Rice and Sturgeon Lakes Nutrient Budget Study

Sediment Pigment Stratigraphy as Evidence of Long Term Changes in Primary Productivity of Sturgeon and Rice Lakes

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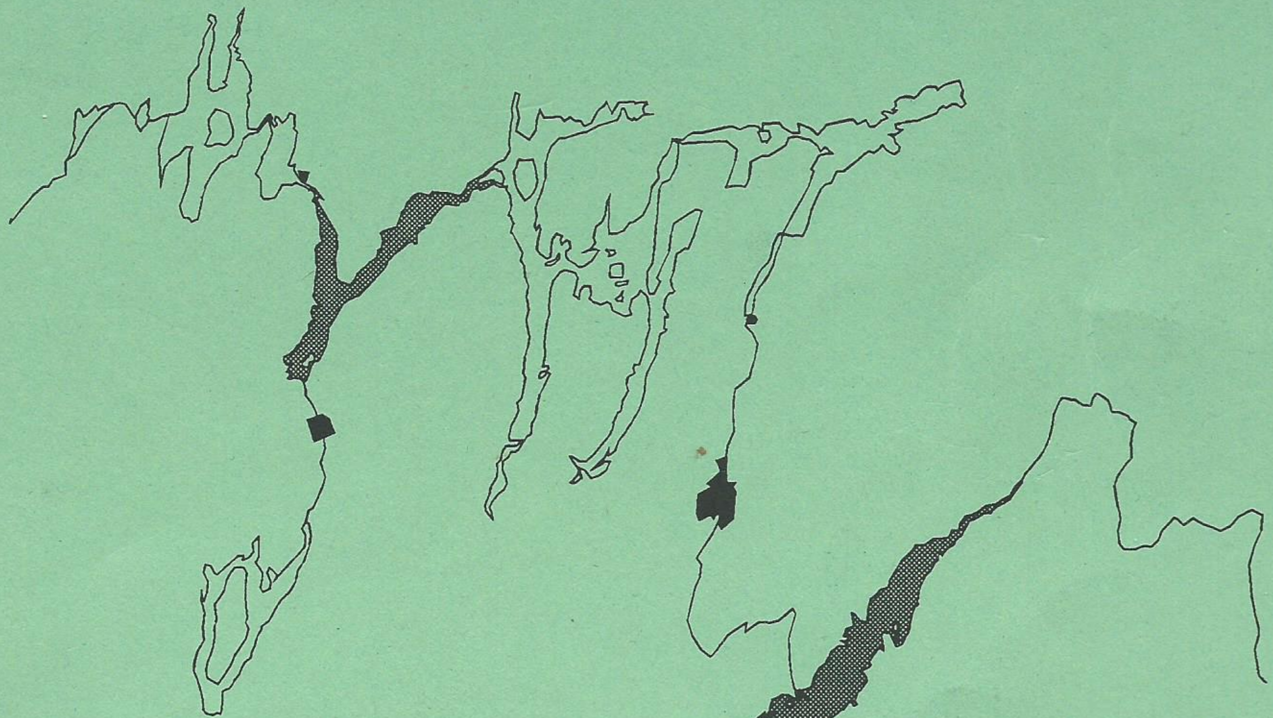

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SEDIMENT PIGMENT STRATIGRAPHY AS EVIDENCE OF LONG TERM CHANGES IN PRIMARY PRODUCTIVITY OF STURGEON AND RICE LAKES

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PREFACE

The Kawartha lakes are a large and economically important system of eight large lakes which are located in central Ontario. Sturgeon Lake and Rice Lake are located near the upper and lower ends of the Kawartha Lakes system respectively and both support significant amounts of urban and recreational development. They were chosen for detailed study because of their importance within the system and because both have shown the symptoms associated with excessive nutrient input for several years.

The Rice and Sturgeon Lakes Nutrient Budget Study was initiated to investigate linkages between point and non-point sources of nutrients, water quality, and aquatic life within the lakes and to estimate the impacts of these processes on in-lake water quality.

The study was supervised by the Rice - Sturgeon Lakes Nutrient Budget Technical Committee which had representatives from the Limnology Section (Water Resources Branch) and Central Region of the Ontario Ministry of the Environment and Energy, the Trent Severn Waterway (Environment Canada) and the Kawartha Lakes Fisheries Assessment Unit of the Ontario Ministry of Natural Resources.

This is one of a series of technical reports. These and the summary report (R/S Tech. Rep. No. 13) will provide a technical basis for the management of the Rice Lake and Sturgeon Lake ecosystems and for the use of land and water resources in the Kawartha Lakes region in general. A list of all reports in the R/S Tech. Rep. series is as follows:

1. Hutchinson N.J., B.J. Clark,, J.R. Munro and B.P. Neary 1993. Hydrological data for the watersheds of Rice Lake and Sturgeon Lake.1986 - 1989, 100 pp.

2. Hutchinson N.J., J.R. Munro, B.J. Clark and B.P. Neary. 1993. Water chemistry data for Rice Lake, Sturgeon Lake and their respective catchments. 1986-1989, 169 pp.

3. Hutchinson N.J., B.P. Neary, B.J. Clark and J.R. Munro 1993. Nutrient Budget data for the watersheds of Rice Lake and Sturgeon Lake. 120 pp.

4. Ryback, M. and I. Rybak. 1993. Sediment pigment stratigraphy as evidence of long term changes in primary productivity of Sturgeon and Rice Lakes (Kawartha Lakes). 24 pp.

5. Nicholls, K.H., M.F.P. Michalski and W. Gibson. 1993. Trophic interactions in Rice Lake I: An experimental demonstration of effects on water quality.

