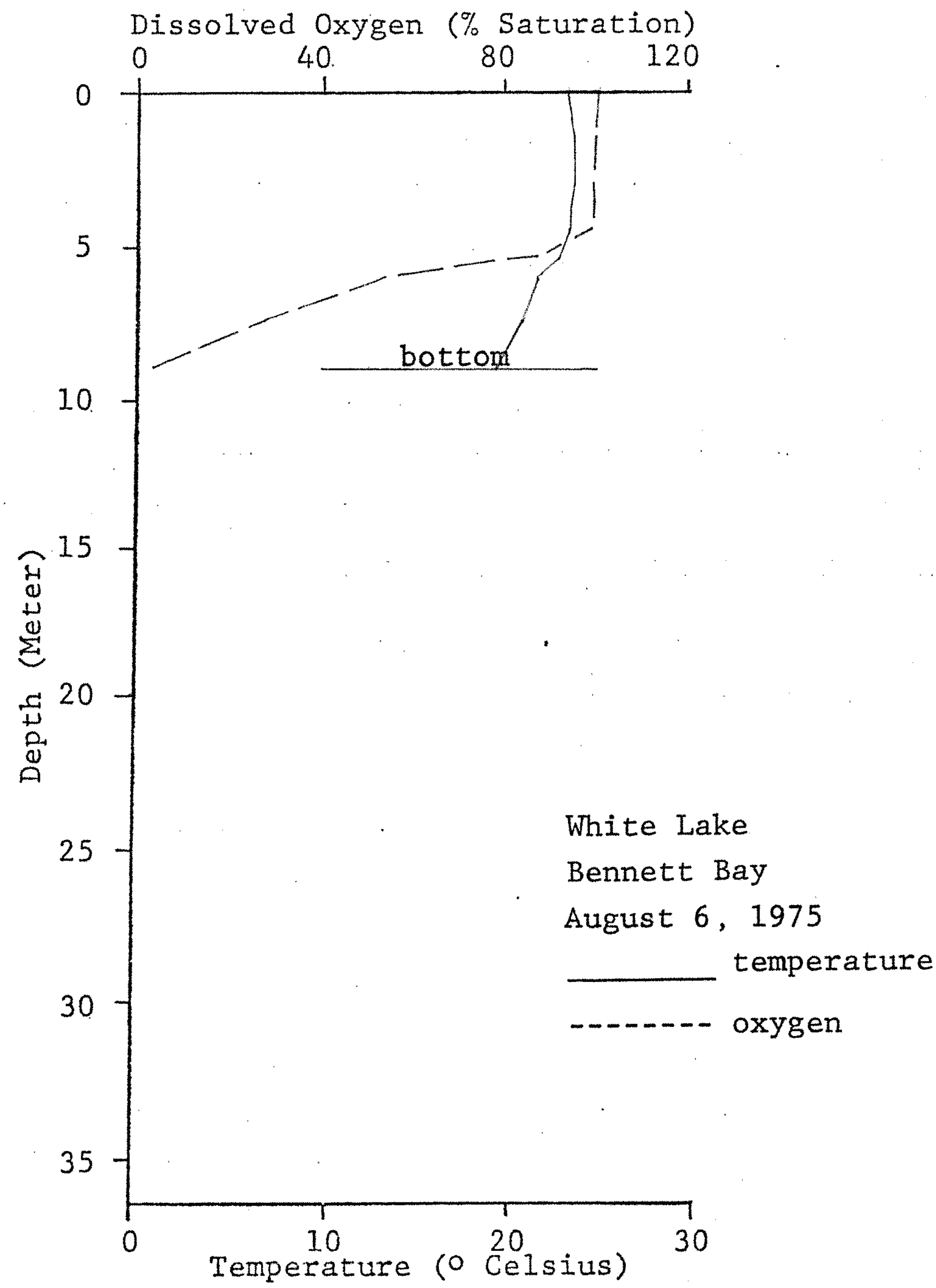



Figure 2: The relationship between Secchi disc and chlorophyll a. All data are seasonal means.

| | | |
|---|---|---|
| 8 | Canoe Lake | 1975 |
| 19 | Upper Rideau Lake | 1975 |
| 3 | Bay of Quinte | 1974 |
| 4 | Moira Lake | 1972 |
| | **White Lake** | |
| 62 | North End | 1975 |
| 63 | Bennett Bay | 1975 |
| 64 | Three Mile Bay | 1975 |


Dissolved Oxygen (% Saturation)
0
40
80
120
0
5
10
15
20
25
30
35
Depth (Meter)
bottom
White Lake
Bennett Bay
August 6, 1975
temperature
oxygen
0
10
20
30
Temperature (o Celsius)

MOE - MNR LAKE DATA SHEET

FISHERIES COMPONENT

LAKE NAME WHITE LAKE

DISTRICT Lanark

## 1. ANGLING SUCCESS

| SPECIES | C.U.E. | | Calculated Harvest lbs/Ac./yr. |
|---|---|---|---|
| Pickerel | .004 Av. | 1.5 lb. | .08 |
| Bass (L.M. & S.M.) | .08 | 1.0 lb. | 1.14 |
| Pike | .08 | 1.5 lb. | 1.72 |
| Pan fish | .81 | .3 lb. | 3.4 |
| | | | |
| | | | |
| | | | |
| | | | |
| TOTAL ALL SPECIES | .97 | | |

## 2. FISHING PRESSURE

| | ROD HOURS Per Yr. | Per Acre | Tot. |
|---|---|---|---|
| By Cottagers | 20,000 | 3.57 | |
| By Tourist Camps | 48,000 | 8.58 | |
| By Day Users | 12,000 | 2.15 | |
| TOTAL | 80,000 | 14.3 | |

## 3. MANAGEMENT SUMMARY

Stocked with pickerel eyed-eggs 1963 to 1967, 1 million per year. Muskellunge stocked 1963 to 1971 from 1500 to 40000 f. Trap-net studies 1959 & 1969, creel programs in 1972 and 197 Crash in pickerel C.U.E. from 1959 till present. Artificial shoals made & streams improved for pickerel also water level manipulated. Fish & Game clubs introduced pickerel fry in 1 (213) and 1976 (10,000).

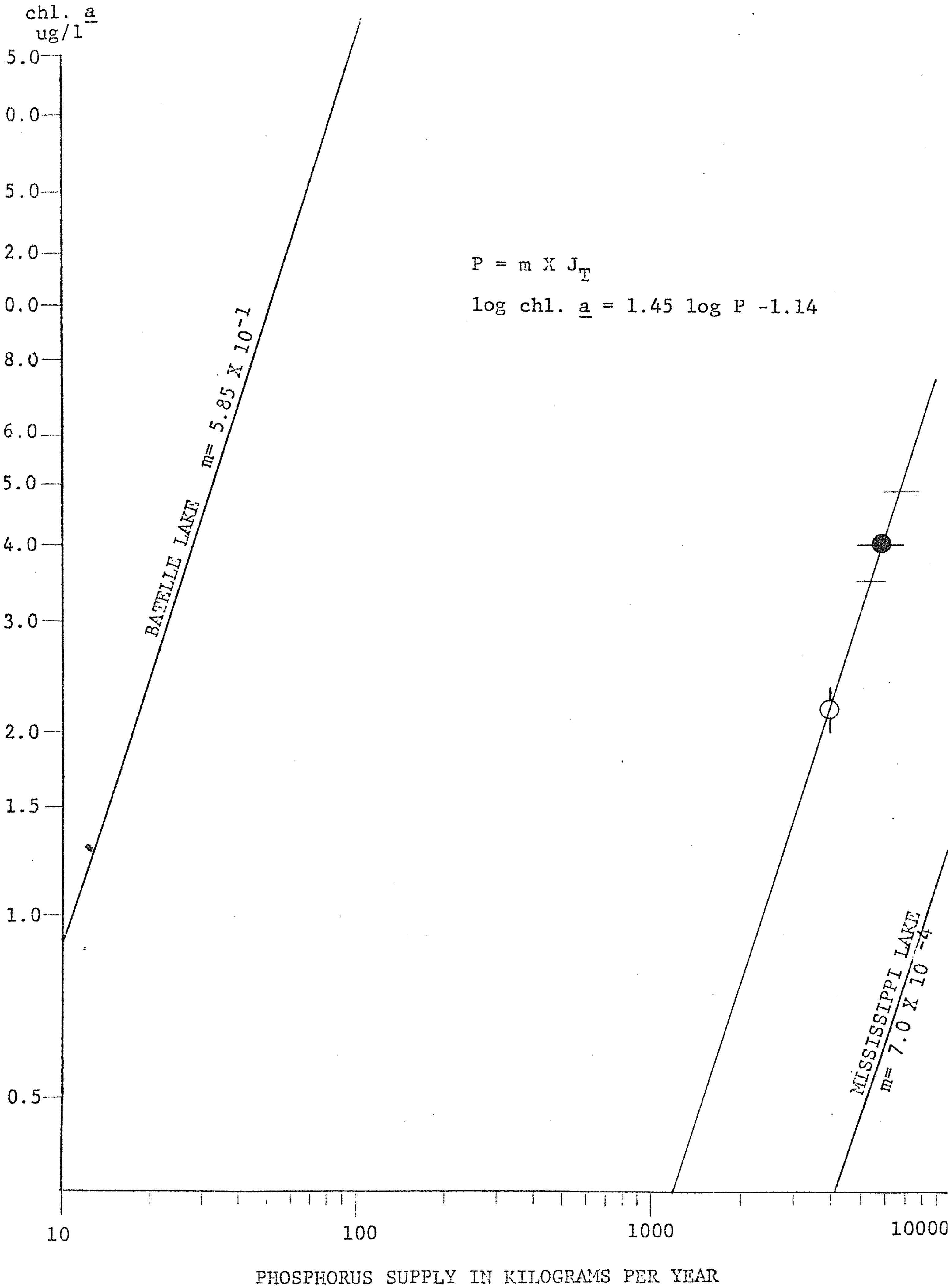
## 4. FISHERIES MANAGEMENT OBJECTIVES

To improve the quality of the fishery by increasing the C.U.E of pickerel to .02.

