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WATER RESEARCH IN NOVA SCOTIA IN THE EARLY SEVENTIES – A PERSONAL PERSPECTIVE

JOHN C.O'C. YOUNG*

Department of Chemistry, Saint Mary's University
Halifax, NS B3H 3C3

PREAMBLE

Late in the Fall of 1969, I resigned from my position as a senior research chemical engineer with a US oil company and drove my brand new, yellow Barracuda convertible (Fig 1) from Staten Island, New York up to Halifax, Nova Scotia, where I had decided to reside.

At that time, employment opportunities for a person with my academic background and industrial research experience were distinctly limited in Halifax. However, through the good offices of Dr. William Bridgeo, the Dean of Science of Saint Mary's University (SMU), I obtained a part-time appointment as a computerization advisor to the University President, Dr. Henry Labelle, S.J., in January, 1970.

My subsequent computerization experiences after being made an associate professor in the university's Chemistry Department in 1972, and promoted to full professor in 1980, have been reported elsewhere (Young 2025).

What follows here are recollections of my early water related research experiences while at SMU in 1970-73.



Fig 1 The Barracuda.

* Author to whom correspondence should be addressed: john.young@smu.ca

WATER STUDY 1970

Introduction

In 1965, the Government of Nova Scotia decided to assume responsibility for treating the effluent from what was then the Scott (Maritimes) Pulp Limited mill. Its Boat Harbour effluent "treatment" facility represented a potential health hazard for a neighbouring indigenous First Nations community.

Shortly after my arrival at SMU in 1970, the Provincial Minister responsible for the Water Act offered me a contract to assess this situation and make recommendations for its amelioration.

Site Visitations and Recommendations

After carrying out a number of onsite surveys and water quality analyses, I reported back in December 1970 that the lignin and cooking liquor content of the effluent stream delivered into Boat Harbour was high by normal industry Kraft process delignification standards. I proposed a number of measures initially aimed at reducing this pollution problem by up to 50%.

Illustrated in Fig 2 is one of these measures. The installation of an array of aerators to reduce chemical oxygen demand was implemented.

This measure proved inadequate, given the increasing organic loading of the effluent stream. That led to the buildup of a layer of lignin rich solids at the bottom of Boat Harbour. The use of this ineffective effluent



Fig 2 The Boat Harbor effluent aeration system.

treatment system was abandoned when the mill was finally closed down in 2020. Unfortunately, the harbour remains contaminated and is unlikely to be cleaned up.

WATER STUDY 1971

Introduction

As part of my teaching responsibilities I regularly planned and delivered a section of the chemistry department's first year, inorganic chemistry course and its associated laboratory section.

This gave me regular opportunities to recruit promising first year students and provide them with employment and early research experience in my research program in the following summer, beginning in 1971. In that summer, chemistry students Paul MacGillivray, Richard Martin, Glen Roger, Vipin Segal and Ralph Wasson, biology student James Baker and geology Diane Gregory joined my research group. Aided by graduate chemistry assistant Vaughan Munroe, these students carried out several environmental water quality analysis studies.

A Water Supply Manganese Contamination Problem

With a grant from the Inland Waters Branch of Environment Canada, I was asked to investigate a problem of manganese contamination of the municipal water supply of the City of Dartmouth. The incoming lake water contained soluble colourless manganous ions that precipitated out as coloured manganic oxide solids when oxidized by chlorine in the municipal water treatment plant:

$$\underset{\textit{colorless}}{Mn2+(aq)} + 2H2O(l) + Cl2(aq) = \underset{\textit{brown}}{MnO2(s)} + 4H+(aq) + 2Cl\text{-}(aq)$$

Small quantities of this gelatinous brown insoluble compound deposited and gradually accumulated on internal surfaces of the water treatment plant and distribution pipelines. Periodically, these brown deposits detached into the water flow through the plant and found their way into the domestic water supply where they settled on garments in domestic washing machines, resulting in the mayor receiving telephone calls.

The Dartmouth City Water Supply System

In 1971, the Dartmouth city water supply originated in Lake Major from which it was pumped through a pipeline into an embayment



Fig 3 Water flow into the Lake Topsail embayment.