6. Limnos Ltd. 1993. Partitioning of phosphorus in *Potamogeton crispus*. 22 pp.

7. Limnos Ltd. 1993. Rice Lake macrophytes: distribution, composition, biomass, tissue nutrient content and ecological significance. 123 pp.

8. Beak Consultants Ltd. 1993. Release of phosphorus from Rice Lake sediments. 31 pp .

9. Limnos Ltd., Michael Michalski Associates and D.J. McQueen. 1993. Trophic interactions in Rice Lake II. Young-of-the-year yellow perch - *Daphnia* interactions, preliminary findings. 101 pp.

10. Badgery, J.E., D.J. McQueen, K.H. Nicholls and P.R.H. Schaap. 1993. Trophic interactions in Rice Lake III: Potential for biomanipulation. 1988 and 1989 .

11. Standke, S. 1993. The zooplankton of Rice Lake and Sturgeon Lakes, 1986-1988, Kawartha Lakes, Ontario .

12. Nicholls, K.H. 1993. The phytoplankton- water quality relationships of the Kawartha Lakes, 1972-1989.

13. Hutchinson, N.J., K.H. Nicholls and S.H. Maude, 1993. Rice and Sturgeon Lake Nutrient Budget Study: Summary and recommendations.

DISCLAIMER

This report was prepared for the Ontario Ministry of Environment and Energy as part of the Rice and Sturgeon Lakes Nutrient Budget Study. The views and ideas expressed in this report are those of the authors and do not necessarily reflect the views and policies of the Ontario Ministry of Environment and Energy. The mention of trade names and products does not constitute endorsement or recommendation of their use.

ABSTRACT

Some aspects of the limnological histories of Rice Lake and Sturgeon Lake were reconstructed through a detailed analysis of fossil pigments. Sediment deposition rates in Rice Lake and Sturgeon Lake increased from about 10 $mg/dm^2/year$ in the early 1900's to about 60 $mg/dm^2/year$ during the 1980's in both lakes. The blue-green algal pigment oscillaxanthin has increased over time in the sediments of both lakes reflecting the apparently increasing dominant role of blue-green algae with nutrient enrichment over time. The stratigraphic sequence of chlorophyll derivatives to total chlorophyll ratios suggests that the proliferation of macrophytes was also an important component of the eutrophication process in both lakes.

RESEARCH REPORT

prepared for

ONTARIO MINISTRY OF THE ENVIRONMENT
(K.H. Nicholls, Aquatic Biological Section)

July, 1987

INTRODUCTION

Many lakes are undergoing accelerated aging (eutrophication) due to man's activities. The resultant problems (prolific weed growth, nuisance algal blooms, deteriorating fisheries, impaired water quality, and sediment infilling) may pose a serious threat to the utilization of these lakes.

The Kawartha Lakes are an important recreational area in Southern Ontario. Two large lakes in the system, Rice and Sturgeon Lakes have been eutrophic for several decades. Nutrient enrichment is influenced directly by discharges of effluent from municipal sewage treatment plants at Peterborough (Rice Lake) and Lindsay (Sturgeon Lake) (Ontario Ministry of the Environment, 1976).

Concern for water quality conditions in Sturgeon Lake began at least as early as 1948 - 1951. At that time several deaths of animals as a result of drinking water contaminated with toxins associated with blue-green algae have been reported. Investigation by the Ontario Ministry of the Environment (1976) revealed that the phytoplankton communities of Sturgeon and Rice Lakes were dominated by the blue-green algae <u>Anabaena</u> spp. <u>Aphanizomenon</u> spp. and <u>Microcystsis</u> spp. At present, blooms of these algae are still a common occurrence in the Kawartha Lake System.

As a result, this paleolimnological study was initiated to address specific questions about the trophic development of Rice and Sturgeon Lakes: (1) could the record of changes in blue-green algal populations be interpreted from pigments preserved in lake sediments, (2) had productivity changed recently, (3) had the hypolimnetic regime been different in the past (4) could evidence of the past changes in water quality be dated using the Pb-210 radionuclide method?

In this study some aspects of the limnological history of Rice and Sturgeon lakes are reconstructed through a detailed fossil pigments analysis. The development of blue-green algae was traced through myxoxanthophyll, and abundance of Oscillatoria was estimated using oscillaxanthin, a pigment unique to the Oscillatoriacea (e.g. Giriffiths at al. 1968; Zullig, 1961, 1985; Rybak, 1986, Rybak & Dickman, 1987). The Pb-210 radionuclide technique was attempted for reconstruction of the sediment chronology.

MATERIALS AND METHODS

The research was carried out on Rice and Sturgeon Lakes, Ontario. The sediment coring was conducted at Rice Lake in July 1986 (Fig. 1) and at Sturgeon Lake (Fig. 2) in October 1986. Sediment was extruded upward from the core tube and sectioned into 1.0 cm increments.

Pigments were extracted from a subsample of 1 cc of sediment in aqueous 90 % acetone. Chlorophyll derivatives were measured at 665 nm and expressed as absorbance per gram of organic matter, where one unit is equal to an absorbance of 1.0 in a 10 cm cell when dissolved in 100 ml solvent (standard pigment unit). Carotenoids were analysed by solvent sorption with the saponification method (Rybak & Rybak, 1985 b), determined by measuring absorbance at 448 nm and expressed in the same unit as for chlorophylls.

Oscillaxanthin and myxoxanthophyll were determined by solvent sorption. Calculation of these pigments was based on the trichromatic method which mathematicaly separates and quantifies oscillaxanthin, myxoxanthophyll and the contaminating phorbins (Swain, 1985). The concentration of each pigment in the sediment was expressed as ug pigment per gram of organic matter.

For each sediment sample, dry weight and organic content were determined from weight loss on ignition.