## 5. PRODUCTIVITY (Ryder Index)

$$2\sqrt{\frac{T}{D}} = 2\sqrt{\frac{130}{11}}$$

$$= 6.86 \text{ lbs./Ac./yr.}$$


chl. a ug/1
5.0
0.0
5.0
2.0
0.0
8.0
6.0
5.0
4.0
3.0
2.0
1.5
1.0
0.5
P = m X J_T
log chl. a = 1.45 log P -1.14
BATELLE LAKE m= 5.85 X 10-1
MISSISSIPPI LAKE m= 7.0 X 10 -4
10
100
1000
10000
PHOSPHORUS SUPPLY IN KILOGRAMS PER YEAR

## WHITE LAKE

A very thorough sampling program running from April 6 to September 23 was carried out on White Lake. The results indicate there is no difference in water quality between the two sampling locations. Chlorophyll concentrations were higher and Secchi disc visibility lower at the end of the sampling program than they were at the beginning. This seasonal increase in productivity as the summer progresses is characteristic of many lakes.

The results indicate that White Lake has suitable water quality for recreational uses such as swimming and bathing.

LAKE : WHITE LAKE
TWP : DARLING, BAGOT, MCNAB, PAKENHAM
COUNTY : LANARK & RENFREW

ID NUMBER : 18-3490-039-01

| | | | | |
|---|---|---|---|---|
| WATERSHED AREA | : 211.00 | sq.km | SHORELINE | : 97.80 km. |
| SURFACE AREA | : 2269.0 | ha. | COTTAGES | : 449 + 5 HOUSES |
| MAX DEPTH | : 9.20 | m. | RESORTS | : 10 (508) |
| VOLUME | : 74.74 | mill cu. m. | % CROWN LAND | : 50 |

STATIONS 1 AND 2 COMBINED

| SAMPLE DATE (YEAR) | SECCHI DEPTH (METERS) | CHLOROPHYLL A (UG/L) |
|---|---|---|
| 1972 * | 1.8 | 7.2 |
| 1973 | 2.6 | 6.5 |
| 1974 | 3.0 | 3.3 |
| 1975 ** | 3.2 | 5.7 |
| 1976 | 2.4 | 9.6 |
| 1977 | 2.8 | 5.4 |
| 1978 | 3.2 | 5.6 |
| 1979 | 3.0 | 4.5 |
| 1980 | 2.7 | 8.0 |
| 1981 | 2.8 | 5.8 |
| 1982 | 2.4 | 5.1 |
| 1983 | 2.8 | 4.3 |
| 1984 | 2.7 | 5.4 |
| 1985 | 2.5 | 7.9 |
| 1986 | 2.9 | 5.0 |
| 1987 | 2.8 | 4.8 |
| MEAN | 2.7 | 5.9 |
| MAX | 3.2 | 9.6 |
| MIN | 1.8 | 3.3 |
| N | 16 | 16 |
| SD | 0.35 | 1.61 |

NOTE : * Based on less then 6 readings.
** Recreational lakes included.

LAKE : WHITE LAKE
TWP : DARLING, BAGOT, MCNAB, PAKENHAM
COUNTY : LANARK & RENFREW

ID NUMBER : 18-3490-039-01

| | | | | | |
|---|---|---|---|---|---|
| WATERSHED AREA | : 211.00 | sq.km | SHORELINE | : | 97.80 km. |
| SURFACE AREA | : 2269.0 | ha. | COTTAGES | : | 449 + 5 HOUSE |
| MAX DEPTH | : 9.20 | m. | RESORTS | : | 10 (508) |
| VOLUME | : 74.74 | mill cu. m. | % CROWN LAND | : | 50 |

STATION 1

| SAMPLE DATE (MM/DD/YY) | SECCHI DEPTH (METERS) | CHLOROPHYLL A (UG/L) |
|---|---|---|
| 05/06/87 | 2.9 | 1.2 |
| 05/13/87 | 2.9 | 0.9 |
| 05/20/87 | 3.2 | 6.4 |
| 05/29/87 | 3.3 | 1.6 |
| 06/03/87 | 3.8 | 1.9 |
| 06/18/87 | 3.2 | 1.8 |
| 06/25/87 | 3.0 | 0.7 |
| 07/02/87 | 2.4 | 7.1 |
| 07/07/87 | 2.7 | 7.6 |
| 07/15/87 | 2.4 | 2.6 |
| 07/22/87 | 3.3 | 10.8 |
| 07/29/87 | 2.4 | 5.4 |
| 08/05/87 | 2.3 | 7.6 |
| 08/12/87 | 2.0 | 5.5 |
| 08/19/87 | 2.0 | 3.7 |
| 08/27/87 | 2.1 | 6.1 |
| 09/10/87 | 3.2 | 3.8 |
| 09/18/87 | 2.7 | 5.7 |
| 09/23/87 | 2.6 | 10.0 |
| MEAN | 2.8 | 4.8 |
| MAX | 3.8 | 10.8 |
| MIN | 2.0 | 0.7 |
| N | 19 | 19 |
| SD | 0.51 | 3.07 |

STATION 2

| SAMPLE DATE (MM/DD/YY) | SECCHI DEPTH (METERS) | CHLOROPHYLL A (UG/L) |
|---|---|---|
| 05/06/87 | 2.9 | 3.5 |
| 05/13/87 | 2.9 | 0.9 |
| 05/20/87 | 3.2 | 6.9 |
| 05/29/87 | 3.6 | 1.7 |
| 06/03/87 | 4.1 | 2.4 |
| 06/18/87 | 3.2 | 2.4 |
| 06/25/87 | 3.3 | 0.2 |
| 07/02/87 | 3.2 | 6.0 |
| 07/07/87 | 2.4 | 10.0 |
| 07/15/87 | 3.0 | 2.1 |
| 07/22/87 | 3.3 | 5.0 |
| 07/29/87 | 2.4 | 4.2 |
| 08/05/87 | 2.3 | 7.3 |
| 08/12/87 | 2.1 | 6.4 |
| 08/19/87 | 2.1 | 5.5 |
| 08/27/87 | 1.8 | 7.8 |
| 09/18/87 | 2.6 | 6.4 |
| 09/23/87 | 2.6 | 10.0 |
| MEAN | 2.8 | 4.9 |
| MAX | 4.1 | 10.0 |
| MIN | 1.8 | 0.2 |
| N | 18 | 18 |
| SD | 0.59 | 2.94 |

THE WHITE LAKE WATER QUALITY COMMITTEE
General Delivery

White Lake, Ontario KOA 3L0

# NEWSLETTER — 1982

From time to time we hear comments like — "the water is much clearer in the last year or two" or "there is no sign of the pickerel coming back." Well comments are frequently based on subjective judgment and may sometimes be misleading.

The facts about the water quality of White Lake can be determined by looking at the data in this Newsletter. It appears from the data collected over the past 10 years that no major change in water quality can be detected. The Ministry of the Environment (Ontario) state that "it is difficult to determine if three, five or more consecutive years' measurements merely represent fluctuations about a stable long term average condition or whether lakes may perhaps be undergoing a gradual shift in trophic level on a broad scale."

During 1981 the WLWQC had 36 samples tested for clarity and chlorophyll between June 1 and Oct. 15. One set of 3 samples was also analyzed for coliform. The coliform samples tested showed excellent water quality as far as coliform count is concerned, although the Ministry advises that "it is not possible to make a definitive statement relative to water quality based on one set of samples." It should be noted that the Ministry will not undertake coliform testing on a regular basis, however the WLWQC will make strong demands to have at least one or two sets of samples analyzed during 1982.

As far as the pickerel population is concerned there are signs that lead the Ministry of Natural Resources to be cautiously optimistic about the results of their water level management program. During the 1981 net sampling in White Lake a substantial number of small pickerel were collected. This leads MNR to believe that the impact of increased pickerel population could be noticed by 1985. In addition several reports have been received confirming pickerel catches.

In the fall of 1981 the WLWQC executive met with representatives of the MNR. A wide range of pertinent subjects was discussed. The one which evoked the greatest interest was the water level management program.

There have been many concerns expressed about low water affecting boating, swimming, access to boathouses, water intakes etc. All these concerns were discussed with the MNR representatives.

It must be appreciated that the water level management program was initiated in 1977 to encourage the increase in pickerel population. Pickerel had all but disappeared from White Lake. Their decline can be attributed in great part to high static water levels and the pressure of increased angling.

The water level is probably the most significant factor. In 1968 a new dam was built at White Lake and the water level over the next 9 years was maintained at a relatively high and constant level. This allowed the pickerel spawning beds to be silted and covered with algae, resulting in unsuccessful spawning.

The water level management program was started in 1977 and may now just be starting to show some encouraging signs.

The reason for lowering the water relatively early in the season is to allow sunlight to dry out the algae on the spawning beds so that it will be flushed away. The long sunlight days of June, July and August are critical for the success of the program.

Put succinctly — good pickerel fishing and good boating, on White Lake, are mutually exclusive — if — good boating means constant high water.

The water level management program will be continued at least until 1985/86, when some indication of its success may be evident. Another subject of interest, discussed at the meeting, was real estate development. It was suggested that a rough guideline for lake development is one unit per 10 acres of lake surface. White Lake has 5800 acres of surface and at last count there were close to 500 cottages. In addition there are thought to be something in the order of 1000 tent/trailer sites — many of them year round.

There are two areas of the lake currently being considered for further development — a 500 acre site at the end of Snye Road in the 3 Mile Bay area and a 400 acre site in the Windy Point area.

The WLWQC feels strongly that plans for future development will have to be carefully evaluated and monitored in order to ensure that no detrimental effects result to the lake environment. If you have concerns let us know

It may be of interest to present a few excerpts from a letter already received concerning the proposed developments — it reads in part — "As a taxpayer I am greatly concerned about the added burden that all this development will be putting on the property owners of this municipality. It is an accepted fact that no residential development of this kind ever pays for itself in added revenues. We connot maintain the roads we have with the present travel as it is. Our dumping facility is no more than adequate for the present population and as I have been informed once that area designated for the dump is filled that is it as far as the Ministry of Natural Resources is concerned.

"It can be, and has many times been argued that we who are already situated on a lake are selfish when we are not in favour of further development around the lake. In trying to share the natural beauty and great out of doors with too many people is like attempting to put more than the recommended number of people in a life boat. You end up losing everything.

"There needs to be a universal concern regarding the world's depleting supply of water, soil, forest resources, clean air — for instance acid rain — and our rapidly diminishing wilderness areas. Our whole world ecology is based on a working concern of so many factors. It starts right here with you and I and Darling Township and wherever we happen to be standing. We as individuals have to care and show that we care if you and I are to have anything decent to leave to our descendents."

If you are also concerned you may wish to write to the proper authorities to express your views — (see attachment for addresses).

The Committee wishes to extend thanks to A.E. Baker and Claud Dixon for acting as area representatives for the past number of years. Area #1, formerly Claud Dixon's, will be taken over by Bob Jackson. A representative for area #14 will be appointed as soon as possible.