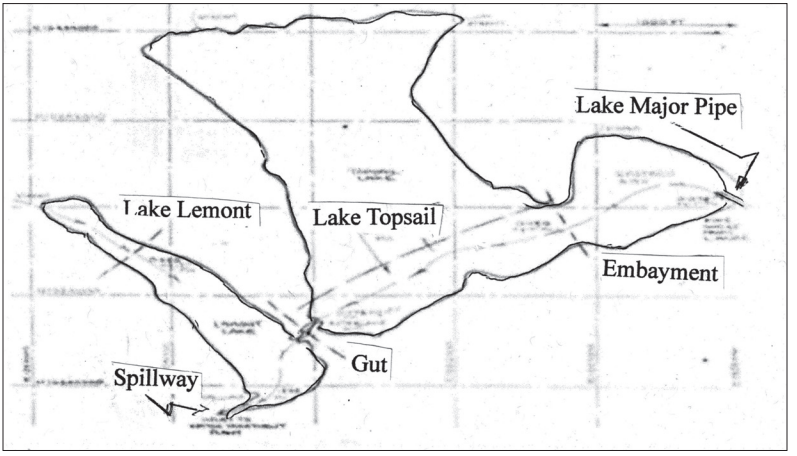


Fig 4 Water flow path through the lake system.

in the eastern shore of Lake Topsail, illustrated in Fig 3. From this point, the water supply flowed through Lake Topsail to the municipal water treatment plant on the western shore of Lake Lemont, shown on the map in Fig 4.

Site Inspection Tour

Our site inspection tour began at the water treatment plant on the western shore of Lake Lemont where the water over-flow at the plant spillway appeared to be clear of suspended solids and colourless.

Paddling eastward by inflatable canoes, we observed a light lignin coloration but no suspended solids in the water flow through the narrow gut that joined Lake Lemont to Lake Topsail. This suggested to us that the insoluble brown manganic compound found downstream on laundry was present in the streamflow through the lake system in the form of soluble, virtually colorless, manganous ions.

Continuing upstream, we reached the eastern end of Lake Topsail where the system water supply from Lake Major discharged from the pipeline into the Lake Topsail embayment illustrated in Figs 3 and 4. Actually, the pump was not turned on during our one month site visit.

In this embayment, we observed a submerged deposit of solids in the immediate vicinity of the outlet of the pipeline. Poking it with a stick, we found that this deposit was composed of a readily disturbed layer of fine solids more than a meter thick and on a firm base.

The location and nature of this deposit suggested that it was likely formed from solid particles transported in the water through the pipeline from Lake Major. The particles then settled out in the vicinity of its outlet in Lake Topsail which served as a solids settling pond. We were told that the water supply exiting from the pipeline was often observed to be laden with silt.

We surmised (i) that small solid particles containing a concentration of an insoluble manganic manganese compound were conveyed through the water delivery pipeline from Lake Major and deposited in the Lake Topsail embayment; (ii) that the insoluble manganic constituent of these particles was gradually reduced to soluble manganous ions by reaction with decomposing organic matter in the deposited silt layer; (iii) that these manganous ions migrated upwards in the interstitial water column in the silt layer and out into the overhead streamflow and through the lake system to the water treatment plant; (iv) that at the treatment plant, the ions were oxidized by chlorine gas forming insoluble manganic oxide molecules; (v) that a gradual buildup of theses solids occurred on the walls of the water supply distribution pipework system; and (vi) that after a certain amount of thickneking, this solids layer collapsed, sending a pulse of virtually pure gelatinous brown manganic chloride forward to stain the laundry.

This reaction pathway would explain how manganese embedded in solids in Lake Major became virtually pure insoluble manganic chloride, with likely a certain amount of ferric chloride occurring downstream of the treatment plant.

During our onsite visit of approximately one month, the Lake Major water delivery pump to the Lake Topsail embayment was never turned on.

In this period, upward diffusion of manganous ions through the interstitial water phase should have led to a greater decrease in their concentration at the top of the silt layer than at its bottom.