Your support and participation in the work of the Committee is in your own interest.

If you would like to participate or contribute please get in touch with your area representative or one of the executive (see attached list).

Protect your lake environment — have a good summer.

| | 1981 | | 1980 | | 1979 | | 1978 | | 1977 | | 1976 | | 1975 | | 1974 | | 1973 | | 1972 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SD | CHL | SD | CHL | SD | CHL | SD | CHL | SD | CHL | SD | CHL | SD | CHL | SD | CHL | SD | CHL | SD | CHL |
| (1) | 2.8 | 3.9 | 2.7 | 5.3 | 3.0 | 3.0 | 3.2 | 3.7 | 2.8 | 3.6 | 2.3 | 6.4 | 3.1 | 3.5 | 3.0 | 2.2 | 2.6 | 4.2 | 1.8 | 4.8 |
| (2) | — | — | 4.05 | 3.83 | 4.01 | 3.24 | 4.20 | 2.92 | 4.05 | 2.97 | 4.15 | 2.65 | 3.76 | 2.91 | 3.68 | 2.83 | 3.63 | 4.27 | 3.08 | 7.20 |

**(1) White Lake.**

**(2) Overall Mean of 68 Lakes in Southeastern Ontario.**

S.D. — Secchi Disc — This is a test for visual clarity. A 10 inch black and white disc is lowered into the water on a graduated cord and a record taken of the depth at which the disc can no longer be seen.

CHL — Chlorophyll — A weighted bottle is lowered to a predetermined depth and the water collected is analyzed for phytoplankton.

Letters may be addressed to:

Ministry of Municipal Affairs and Housing
Planning Administration Division
Community Planning and Review Branch
Mr. M.G. Morris - Senior Planner
56 Wellesley St. West, 8th floor
Toronto, Ontario, ~~M5S 2S3~~ M7A 2K4

A TABULATION OF THE VARIETY AND DENSITY OF PLANTS FOUND AT EACH SAMPLING LOCATION

SECTOR: IV DATE: Aug. 25/76

| PLANT TYPE | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chara | | | | | I | | | | | IV | | | | | | | | | | IV | | | IV |
| Richardson's pondweed | | III | | I | IV | | | | | | II | II | | | IV | | | | III | | III | | III |
| Sago pondweed | | | | | | | | | | | | | | | | | | III | II | II | II | | I |
| Floating pondweed | | | | IV | IV | | IV | | | | | | | | | | | | | | | | |
| Horned pondweed | IV | I | | II | III | | I | III | IV | I | IV | II | II | IV | I | IV | | II | | | I | IV | |
| Bushy pondweed | I | | | | | | | | | | | | III | | | | II | | I | II | III | | I |
| Bladderwort | | | | | IV | | IV | | | | | | | | | | | | | IV | | | IV |
| Wild celery | | | | | | I | II | | | | | II | II | | IV | III | III | II | III | I | | | III |
| Canada waterweed | I | IV | | II | III | IV | II | | | III | IV | II | II | | | IV | II | II | IV | II | | IV | IV |
| Coontail | III | IV | | II | IV | | III | | | | IV | | | | | IV | IV | IV | | | | IV | IV |
| Common cattail | | | | | | | I | | | | | | | | | | | | | II | | | II |
| Wild rice | | | | | | | | | | | | | | | | | | | | | | | |
| Reed grass | | | | | | | | | | | | | | | | | | | | | | | |
| Water star grass | | | | | | | | | | | | | | | | | | | | | | | |
| Bulrush | | | | | | | | | | | | | | | | | | | | | | | |
| Sweet gale | | | | | | | II | | | | | | | | | | | | | III | | | |
| White water lily | IV | | | | | | IV | | | | | | | | | | | | | | | | |
| Yellow water lily | | IV | | | | | | | | | II | III | | | | | | III | | | | | |
| Arrowhead | | | | IV | | | | | | | | | | | | | | | | | | | |
| Swamp potato | | | | | | | | | | | | | | | | | | | | | | | |
| Spike rush | | | | | | | | | | | | | | | | | | | | | | | |
| Soft rush | | | | | | | | | | | II | | | | | | | | | | | | |
| Bur reed | | | | | | | | | | | | | | | | | | | | | | | |
| Milfoil | IV | I | | I | I | I | III | I | I | II | I | I | I | IV | I | IV | I | I | II | IV | I | | |
| Duckweed | | IV | | I | II | IV | | IV | IV | | III | II | III | | | | IV | IV | | | IV | | |

ppendix II:

A TABULATION OF THE VARIETY AND DENSITY OF PLANTS FOUND AT EACH SAMPLING LOCATION

SECTOR: III DATE: Aug. 18-23/76

| PLANT TYPE | SAMPLING LOCATIONS AND DENSITY RATINGS | |
|---|---|---|
| | 27. | 28. |
| hara | | I |
| ichardson's pondweed | III | |
| ago. pondweed | | |
| loating pondweed | | |
| o ed pondweed | I | IV |
| ushy pondweed | | IV |
| ladderwort | | |
| ild celery | | |
| anada waterweed | | IV |
| oontail | II | IV |
| ommon cattail | | |
| ild rice | | |
| eed grass | | |
| ater star grass | | |
| u ush | III | |
| weet gale | | |
| hite water lily | | |
| ellow water lily | | |
| rrowhead | | |
| wamp potato | | |
| pike rush | | |
| oft rush | | |
| ur reed | | |
| Milfoil | II | IV |
| Duckweed | | IV |

A TABULATION OF THE VARIETY AND DENSITY OF PLANTS FOUND AT EACH SAMPLING LOCATION

SECTOR: III DATE: Aug. 18-23/76

| PLANT TYPE | SAMPLING LOCATIONS AND DENSITY RATINGS | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. | 24. | 25. | 26 |
| Chara | | | | | | | | | | | | | | | III | | | | | | | | | | | |
| Richardson's pondweed | | | | IV | | IV | IV | | | | | | III | | | | | | | | | III | | | | |
| Sago pondweed | | | | IV | | IV | II | | | | | | | | IV | IV | | | II | | | | IV | | II | IV |
| Floating pondweed | | | | | | | II | | | | | | | | | II | | | | | | | | | | |
| Horned pondweed | | | | IV | IV | III | III | IV | | | | | III | III | IV | III | II | | III | | | | II | | IV | |
| Bushy pondweed | | | | II | | | III | | | | | | III | | | II | | | II | | | | | | IV | |
| Bladderwort | | | | IV | | | | | | | | | | | IV | IV | | | | | | | | | III | |
| Wild celery | | | | III | | | IV | | | | | | | IV | IV | IV | IV | | III | | | | IV | | IV | |
| Canada waterweed | | | | | | | IV | | | | | | | | IV | IV | | | II | | | | | | II | II |
| Coontail | | | | IV | | IV | IV | IV | | | | III | IV | IV | | III | IV | | IV | | | | II | IV | II | IV |
| Common cattail | | | | I | | | | | | | | | | | | I | | | | | | | | | | |
| Wild rice | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reed grass | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Water star grass | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bulrush | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sweet gale | | | IV | III | | | | III | | | | | | | | II | | | | | | | IV | | | |
| White water lily | | | | IV | | | III | | | | | | | | IV | III | | | | | | | III | | | |
| Yellow water lily | | | | IV | | | III | | | | | | | | III | II | | | III | | | | III | | | |
| Arrowhead | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Swamp potato | | | | IV | | | | | | | | | | | | | | | | | | | | | | |
| Spike rush | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Soft rush | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bur reed | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Milfoil | | | IV | III | IV | II | I | IV | | | | | IV | IV | II | IV | IV | | II | | | | III | IV | I | II |
| Duckweed | | | | | | | III | | | | | IV | IV | IV | | | | | | | | | | | I | II |

A TABULATION OF THE VARIETY AND DENSITY OF PLANTS FOUND AT EACH SAMPLING LOCATION

SECTOR: II DATE: Aug. 17-18/76

| PLANT TYPE | SAMPLING LOCATIONS AND DENSITY RATINGS | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. | 24. |
| Chara | | IV | | | | | | | | | | | | | | | | | | | | IV | | |
| Richardson's pondweed | III | | | | | | III | IV | | IV | | | | | | | III | | III | | | | | |
| Sago pondweed | II | III | | | | | | I | I | | | | IV | | | III | II | IV | IV | | | | | III |
| Floating pondweed | | | | | | | | | III | | | | | | | | | | | | | | | |
| Horned pondweed | II | IV | | | IV | | | | III | | | | IV | | | IV | | | | | IV | IV | IV | IV |
| Bushy pondweed | III | II | | II | | | | IV | | | IV | | | IV | I | | IV | I | III | | I | I | II | I |
| Bladderwort | | | | | | | | | | | | | III | I | | | | | | | | IV | | |
| Wild celery | III | IV | | | II | IV | | | | | | | | III | | | | | | | | III | | II |
| Canada waterweed | III | | | | | | | | | | | | | | | | | | | | | | | |
| Coontail | III | | | | | | | | | | | | | | | | | | | | | | | |
| Common cattail | | | | | | I | | III | | | I | | III | III | I | | | I | IV | I | | I | I | |
| Wild rice | IV | | | | | | | | | | | IV | | | | | | | | | | | | |
| Reed grass | | | | | | | | | | | | | II | | | | | | | | | | | |
| Water star grass | | | | | | | | | | | | | | | | | | | | | | | | |
| Bulrush | | | | | | | | | | | | | | IV | | | | III | | I | | | | |
| Sweet gale | | | | | | | | | | | | | I | | | | | III | IV | II | | II | II | I |
| White water lily | | | | | | III | | II | III | | | | IV | II | III | | | II | IV | | | IV | | IV |
| Yellow water lily | | | | | | | | II | | | | | | II | II | | | | II | IV | I | | II | |
| Arrowhead | | | | | | | | | | IV | | | | | | | | | | | | | | |
| Swamp potato | | | | | | | | | | | | | | | | | | | | | | | | |
| Spike rush | | | | | | | | | | | | | | | | | | | | | | | | |
| Soft rush | | | | | | | | | | | | | | | | | | | | | | | | |
| Bur reed | | | | | | | | | | | | | | | | | | | | | | | | |
| Milfoil | II | II | | | | | | | | | | | | IV | | IV | IV | | | IV | | IV | IV | IV |
| Duckweed | III | | | | | | | | | | | | | | | | | | | | | | | |

Appendix II:

A TABULATION OF THE VARIETY AND DENSITY OF PLANTS FOUND AT EACH SAMPLING LOCATION

SECTOR: I DATE: Aug. 9-11/76

| PLANT TYPE | SAMPLING LOCATIONS AND DENSITY RATINGS | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. | 16. | 17. | 18. | 19. | 20. | 21. | 22. | 23. |
| Chara | | | | | | | II | | | III | | | | | I | | | | IV | II | III | II | |
| Richardson's pondweed | | | | IV | III | IV | | II | | II | | | | I | IV | | | I | I | IV | | I | |
| Sago pondweed | | I | | | III | | II | | | | | | | | | | | | | | | | III |
| Floating pondweed | | III | | | | | | | | | | | | | | | | | | | | | |
| rned pondweed | I | | | III | III | | I | I | | II | | | | | | | IV | IV | | | II | | |
| Bushy pondweed | | | | | III | | II | | IV | | | | I | | | | | | III | II | | | |
| Bladderwort | | II | | | | | III | | | | | | | | | | | | | | | | |
| Wild celery | | III | | | III | | | | | | IV | | | | | | | | | | III | | III |
| Canada waterweed | IV | | | | III | | III | IV | | | | | | | | | | | | | | | |
| Coontail | | III | | | | | | | | | | | | | IV | | | | | | | | |
| Common cattail | | | | | | | II | | | | I | | | | | | I | | | | | | |
| Wild rice | | | | | | | | | | | I | | | II | IV | IV | | | IV | IV | IV | | IV |
| Reed grass | | | | | | | | | | | | I | | | | | | | | | | | |
| Water star grass | | | | | | | | | | | | | | | | | | | | | | | III |
| Bulrush | | | | | | | II | | | | I | II | | | | | | | | | III | | |
| eet gale | | | | | | | | | | | III | II | III | | | | | | | | | | IV |
| White water lily | | | | | | | III | | | | IV | | | | | | II | | | | | | |
| Yellow water lily | | | | | | | | | | | | | II | | | | II | | | | | | |
| Arrowhead | | | | | | | | | | | | | | | | | | | | | | | |
| Swamp potato | | | | | | | IV | | | | | | | | | | | | | | | | |
| Spike rush | | | | | | | | | | | | | III | | | | | | | | | | II |
| Soft rush | | | | | | | | | | | | | | | | | | | | | | | |
| Bur reed | | | | | | | III | | | | | | | | | | | | | | | | |
| Milfoil | II | III | | IV | III | | I | I | | III | | | IV | | | | | | | | | | IV |
| Duckweed | | | | | | | | | | | | | | | | | | | | | | | |

# APPENDIX I

The Relationship between Secchi Disc and Chlorophyll a using mean values for White Lake - 1972 to 1976

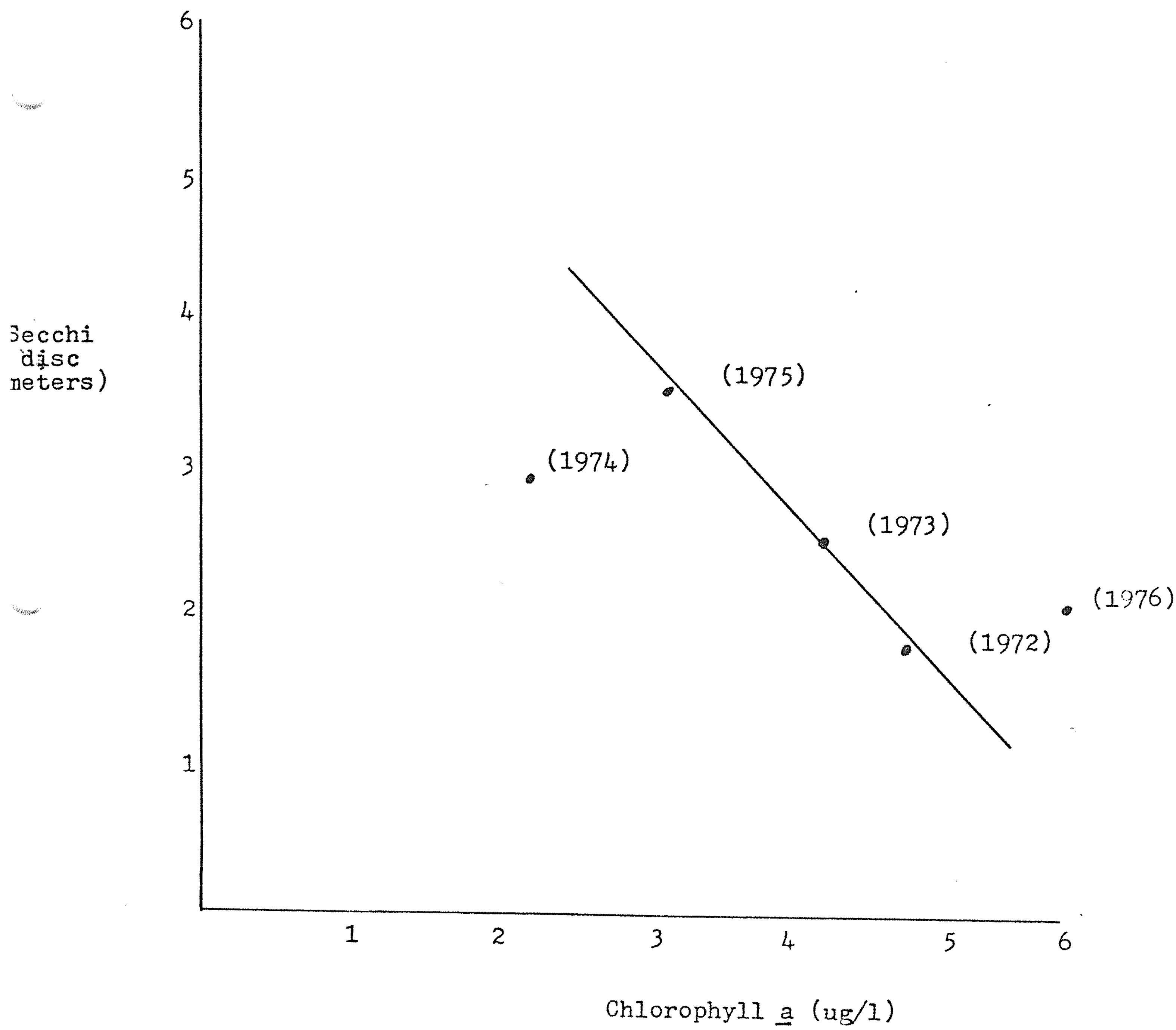


Table 2 is derived from Appendix III which gives a tabulation of the variety and density of plants found at each sampling location.

The values of table 2 indicate milfoil to be the most abundant and most frequently encountered species on White Lake. It was found at 56 of the 98 stations.

Milfoil is closely followed by horned pondweed. In fact this table shows a very close association for these two species in relative distribution and abundance. This is especially evident when these are considered by sector.

Milfoil and horned pondweed are followed in frequency of occurrence and abundance by bushy pondweed and Richardson's pondweed.

Of the genus Potamogeton, four species are recognized. In fact pondweed as a family, including the genus Najas (Najas flexilis) represented by these five species, occurred in one form or another in 78 of the 98 stations (80% frequency of occurrence). Similarly in abundance, pondweed as a family is rated high, with at least one species having a density rating of I, II or III at 59 stations (60% abundance value).

By considering the lake as four mini-lakes in reference to the sector divisions for which the data was collected, various other interesting patterns of distribution and abundance can be derived from table 2. Each sector can be looked at more closely in terms of distribution, abundance and association of species by ordering this table in decreasing values for the four assigned sections of the lake.

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For example, Richardson's pondweed is the most widely distributed species (frequency 48%, abundance 30%) in the northern section of the lake or sector I, whereas in the southern section, sector IV, it is milfoil (frequency 87%, abundance 70%) closely followed here by Canada waterweed (frequency 74%, abundance 43%).

Continuing this exercise for sector II shows bushy pondweed (frequency 58% abundance 42%) to be the most widely distributed plant in this section of the lake as well as the most abundant. In sector III milfoil (frequency 64%, abundance 32%) is again the most predominant species. However, it is followed here in frequency of occurrence by coontail (frequency 57%, abundance 18%) yet horned pondweed (frequency 54%, abundance 32%) is more abundant.

Zooplankton found in White Lake, by sector, is listed in table 3. This table gives an indication of species diversity and distribution.

An effort is made to quantify the observed data for zooplankton in table 4. The number of stations where each species was found, the frequency of their occurrence and abundance values is presented here. The means of arriving at these values is explained on the table itself. Again this data is given by sector, to facilitate analysis and for future comparisons.

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Benthic analysis of samples taken from the spawning shoals (Appendix IV) appears in table 5. As can be seen for the flora, there is a predominance of encrustations of algae, (largely blue-greens), most notebly <u>Oscillatoria</u>. Appendix IV shows this even more so, with many of the comments for various sites describing medium to heavy crusty growth.

Although the sample chosen for analysis was selective and bias toward sector I (9 samples) as opposed to II (2 samples) and III and IV (5 samples each), the results points to a relatively even distribution of the algal mats. However, Appendix IV points toward the heaviest growths on the shoals of the southern sections of the lake or sectors III and IV.

It is obvious however, that a large number of shoals contained substrate covered with algal mats - either encrusting on stones and rocks or forming a blanket over finer sediments. In the latter case the mucilaginous mats of blue-green algae formed a 'rubber cement' bond to the sediment. As well, the mats all showed evidence of $Ca\ CO_3$ precipitation.

The species present in the benthic fauna suggest adequate dissolved oxygen on the shoals. The snails (Vivaparidae) in particular, require a high oxygen supply.

As of the writing of this report, the core sample analysis is not available. However, the core sampling collection data for 1976 is provided in Appendix V for inclusion when this information becomes available.

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There were several interesting incidental observations made on this lake while this study was being carried out. Of note was the Bryozoans that were encountered mostly in the shallow bays. Pectinatella was found here in its large gelatinous colonial brown masses. There was also to be found, a linear form of about eight centimeters in diameter (unidentified), that grew dichotomously branched and when broken appeared white inside like bread fibre. This was probably a calcareous encrusting form that had anchored onto a piece of wood and had partially decomposed the wood fibres.

## DISCUSSION

The aquatic macrophyte assessment on White Lake for 1976 provides a baseline point of reference from which to monitor the macrophytic plant communities, their distribution, species composition and associations. It is realized new species will probably be added to the list, some which have been missed in this sampling and will be unrelated to changing conditions on the lake. Other species may appear and present species intensities change, with new distribution patterns emerging in response to physical, chemical and cultural (developmental) changes to White Lake. Now, however, by knowing the present diversity of the existing aquatic macrophyte communities, a measure of the degree of those changes can be made in regard to the ecological impact these changes have on the lake. The stability of the present communities may also, with time, be assessed.

The 98 sampling stations for aquatic macrophytes, distributed uniformly across White Lakes 5,608 surface acres, represents a relatively fine grain coverage, for this study, of one sampling station per 57 acres.

The zooplankton showed a species composition common in shallow southern Ontario lakes. Although the numbers counted were small (August sample) there is good species diversity.

For zooplankton it is realized, because of the superficial and limited sample in this study, both in number and time of sample (late summer), this analysis is of limited value by itself. It is included here primarily for comparison with future samples taken at this same time of year.

The phytoplankton noted incidentally in the zooplankton analysis is considered to be indicative of a southern Ontario, weakly eutrophic lake, sampled in late summer.

Bryozoans are of interest as they seldom occur in turbid or polluted waters yet can become quite conspicuous at times in shallow eutrophic lakes. Although not animals of quantitative importance in lakes, their colonial habit, provides habitat for many other invertebrate animals. Also they have been linked to certain general limnological parameters such as pH, current and substratum type (Bushnell, 1974). The growth rate and forms of these animals have also been shown to be related to fish predation (Dendy, 1963).

Analysis of the shoal samples are most instructive in regard to the specific problem on White Lake with the pickerel fishery.

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The benthic fauna offered no apparent clue to the problem. The species present in fact suggest adequate dissolved oxygen. The snails (Viviparidae) require high amounts of oxygen.

The benthic flora on the other hand offers many interesting clues, all of which centre around the large mats of blue-green algae growth observed on many of the shoals.

Should these algal mats occur extensively in sufficient numbers and densities on the spawning beds during the spring, there is a possibility ofa problem due to large diurnal $O_2 - CO_2$ fluctuations. The respiratory demand of the blue-greens at night, in the absence of photosynthesis, may lower the oxygen tension in the water to a point where pickerel eggs will suffocate.

Another possibility is that excretion of a toxin by the algae may detrimentally affect egg development.

However, an indirect mechanical influence of the blue-greens is thought to be having a detrimental affect here.

These algae have the ability to secrete calcium. This is the result of a physiological mechanism which allows them to utilize bicarbonate ions as well as carbon dioxide as a source of carbon. This results in precipitation of $CaCO_3$. An accumulation of such by-products on the bed will make these shoals less condusive for pickerel egg development. Past history of the lake and water chemistry indicates the potential of a problem of this nature does exist. Sediment core samples taken in 1973 indicated thick marl deposits caused by significant biogenic calcium carbonate percipitation (Thomas, 1974). This lake is a definate hard water lake. Water chemistry (1975 - M.O.E. - M.N.R. Survey) showed a mean hardness of 117 mg/l with a mean alkalinity of 109 mg/l resulting in a mean pH of 8.2.

If calcium carbonate deposits however, were all that were affecting the shoals, wave action would be sufficient to remove any biogenic calcium carbonate secretion, or precipitations from the open water above, from the shoals. In fact as can been seen from Appendix IV - map showing the shoal sites, there is a definite pattern whereby the shoals cluster along the eastern shores of the lake. The westerly winds and ensuing wave action would cleanse this area.

The real problem, it is felt, is caused by the nature of these calcareous blue-green algae interactions with the sediments. The algae themselves concentrate sediment particles on the shoals! The process is understood and the machanism for this biological induced accummulation will be briefly outlined here.

During the day, vertical growth of filamentous forms (*Oscillatoria*, *Calothrix*, *Nostoc* etc.) trap fine particles of sediment. At night, horizontal growth firmly bind these particles. Thus, trapping and binding of sediment particles by mucilagenous mats of calcareous blue-green algae continues, to form a 'rubber cement' bond to sediments. The ensuing crusty mats form a layer over the original substrate. And when this crustose algal mat decays it produces lime mud that is not easily identified even as organic matter.

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But now even the position of the shoals, along the eastern shores, may be accelerating the sediment accummulation process, by the waves bringing in sediment particles.

Of course, this increased sedimentation on the spawning shoals will have the same effect on pickerel eggs as the increased photosynthesis by the algae has at these sites. The algae themselves act to suffocate the eggs by reducing oxygen tension in the water as mentioned earlier. The increased sedimentation caused by the algae however, will act indirectly to mechanically suffocate the eggs by reducing currents over the eggs and thus reducing the oxygen supply to them.

A closer inspection into the nature of the growth of benthic blue-green algae, as it relates to a lake such as White Lake and the pickerel problem experienced here seems in order. However, there is a definite lack of knowledge in this area, due partly to the complexities of the relationships involved with benthic algae as opposed to the planktonic algae. A few of the more obvious relationships can be given here.

Blue-green algae are the most common algae in alkaline water. And although not 'indicators' of eutrophication, they often thrive under such conditions, and obviously the observations made in this study reflect this.

There are several spacial, chemical, biotic and temporal factors affecting the growth of these algae populations which has a bearing on the problem for pickerel in White Lake.

A pattern of relatively uniform growth of benthic algae has been shown to occur between 1 to 6 meters in depth. Wave

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action in shallow zones (0-1 meter) makes growth here erratic. Growth in depth of water is primarily determined by availabilit of light and temperature. Below 8 meters no growth occurs. Th the shallow nature of White Lake makes it condusive to benthic algae growth.

Blue-green algae populations are directly correlated to the calcium content in the sediment. But the importance of major cations in general, including calcium, has yet to be thoroughly investigated. Sodium for example has been implicated in blooms of blue-green algae (Provosoli, 1958). These algae may be limited in their growth by low sodium (Wetzel, 1966). There is good evidence that sodium in uncontaminated lakes limits growth of blue-green algae. Some sources of sodium that may apply to the White Lake area are synthetic detergents from cottage wastes and rock salt used on the highways for melting snow. Blue-green algae may also be specifically affected by cations in the environment by determining to some degree what forms the algae takes, i.e. colonial or solitary. This in turn would affect the symbiotic relationships that exist between algae species and other organisms of the environment.

No one species of benthic algae predominates in large numbers throughout the year. However, the succession of blue-greens and their symbiotic relationships with other flora and fauna is not, as yet, well understood. The annual and seasonal cycles however, are known to be marked and complex.

Seasonally benthic algae tend to have early winter and spring peaks followed by midsummer maxima. Our shoal sample no doubt caught this midsummer growth.

Those species adapted to the various microhabitats existing at the sediment level and to the unique chemical composition of the water here are not directly under control by factors existing in the overlying water. Therefore, there is little correlation between the growth cycles of the benthic blue-greens on the sediment and the free-floating (planktonic) blue-green algae. In some lakes in fact, a conspicuous growth can occur on the sediments but not in the plankton. It follows therefore, that Chlorophyll a tests, which measures only suspended algae productivity, would be of little use in elucidating the underlying problem associated with benthic algae.

However, there are obviously other factors contributing to pickerel decline here other than the blue-green algae - sedimentation on the spawning shoals.

As to what affect if any, the largemouth bass population increase has had on the pickerel population is unknown. Their coinciding increase with the latters decrease would suggest there may be a relationship occurring in the overall ecology of the lake. The largemouth bass may certainly have been a contributing factor to the pickerel decline.

This species shift however, would be more in response to the changing water conditions as such. For it is known that as compared to the more desirable mesotrophic conditions. Previous studies on White Lake support this in showing that the lake is approaching a degree of eutrophication which favours Centrarchidae species (sunfish, bass etc.) as opposed to pickerel.

Largemouth bass prefer weedy areas using marly or muddy bottom types and guarding their eggs and fry. Pickerel, which do not make a nest or do not guard, are immediately put at a distinct reproductive disadvantage when conditions change to reduce their spawning sites while enhancing bass needs. Another distinct advantage is conferred to largemouth bass by its fanning the eggs and thus ensuring sufficient oxygen exposure for development. As stated earlier, the lack of sufficient oxygen to pickerel eggs will hamper their development.

## CONCLUSION

This study points to one source of siltation or at least accelerated siltation on White Lake. One example of the interdependence of aquatic plants and siltation rates is given, namely the benthic blue-green algae-sedimentation accummulation relationship, on the sensitive spawning shoals.

Shifts in vegetation and silt deposits have occurred naturally in the past. But by elucidating the relationships between localized sediment deposits and vegetation and understanding the mechanism of their interactions, one can better predict and perhaps prevent undesirable conditions from developing at such

This is of greatest importance in considering economically and realistically the cost-benefit of rehabilitation of these sites. The cost of rehabilitation is prohibitive unless assurance can be had that they will not silt in again. A rate of siltation is required.

Monitoring certain types of plants, benthic blue-green algae in White Lake, suggests itself as an index for a predictive sediment deposition rate. Also the predominant plant responsible for sediment accummulation at critical sites, and times, suggests itself for analysis in preventative measures for controlling the quality of these sensitive areas.

The abundance of benthic calcareous blue-green algae on the spawning beds, would suggest a calcium bicarbonate - carbon dioxide imbalance in this lake.

It would seem that a threshold of condusive conditions in the uptake of calcium with the overall growth rate of the blue-green algae complexes, has been reached, whereby the algae are now quickly utilizing much of the spawning shoal substrate to form their 'rubber cement' attachments, from which they trap and bind sediments, at a much accelerated rate than in the past.

This condition has no doubt been brought about by the lakes relatively recent increase in nutrients, due primarily to mushrooming development on the lake since 1959, as well as agricultural activities of the watershed which drains into this lake. The role of the dam is also implicated here by its reducing of the

Blue-green algae are analogous to the nodule-bacteria of agricultural legumes. They fix nitrogen when it is not present. When present these algae simply incorporate the readily available nitrogenous compounds into their metabolic pathways. If nitrogen nutrients (cottage wastes, farming fertilizer etc.) could be effectively withheld from the lake, the growth rate of these blue-green algae might be reduced. These algae would be forced to shunt over to an elemental nitrogen fixing metabolic pathway requiring more net energy expenditure, and thus it is assumed, slower growth would result. Similarly should the imbalance between available bicarbonate and carbon dioxide be rectified a slower growth rate is postulated.

This report does not intend to imply that benthic blue-green algae and accumulating sediments in White Lake is the only limiting factor for the pickerel population. Obviously no single factor is responsible by itself. However, this study strongly suggests that benthic algae on the spawning shoals is now the dominant limiting factor for pickerel.

This study also emphasizes the need for continued monitoring of the various factors involved in determining a lakes status. This points toward a continued use of a diversity index that will detect specific and subtle changes to the aquatic environment.