Manganous Ion Concentration Determination

After our initial visit to the Lake Topsail embayment, we returned to it with a hammer and a one meter length of a plastic pipe and two rubber bungs. We hammered the pipe down into the silt bank to obtain a vertical sample, removed the pipe and closed its ends with the rubber bungs.

Back in the lab, we cut the silt filled pipe into a set of short lengths and temporarily closed their ends with rubber bungs. Removing the rubber bungs, we spooned the silt contents of each pipe section in turn into a vacuum filtration system and separated its water and solids contents. We then carried out atomic absorption analyses for manganese concentrations in the water samples.

I have been unable to track down the lab book in which these analytical data were recorded. However, I do recall that there was approximately a tenfold decrease in the manganous ion concentration in the water phase, from the one meter depth in the silt layer up to its surface.

To check our assumption that the inflow from Lake Major contained significant amounts of manganic manganese in its suspended solid particle phase, we had hoped to take water samples at the pipeline outlet and filter and analyze the two phases for their manganese contents. Unfortunately, we were unable to visit the Lake Major site and the pump was never turned on during the time of our study of the Lake Topsail embayment.

Summarizing

In our final project report (now lost), we proposed a plausible reaction path that merited further investigation. Insoluble manganic manganese dispersed in a suspension of solid mineral particles delivered from Lake Major became a solution of manganous manganese in Lake Topsail and a suspension of virtually pure, insoluble manganic oxide occurred following chlorination in the treatment plant on the shores of Lake Lemont. We recommended further study of the silt deposit in Lake Topsail and an investigation of the practicality of extending

the inlet section of the Lake Major pumping station pipeline back to a location at which less silt would be picked up when the pump was turned on. Unfortunately, we had no opportunity to inspect this part of the treatment system.

My students had an enjoyable early summer employment experience transversing the lakes gathering and analyzing water samples. Swimming was not permitted in the water supply lakes.

Perhaps there is a rich manganese ore deposit somewhere in the watershed area of Lake Major, possibly detectable by an unnaturally high ratio of dissolved manganese to iron concentrations in the flow of an influent stream.

Footnote

The Lake Lemont water supply plant was decommissioned in the early 2000's. It was replaced by a new water supply plant installed on the shore of Lake Major adjacent to the pumping station that had previously served to deliver the water supply to Lake Topsail.

In the new water supply plant, chemical treatment of the raw water supply from Lake Major includes solidification of a small dissolved manganous ion content by oxidation with chlorine gas, followed by filtration of it and any suspended manganic manganese solids in the raw water supply. The raw water manganese content has been trending downward over the past ten years and averaged 31μ g^{-1} in 2024-25; the average treated water level was 2 μ g^{-1} in that year. (Edge 2025).

A River Water Quality Study

The second project that we carried out during the summer of 1971 for the Inland Waters Branch of Environment Canada involved a spot survey of river and estuarine water quality throughout mainland Nova Scotia. This required many trips in the barracuda convertible that could accommodate four student passengers and sometimes considerably more with the top down.

The objective of this survey was to take and analyze a few water samples from as many locations as possible, not to characterize them based on a limited amount of data but rather to pick out a sample of locations that might merit more detailed study. However, we did make a slightly more detailed assessments of a few locations.

We collected and analyzed approximately 250 water samples for temperature, dissolved oxygen concentration, pH value, colour, turbidity, alkalinity, conductance, hardness, phosphate concentration,

total and nitrate nitrogen, chemical oxygen demand, mercury, copper and zinc and a few of them for coliform count. Geology student Diane Gregory organized and ran the computerized data logging and analysis program. Biology student James Baker performed the coliform tests while field sampling and physical and chemical analyses were carried out by chemistry students Paul MacGillivray, Rick Martin, Glen Roger, Vipin Segal and Ralph Wasson. I did most of the driving and some of the sample collection.

Our Test Results

Our water sample analysis test indicated that the Salmon River in Truro and the Cornwallis River in Kentville were relatively heavily polluted. The Gaspereau River near Wolfville showed a progressive increase in total nitrogen concentration as it meandered through farmland down to its estuary. We noted a general pickup in pollution levels of the Little River as it passed through Sackville and a particularly high total nitrogen level in the vicinity of the trailer park. The Sackville River also showed a jump in its phosphate content after it was joined by the relatively phosphate rich waters of the Little River. The Sackville River showed increasing nitrogen and phosphate levels as it progressed through Bedford. On a more positive note the Annapolis River appeared to be relatively unpolluted.

Footnote

It should be noted that the above observations were based on a limited amount of data, collected for the most part on single occasions. The purpose of this study was to identify and suggest sites for more detailed subsequent study.

OYSTERS IN 1972 AND 1973

Introduction

In 1972 and 1973 I was awarded contracts by the Cape Breton Development Corporation (DEVCO) to carry out studies in support of an initiative to increase oyster culture activity on the Island through its affiliate, Cape Breton Primary Production Limited (CBPPL).

CBPPL staff wanted to know whether the meat of their oysters was accumulating increasing concentrations of heavy metals during their period of growth.

Heavy Metals Analysis

To tackle this problem, we set up a field analytical laboratory in an abandoned bowling alley conveniently located behind Wong's Chinese Restaurant in Baddeck, Cape Breton Island.

In this lab, chemistry students MacDonald and Mader and biology students Lewis and Liu shucked an oyster collection of a range of sizes. After determining their wet and dry weights, they dissolved the meat of the oysters in concentrated nitric acid in glass vials. These samples were shipped back to an SMU analytical lab in Halifax for analysis of heavy metals.

Atomic absorption analyses for various trace metals, but mostly for ion, copper and zinc, were carried out by chemistry students Gay, Lamb and Ling, with general guidance from laboratory assistants Creamer and Munroe.

The relationship between iron content and moist oyster meat weight (Fig 5) indicated that the concentration of iron remained constant as oyster meat weight increased from close to zero to 8 grams. That iron concentration did not increase with growth of the oyster meats was also observed in the case of copper and zinc.

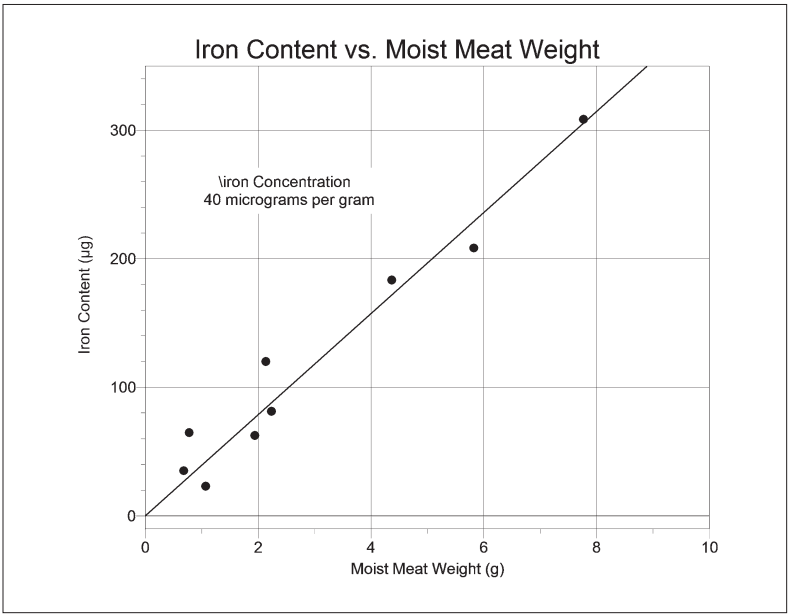


Fig 5 Iron content versus moist oyster meat weight.

A Second Task

CBPPL staff told us that they had observed that oysters grew faster in phytoplankton rich locations and asked us to investigate this relationship.

The Stages of Oyster Growth

Oysters reproduce by releasing eggs and sperm into the water, the fertilized eggs developing into embryos and eventually hatching as free swimming larvae. After a short period, the larvae attach themselves to some solid surface where they become known as spat.

The local oyster farming practice in Cape Breton included making spat collectors. These consisted of a number of scallop shells strung on a string separated by short plastic tube spacers. Illustrated in Fig 6, sets of these strings were hung from rafts that were located above natural oyster beds before spat fall, followed by waiting for nature to take its course.