Diversity is a useful and sensitive index because, like indicator species, it tends to integrate changes over a period of time and thereby reduce sampling effort required to monitor environments. However, only when indices measure changes over a considerable period do they gain specificity. Then distinctions between stages of enrichment, normal or cultural eutrophication, and degree of acceleration of the process can be made.

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## RECOMMENDATIONS

The present findings indicate a benthic calcareous blue-green algae problem existing in this water. If as is suspected, these algae encrusted mats are reducing available oxygen for pickerel eggs on spawning beds, by creating large diurnal $O_2$ - $CO_2$ fluctuations and by accumulating sediments here, to smother the eggs; then the relationship between the reduced water flow caused by a dam and accumulating sediments caused by calcareous algae colonies, is of the greatest interest and significance in suggesting remedial action to reinstate a healthy pickerel fishery. The pickerel fishery decline corresponds to the introduction of efficient artificial water level control here, which has certainly contributed to the low overall water turnover or flushing rate. Thus a study into the possible relationship of calcareous algae growth and increased siltation caused by dams is suggested.

It is obvious from this study however, that planting of pickerel eyed-eggs should be discontinued until the appropriate studies have been carried out which will elucidate the underlying causes of the specific problems that plague White Lake.

Meanwhile, continued effort should be directed toward rehabilitating stream spawning facilities and toward the acceptance and promotion of the existing sport fishery here, namely largemouth bass and pike.

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It is further recommended that another study such as this be carried out in five years to ascertain, by use of these findings, the degree of accelerated eutrophication which is occurring in White Lake. And obviously no further development on the lake should be encouraged.

The feasibility of monitoring algal blooms, throughout the ice-free period, by remote sensing should be examined. This type of information (gathered every nine days by satellite) would provide the overall perspective to complement a continued monitoring of White Lake by chlorophyll a data and secchi disc readings.

## ACKNOWLEDGEMENTS

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Table 5: Completed

| Sample No. | Substrate | Flora | Fauna |
|---|---|---|---|
| IV - 5 | one large stone, some pebbles | encrusting algae on stone | empty caddis case<br>Gastropod (Vivparidae) (1) |
| IV - 6 | one rock | encrusting algae on rock (mat) | Chironomidae (9)<br>*Hyalella azteca* (4)<br>*Haliplus* sp. (1)<br>*Stenonema* sp. (1) |
| IV - 22 | two rocks | large mat of encrusting algae *Oscillatoria* and diatoms identifiable | *Hyalella azteca* (7)<br>Ceratopagonidae (2)<br>Chironomidae (6) |
| IV - 29 | one rock | mat of blue-green algae on rock *Calothrix* sp.<br>*Oscillatoria* sp.<br>*Cladophora* sp. | Chironomidae (11)<br>*Hyalella azteca* (1) |
| IV - 31 | two medium sized rocks | *Oscillatoria*, mixed diatoms, *Calothrix*, *Cladophora* sp. | *Ascellus* sp. (1) |

Table 5: Cont'd...

| Sample No. | Substrate | Flora | Fauna |
|---|---|---|---|
| I - 29 | algae | Spirogyra and Other Chlorophyta | Chironomidae (1)<br>Hyalella azteca (1) |
| II - 2 | algae mat holding some silt and gelatinous matrix of unknown origin | Diatoms<br>Oscillatoria | Hyalella azteca (2)<br>Chironomidae (12) |
| II - 9 | sand and silt | Small mat of encrusting algae | Two empty caddis cases |
| III - 4 | medium gravel | Small mat of encrusting algae | Viviparidae (1) |
| III - 5 | sand, gravel | — | empty caddis case and unidentified adult caddis fly |
| III - 16 | one large rock | luxuriant growth of Mougeotia and Oscillatoria | large number of Hyalella azteca enmeshed in algae<br>Chironomidae (1) |
| III - 25 | one large rock | mat of encrusting algae on rock | Chironomidae (1) |
| III - 27 | four small rocks | encrusting algae on rocks | — |

Table 5: Benthic Analysis of Spawning Shoal Samples
From White Lake - 1976

| Sample *No. | Substrate | Flora | Fauna |
|---|---|---|---|
| I - 2 | pebble bed | — | Hyalella azteca |
| I - 3 | large stone bed | — | Vivparidae **(4) |
| I - 4 | medium stones | Mougeotia | Hyalella azteca (3) |
| | | | Chironomidae (2) |
| | | | Viviparidae (5) |
| I - 17 | sand | Oscillatoria mat | Hyalella azteca (3) |
| | | Chara sp. | Chironomidae (4) |
| | | | Haliplus sp. (7) |
| I - 18 | gravel, sand | — | Oligochaetes (2) |
| | pine needles | | Gastropod (Viviparidae) (1) |
| I - 19 | rock with algal | Phormidium sp. | Chironomidae (3) |
| | mat | | |
| I - 20 | sand and algal | Oscillatoria | Asellus sp. (1) |
| | mat | | Molanna sp. (1) |
| | | | Chironomidae (1) |
| I - 23 | algae | Mougeotia | — |

* Sampling No. refers to the sector and location on the lake where these samples were collected - see Appendix IV

** No. observed

Table 4: Completed.

| Species | *No. of stations where found | | | | | **Frequency of Occurrence (1%) | | | | | Abundance value (ie. no. of stations where found X mean number pe sample) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sector | | | | | Sector | | | | | Sector | | | | |
| | I | II | III | IV | Total | I | II | III | IV | Total | I | II | III | IV | Total |
| 14. Tropocyclops prasinus mexicanus | 2 | 1 | 1 | 0 | 4 | 100 | 50 | 50 | 0 | 50 | 2 | 27 | 2 | 0 | 31 |
| 15. Holopedium gibberum | 0 | 2 | 0 | 0 | 2 | 0 | 100 | 0 | 0 | 25 | 0 | 13 | 0 | 0 | 13 |
| 16. Tropocyclops minutus | 0 | 1 | 0 | 0 | 1 | 0 | 50 | 0 | 0 | 13 | 0 | 13 | 0 | 0 | 13 |
| 17. Polyphemus pediculus | 0 | 1 | 0 | 0 | 1 | 0 | 50 | 0 | 0 | 13 | 0 | 3 | 0 | 0 | 3 |
| 18 Chaoborus Sp. | 1 | 0 | 0 | 0 | 1 | 50 | 0 | 0 | 0 | 13 | 1 | 0 | 0 | 0 | 1 |
| 19. Cyclops vernalis | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 50 | 13 | 0 | 0 | 0 | 1 | 1 |
| 20. Leptodora kindtii | 0 | 1 | 0 | 0 | 1 | 0 | 50 | 0 | 0 | 13 | 0 | 1 | 0 | 0 | 1 |

Table 4: continued...

| Species | *No. of stations where found | | | | | **Frequency of Occurrence (%) | | | | | Abundance value (ie. no. of stations where found X mean number pe sample) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sector | | | | | Sector | | | | | Sector | | | | |
| | I | II | III | IV | Total | I | II | III | IV | Total | I | II | III | IV | Total |
| 6. Ceriodaphnia lacustris | 2 | 2 | 0 | 2 | 6 | 100 | 100 | 0 | 100 | 75 | 7 | 151 | 0 | 28 | 186 |
| 7. Cyclopoid nauplii | 2 | 2 | 2 | 2 | 8 | 100 | 100 | 100 | 100 | 100 | 52 | 61 | 11 | 24 | 148 |
| 8. Daphnia retrocurva | 2 | 0 | 2 | 2 | 6 | 100 | 0 | 100 | 100 | 100 | 12 | 0 | 46 | 51 | 109 |
| 9. Diaphanosoma leuchtenbergianum | 1 | 2 | 1 | 2 | 6 | 50 | 100 | 50 | 100 | 75 | 7 | 50 | 6 | 22 | 85 |
| 10. Diaptomus minutus | 2 | 2 | 1 | 2 | 7 | 100 | 100 | 50 | 100 | 88 | 13 | 40 | 7 | 5 | 65 |
| 11. Mesocyclops edax | 2 | 2 | 1 | 2 | 7 | 100 | 100 | 50 | 100 | 88 | 3 | 4 | 13 | 44 | 64 |
| 12. Bosmina longirostris | 2 | 2 | 0 | 0 | 4 | 100 | 100 | 0 | 0 | 50 | 9 | 40 | 0 | 0 | 49 |
| 13. Diaptomus orogonensis | 1 | 2 | 1 | 2 | 6 | 50 | 100 | 50 | 100 | 75 | 2 | 10 | 6 | 25 | 43 |

Table 4: Zooplankton found in White Lake by sector by the number of stations where they were found, their frequency of occurrence and abundance values.

| Species | *No. of stations where found | | | | | **Frequency of Occurrence (%) | | | | | Abundance value (ie. no. of statio[n] where found X mean number per sample) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sector | | | | | Sector | | | | | Sector | | | | |
| | I | II | III | IV | Total | I | II | III | IV | Total | I | II | III | IV | Total |
| 1. Daphnia galatea mendotae | 2 | 0 | 2 | 2 | 6 | 100 | 0 | 100 | 100 | 75 | 72 | 0 | 344 | 146 | 562 |
| 2. Chydorus sphaericus | 2 | 2 | 2 | 2 | 8 | 100 | 100 | 100 | 100 | 100 | 93 | 12 | 189 | 126 | 420 |
| 3. Cyclopoid copepodids | 2 | 2 | 2 | 2 | 8 | 100 | 100 | 100 | 100 | 100 | 41 | 156 | 35 | 90 | 322 |
| 4. Calanoid copepodids | 2 | 2 | 2 | 2 | 8 | 100 | 100 | 100 | 100 | 100 | 45 | 151 | 40 | 39 | 275 |
| 5. Calanoid nauplii | 2 | 2 | 1 | 2 | 7 | 100 | 100 | 50 | 100 | 88 | 52 | 113 | 14 | 27 | 206 |

* A total of eight stations were sampled, two from each sector.