The subsequent spat growth stage typically takes up to two years. Medcof (1962) described an example of this stage in which spat catching shell strings were set out in July 1960, a few days before spat fall. By November 1960, the spats had grown to an average size of ½ inch,

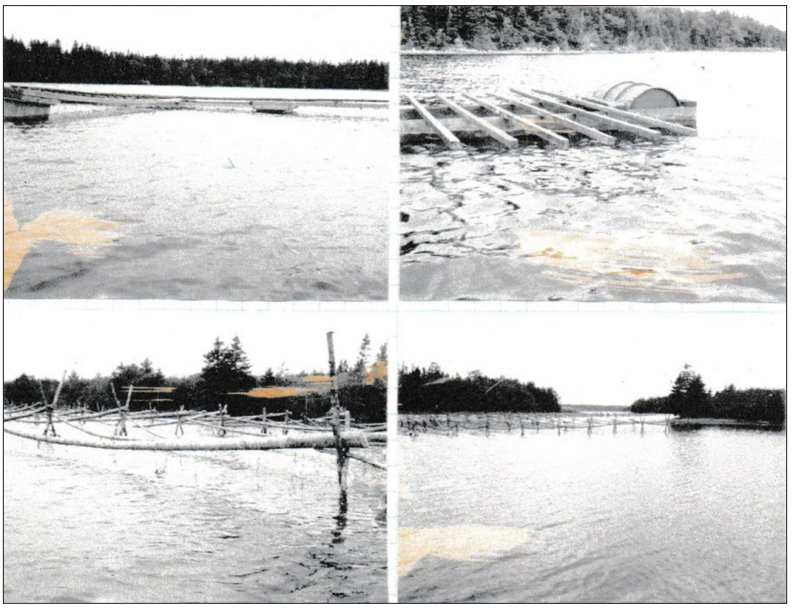


Fig 6 Anchored and moored spat collection setups, Gillis Cove.

with some as large as ¾ inch. By the following November, they had grown to a bedding size of 1½ to 2 inches.

Oyster Growth and the Role of Phytoplankton

Oysters are filter feeders and their primary source of nutrition is phytoplankton. Phytoplankton content levels are commonly determined by fluorometric absorbance analysis of their chlorophyll-a concentration.

Setting Up to Measure Chlorophyll-a

We fitted a high sensitivity door to our laboratory Model III Turner fluorometer (Undated) and followed the fluorometric analytical procedure recommended by Strickland and Parsons (1962) for determining chlorophyll-a concentration as a measure of phytoplankton content.

The Experimental Setup

We arranged for a set of spat collector strings from one particular site to be removed and set up singly at a number of other oyster growing sites and to collect water samples at these sites for chlorophyll analysis. Taken from the same source site, the initial size of the spat was assumed to be the same on the individual test strings.

Finally, before we packed up for the summer, we arranged for our test set of spat strings to be picked up and delivered to our lab in Baddeck. There, we laid them out side by side and tried to arrange them in ascending order of spat size.

Experimental Findings

The range of chlorophyll concentration values observed from the water samples collected at the individual string setup sites at the start of the test period was tenfold but quite small. The subsequent period during which the spats grew on their test strings in the different chlorophyll concentrations was only about two months.

Despite the limitations of the test procedure, the plot of chlorophyll-a site concentration versus spat growth ranking in Fig 7 does show a modest uptrend.

Monitoring Oyster Growth

The progress of oyster growth in the bedding stage is commonly followed by visual inspection or occasionally by weighing selected oysters. It occurred to us that volume is preferable to weight as the parameter for following growth because it is more closely related to the volume contained by the shell halves and therefore the size of the oyster meat.