** Frequency refers to the percent of the total number of sample stations where found.

Table 3: A Listing of Zooplankton Species and

Where They Were Found in White Lake *(August) 1976

| Species | Distribution by Sector | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| 1. Bosmina longirostris | X | X | | |
| 2. Calanoid copepodids | X | X | X | X |
| 3. Calanoid nauplii | X | X | X | X |
| 4. Ceriodaphnia lacustris | X | X | | X |
| 5. Chaoborus sp. | X | | | |
| 6. Chydorus sphaericus | X | X | X | X |
| 7. Cyclopoid copepodids | X | X | X | X |
| 8. Cyclopoid nauplii | X | X | X | X |
| 9. Cyclops vernalis | | | | X |
| 10. Daphnia galatea mendotae | X | | X | X |
| 11. Daphnia retrocurva | X | | X | X |
| 12. Diaphanosoma leuchtenbergianum | X | X | X | X |
| 13. Diaptomus minutus | X | X | X | X |
| 14. Diaptomus orogonensis | X | X | X | X |
| 15. Holopedium gibberum | | X | | |
| 16. Leptodora kindtii | | X | | |
| 17. Mesocyclops edax | X | X | X | X |
| 18. Polyphemus pediculus | | X | | |
| 19. Tropocyclops minutus | | X | | |
| 20. Tropocyclops prasinus mexicanus | x | x | x | |

* Two samples from each sector were collected from a depth of 1.5–5 meters on August 24th and 25th. Both days were calm, sunny with no overcast, $24^{o}$c.

Table 2: Completed.

| Species Common Name | *No. of Stations where found | | | | | **Frequency of Occurrence | | | | | Abundance value (% of total stations whose density rating was I, II or III) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sector | | | | | Sector | | | | | Sector | | | | |
| | I | II | III | IV | Total | I | II | III | IV | Total | I | II | III | IV | Total |
| 14. Wild rice | 8 | 2 | 0 | 0 | 10 | 35 | 8 | 0 | 0 | 10 | 9 | 0 | 0 | 0 | 2 |
| 15. Bulrush | 4 | 3 | 1 | 0 | 8 | 17 | 13 | 4 | 0 | 8 | 17 | 8 | 0 | 0 | 6 |
| 16. Floating pondweed | 1 | 1 | 2 | 3 | 7 | 4 | 4 | 7 | 13 | 7 | 4 | 4 | 7 | 0 | 4 |
| 17. Arrowhead | 0 | 1 | 0 | 1 | 2 | 0 | 4 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 |
| 18. Swamp potato | 1 | 0 | 1 | 0 | 2 | 4 | 0 | 4 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 19. Water star grass | 1 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 1 |

Table 2: continued...

| Species Common Name | *No. of Stations where found | | | | | **Frequency of Occurrence | | | | | Abundance value (% of total stations whose density rating was I, II or III) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sector | | | | | Sector | | | | | Sector | | | | |
| | I | II | III | IV | Total | I | II | III | IV | Total | I | II | III | IV | Total |
| 6. Canada waterweed | 4 | 2 | 7 | 17 | 30 | 17 | 8 | 25 | 74 | 31 | 9 | 8 | 11 | 43 | 17 |
| 7. Coontail | 2 | 1 | 16 | 11 | 30 | 9 | 4 | 57 | 48 | 31 | 4 | 4 | 18 | 13 | 10 |
| 8. Sago pondweed | 4 | 10 | 9 | 5 | 28 | 17 | 42 | 32 | 22 | 29 | 17 | 29 | 11 | 22 | 19 |
| 9. Star duckweed | 1 | 1 | 7 | 12 | 21 | 4 | 4 | 25 | 52 | 21 | 4 | 4 | 11 | 22 | 10 |
| 10. White water lily | 3 | 10 | 5 | 2 | 20 | 13 | 42 | 18 | 9 | 20 | 9 | 25 | 11 | 0 | 11 |
| 11. Yellow water lily | 2 | 7 | 6 | 4 | 19 | 9 | 29 | 21 | 17 | 19 | 9 | 25 | 18 | 13 | 16 |
| 12. Chara | 7 | 2 | 2 | 4 | 15 | 30 | 8 | 7 | 17 | 15 | 26 | 0 | 7 | 4 | 9 |
| 13. Bladderwort | 2 | 3 | 4 | 4 | 13 | 9 | 13 | 14 | 17 | 13 | 9 | 8 | 4 | 0 | 5 |

Table: 2 Aquatic Macrophytes found in White Lake by sector by, the number of stations where they were found, the frequency of their occurrence and abundance values.

| Species Common Name | *No. of Stations where found | | | | | **Frequency of Occurrence (%) | | | | | Abundance value (% of total stations whose density rating was I, II or III) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sector | | | | | Sector | | | | | Sector | | | | |
| | I | II | III | IV | Total | I | II | III | IV | Total | I | II | III | IV | Total |
| 1. Milfoil | 9 | 9 | 18 | 20 | 56 | 39 | 38 | 64 | 87 | 57 | 26 | 8 | 32 | 70 | 34 |
| 2. Horned pondweed | 9 | 10 | 15 | 17 | 51 | 39 | 42 | 54 | 74 | 52 | 30 | 8 | 32 | 48 | 30 |
| 3. Bushy pondweed | 6 | 14 | 7 | 7 | 34 | 26 | 58 | 25 | 30 | 35 | 22 | 42 | 18 | 30 | 28 |
| 4. Richardson's pondweed | 11 | 6 | 6 | 9 | 32 | 48 | 25 | 21 | 39 | 33 | 30 | 17 | 11 | 30 | 21 |
| 5. Wild celery | 5 | 7 | 9 | 11 | 32 | 22 | 29 | 32 | 48 | 33 | 17 | 21 | 7 | 43 | 21 |

* A total of 98 stations were sampled. Sector I - 23, Sector II - 24, Sector III - 28, Sector IV - 23.

** Frequency refers to the percent of the total number of sample stations where found.

Table 1: Completed

| FAMILY (SCIENTIFIC NAME) | FAMILY (COMMON NAME) | GENUS | SPECIES (SCIENTIFIC NAME) | SPECIES (COMMON NAME) |
|---|---|---|---|---|
| Alismaceae | water plantain | Sagittaria | graminea<br>latifolia | arrowhead<br>swamp potato |
| Cyperaceae | sedge | Eleocharis | | spike rush |
| Juncaceae | rush | Juncus | effusus | soft reed |
| Sparganiaceae | bur reed | Sparganium | | bur reed |
| Lemnaceae | duckweed | Lemna | trisulca | star duckweed |

Table 1: A listing of all the families, genera, and species found in White Lake - 1976

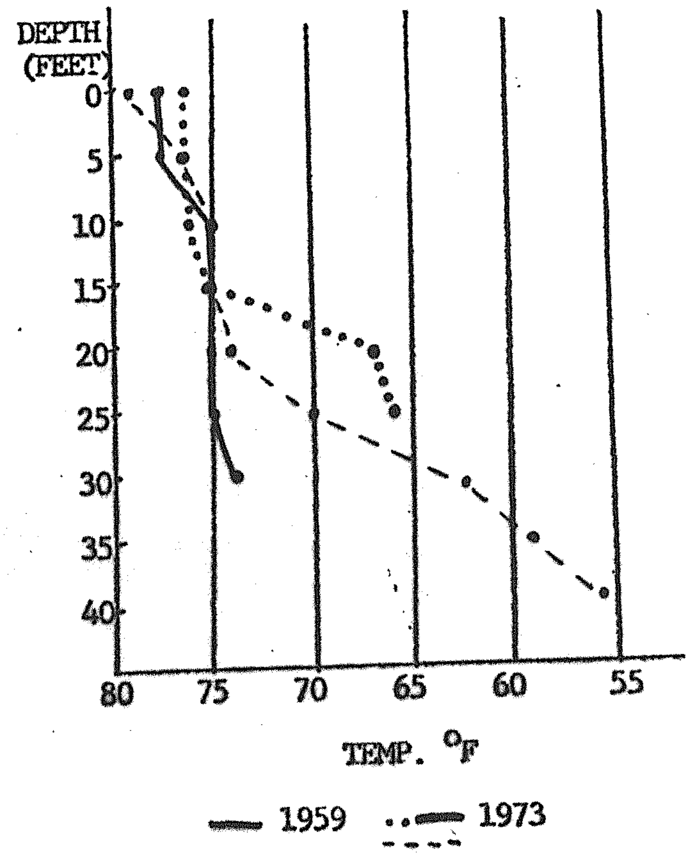
| FAMILY (SCIENTIFIC NAME) | FAMILY (COMMON NAME) | GENUS | SPECIES (SCIENTIFIC NAME) | SPECIES (COMMON NAME) |
|---|---|---|---|---|
| Halorgidaceae | water milfoil | Myriophyllum | verticillatum exalbescens | milfoil |
| Characeae | chara | Chara | aspera | chara |
| Najadaceae | pondweed | Potamogeton | richardsonii | richardson's pondweed |
| | | | pectinatus | sago pondweed |
| | | | natans | floating pondweed |
| | | | zannichellia | horned pondweed |
| | | Najas | flexilis | bushy pondweed |
| Lentibulariaceae | bladderwort | Utricularia | | bladderwort |
| Hydrocharitaceae | frogbit | Vallisneria | americana | wild celery |
| | | Anacharis | canadensis | canada waterweed |
| Ceratophylaceae | hornwort | Ceratophyllum | demersum | coontail |
| Typhaceae | cattail | Typha | latifolia | common cattail |
| Gramineae | | Zizania | aquatica | wild rice |
| | | Phragmites | maximus | reed grass |
| Pontederiaceae | pickerel weed | Heteranthera | dubia | water star grass |
| Cyperaceae | sedge | Scirpus | | bulrush |
| Myricaeae | sweet gale | Myrica | gale | sweet gale |
| Nymphaeaceae | water lily | Nymphaea | | white water lily |
| | | Nuphar | | yellow water lily |

# White Lake Data Summary

## (1959 - 1974)

1. Temperature Profile

| DEPTH (FT.) | Aug. 31 1959 | Aug. 6 1969 | July 24 1973 | |
|---|---|---|---|---|
| 0 | 77°F | 78° | 79° | 76° |
| 5 | 77 | 78 | 76 | 76° |
| 10 | 75 | 76 | 75 | 76° |
| 15 | 75 | 76 | 75 | 75° |
| 20 | 75 | 74 | 74 | 67° |
| 25 | 75 | 72 | 70 | 66° |
| 30 | 74 | 70 | 63 | |
| 35 | | | 58 | |
| 40 | | | 56 | |