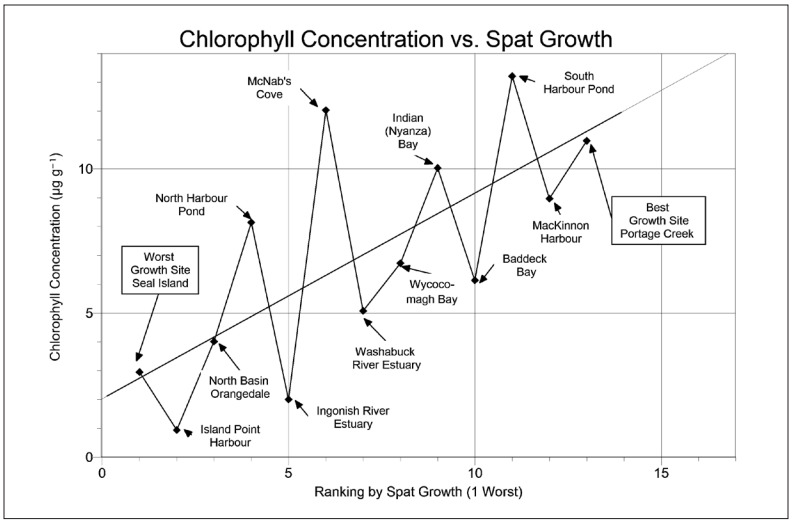


Fig 7 Chlorophyll-a concentration vs. oyster growth.

The problem of accurately determining the volume of an irregularly shaped object denser than water such as an oyster was solved by Archimedes of Syracuse. Archimedes principle states that when an object is immersed in a fluid, it will experience a buoyancy force equal to the weight of the fluid that it displaces.

If an oyster of volume v shows a weight of ρgv in a vacuum, it will show a weight values of $w_{air} = \rho gv - \rho_{air} gv$ in air and $w_{water} = \rho gv - \rho_{water} gv$ in water, from which the volume of the oyster can be calculated:

$$v = (w_{air} - w_{water}) / (\rho_{water} - \rho_{air})g$$
$$\approx (w_{air} - w_{water}) / \rho_{water} g \text{ since } \rho_{air} <<< \rho_{water}$$
$$\approx (w_{air} - w_{water}) \text{ cm}^3 \text{ since } \rho_{water} g \approx 1 \text{ g cm}^3 \text{ in cgs units}$$

With these approximations, the volume of an oyster in cubic centimeters is numerically equal to the difference between its weight in grams in air and when it is immersed in water.

In our oyster volume measuring setup shown in Fig 8, we required a top loading balance, a beaker of water placed on a bridge over the balance pan so that its weight would not be recorded, a deformed wire coat hanger placed on the balance pan so that its weight and anything attached to it would be recorded, some string and some adhesive tape or a metal clip to suspend the oyster specimen from a string attached to the coat hanger, and of course, an oyster.

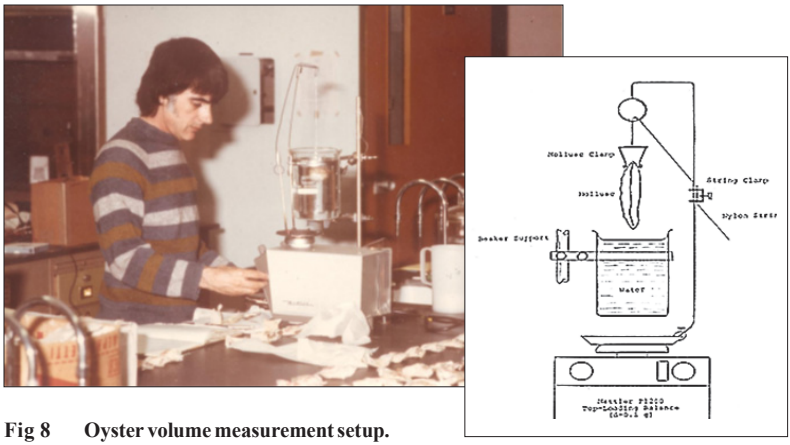


Fig 8 Oyster volume measurement setup.

Small oysters were attached to the string by a metal clip and their volumes were determined from the relationship

$$v = (w_{air} - w_{water}) - (w_{clip,\ air} - w_{clip,\ water})\ cm^3$$

Larger oysters were taped to the string and their volumes were determined from the relationship v = (wair – wwater) cm^3 when each oyster was weighed in air and then lowered to be weighed in water.