2. Sechi Disc Readings

| | Date | Depth | Cloud |
|---|---|---|---|
| 1959 | July | 11' | |
| 1969 | Aug. 6 | 10' | 40% |
| 1972 | Aug. 31 | 5.9' | |
| 1973 | July | 8.9'-9.8' | |
| 1973 | Aug. | 5.9'-8.9' | |
| 1974 | July 31 | 7.0' | 75% |
| 1974 | Aug. 21 | 10.0' | 0% |

| 1975 | Station #7 | | Bane Bay | |
|---|---|---|---|---|
| Date | Secchi | chlorophyll a | Secchi | chlorophyll a |
| June 8 | 3.2 | 2.7 | | |
| 15 | 3.0 | 10.3 | – | 2.7 |
| 22 | 3.4 | 2.5 | – | 0.8 |
| July 6 | – | – | – | 1.6 |
| 13 | 2.4 | 3.2 | – | 1.5 |
| Aug. 4 | 3.2 | – | – | – |
| 10 | 2.3 | 2.5 | – | 1.6 |
| 25 | 3.0 | 4.5 | – | 2.2 |
| Sept. 1 | 3.0 | – | – | 2.4 |
| 7 | 3.4 | 2.7 | – | 2.1 |

| 1975 | Stat. 62 | | Pickeral Bay Station 63 | | 3 Mile Bay Station 64 | |
|---|---|---|---|---|---|---|
| Date | S | C | S | C | S | C |
| May 28 | 3.7 | 4.9 | 2.7 | 2.9 | 3.1 | 1.8 |
| June 9 | 4.0 | 2.8 | 4.3 | 3.8 | 3.7 | 2.2 |
| 24 | 3.0 | 4.0 | 4.0 | 3.4 | 4.3 | 3.3 |
| July 14 | 2.4 | 4.6 | 3.4 | 4.9 | 2.7 | 4.4 |
| 22 | 3.7 | 3.6 | 3.7 | 2.7 | 2.7 | 3.2 |
| Aug. 6 | 2.4 | 4.5 | 3.4 | 3.3 | 3.0 | 3.0 |
| 19 | 4.0 | 3.8 | 2.7 | 7.3 | 3.2 | 5.0 |
| Sept. 3 | 3.4 | 4.6 | 2.9 | 8.5 | 3.7 | 5.6 |
| 16 | 2.4 | 2.5 | 3.0 | 5.9 | 4.9 | 2.9 |
| | | | mean = 3.3 | mean = 4.7 | mean = 3.5 | mean = 3.5 |

1976

Mean Values

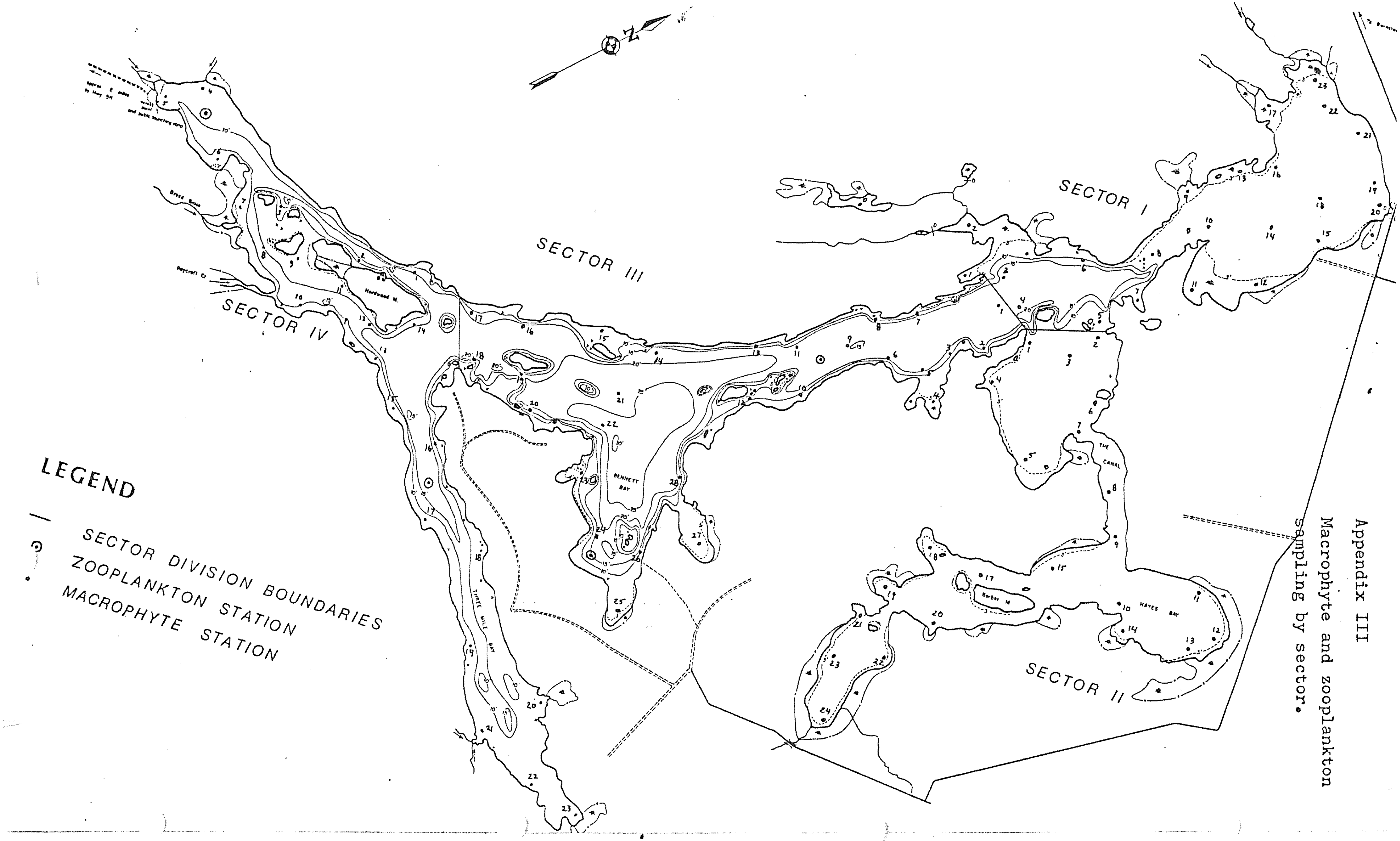
| Station 1 | | Station 2 | | Station 3 | |
|---|---|---|---|---|---|
| S | C | S | C | S | C |
| 2.0 | 6.7 | 2.3 | 7.1 | 2.7 | 5.2 |

| | | | |
|---|---|---|---|
| July | 12 | 2.8 | 2.0 |
| Aug. | 8 | 1.6 | 5.6 |
| | 15 | 1.0 | 9.0 |
| Sept. | 12 | 1.6 | 1.0 |
| | 20 | 2.2 | 5.8 |

| 1973 | | Station #1 | | Station #2 | |
|---|---|---|---|---|---|
| Date | | Secchi | chlorophyll a | Secchi | chlorophyll a |
| May | 21 | 4.5 | 1.3 | | |
| | 27 | 3.9 | 2.3 | 3.8 | 3.0 |
| June | 10 | 3.6 | 1.3 | 4.2 | 1.1 |
| | 17 | 3.0 | 2.6 | 3.3 | 2.6 |
| | 24 | 3.0 | 2.3 | 3.3 | 3.5 |
| July | 9 | 2.7 | 5.2 | 2.7 | 3.9 |
| | 15 | 2.7 | 3.2 | 2.7 | 5.0 |
| | 22 | 3.0 | 2.4 | 3.0 | 3.7 |
| Aug. | 5 | 2.7 | 2.5 | 2.4 | 3.2 |
| | 12 | 2.6 | 1.8 | 2.2 | 11.0 |
| | 19 | 2.2 | 7.0 | 1.6 | 14.0 |
| | 26 | 1.8 | 1.3 | 1.6 | 1.7 |
| Sept. | 3 | 2.1 | 2.8 | 2.0 | 4.9 |
| | 9 | 2.1 | – | 2.1 | – |
| | 16 | 2.4 | – | 2.2 | – |
| | 23 | 2.7 | 2.1 | 1.8 | 4.5 |
| | 30 | 2.0 | 7.6 | 1.8 | 14.0 |
| Oct. | 8 | 2.2 | 5.6 | 1.5 | 5.8 |

| 1974 | | Station #1 | | Station #2 | |
|---|---|---|---|---|---|
| Date | | Secchi | chlorophyll a | Secchi | chlorophyll a |
| Apr. | 28 | 3.9 | 0.3 | 3.6 | 0.9 |
| May | 12 | 3.2 | 1.3 | 2.8 | 1.4 |
| | 20 | 3.0 | 2.3 | 2.6 | 2.9 |
| | 26 | 3.0 | 1.9 | 2.6 | 1.4 |
| June | 2 | 2.8 | 3.1 | 2.8 | 2.2 |
| | 9 | 3.2 | 2.3 | 3.2 | 2.2 |
| | 16 | 3.2 | 0.8 | 3.0 | 1.2 |
| | 23 | 3.3 | 0.6 | 2.7 | 1.5 |
| July | 1 | 3.3 | 2.0 | 3.0 | 2.8 |
| | 14 | 3.0 | 0.6 | 2.8 | 0.6 |
| | 21 | 2.7 | 2.5 | 2.4 | 4.6 |
| Aug. | 5 | 2.8 | 2.6 | 2.4 | 4.0 |
| | 11 | 3.4 | 1.8 | 2.6 | 2.1 |
| | 17 | 3.0 | 2.2 | 3.0 | 2.9 |
| Sept. | 2 | 2.7 | 3.6 | 2.1 | 5.5 |
| | 8 | 2.8 | 1.6 | 2.4 | 1.9 |
| | 15 | 2.8 | 2.9 | 2.0 | 6.2 |
| | 22 | 2.2 | 2.1 | 2.1 | 3.3 |
| | 29 | 3.6 | 1.7 | 3.3 | 1.4 |
| Oct. | 6 | 4.2 | 1.5 | 3.3 | 5.6 |
| | 14 | 4.6 | 0.7 | 3.8 | 0.9 |

| 1975 | | Station #1 | | Station #2 | |
|---|---|---|---|---|---|
| Date | | Secchi | chlorophyll a | Secchi | chlorophyll a |
| Jume | 8 | 3.4 | 2.3 | 3.9 | 3.5 |
| | 15 | 3.4 | 3.0 | 3.0 | 5.4 |
| | 22 | 3.2 | 3.4 | 3.4 | 2.9 |
| July | 6 | 3.3 | 2.7 | 3.7 | 3.6 |
| | 13 | 2.8 | 3.1 | 2.9 | 3.0 |
| Aug. | 4 | 4.7 | - | 3.4 | 3.9 |
| | 10 | 2.4 | 3.2 | 2.7 | 3.2 |
| | 25 | 2.3 | 4.9 | 2.3 | 6.5 |
| Sept. | 1 | 2.4 | 5.3 | 2.3 | 4.7 |
| | 7 | 3.0 | 4.9 | 3.0 | 4.7 |




Appendix III Macrophyte and zooplankton sampling by sector.