Shown in Fig 9, John MacDonald and I made many boat trips during the summer of 1972 to gather water and oyster samples for chemical analysis. We eventually sized and analyzed several hundred oysters from about a dozen bedding site locations.



Fig 9 John McDonald and John Young off on a water and oyster sampling run.

Hardships

I remember two hardships of this project - firstly of overnight sleeping on inflated rubber mattresses on the concrete floor of the bowling alley, and secondly, that Baddeck was “dry” at the time. This meant a trip across the Island in the Barracuda to St. Peter’s to have a beer.

Final 1992 Report

In my 1972 report of our activities to CBPPL, I referred to the recognized desirability of bedding oysters at sites rich in phytoplankton located by chlorophyll-a concentration determination. The suggestion was made that we might be able to develop an automated procedure for mapping such sites.

OYSTERS IN 1973

Setting Up the Fluorescence Recording System

In the summer of 1973, we returned to the Island with, amongst other things, a marine battery, a dc powered pump, a dc-to-ac inverter, a strip chart recorder and a filter fluorometer fitted with a flow-through door. All of this (Fig 10) was assembled on the stern of a Cape Island fishing boat so as to pump lake water through the fluorometer and continuously measure the fluorescence of the chlorophyll-a concentration, representing its phytoplankton content.

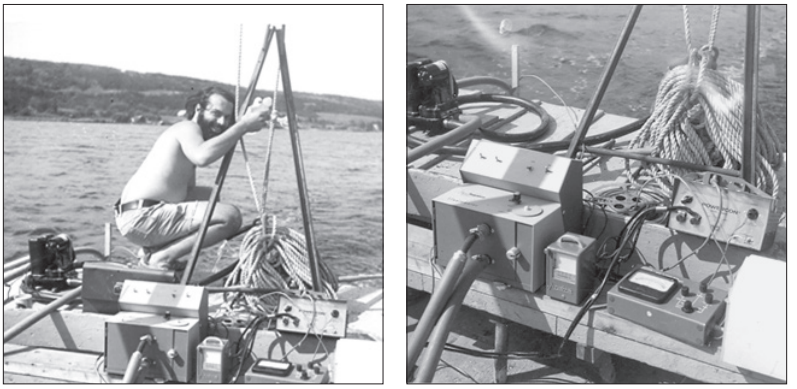


Fig 10 The setup including student John MacDonald. A Chlorophyll-a, Fluorescence Survey.

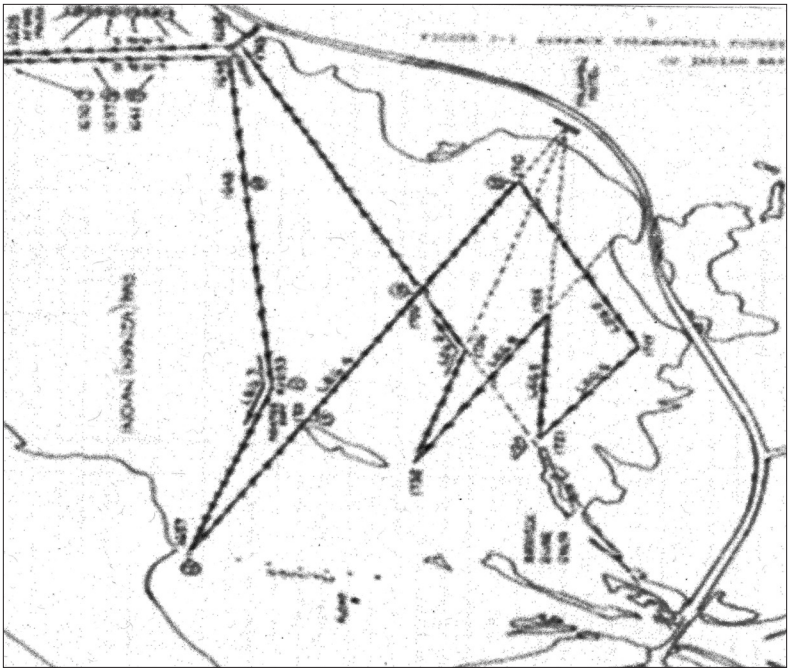


Fig 11 Mapping traverses across Indian Bay.

A Chlorophyll-a Fluorescence Survey

Shown in Fig 11, the fisherman owner piloted his Caper backwards and forwards across the waters of Indian Bay near Baddeck, recording its location at regular time intervals.

Meanwhile, John (M) and I nervously watched the corresponding chart recorder plot of chlorophyll-a concentration fluorescence which for the most part flat lined in the first data sample section shown in Fig 12 which was obtained as we traversed open water approaching the shoreline.

The second section of the data plot (Fig 12) as we travelled along close to the shoreline showed repeated indications of the presence of phytoplankton, particularly towards the right side as we passed for about three minutes over a submerged vegetation bed.in water too shallow to hang spat strings. Evidence of the presence of phytoplankton ceased as we turned back into open water as shown in the third section of the graph (Fig 12).

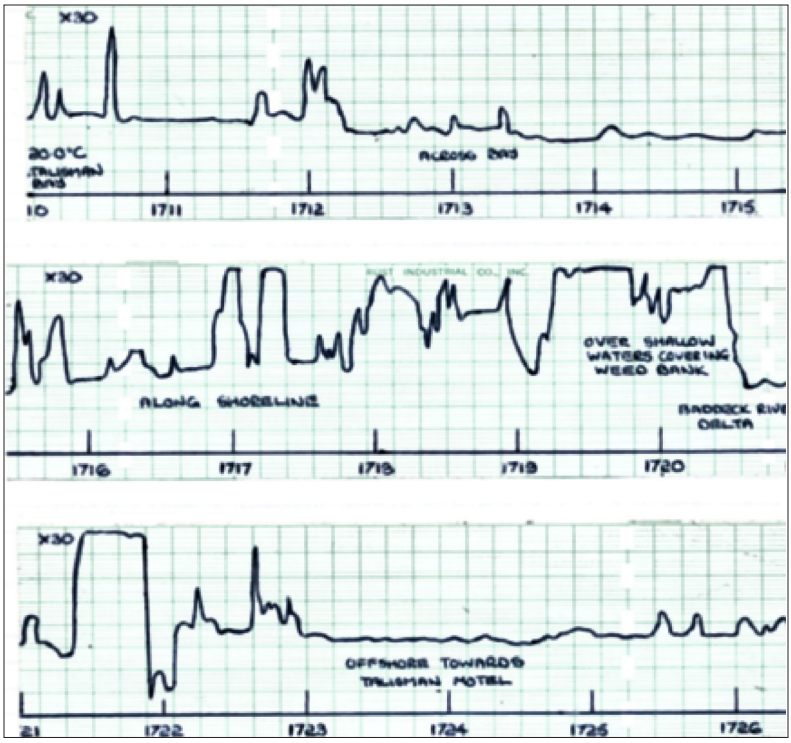


Fig12 Sample plot of the fluorometer reading.

From an aquaculture perspective, this test was unsuccessful because we failed to locate a phytoplankton rich site suitable for hanging strings or bedding oysters. However, operationally it was successful because we demonstrated the location of a patch of phytoplankton growth *in vivo* based on optical measurements of the absorbance of its chlorophyll a content.

We would have liked to carry out tests at other sites but the boat and its skipper were only available to us over a two day period, the first day of which was spent installing and testing the monitoring system. Upon completing our 1993 activity, my students made a study of mussel culture in Cape Breton.

REFERENCES

Edge, M. (2025). Personal communication. G.K. Turner Associates, Palo Alto. California, 94303, USA.

Medcof, J.C. (1962). "Collecting Spat and Producing Bedding Oysters on Shell Strings," Fisheries Research Board of Canada, General Series No. 38, July 1962.

Strickland, J.D.H. & Parsons, T.R. (1962). "A Practical Handbook of Seawater Analysis," Fisheries Research Board of Canada, Bulletin 167, Ottawa, 1962, p. 205-206.

Young, J.C.O'C. (2025). "Chemistry and Computers," *Proceedings of the Nova Scotian Institute of Science* 54(1): 23-35.